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BARLEY IN THE GREAT PLAINS AREA: RELATION OF CULTURAL METHODS TO PRODUCTION.

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INTRODUCTION.

In this bulletin are given the data obtained from different methods of seed-bed preparation for barley and a study of the cost of production under each of the various methods. Investigations have been

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The following-named men have held positions on the scientific staff of the Office of Dry-Land Agriculture during the past nine years, but have resigned or have been transferred to other offices of the Department of Agriculture: Sylvester Balz, F. L. Kennard, J. E. Payne, L. E. Hazen, C. A. Jensen, H. R. Reed, W. O. Whitcomb, C. H. Plath, F. Knorr, and R. W. Edwards.

The data here reported from the stations in Kansas, Nebraska, North Dakota, and Montana have been obtained in cooperation with the agricultural experiment stations of their respective States. In South Dakota, Colorado, Texas, Oklahoma, and New Mexico the stations are operated by the United States Department of Agriculture.

Field, office, and laboratory facilities, teams, and implements have been provided by the Office of Western Irrigation Agriculture, at Huntley, Mont., Belle Fourche, S. Dak., and Mitchell, Nebr., and by the Office of Cereal Investigations at Amarillo, Tex., and Archer, Wyo. The Biophysical Laboratory has cooperated in obtaining the meteorological data reported.

Note.—This bulletin is intended for all who are interested in the agricultural possibilities of the Great Plains area.

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conducted at fourteen different stations in the Great Plains area. Barley has been grown to a minor extent in the rotations at all stations, although it has not been considered as important a crop as either wheat or oats.

At some of the stations the work has been continuous for eight years; at other stations it has been but recently started. The results of the first year's work at any station are not used, as the land is uniform in preparation for all plats. From the stations having the longer records the results are the most valuable, since they include a greater range of climatic conditions. Where a short record is given it can show only the effect of the different tillage methods under the particular combinations of climatic factors obtaining during that time. The crop on any series of plats having the same methods of tillage may behave quite differently under the combinations of climatic factors that may occur in succeeding years. The relative position assumed by the various methods in the first year's results may or may not be changed from that arrangement by subsequent work. It is certain, however, that the range of difference between the methods will vary with changing climatic factors. Wide differences in yields between methods that may be shown in a short record will tend to be narrowed as the length of the record is increased.

The method of work adopted was that of raising the standard crops of each station both in rotations and by different methods of preparation under systems of continuous cropping. In no case have rotations requiring more than six years been used. Those of even this length have been tried only when sod of tame-grass crops is included. More of the work has been done with 3-year and 4-year rotations.

In this bulletin are shown only the crop immediately preceding and the tillage involved in preparing the seed bed for barley. In the present stage of development of the work the effect of the immediately preceding crop and of the method of handling its stubble in preparing the seed bed greatly overshadows the effects of the rotations considered as units. Some of the rotations are calculated to conserve or to accumulate fertility and organic matter in the soil, while others may perhaps deplete it, but on the naturally fertile soils of the Plains such results are not strongly shown in the first years of treatment. The controllable factors that exert the greatest influence on production are the water supply, the physical condition of the seed bed, and a recognized, if not understood, effect of the immediately preceding crop. The crop of a single year brings the land back to so near uniformity in these factors that their probable residual effect is not great enough with the work in hand to introduce serious error into the study here made.

This bulletin, which deals with only one crop, does not afford any criterion by which to judge the agricultural possibilities of any sec-

tion of the region for other crops. The fact that the combination of soil and climatic conditions in certain sections is not favorable to the production of barley does not signify that such conditions will prove unfavorable to other crops.

IMPORTANCE OF BARLEY AS A GRAIN CROP.

In some sections of the region barley has not been considered strictly as a market crop, but rather as a feed crop. In certain parts of the Northwest it has been grown quite extensively as a market crop. The price is usually determined by the quality of the barley from a brewing standpoint, the demand being for a product that is uniform, well matured, and of good color. Certain sections of the dry-land regions afford opportunity to grow barley of good quality, especially in those years when conditions are favorable for the production of a good, plump berry. The dry weather, with the absence of dews, gives good conditions under which to harvest the crop without injury to quality or color. In the main, however, barley has been grown in the Great Plains as feed rather than as a market crop.

Barley has the advantage of requiring on the average a shorter growing season than either oats or wheat, and is, therefore, exposed for a shorter length of time to the unfavorable climatic conditions likely to occur. When seeded at approximately the same time as oats, it will ripen with or before the earliest oats. The variety of barley which is grown determines somewhat the length of the growing season, but the foregoing applies to the average barleys. Earliness of maturity may be of considerable importance in enabling a crop to escape drought.

AREA INCLUDED IN THESE INVESTIGATIONS.

The area included in these investigations covers a part of 10 States, viz, Montana, North Dakota, South Dakota, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, Texas, and New Mexico. It extends from the ninety-eighth meridian of longitude to the foothills of the Rocky Mountains and from the Canadian border to the thirty-second parallel.

The altitude varies from approximately 1,400 feet in the northeastern part of the area to 6,000 feet at Cheyenne, Wyo. These represent the highest and the lowest altitudes. The southern portion of the territory has a higher average altitude and higher average rainfall and a correspondingly higher rate of evaporation than the northern portion. The average annual precipitation at the various stations varies from about 15 to 21 inches.

Figure 1 shows the location of the various field stations within the area which, as outlined, is bounded on the west by the 5,000-foot contour and does not include Archer, Wyo.

CLIMATIC CONDITIONS.

The climate of the Great Plains has been classified as semiarid. It may be better to say that it is changeable, varying from season to season from almost humid to almost arid, with a relatively low mean annual precipitation. Years of relatively high precipitation may be followed by years of relatively low precipitation. Other climatic factors usually correspond to the rainfall. A year of relatively high rainfall will have a lower rate of evaporation and higher relative humidity than will be found in the unfavorable years.

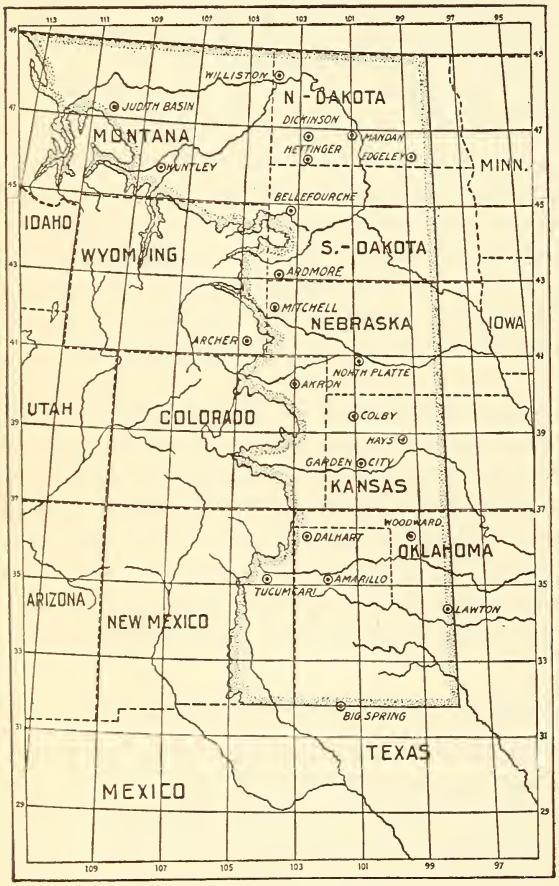

FIG. 1.—Sketch map of the Great Plains area, which includes parts of ten States and consists of about 400,000 square miles of territory. Its western boundary is indicated by the 5,000-foot contour. The location of each field station within the area is shown by a dot within a circle (⊙).

Another climatic factor of much importance in crop production on the Plains is the distribution of the rainfall, which within certain limits is more important than the total amount. A relatively low rainfall properly distributed may produce a crop where a much higher rainfall coming with unfavorable distribution may result in a crop failure, each starting with the same amount of available water in the soil. A vast difference in crop yields usually results from a soil that starts out in the spring with a small amount of stored moisture and one that is well supplied with moisture.

Space in this bulletin will not allow a full description or record of the climatic conditions at the various stations during the time covered by these investigations. These records are published by the United States Weather Bureau.

Seasonal variation in climatic factors is probably more important than difference in methods of tillage. This is shown by the fact that in some years climatic conditions at some stations are such that all methods result in failures. In other years all methods may give fair returns. At some stations the greatest actual increases in yield as a result of tillage methods is usually obtained under the most favorable climatic conditions. In Table I are given the maximum, minimum, and average annual and seasonal precipitation and seasonal evaporation. By seasonal is meant the time between the average seeding and the average harvesting dates. No attempt is made to show other climatic factors, though all are important.

TABLE I.—*Annual and seasonal precipitation and seasonal evaporation at fourteen stations in the Great Plains area.*[1]

Station.	Altitude (feet).[2]	Precipitation (inches).[3]						Seasonal evaporation (inches).[3]		
		Annual.			Seasonal.					
		Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.
Judith Basin	4,228	14.96	23.78	18.06	6.50	10.90	8.62	19.117	26.273	21.330
Huntley	3,000	11.92	11.92	11.92	5.00	7.35	6.18	19.820	20.594	20.207
Williston	1,875	10.28	18.99	14.84	5.62	12.00	8.31	21.104	28.269	24.705
Dickinson	2,543	11.93	21.22	16.69	5.31	16.27	10.06	18.379	27.366	22.377
Edgeley	1,468	11.94	21.95	16.71	5.08	15.73	9.60	17.664	25.362	20.657
Hettinger	2,253	12.72	15.68	14.20	8.82	12.89	10.69	20.111	24.248	22.430
Belle Fourche	2,950	6.64	17.73	13.11	1.92	12.75	6.82	23.627	33.906	27.220
Scottsbluff	3,950	13.77	18.51	16.14	5.56	8.26	7.11	24.698	26.647	25.718
North Platte	3,000	11.18	23.01	18.05	4.38	11.25	7.77	25.954	36.255	30.253
Akron	4,660	14.51	22.46	18.28	5.32	9.52	7.82	25.917	32.691	28.781
Hays	2,050	15.59	27.80	21.30	3.87	12.87	9.55	29.390	41.317	32.628
Garden City	2,900	11.82	23.58	18.54	5.01	8.16	6.85	33.315	38.926	35.332
Dalhart	4,000	13.69	16.35	15.11	4.54	14.86	8.17	33.381	41.002	38.596
Amarillo	3,676	10.69	27.80	18.28	5.03	11.49	7.05	32.305	40.704	36.709

[1] The years covered are the same as for the data shown in the other tables for each station.

