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DEPARTMENT OF CHEMISTRY

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OF
Some Eastern Wheats in Idaho

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PERFORMANCE RECORDS OF SOME EASTERN WHEATS IN IDAHO

By J. S. Jones and C. W. Colver

INTRODUCTION

In all wheat-producing countries, two factors—yielding capacity and quality of grain for milling purposes—determine the relative standing of wheat varieties. Growers are continually looking for varieties that can be depended upon to increase yields. Prices being equal, the greater the yield the greater the returns for capital and labor invested in producing and marketing the crop. Millers and shippers attach greater importance to quality of grain for milling purposes and are frequently active in introducing and urging the growing of varieties whose principal recommendation is a higher value for milling purposes than is possessed by others more commonly grown. They are in a position to penalize to a certain extent the grower who goes too far in sacrificing quality for quantity, because of the demand that is ever present locally for high-grade flour and because of the competition between buyers for large milling firms which must have wheat of the best quality to meet the demand of their retail trade for the strongest flour obtainable.

In the very general ability of flours made from hard wheats to make large, shapely, "well-piled" loaves of light bread lies the fundamental reason for the universal demand in the milling world for larger and larger quantities of these wheats of both the red and white classes for milling purposes. In the inability of flours made from soft wheats to make loaves possessed of these characteristics to a satisfactory degree lies the fundamental reason for the impatience shown toward them and the tendency on the part of buyers for large milling centers to distinguish sharply in price between the hard and the soft wheats. The precise combination of physical and chemical characteristics which determine the ability of flours to make large, shapely, "well-piled" loaves unfortunately is not known with absolute accuracy but beyond question protein content is a factor of so much

importance that within classes and varieties of the bread wheats, samples may be roughly arranged in the order of their milling or bread-making values on the basis of their protein content. It is highly important that protein content be maintained at a high level in all wheats intended for milling purposes if the manufactured flour is intended for the making of light bread. Richness in protein is coincident with hardness of kernel and for that reason protein determinations occupy a prominent position in any line of investigation that has for its object the placing of relative milling values upon varieties and samples produced in the course of work in wheat improvement or in following the behavior of the hard wheats when grown under new and untried environments.

Among varieties, hardness and softness of kernel and corresponding richness in protein are generally recognized as inherited characteristics. So also is capacity for yield. The first-mentioned characteristics, however, are perhaps more susceptible to changes with changes in the common environments of growth, such as climate