[2] The altitude given is for the field where the work was done and is based in most cases on that of the nearest town.

[3] The record of annual precipitation for 1914 is not included. The records of seasonal precipitation and evaporation for 1914 are included for all stations, the evaporation being figured from Apr. 1 to July 31. The seasonal rainfall is the amount from Apr. 1 to July 31 for stations north of and including that at Belle Fourche. For stations south of Belle Fourche it is the amount between Mar. 1 and June 30. Evaporation measurements are made from a free water surface, in a tank sunk into the soil to almost its full depth. The water surface is kept about level with the surface of the ground.

GENERAL PLAN OF THE INVESTIGATIONS.

In the work at the various stations barley has been grown under a number of different tillage methods, but has not occupied as many plats as the other crops.

The same variety of barley has been grown on all the plats seeded to that crop at the same station during the same year. The aim has been to grow a variety adapted to the local conditions at the station where it has been grown. Different varieties have been grown at different stations. At some stations a 6-rowed barley has been used, some stations have used a 2-rowed barley, and some have used a hull-less variety. It is possible that in some cases the variety grown may

not have been the very best obtainable for that section, but by using the same variety in all of the methods under study uniformity in this factor has been obtained.

Uniformity in rate, time, and manner of seeding has been observed on all plats at the same station. There is naturally some variation between the different stations. Differences in climatic conditions have been recognized in differences in the rate of seeding, but at the same stations it has been uniform. The usual rate of seeding has been 6 pecks of hulled barley and 3 pecks of hull-less. Both the 6-rowed and the 2-rowed barleys are hulled varieties.

There is considerable variation in the time of seeding for the different field stations throughout the area, it being about a month earlier in the southern than in the northern portion. At some of the stations the time of seeding is about the same as that of wheat and oats. At others it is a little later. All seeding has been done with a drill. Some stations, on account of the type of soil, have used the press drill in order to firm the soil around the seed. At other stations a drill without a press attachment has been used.

For a comparative study of the effect of environment and for securing data on production, certain parts of the work are made uniform at all stations. This results in the attempted growth of barley and other crops in sections to which they are not adapted and in their growth at certain stations by methods not adapted to the conditions obtaining there.

Considering the fact that no two stations can have exactly the same combination of soil and climatic factors and that the combination resulting from any two seasons is not the same, it is evident that the consequent effects of the different tillage methods will not be the same. Therefore, the results obtained from different methods at each station are given separately.

In this bulletin a table divided into two parts is presented for each station. The first part shows the yields that have been obtained each year by each of the different methods under which barley has been grown, considering only the treatment during the one year immemediately preceding the crop. Where more than one plat has been grown under the same treatment for the previous year, only the average yield of the whole number of plats so grown is given. Column 2 shows the number of plats so averaged. In the presentation of yields, the column headed "Treatment and previous crop" indicates the method of preparation, whether fall plowed, spring plowed, listed, subsoiled, disked, green manured, or summer tilled. Some of these are again subdivided, to show the previous crop. In the last column, where the average appears under the heading "Average," the calculation is from the left. For a rough comparison of seasons, the bot-

tom line of the first half of the table gives the averages of all plats for each year, the average of the yearly average yields appearing in the last column to the right.

In the second part of the table for each station the yields are brought together to show the average yields by years for each method and the average yield for the entire period for each method. The computations of cost and profit are founded on the basic data shown in Tables II, III, and IV. The value of the average yields by each method is calculated. The last line of the table gives the average profit or loss resulting from the production of barley by the method stated at the head of the column. Loss is indicated by the minus sign. This study deals with only the one crop and does not take into consideration the relative profitableness of other crops or of all crops, considered as a whole, in the farming system.

Throughout the tables, where barley follows barley under any treatment, it is in a system of continuous cropping to barley by the method indicated.

The methods of operation have been similar at all stations. Fall plowing is done as early as practicable after harvest. It is done to a good depth, the standard being set at 8 inches. Ground may be either worked down or left rough over winter. Where barley follows barley after spring plowing, the stubble is undisturbed until spring, when it is plowed shallow, usually to a depth of 4 inches, and given a minimum of cultivation, which usually consists of one or two harrowings. In those cases where an additional plat appears under the heading "Spring plowed," it is plowed deep instead of shallow.

Under the subhead "Listed" there is shown at some stations the yield from one plat continuously cropped to barley. Instead of plowing this plat, it is furrowed out with a lister at the time of fall plowing. It is cultivated down level by seeding time.

Under the subhead "Subsoiled" there is shown at the stations where it has been tried the results of a plat continuously cropped to barley. At the time of plowing, a subsoil plow is run in the bottom of the furrow, usually loosening the soil to a total depth of about 14 inches. The variation from this depth is hardly more than 2 inches either way. In general, subsoiling has been done for two years in succession and omitted for two years.

Under the subhead "Disked" are given the yields obtained on corn stubble prepared by disking. The corn is harvested in the fall with a corn binder and no tillage given the plat until spring. Then it is disked to put it in condition for seeding.

Under the subhead "Green manured" are given the yields of barley following the plowing under of rye or peas, as specified. This treatment is in a 4-year rotation in which one of the other crops consists of corn and one of small grain.

At each station at least one plat of barley is grown on summer-tilled land. The method of summer tillage practiced has been of the intensive type. The ground is fall plowed, and clean cultivation is continued through the next year and until the barley is seeded in the second spring. In some cases it is necessary to replow during the summer, when the land is fallow. At other stations summer-tilled plats are plowed but once. Experiments not here reported are under way to ascertain the best method of fallowing. Indications are that equally good results can be obtained with a less intensive method than has been practiced.

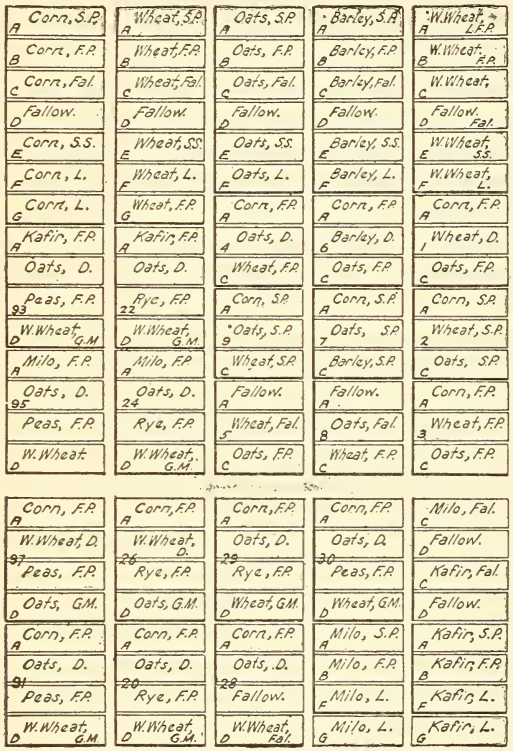

FIG. 2.—Diagram of the dry-land rotation field at the Amarillo Field Station. The lettering shows the cropping practiced in 1914. The explanation of the abbreviations used after the name of a crop is as follows: *D.*=Disked, *Fal.*=summer tilled, *F. P.*=fall plowed, *G. M.*=green manured, *L.*=listed, *M.*=manured, *S. P.*=spring plowed, *S. S.*=subsoiled.

The yields given in these tables begin with the second year of crop production at each station. All crops are produced the first year on land under uniform treatment. In some cases an entire crop has been lost by hail. These years are not considered in computing averages, as the crops under all methods alike were destroyed.

Figure 2 shows dia a-gram of the dry-land rotation field at the Amarillo Field Station. This station, being a representative one, will serve to illustrate the general scheme and plan of work. The plats here, as in all the work, are one-tenth acre in size. Their dimensions are 2 by 8 rods. Along their larger dimension the plats are separated by bare alleys 4 feet in width. Along the ends of the plats they are separated by roads 20 feet wide. At this station five crops are represented in a series of continuously cropped plats lettered from A to F or G. In this group plats C and D are alternately cropped and summer tilled, so that each year a crop is grown on land that was summer tilled the previous year and a plat is summer tilled for cropping the next year.

The remainder of the field is in rotations in which each plat is known by a rotation number and letter. On the field diagram the separation of the rotations is indicated by heavy lines.

The movement of the crops in the rotation is in the direction from Z to A and from A back to the letter that marks the other end of the rotation.

In figure 2 the diagram is filled out to show the cropping in 1914. The letters following the crop indicate the treatment given the ground in preparation for it, S. P. standing for spring plowed, F. P. for fall plowed, Fal. for summer tilled, G. M. for green manured, S. S. for subsoiled, L. for listed, and D. for disked. To illustrate: In 1914 plat A of the 4-year rotation No. 91 was in corn on fall-plowed ground, plat B was in oats on disked corn ground, and plat C was in peas on fall-plowed land. This would be plowed under for green manure. Plat D was in winter wheat where peas had been turned under the year before. In 1915, A will be in oats, B in peas, C in winter wheat, and D in corn.

COMPARISON OF CULTURAL METHODS ON THE BASIS OF COST.

The methods under study vary a great deal in the labor involved and in the consequent cost of preparation. Table IV has therefore been compiled in order to show the average cost by the methods under study as determined from the data of eight of the stations having the most trustworthy records. An average of the records for 5½ years at each station has been used in compiling this table. This is equivalent to a record of 44 years at one station. An accurate record has been kept of all the farm operations performed under the various methods under trial. These have been averaged for the eight stations. The amount of work required for some methods of treatment varies with the season and with the soil, and the expense of some operations varies with the soil. The amount of labor performed under each of the methods was neither more nor less than that which the man in charge believed to be necessary to bring about the results sought.

In computing the costs of the various operations a fixed wage of $2 a day for a man and $1 a day for a horse was adopted. This may be above or below the actual labor cost in any particular locality, but it is believed to be a fair average and one that will afford a profitable market to the farmer for his labor. The time required for men and teams to cover a given acreage in each of the several farm operations obviously varies with soils and other conditions. The average shown in Table II has been determined from the actual experience of a large number of men connected with these investigations, which experience has extended over a wide range of conditions and many years of time.

The factors included in the cost of production are calculated on an acre basis for each of the separate operations performed, beginning with the preparation of the land and ending with the harvesting and shocking of the grain. To these items are added the cost of seed at 75 cents per acre, interest and taxes on the land investment calculated at 8 per cent on a valuation of $20 per acre, and the deterioration and repair of the binder at 15 cents per acre. No allowance is made for the deterioration of other farm equipment, as it is believed that the wages allowed for men and teams are sufficient to cover this item for the remainder of the equipment. The above-mentioned items are fixed charges per acre; that is, they do not vary greatly with the yield per acre except for the item of twine, but this variation is not sufficient to materially affect the relative total cost of production under the several methods.

Table II shows the cost per acre based upon what is considered an average day's work for each of the farm operations involved at the above-mentioned wage. As before stated, the type of soil and seasonal conditions will determine to a certain extent the labor required and the consequent cost per acre. The cost of production as computed in Tables II and IV is not offered as being absolute for any locality, either in the amount of labor required or its cost, but is given as a working basis for the comparison of the results by different methods of preparation.

TABLE II.—*Average cost per acre* [1] *of the farm operations involved in growing barley in the Great Plains area.*

[The wage scale assumed is $2 per day for each man and $1 per day for each horse.]

Operation.	Force employed.		Day's work.	Item cost.	Cost per acre.
	Men.	Horses.			
			Acres.		
Plowing	1	4	3½	.....	$1.71
Disking	1	4	8	.....	.75
Harrowing	1	4	35	.....	.17
Subsoiling	1	3	3½	.....	1.43
Drilling	1	4	15	.....	.40
Cultivating	1	4	16	.....	.38
Listing	1	4	10	.....	.60
Harvesting:					
Cutting and binding	1	4	15	$0.40	
Shocking	1	.....	.....	.13	.93
Twine	.....	.....	.....	.25	
Binder wear and repair	.....	.....	.....	.15	

[1] The cost of thrashing is not included in the cost per acre, but it is estimated at 6 cents per bushel and deducted from the price of 47 cents in the granary, thus giving a value of 41 cents per bushel in the shock.

The average farm price of barley used in these computations is based on the data given in Table III, furnished by the Bureau of Crop Estimates. The four States of North Dakota, South Dakota, Nebraska, and Kansas were selected because their extensive grain production has given them established market prices which are not greatly influenced by local conditions.

TABLE III.—*Average price of barley at the farm granary for ten years in four States of the Great Plains area.*

[The quotations are given in cents per bushel. Those for the year 1914 are for the date of Nov. 1; in other years Dec. 1 is taken as the date.]

Year.	North Dakota.	South Dakota.	Nebraska.	Kansas.	Average.	Year.	North Dakota.	South Dakota.	Nebraska.	Kansas.	Average.
1905	30	29	31	32	30½	1911	85	88	60	60	73½
1906	33	32	31	33	32¼	1912	35	42	42	40	39¾
1907	58	61	50	54	55¾	1913	40	46	49	55	47¾
1908	46	47	46	54	48¼	1914	42	49	42	44	44¼
1909	43	45	43	53	46						
1910	55	57	45	45	50½	Average.	47	50	44	47	47

Table III shows that the average farm price of barley on December 1 for the past 10 years has been 47 cents per bushel. It costs about 6 cents per bushel to take the grain from the shock, thrash it, and put it in the granary on the farm. This cost per bushel does not vary greatly with the yield, and is therefore a fixed price per bushel instead of a fixed price per acre, as is the case with the other costs of production.

The relative profits of producing barley under the different methods can therefore be best determined by finding the difference between the fixed cost per acre and the value per acre of the grain at the point where the fixed cost per acre ends, which, as before stated, is when the grain is in the shock. Knowing that the average farm value of barley in the granary is 47 cents per bushel, and that it costs 6 cents per bushel to take it from the shock, thrash it, and put it in the granary it is obvious that it would be worth 41 cents per bushel in the shock. This valuation of 41 cents per bushel has therefore been used as a basis for calculating the relative crop values, costs, and profits per acre by the various methods under trial.

TABLE IV.—*Cost per acre of producing barley in the shock in the Great Plains area, showing averages of data from eight stations.*

Method of preparation.	Number of operations.						Cost of preparation.	Cost per acre.				Total cost of production.	
	Plowing.	Harrowing.	Disking.	Subsoiling.	Listing.	Drilling.		Seed.	Drilling.	Harvesting.	Interest and taxes.	In dollars.	In grain at 41 cents per bushel.
Disked corn land	.....	1.3	1	.....	.....	.....	$0.97	$0.75	$0.40	$0.93	$1.60	4.65	11.3
Listed	.....	1.6	1.2	.....	1	.....	1.77	.75	.40	.93	1.60	5.45	13.3
Spring plowed	1	1.3	.5	.....	.....	.....	2.31	.75	.40	.93	1.60	5.99	14.6
Fall plowed	1	2.3	.9	.....	.....	.....	2.78	.75	.40	.93	1.60	6.46	15.8
Subsoiled	1	1.7	.9	0.5	.....	.....	3.39	.75	.40	.93	1.60	7.07	17.2
Summer tilled	1.5	9.2	2.6	.....	.....	.....	6.12	.75	.40	.93	3.20	11.40	27.8
Green manured:													
With rye [1]	2	6.5	2.4	.....	.....	1	7.73	.75	.40	.93	3.20	13.01	31.7
With peas [2]	2	5.8	2.7	.....	.....	1	10.73	.75	.40	.93	3.20	16.01	39.0
Average cost of green manuring	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	14.51	35.4

[1] The cost of rye per acre for seed is estimated at $1. [2] The cost of peas per acre for seed is estimated at $4.

In conformity with the foregoing explanation, Table IV gives in detail the cost of producing barley in the shock, expressed in dollars and cents and in bushels per acre at 41 cents per bushel in the shock.

RESULTS AT THE SEVERAL STATIONS.

No attempt will be made in this bulletin to discuss the various types of soils found at the several stations.[1] It will be noted in the tables that follow that the soils at some of the stations have given but little response to differences in tillage methods under any climatic conditions thus far obtaining. The soils at some other stations do respond to tillage. Differences in yields are obtained from different methods of tillage. The amount of variation in yields changes from year to year with the changing combination of climatic conditions.

JUDITH BASIN FIELD STATION, MONT.

The results of five years are presented from the field station at Moccasin, Mont., in the Judith Basin. The crop in the sixth year was destroyed by hail before maturity and is not used in calculating the averages. Four of the years have been productive of heavy yields, but in the other year the yields were light.

Barley, like the other spring-sown grain crops at this station, does not exhibit marked differences in yield as a result of different preparations for the crop. In 1913 both fall and spring plowed barley land show a marked drop in yields. In 1914 the same thing is noted on the spring-plowed barley plat. This was due to injury from gophers rather than to the difference in seed-bed preparation. This damage with the consequent shortage of yield, unduly augments the average differences.

The uniformity of results obtained shows that the method of seed-bed preparation is not an important factor in the production of spring-sown crops at this place. The farmer should concern himself with the problem of getting the work done at the most convenient time and in the most economical manner.

The lack of wide variation in yield is explained by the shallowness of the soil on the station farm. The water that falls either in rain or snow between the time of harvest of one crop and the commencement of rapid growth of the next, during the years under study, was sufficient to supply the proportion of water that the soil can retain within reach of the crop. Water accumulated in the soil by the special methods of cultivation in excess of this proportion was lost by penetrating beyond recovery by the plant, and no increase in yield was realized from it.

[1] For a brief discussion of the different soil types, see U. S. Dept. of Agriculture Bul. 214, entitled "Spring wheat in the Great Plains area: Relation of cultural methods to production."

TABLE V.—*Yields and cost of production of barley by different methods at the Judith Basin Field Station, 1909 to 1914, inclusive.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).						
		1909	1910	1911	1912	1913	1914	Average.
Fall plowed: Barley	1	43.3	12.5	24.1	(1)	21.9	18.0	24.0
Spring plowed:								
Barley	1	45.2	10.0	(2)	(1)	21.9	11.6	22.5
Oats	1	39.1	11.6	23.9	(1)	31.7	21.2	25.9
Total or average	2	42.2	10.8	23.9	(1)	26.8	16.4	24.0
Listed: Barley	1	47.9	12.5	30.4	(1)	32.5	21.8	29.0
Subsoiled: Barley	1	48.3	15.0	32.6	(1)	32.9	23.5	30.5
Disked: Corn	1	42.7	16.6	29.7	(1)	34.6	21.6	29.0
Summer tilled	1	49.4	15.8	27.5	(1)	32.7	25.8	30.2
Average of all 7 plats		45.1	13.4	28.0	(1)	29.7	20.5	27.3

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.						Previous crop.	
	Fall plowed (1 plat).	Spring plowed (2 plats).	Disked (1 plat).	Listed (1 plat).	Subsoiled (1 plat).	Summer tilled (1 plat).	Small grain (5 plats).	Corn (1 plat).
Yields of grain:								
1909 bushels	43.3	42.2	42.7	47.9	48.3	49.4	44.8	42.7
1910 do	12.5	10.8	16.6	12.5	15.0	15.8	12.3	16.6
1911 do	24.1	23.9	29.7	30.4	32.6	27.5	27.8	29.7
1912 do	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
1913 do	21.9	26.8	34.6	32.5	32.9	32.7	28.2	34.6
1914 do	18.0	16.4	21.6	21.8	23.5	25.8	19.2	21.6
Average	24.0	24.0	29.0	29.0	30.5	30.2	26.5	29.0
Crop value, cost of production, etc.:								
Value	$9.84	$9.84	$11.89	$11.89	$12.51	$12.38	.....	.....
Cost	6.46	5.99	4.65	5.45	7.07	11.40	.....	.....
Profit	3.38	3.85	7.24	6.44	5.44	.98	.....	.....

[1] Destroyed by hail. [2] The yield from this plat is omitted, owing to an error in time of seeding.

The cost of production and the value of the crop as here computed show a profit by all methods under trial. The profits range from 98 cents by summer tillage to $7.24 on disked corn ground.

HUNTLEY FIELD STATION.

The records of only two years of yields under four different methods of treatment are available for study from Huntley, Mont. In 1913 there was little difference between spring-plowed oat stubble and disked corn ground as a preparation for barley. In 1914 disked corn ground was markedly the better of the two. The heaviest yields each year were obtained from land on which peas were plowed under for green manure. In 1914 there was a marked increase in the yield on ground on which rye was plowed under. In preparation for 1913,

barley was plowed under instead of rye, with the result that there was a sharp decrease in yield.

A profit was realized from all the methods under trial. The largest profit, $9.50 per acre, was on disked corn ground. Spring plowing shows a profit of $6.15 per acre, while the average profit from green manure was $3.45.

TABLE VI.—*Yields and cost of production of barley by different methods at the Huntley Field Station, 1913 and 1914.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).		
		1913	1914	Average.
Spring plowed: Oats	1	24.5	34.6	29.6
Disked: Corn	4	23.2	45.7	34.5
Green manured:				
Rye	1	19.6	55.6	37.6
Peas	1	36.3	63.6	50.0
Total or average	2	28.0	59.6	43.8
Average of all 7 plats		24.7	48.1	36.4

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields (average per acre).	Tillage treatment.			Previous crop.		Values, etc. (average per acre).	Tillage treatment.		
	Spring plowed (1 plat).	Disked (4 plats).	Green manured (2 plats).	Small grain (1 plat).	Corn (4 plats).		Spring plowed (1 plat).	Disked (4 plats).	Green manured (2 plats)
Yields of grain:						Crop value, cost, etc.:			
1913 ..... bushels..	24.5	23.2	28.0	24.5	23.2	Value...	$12.14	$14.15	$17.96
1914 ..... do....	34.6	45.7	59.6	34.6	45.7	Cost.....	5.99	4.65	14.51
Average.....	29.6	34.5	43.8	29.6	34.5	Profit.	6.15	9.50	3.45

WILLISTON FIELD STATION.

The results of five years are available from Williston, N. Dak. In two of these years the yields were heavy, one year they were fair, and two years they were very poor.

Between the fall and spring plowing of barley stubble, there is little difference to be noted, except in 1912, when fall plowing was much the better. Between barley and oat stubble plowed in the spring, the only year that showed a significant difference was 1914, when the advantage was with the oat stubble. The crop on summer tillage was every year better than that following either oats or barley. For three years summer tillage yielded heavier than disked corn ground and for two years the reverse was the case. The high yield together with low cost combined to make disked corn ground show the greatest profit, $6.63 per acre. The higher cost of summer tillage reduced the profit from it to 41 cents per acre. Both fall and spring plowing show small profits.

TABLE VII.— *Yields and cost of production of barley by different methods at the Williston Field Station, 1910 to 1914, inclusive.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).					
		1910	1911	1912	1913	1914	Average.
Fall plowed: Barley	1	0.6	3.3	46.1	14.8	17.4	22.0
Spring plowed: Barley	1	.8	5.8	31.7	14.4	21.4	14.8
Oats	1	.2	4.6	30.0	15.6	36.7	17.4
Total or average	2	.5	5.2	30.9	15.0	29.1	16.1
Disked: Corn	1	.4	4.2	50.8	28.6	53.5	27.5
Summer tilled	1	5.2	12.7	54.4	21.9	49.7	28.8
Average of all 5 plats		1.4	6.1	42.6	19.1	36.7	21.2

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.				Previous crop.	
	Fall plowed (1 plat).	Spring plowed (2 plats).	Disked (1 plat).	Summer tilled (1 plat).	Small grain (3 plats).	Corn (1 plat).
Yields of grain:						
1910 bushels	0.6	0.5	0.4	5.2	0.5	0.4
1911 do	3.3	5.2	4.2	12.7	4.6	4.2
1912 do	46.1	30.9	50.8	54.4	35.9	50.8
1913 do	14.8	15.0	28.6	21.9	14.9	28.6
1914 do	22.0	29.1	53.5	49.7	26.7	53.5
Average	17.4	16.1	27.5	28.8	16.5	27.5
Crop value, cost of production, etc.:						
Value	$7.13	$6.60	$11.28	$11.81	.....	.....
Cost	6.46	5.99	4.65	11.40	.....	.....
Profit	.67	.61	6.63	.41	.....	.....

DICKINSON FIELD STATION.

The results of six years are available from Dickinson, N. Dak. The crop of 1912 was destroyed by hail before maturity, and as failure from this cause could not be overcome by cultural methods it is not included in determining the average. Five of the years studied produced good crops of barley. In the remaining year the average yield was small, but the variation between the results from different methods of preparation was wide.

The results attendant upon the fall and spring plowing of barley stubble and of growing barley on either spring-plowed oat stubble or barley stubble have been largely dependent upon the season. The seasonal differences have equalized each other until, when the results of the five years are averaged, little choice is to be made between them. Summer tillage increased the crop an average of about 7 bushels, bringing it up to 32.5 bushels per acre. Disked corn ground, however, brought the average yield up to 37.4 bushels per acre and gave a higher yield than summer tillage five years out of six.

Having at the same time the highest yield and the lowest cost of production, disked corn ground shows much the highest profit of any method under trial. The average profit from it was $10.68 per acre. Both spring and fall plowing show profits of about $4 per acre. The cost of summer tillage reduced the profits from it to $1.93 per acre.

TABLE VIII.— *Yields and cost of production of barley by different methods at the Dickinson Field Station, 1908 to 1914, inclusive.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).							
		1908	1909	1910	1911	1912	1913	1914	Average.
Fallplowed: Barley	1	24.0	39.0	31.1	1.2	(1)	34.8	20.2	25.1
Spring plowed:									
Barley	1	33.5	39.8	28.3	9.6	(1)	19.2	25.0	25.9
Oats	1	34.4	49.2	19.8	2.4	(1)	20.2	13.3	23.2
Total or average	2	34.0	44.5	24.1	6.0	.....	19.7	19.2	24.6
Disked: Corn	1	45.6	53.8	28.6	12.3	(1)	44.8	39.1	37.4
Summer tilled	1	30.0	50.0	24.0	19.1	(1)	36.9	35.2	32.5
Average of all 5 plats	.....	33.5	46.4	26.4	8.9	(1)	31.2	26.6	28.8

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.				Previous crop.	
	Fall plowed (1 plat).	Spring plowed (2 plats).	Disked (1 plat).	Summer tilled (1 plat).	Small grain (3 plats).	Corn (1 plat).
Yields of grain:						
1908 bushels	24.0	34.0	45.6	30.0	30.6	45.6
1909 do	39.0	44.5	53.8	50.0	42.7	53.8
1910 do	31.1	24.1	28.6	24.0	26.4	28.6
1911 do	1.2	6.0	12.3	19.1	4.4	12.3
1912 do	(1)	(1)	(1)	(1)	(1)	(1)
1913 do	34.8	19.7	44.8	36.9	24.7	44.8
1914 do	20.2	19.2	39.1	35.2	19.5	39.1
Average	25.1	24.6	37.4	32.5	24.7	37.4
Crop value, cost of production, etc.:						
Value	$10.29	$10.09	$15.33	$13.33	.....	.....
Cost	6.46	5.99	4.65	11.40	.....	.....
Profit	3.83	4.10	10.68	1.93	.....	.....

[1] Destroyed by hail.

EDGELEY FIELD STATION.

The results of eight years of uninterrupted work are presented from Edgeley, N. Dak. In five of these years the yields were good, in one year they were light, and in two years the crops were practically failures from all methods under trial. No method showed any merit in overcoming the drought of these extreme years at this station. In five of the years under study the highest yield was obtained on disked corn ground. The maximum yield by this method was 37.1 bushels per acre, while the average for the eight years was 23.4 bushels per acre.

The next highest average yield, 20 bushels per acre, was by summer tillage. The average from spring-plowed oat land was 19.7 bushels per acre. The advantage of either fall or spring plowing barley stubble varied within narrow limits, but in the average of the series of years no choice is to be made between the two. This indication that the time of plowing is not an important factor allows greater latitude in planning the work of the farm. The plan should be to get the work done early and thus avoid as far as possible the augmentation of work at seeding time. This is of especial importance in the northern portion of the Great Plains, where the seeding season is necessarily short.

The only method under trial that did not produce barley at a profit is summer tillage. This shows an average loss of $3.20 per acre. The greatest profit, $4.94, was realized from disked corn ground. Fall and spring plowing both show small profits.

TABLE IX.—*Yield and cost of production of barley by different methods at the Edgeley Field Station, 1907 to 1914, inclusive.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).								
		1907	1908	1909	1910	1911	1912	1913	1914	Average.
Fall plowed: Barley	1	9.4	24.2	24.7	1.6	0.1	26.5	20.2	26.9	16.7
Spring plowed:										
Barley	1	10.2	25.0	27.0	1.2	.....	24.2	17.9	32.3	17.2
Oats	1	10.6	26.0	32.7	1.4	.1	34.0	18.9	33.6	19.7
Total or average	2	10.4	25.5	29.9	1.3	.1	29.1	18.4	33.0	18.5
Disked: Corn	1	18.3	31.9	33.1	2.9	.4	30.2	37.1	33.1	23.4
Summer tilled	1	16.0	24.2	28.3	2.2	.8	32.3	26.8	29.4	20.0
Average of all 5 plats	.....	12.9	26.3	29.2	1.9	.3	29.4	24.2	31.1	19.4

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.				Previous crop.	
	Fall plowed (1 plat).	Spring plowed (2 plats).	Disked (1 plat).	Summer tilled (1 plat).	Small grain (3 plats).	Corn (1 plat).
Yields of grain:						
1907 ..... bushels	9.4	10.4	18.3	16.0	10.1	18.3
1908 ..... do	24.2	25.5	31.9	24.2	25.1	31.9
1909 ..... do	24.7	29.9	33.1	28.3	28.1	33.1
1910 ..... do	1.6	1.3	2.9	2.2	1.4	2.9
1911 ..... do	.1	.1	.4	.8	.1	.4
1912 ..... do	26.5	29.1	30.2	32.3	28.2	30.2
1913 ..... do	20.2	18.4	37.1	26.8	19.0	37.1
1914 ..... do	26.9	33.0	33.1	29.4	30.9	33.1
Average	16.7	18.5	23.4	20.0	17.9	23.4
Crop value, cost of production, etc.:						
Value	$6.85	$7.59	$9.59	$8.20	.....	.....
Cost	6.46	5.99	4.65	11.40	.....	.....
Profit or loss	.39	1.60	4.94	—3.20	.....	.....

HETTINGER FIELD STATION.

Results for three years have been obtained at Hettinger, N. Dak. All were years of good barley yields. The highest yields were obtained each year by summer tillage and the lowest, with one exception, on disked corn ground. The average yield from summer tillage was more than twice that from the disked land. Following small grain, a decided advantage attended spring-plowed barley stubble. The crops in this group yielded better than on disked corn ground, but not as good as by summer tillage.

TABLE X.— *Yields and cost of production of barley by different methods at the Hettinger Field Station, 1912, 1913, and 1914.*

Treatment and previous crop.	Yield per acre (bushels).				
	Number of plats averaged.	1912	1913	1914	Average.
Fall plowed: Barley	1	23.5	27.1	9.2	19.9
Spring plowed:					
Barley	1	26.3	39.6	16.3	27.4
Oats	1	22.9	28.0	20.0	23.6
Total or average	2	24.6	33.8	18.2	25.5
Disked: Corn	1	13.5	21.0	10.2	14.9
Summer tilled	1	37.8	38.8	18.7	31.8
Average of all 5 plats	.....	24.8	30.9	14.9	23.5

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.				Previous crop.	
	Fall-plowed (1 plat).	Spring-plowed (2 plats).	Disked (1 plat).	Summer-tilled (1 plat).	Small grain (3 plats).	Corn (1 plat).
Yields of grain:						
1912 ..... bushels	23.5	24.6	13.5	37.8	24.2	13.5
1913 ..... do	27.1	33.8	21.0	38.8	31.6	21.0
1914 ..... do	9.2	18.2	10.2	18.7	15.2	10.2
Average	19.9	25.5	14.9	31.8	23.7	14.9
Crop value, cost of production, etc.:						
Value	$8.16	$10.46	$6.11	$13.04	.....	.....
Cost	6.46	5.99	4.65	11.40	.....	.....
Profit	1.70	4.47	1.46	1.64	.....	.....

The relative position assumed by the various methods may be due in part to the distribution of the rainfall for the two years, 1911 and 1912, and may be changed with subsequent work. In both 1911 and 1912 a heavy rainfall came in August and September. The corn, which was still growing, used this water, while a portion of it was accumulated in the small-grain plats, where the grain was already harvested, and in the summer-tilled plats. The corn plats were

therefore short of available water when the barley was seeded and consequently gave lower yields. Weeds were also a factor in decreasing the yields on disked corn ground.

A profit was realized from all methods under trial. Between fall plowing, disking, and summer tillage there was little difference. Spring plowing shows a considerably larger average profit than any of the other methods.

BELLE FOURCHE FIELD STATION.

The results of six years at Belle Fourche, S. Dak., are available for study. In only one year was the yield heavy. Three of those years gave light yields from most methods; in one year the crop was a total failure from all methods, and in the other year only one method gave any yield and that was light.

TABLE XI.—*Yields and cost of production of barley by different methods at the Belle Fourche Field Station, 1909 to 1914, inclusive.*

Treatment and previous crop.	Yield per acre (bushels).							
	Number of plats averaged.	1909	1910	1911	1912	1913	1914	Average.
Fall plowed: Barley	1	25.0	4.8	0	0	8.9	7.1	7.6
Spring plowed:								
Barley	1	23.8	4.4	0	5.2	17.0	5.2	9.3
Oats	1	28.1	3.6	0	0	6.8	5.8	7.4
Total or average	2	26.0	4.0	.....	2.6	11.9	5.5	8.3
Listed: Barley	1	30.2	0	0	0	7.8	8.1	7.7
Subsoiled: Barley	1	33.8	0	0	0	7.8	6.3	8.0
Disked: Corn	1	47.1	5.0	0	0	8.9	12.2	12.2
Summer tilled	1	37.3	3.0	0	0	13.4	21.7	12.6
Average of all 7 plats	.....	32.2	3.0	.....	.7	10.1	9.5	9.3

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.						Previous crop.	
	Fall plowed (1 plat).	Spring plowed (2 plats)	Disked (1 plat).	Listed (1 plat).	Subsoiled (1 plat).	Summer tilled (1 plat).	Small grain (5 plats)	Corn (1 plat).
Yields of grain:								
1909 bushels	25.0	26.0	47.1	30.2	33.8	37.3	28.2	47.1
1910 do	4.8	4.0	5.0	0	0	3.0	2.6	5.0
1911 do	0	0	0	0	0	0	0	0
1912 do	0	2.6	0	0	0	0	1.0	0
1913 do	8.9	11.9	8.9	7.8	7.8	13.4	9.7	8.9
1914 do	7.1	5.5	12.2	8.1	6.3	21.7	6.5	12.2
Average	7.6	8.3	12.2	7.7	8.0	12.6	8.0	12.2
Crop value, cost of production, etc.:								
Value	$3.12	$3.40	$5.00	$3.16	$3.28	$5.17	.....	.....
Cost	6.46	5.99	4.65	5.45	7.07	11.40	.....	.....
Profit or loss	−3.34	−2.59	.35	−2.29	−3.79	−6.23		

In the year of heavy yields and in the following year of very light yields the best production was on disked corn ground. In 1912 the only yield secured was from spring-plowed barley stubble. The same plat also gave the highest yield in 1913. It is probable that in both cases these results were due to the fact that the crop on this plat made a poor start and had a thinner stand, which helped it in withstanding the drought of the summer.

Subsoiling, as compared with fall-plowing done at the same time, appears to have been effective in increasing the crop in the year of good yield, but not in overcoming drought in other years. The same observation applies to furrowing with the lister instead of plowing.

In the average results from the whole period of years, summer tillage and disking corn ground stand by themselves. On the basis of yield there is little or no choice to be made between the two. But when the cost of production is figured in connection with the value of the crop it is seen that by all methods except the use of disked corn ground the crop has been produced at a loss. The low cost of production by the disking method enables it to show a nominal average profit of 35 cents per acre.

SCOTTSBLUFF FIELD STATION.

The results of only two years with barley are available for study from Scottsbluff, Nebr. The crop of 1913 was lost through a fault in the seed that made it necessary to reseed. The reseeded crop grew and maintained the continuity of the work in the effect upon the ground for the following crop, but was too late to mature before growth was checked by the hot weather of midsummer. Production in one year was good and in the other it was poor.

TABLE XII.— *Yields and cost of production of barley by different methods at the Scottsbluff Field Station, 1912 and 1914.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).[1]		
		1912	1914	Average.
Fall plowed: Barley	1	23.5	4.4	14.0
Spring plowed:				
Barley	1	21.3	6.0	13.7
Oats	1	22.5	11.8	17.2
Total or average	2	21.9	8.9	15.4
Disked: Corn	1	31.3	5.8	18.6
Listed: Barley	1	23.8	5.0	14.4
Subsoiled: Barley	1	24.8	5.2	15.0
Summer tilled	1	39.6	15.6	27.6
Average of all 7 plats		26.7	7.7	17.2

[1] The crop of 1913 was a failure, due to poor seed.

TABLE XII.— *Yields and cost of production of barley by different methods at the Scottsbluff Field Station, 1912 and 1914*—Continued.

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.						Previous crop.	
	Fall plowed (1 plat).	Spring plowed (2 plats)	Disked (1 plat).	Listed (1 plat).	Subsoiled (1 plat).	Summer tilled (1 plat).	Small grain (5 plats)	Corn (1 plat).
Yields of grain:								
1912.....bushels..	23.5	21.9	31.3	23.8	24.8	39.6	23.2	31.3
1913[1].....do....								
1914.....do....	4.4	8.9	5.8	5.0	5.2	15.6	6.5	5.8
Average.....	14.0	15.4	18.6	14.4	15.0	27.6	14.9	18.6
Crop value, cost of production, etc.:								
Value.....	$5.74	$6.31	$7.63	$5.90	$6.15	$11.32	.....	.....
Cost.....	6.46	5.99	4.65	5.45	7.07	11.40	.....	.....
Profit or loss.....	— .72	.32	2.98	.45	— .92	— .08	.....	.....

[1] The crop of 1913 was a failure, due to poor seed.

The highest yield in both years was from summer tillage. The average yield from this method is 9 bushels per acre greater than the average on disked corn ground, the next highest yielding method under trial. Between other methods there is little difference in yields, although in 1914 the spring-plowed oat ground appeared to have a decided advantage. Spring plowing, disking, and listing all show small profits, the greatest being from disking. Fall plowing, subsoiling, and summer tillage all show small losses.

NORTH PLATTE FIELD STATION.

In the eight years under study at North Platte, Nebr., there have been two heavy crops of barley, three light crops, two poor crops, and one failure from drought and grasshoppers.

In the average of the whole series of years a small advantage appears in favor of fall plowing. There have been large differences in individual years of the series. The greatest difference in any one year has been in favor of fall plowing, but in the greater number of years there has been a smaller difference in favor of spring plowing. The greatest difference in favor of spring plowing over fall plowing was in 1909. Germination was much slower on the spring-plowed than on either fall-plowed or summer-tilled land, owing to the fact that the seed bed was not in as good shape. A late freeze caught the crop on the fall-plowed and summer-tilled land at a tender stage, while the crop on the spring-plowed plats, being slower, escaped almost entirely. The difference in yield between spring and fall plowing in that year was therefore due to a difference in stand.

The one plat on disked-corn ground has been low in yield, its average being below that of barley following small grain. There is some evidence to support the belief that the location of the rotation containing this plat is such that it is normally a little lower in yield than the rest of the field.

The only method under trial that exhibits power to markedly increase the yield over other methods is summer tillage. This power has not been manifested every year, but in some years it has been very marked. The average yield for eight years by this method has been 26.7 bushels per acre as against 16.3 bushels where the crop followed small grain. This increase in yield has been just about equal to the increased cost of growing the crop under this method. All methods show either a profit or a loss of less than $1 per acre.

TABLE XIII.—*Yields and cost of production of barley by different methods at the North Platte Field Station, 1907 to 1914, inclusive.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).								
		1907	1908	1909	1910	1911	1912	1913	1914	Average.
Fall plowed: Barley	1	40.0	43.3	10.4	12.5	0	14.6	5.0	11.0	17.1
Spring plowed:										
Barley	1	39.0	19.6	21.5	13.8	0	20.8	6.5	5.3	15.8
Oats	1	40.2	22.3	18.6	16.0	0	20.0	6.3	3.6	15.9
Total or average	2	39.6	21.0	20.1	14.9	.....	20.4	6.4	4.5	15.9
Disked: Corn	1	30.6	24.9	21.5	7.9	0	12.3	5.0	5.2	13.4
Summer tilled	1	39.0	67.7	23.8	26.0	0	20.0	16.5	20.8	26.7
Average of all 5 plats	.....	37.8	35.6	19.2	15.2	.....	17.5	7.9	9.2	17.8

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.				Previous crop.	
	Fall-plowed (1 plat).	Spring-plowed (2 plats).	Disked (1 plat).	Summer-tilled (1 plat).	Small grain (3 plats).	Corn (1 plat).
Yields of grain:						
1907 ..... bushels	40.0	39.6	30.6	39.0	39.7	30.6
1908 ..... do	43.3	21.0	24.9	67.7	28.4	24.9
1909 ..... do	10.4	20.1	21.5	23.8	16.8	21.5
1910 ..... do	12.5	14.9	7.9	26.0	14.1	7.9
1911 ..... do	0	0	0	0	0	0
1912 ..... do	14.6	20.4	12.3	20.0	18.5	12.3
1913 ..... do	5.0	6.4	5.0	16.5	5.9	5.0
1914 ..... do	11.0	4.5	5.2	20.8	6.6	5.2
Average	17.1	15.9	13.4	26.7	16.3	13.4
Crop value, cost of production, etc.:						
Value	$7.01	$6.52	$5.49	$10.95	.....	.....
Cost	6.46	5.99	4.65	11.40	.....	.....
Profit or loss	.55	.53	.84	— .55	.....	.....

AKRON FIELD STATION.

The results at Akron, Colo., secured by fall plowing barley stubble, furrowing with a lister instead of plowing, spring plowing barley stubble, spring plowing oat stubble, and disking corn ground in preparation for barley, have been dependent upon the season. Some seasons have favored one method and other seasons other methods, but on the whole little choice is to be made from the average of the six years under study. Subsoiling as compared with fall plowing without subsoiling has been done at a distinct loss each year except the first.

Summer tillage has increased the average yield from 17.6 bushels following a small-grain crop to 24.8 bushels per acre. Subsoiling and summer tillage show small losses of $1.33 and $1.23 per acre. Other methods show profits ranging from $1.17 on fall-plowed land to $2.89 on disked corn ground.

TABLE XIV.— *Yields and cost of production of barley by different methods at the Akron Field Station, 1909 to 1914, inclusive.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).						
		1909	1910	1911	1912	1913	1914	Average.
Fall plowed: Barley	1	16.8	10.5	16.3	27.9	3.1	36.7	18.6
Spring plowed:								
Barley	1	19.7	13.1	8.7	28.8	4.6	32.1	17.8
Oats	1	22.2	10.2	2.5	35.2	7.9	40.2	19.7
Total or average	2	21.0	11.7	5.6	32.0	6.3	36.2	18.8
Listed: Barley	1	19.2	12.6	4.6	36.0	4.4	30.8	17.9
Subsoiled: Barley	1	19.8	6.9	5.2	22.5	1.5	27.9	14.0
Disked: Corn	3	18.7	12.9	1.7	28.9	6.4	42.0	18.4
Summer tilled	1	24.6	16.0	12.6	40.2	16.3	46.2	24.8
Average of all 9 plats		19.8	12.0	6.1	30.8	6.3	37.8	18.8

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.						Previous crop.	
	Fall plowed (1 plat).	Spring plowed (2 plats).	Disked (3 plats).	Listed (1 plat).	Subsoiled (1 plat).	Summer tilled (1 plat).	Small grain (5 plats).	Corn (3 plats).
Yields of grain:								
1909 bushels	16.8	21.0	18.7	19.2	19.8	24.6	19.5	18.7
1910 do	10.5	11.7	12.9	12.6	6.9	16.0	10.7	12.9
1911 do	16.3	5.6	1.7	4.6	5.2	12.6	7.5	1.7
1912 do	27.9	32.0	28.9	36.0	22.5	40.2	30.1	28.9
1913 do	3.1	6.3	6.4	4.4	1.5	16.3	4.3	6.4
1914 do	36.7	36.2	42.0	30.8	27.9	46.2	33.5	42.0
Average	18.6	18.8	18.4	17.9	14.0	24.8	17.6	18.4
Crop value, cost of production, etc.:								
Value	$7.63	$7.71	$7.54	$7.34	$5.74	$10.17	.....	.....
Cost	6.46	5.99	4.65	5.45	7.07	11.40	.....	.....
Profit or loss	1.17	1.72	2.89	1.89	−1.33	−1.23	.....	.....

HAYS FIELD STATION.

In the results for seven years presented for study from Hays, Kans., one crop has been lost by hail. With the exception of 3.4 bushels per acre produced by summer tillage, one crop has been lost by drought. In two years the average yield was heavy, in two it was light, and in one it was fair. In the matter of productive and nonproductive years, the record for barley at this station is the same as that of oats. The year when the crop was destroyed by hail is not included in computing the averages.

TABLE XV.—*Yields and cost of production of barley by different methods at the Hays Field Station, 1908 to 1914, inclusive.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).							
		1908	1909	1910	1911	1912	1913	1914	Average.
Fall plowed: Barley	1	12.4	(1)	19.7	0	28.8	4.0	16.7	13.6
Spring plowed:									
Barley	1	5.8	(1)	12.5	0	22.4	2.6	9.9	8.9
Oats	1	9.2	(1)	15.0	0	29.8	17.0	9.4	13.4
Total or average	2	7.5	.....	13.8	.....	26.1	9.8	9.7	11.2
Listed: Barley	1	10.1	(1)	19.7	0	31.8	2.1	12.6	12.7
Subsoiled: Barley	1	14.8	(1)	19.3	0	33.8	4.6	15.2	14.6
Disked	6	11.0	(1)	28.3	0	25.1	3.5	16.4	14.1
Green manured:									
Rye	1	21.5	(1)	32.3	0	16.9	12.9	15.3	16.5
Peas	1	5.0	(1)	34.1	0	17.7	14.0	16.2	14.5
Total or average	2	13.3	.....	33.2	.....	17.3	13.5	15.8	15.5
Summer tilled	1	18.9	(1)	18.4	3.4	36.2	20.9	18.0	19.3
Average of all 14 plats	.....	11.7	.....	24.3	.2	26.3	7.1	15.1	14.1

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.							Previous crop.		
	Fall plowed (1 plat).	Spring plowed (2 plats).	Disked (6 plats).	Listed (1 plat).	Subsoiled (1 plat).	Green manured (2 plats).	Summer tilled (1 plat).	Small grain (5 plats).	Corn. (4 plats).	Kafir. (2 plats).
Yields of grain:										
1908.....bush..	12.4	7.5	11.0	10.1	14.8	13.3	18.9	10.5	11.3	10.4
1909.....do....	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
1910.....do....	19.7	13.8	28.3	19.7	19.3	33.2	18.4	17.2	26.6	31.6
1911.....do....	0	0	0	0	0	0	3.4	0	0	0
1912.....do....	28.8	26.1	25.1	31.8	33.8	17.3	36.2	29.3	26.1	23.0
1913.....do....	4.0	9.8	3.5	2.1	4.6	13.5	20.9	6.1	3.1	4.4
1914.....do....	16.7	9.7	16.4	12.6	15.2	15.8	18.0	12.8	15.6	18.2
Average.....	13.6	11.2	14.1	12.7	14.6	15.5	19.3	12.7	13.8	14.6
Crop value, cost of production, etc.:										
Value.....	$5.58	$4.59	$5.78	$5.21	$5.99	$6.36	$7.91	.....	.....	.....
Cost.....	6.46	5.99	4.65	5.45	7.07	14.51	11.40	.....	.....	.....
Profit or loss.	−.88	−1.40	1.13	−.24	−1.08	−8.15	−3.49	.....	.....	.....

[1] Destroyed by hail.

The results range from an average yield of 8.9 bushels per acre on spring-plowed barley land to 19.3 bushels per acre on summer-tilled land. Green manure is in second place, with average yields of 15.5 bushels per acre. In all but the first year, peas plowed under produced slightly larger crops than winter rye similarly treated. There has been a gain of 1 bushel per acre from subsoiling over fall plowing not subsoiled. Furrowing over winter with a lister produced practically the same as fall plowing. Fall-plowed barley stubble gave better results than spring-plowed barley stubble. Spring-plowed oat stubble produced practically the same as fall-plowed barley stubble. Disked corn ground produced slightly better yields than the average of the crops following small grains on fall or spring plowing.

The main positive result shown in the table of yields is an increase of about 6 bushels an acre as the result of summer tillage, or a somewhat lesser increase as a result of modifying the summer tillage by plowing under a crop of green manure.

The only method that produced barley at a profit was that of disking corn ground. This shows a profit of $1.13 per acre. All other methods show losses which range from 24 cents on listed ground to $3.49 on summer-tilled land and $8.15 on green-manured land.

GARDEN CITY FIELD STATION.

During the work of six years with barley under study at Garden City, Kans., one crop has been lost by drought and one by hail. In the other four years, yields have been obtained.

The highest average yield, 11 bushels per acre, has been obtained from summer tillage. Next to this in point of average yield is disked corn ground. Subsoiling has given the same average yields as fall plowing done at the same time without subsoiling. Marked advantage in two years appears to have been derived from furrowing with a lister and leaving the land rough through the winter instead of plowing.

On the whole the average yields are so low and there are so many inconsistencies in the behavior of the different methods from year to year that the results are chiefly valuable as indicators rather than as definite guides to practice. It appears that there is sound reason for the consensus of opinion as evidenced by farm practice which gives little place to spring-sown barley in the territory served by this station.

The crop has been produced at a loss by all the methods under trial. The losses range from $1 per acre on disked corn ground to $6.89 on summer-tilled land.

TABLE XVI.—*Yields and cost of production of barley by different methods at the Garden City Field Station, 1909 to 1914, inclusive.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).						Average.
		1909	1910	1911	1912	1913	1914	
Fall plowed: Barley	1	4.8	5.4	0	9.0	(1)	15.2	6.9
Spring plowed:								
Barley	1	2.4	1.0	0	6.9	(1)	3.9	2.8
Oats	1	5.7	2.3	0	17.0	(1)	3.5	5.7
Total or average	2	4.1	1.7	.....	12.0	.....	3.7	4.3
Listed: Barley	1	3.2	5.0	0	14.5	(1)	18.8	8.3
Subsoiled: Barley	1	3.7	5.2	0	8.5	(1)	17.3	6.9
Disked: Corn	3	4.8	5.4	0	15.8	(1)	18.5	8.9
Summer tilled	1	10.0	13.5	0	13.1	(1)	18.5	11.0
Average of all 9 plats	.....	4.6	5.4	.....	12.9	.....	15.7	7.7

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.						Previous crop.	
	Fall plowed (1 plat).	Spring plowed (2 plats).	Disked (3 plats).	Listed (1 plat).	Subsoiled (1 plat).	Summer tilled (1 plat).	Small grain (5 plats).	Corn (3 plats).
Yields of grain:								
1909 bushels	4.8	4.1	4.8	3.2	3.7	10.0	4.0	4.8
1910 do	5.4	1.7	5.4	5.0	5.2	13.5	3.8	5.4
1911 do	0	0	0	0	0	0	0	0
1912 do	9.0	12.0	15.8	14.5	8.5	13.1	11.2	15.8
1913 [1] do	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
1914 do	15.2	3.7	18.5	18.8	17.3	18.5	11.7	18.5
Average	6.9	4.3	8.9	8.3	6.9	11.0	6.1	8.9
Crop value, cost of production, etc.:								
Value of crop	$2.83	$1.76	$3.65	$3.40	$2.83	$4.51	.....	.....
Cost of production	6.46	5.99	4.65	5.45	7.07	11.40	.....	.....
Loss	−3.63	−4.23	−1.00	−2.05	−4.24	−6.89	.....	.....

[1] Destroyed by hail.

DALHART FIELD STATION.

Persistent attempts have been made for six years to grow barley at the station at Dalhart, Tex. The crop has been lost in the different years by hail, drought, and soil blowing.

In only two years have any yields been obtained. If this record is indicative of average conditions, as it is believed to be, it would show that spring-sown barley has no place in the farm practice of this section.

TABLE XVII.— *Yields and cost of production of barley by different methods at the Dalhart Field Station, 1909 to 1914, inclusive.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).						Average.
		1909	1910	1911	1912	1913	1914	
Fall plowed: Barley	1	0	(1)	0	(1)	0	15.6	3.9
Spring plowed:								
Barley	1	0	(1)	0	(1)	0	7.7	1.9
Oats	1	0	(1)	0	(1)	0	.....	.....
Total or average	2	.....	.....	.....	.....	.....	7.7	1.9
Listed: Barley	1	0	(1)	0	(1)	0	17.6	4.4
Disked: Corn	3	0	(1)	0	(1)	0	6.4	1.6
Summer tilled	1	7.5	(1)	0	(1)	0	18.1	6.4
Average of all 8 plats	.....	1.3	.....	.....	.....	.....	13.1	3.6

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.					Previous crop.	
	Fall plowed (1 plat).	Spring plowed (2 plats).	Disked (3 plats).	Listed (1 plat).	Summer tilled (1 plat).	Small grain (4 plats).	Corn (3 plats).
Yields of grain:							
1909.....bushels..	0	0	0	0	7.5	0	0
1910.....do....	(1)	(1)	(1)	(1)	(1)	(1)	(1)
1911.....do....	0	0	0	0	0	0	0
1912.....do....	(1)	(1)	(1)	(1)	(1)	(1)	(1)
1913.....do....	0	0	0	0	0	0	0
1914.....do....	15.6	7.7	6.4	17.6	18.1	13.6	6.4
Average	3.9	1.9	1.6	4.4	6.4	3.4	1.6
Crop value, cost of production, etc.:							
Value	$1.60	$0.78	$0.66	$1.80	$2.62	.....	.....
Cost	6.46	5.99	4.65	5.45	11.40	.....	.....
Loss	−4.86	−5.21	−3.99	−3.65	−8.78	.....	.....

[1] Destroyed by hail.

AMARILLO FIELD STATION.

The results with barley at Amarillo, Tex., have been tabulated for six years; 1910 is not included, owing to the necessity of changing the location of the farm. The crop of that year was the first from prairie sod and was raised on land uniform in its preparation for all plats. While there was some growth of straw, a crop of grain did not mature. Three of the six years under study were productive of much better average yields than the other three. During two years the crop was practically a failure by all methods. In the remaining year one method, summer tillage, gave a yield of 17.5 bushels per acre, while most of the other methods were failures. On the average, there appears to have been no increase in yields from subsoiling, from listing instead of plowing, or from raising the barley on disked corn ground.

The only method that has consistently shown increases sufficient to attract attention is summer tillage. Under this method barley has given an average yield for six years of 12.6 bushels per acre, with a maximum yield in any one year of 19.6 bushels per acre. On the whole, barley does not seem to offer more promise for this section than any other of the spring-sown small grains.

A loss by all methods under trial has attended the growth of the crop. These losses range from $1.94 on disked corn ground to $6.23 on summer-tilled land.

TABLE XVIII.— *Yields and cost of production of barley by different methods at the Amarillo*[1] *Field Station for 1908, 1909, and 1911 to 1914, inclusive.*

Treatment and previous crop.	Number of plats averaged.	Yield per acre (bushels).						
		1909	1910	1911	1912	1913	1914	Average.
Fall plowed: Barley	1	13.2	5.8	11.7	1.7	0	16.7	8.2
Spring plowed:								
Barley	1	7.9	0	12.2	2.7	0	21.0	7.3
Oats	1	8.1	0	12.3	1.1	0	2.7	4.0
Average	2	8.0	0	12.3	1.9	0	11.9	5.7
Listed: Barley	1	10.8	0	11.4	1.5	0	13.1	6.1
Subsoiled: Barley	1	11.9	0	10.3	1.5	0	17.1	6.8
Disked: Corn	1	7.5	0	11.8	1.7	0	18.8	6.6
Summer tilled	1	15.2	17.5	15.0	4.2	4.2	19.6	12.6
Average of all 7 plats		10.7	3.3	12.1	2.1	.6	15.6	7.4

SUMMARY OF YIELDS AND DIGEST OF COST.

Yields, values, etc. (average per acre).	Tillage treatment.						Previous crop.	
	Fall-plowed (1 plat).	Spring-plowed (2 plats).	Disked (1 plat).	Listed (1 plat).	Subsoiled (1 plat).	Summer-tilled (1 plat).	Small grain (5 plats).	Corn (1 plat).
Yields of grain:								
1908 bushels	13.2	8.0	7.5	10.8	11.9	15.2	10.4	7.5
1909 do	5.8	0	0	0	0	17.5	1.2	0
1911 do	11.7	12.3	11.8	11.4	10.3	15.0	11.6	11.8
1912 do	1.7	1.9	1.7	1.5	1.5	4.2	1.7	1.7
1913 do	0	0	0	0	0	4.2	0	0
1914 do	16.7	11.9	18.8	13.1	17.1	19.6	14.1	18.8
Average	8.2	5.7	6.6	6.1	6.8	12.6	6.5	6.6
Crop value, cost of production, etc..								
Value	$3.36	$2.34	$2.71	$2.50	$2.79	$5.17	.....	.....
Cost	6.46	5.99	4.65	5.45	7.07	11.40	.....	.....
Loss	−3.10	−3.65	−1.94	−2.95	−4.28	−6.23	.....	.....

[1] The location of the station was changed in 1910, and the records for that year were not used.

GENERAL DISCUSSION OF RESULTS.

In the preceding pages the data have been presented and discussed for each station separately. In the following pages some of the more important phases are discussed from a more general standpoint.

To facilitate this study, Table XIX has been prepared, bringing together for each station the average yields as grouped for this study under different methods of preparation, and also assembling the data from the tables of yields and cost of production in such a way as to show the profit or loss in dollars and cents per acre for the average crop by each method for which it has been computed at each station.

Table XIX shows that the yields at Belle Fourche, Garden City, Dalhart, and Amarillo have been markedly lower than at the 10 other stations. While some methods have increased the yields at these stations, they have not brought them up to a point that offers much encouragement for the growth of barley. The only profit shown from any method under study at these stations is one of 35 cents per acre from disked corn ground at Belle Fourche. This nominal profit has resulted from the low cost of production rather than from the amount of yield. The indications are that the combination of soil and climatic conditions at these stations is not favorable to the growth of barley, nor can the unfavorable conditions be overcome by cultural practices.

TABLE XIX.—*Comparison of the average yields and profit or loss in the production of barley by different methods of tillage at fourteen stations in the Great Plains area.*

Statement of data.	Number of years averaged.	Methods of tillage.						
		Fall plowed.	Spring plowed.	Listed.	Subsoiled.	Disked.	Green manured.	Summer tilled.
Yields per acre (bushels):								
Judith Basin	5	24.0	24.0	29.0	30.5	29.0	.....	30.2
Huntley	2	.....	29.6	.....	.....	34.5	43.8	.....
Williston	5	17.4	16.1	.....	.....	27.5	.....	28.8
Dickinson	6	25.1	24.6	.....	.....	37.4	.....	32.5
Edgeley	8	16.7	18.5	.....	.....	23.4	.....	20.0
Hettinger	3	19.9	25.5	.....	.....	14.9	.....	31.8
Belle Fourche	6	7.6	8.3	7.7	8.0	12.2	.....	12.6
Scottsbluff	2	14.0	15.4	14.4	15.0	18.6	.....	27.6
North Platte	8	17.1	15.9	.....	.....	13.4	.....	26.7
Akron	6	18.6	18.8	17.9	14.0	18.4	.....	24.8
Hays	6	13.6	11.2	12.7	14.6	14.1	15.5	19.3
Garden City	5	6.9	4.3	8.3	6.9	8.9	.....	11.0
Dalhart	4	3.9	1.9	4.4	.....	1.6	.....	6.4
Amarillo	6	8.2	5.7	6.1	6.8	6.6	.....	12.6
Profit or loss (−) per acre:								
Judith Basin	5	$3.38	$3.85	$6.44	$5.44	$7.24	.....	$0.98
Huntley	3	.....	6.15	.....	.....	9.50	$3.45	.....
Williston	5	.67	.61	.....	.....	6.63	.....	.41
Dickinson	6	3.83	4.10	.....	.....	10.68	.....	1.93
Edgeley	8	.39	1.60	.....	.....	4.94	.....	−3.20
Hettinger	3	1.70	4.47	.....	.....	1.46	.....	1.64
Belle Fourche	6	−3.34	−2.59	−2.29	−3.79	.35	.....	−6.23
Scottsbluff	2	− .72	.32	.45	− .92	2.98	.....	− .08
North Platte	8	.55	.53	.....	.....	.84	.....	− .55
Akron	6	1.17	1.72	1.89	−1.33	2.89	.....	−1.23
Hays	6	− .88	−1.40	− .24	−1.08	1.13	−8.15	−3.49
Garden City	5	−3.63	−4.23	−2.05	−4.24	−1.00	.....	−6.89
Dalhart	4	−4.86	−5.21	−3.65	.....	−3.99	.....	−8.78
Amarillo	6	−3.10	−3.65	−2.95	−4.28	−1.94	.....	−6.23

Table XIX also shows that at 10 of the 14 stations under study disked corn ground has been productive of higher yields of barley than either the fall or spring plowing of stubble. At Hettinger and North Platte it has been clearly exceeded by both. At Akron it

has been exceeded by both, but the differences among the three are only fractions of a bushel. At Amarillo disked corn land has been between fall-plowed and spring-plowed stubble in yield Its low cost of production has made it the most profitable method under trial at all stations except Hettinger. It has been productive of a profit at all stations except Garden City, Dalhart, and Amarillo. This study, dealing with but one crop, does not consider the relative profitableness of other crops in the farming system.

It should be borne in mind that at all stations disking corn ground as a preparation for all small grain crops has been done upon corn land kept free from weeds. If weeds were allowed to develop in the corn, similar results should not be expected. To the extent that the weeds developed or were unhindered in their growth, just so far would the corn ground approach a grain stubble in the condition of the seed bed. If the weeds matured seed, further damage by their growth might be done to the succeeding crop.

Preparing the ground with a lister instead of a plow has been practiced at eight stations. At only one station, Judith Basin, were the yields very materially different from those on fall-plowed land. But, as has been pointed out, the yields on fall-plowed land at that station were lowered somewhat by damage done by gophers. At the other stations, though it did not in all cases give higher yields than plowing, it showed, owing to a lower cost of preparation, slightly more profit where profits are shown and less loss where losses are shown than plowing.

The difference between spring and fall plowing is largely one of season. In the average of the 13 stations at which both were under trial there is practically no difference. At only three stations is there a difference of over 2 bushels per acre. At the four more southern stations the advantage has been with fall plowing. This is the only consistent territorial difference to be noted in the comparison of these two methods, but production at these four stations and at Belle Fourche has resulted in a loss by both methods. Spring plowing shows a profit at all other stations, and fall plowing shows a profit at all others except Scottsbluff.

Subsoiling in preparation for the barley crop has been practiced at seven stations. At only two of these has the consequent yield departed far from that on fall-plowed land. At the Judith Basin station there has been a marked gain and at Akron a marked decrease. In the average of the seven stations the yield from this method has been only 0.4 of a bushel more than from fall plowing. The cost of the method has been such that it has paid a profit at only the Judith Basin station.

The highest average yields at eleven of the fourteen stations have been by summer tillage. At the Judith Basin station subsoiled land

has yielded a fraction of a bushel higher. At Dickinson and Edgeley the yields on disked corn ground have been appreciably higher than on summer tilled-land. While the averages of all the stations are not strictly comparable, summer tillage has increased the yield over the fall plowing and the spring plowing of cropped land nearly one-half. The average increase over disked corn ground has not been nearly so great.

These increases in yields have not been in proportion to the increased cost of the method. In no case has summer tillage been the most profitable method under trial. As values and costs are here figured, this method shows a profit at only four stations, Judith Basin, Williston, Dickinson, and Hettinger. At Scottsbluff, North Platte, and Hays the losses have been small. At the other seven stations they have been sufficiently great to discourage hope of changing them to profits by the extension of the record or by an adjustment of value or cost.

Green manuring for barley has been tried at only two stations, Huntley and Hays. At Huntley, where it was in comparison with only spring-plowed land and disked corn ground, it gave the highest average yield. This average is the highest resulting from any method at any station. The record, however, is for only two years. At Hays its yield has been greater than that on land from which a crop was harvested, but not as high as that on summer-tilled ground.

On the whole, differences in climatic conditions of different seasons have produced much wider variations in yields than have resulted from differences in cultivation. Some seasons have a combination of climatic factors so adverse as to produce failures by all methods of tillage at some stations. Other seasons have conditions so favorable that any and all methods of tillage produce good crops. Still other seasons prohibit production by some methods, but allow it with others. The greater the number of years averaged the more nearly will the final figure represent average seasonal conditions. This longer average will also tend to reduce the wide differences that may result between methods during some seasons especially favorable to some particular method. No method so far tried, however, has been able to overcome the extremely unfavorable conditions which sometimes exist.

CONCLUSIONS.

(1) Differences in the climatic conditions of different seasons have caused much wider variations in yields than have resulted from differences in cultivation.

(2) Yields at Belle Fourche, Garden City, Dalhart, and Amarillo have been markedly lower than those obtained at the other field

stations. The only profit shown at any of these stations is 35 cents an acre on disked corn ground at Belle Fourche.

(3) The highest average yields at eleven of the fourteen stations have been by summer tillage. On the average, it increased the yields nearly one-half over those produced on land cropped in the preceding year. On account of its cost it has not been the most profitable method of production.

(4) At ten of the fourteen stations under study disked corn ground produced higher yields than from either the fall plowing or the spring plowing of barley stubble. It has been the most profitable method under trial at all the stations except Hettinger.

(5) The relative advantage of either fall or spring plowing is largely dependent upon the season. In the general average of the thirteen stations at which each method has been tried there is practically no difference. At only three stations has there been an average difference of over 2 bushels per acre between the two methods. At the four more southern stations fall plowing has been better than spring plowing.

(6) At the seven stations where subsoiling for barley has been tried it has produced an average of only 0.4 of a bushel more than fall plowing. At only two stations has there been a marked difference in the results of the two methods. At one of these, subsoiling has been responsible for an increase and at the other for a decrease in yield.

(7) At eight stations listing instead of plowing has been tried. While the resulting yields have not been materially different from those on fall-plowed land, the lower cost of listing has made it the more profitable method.

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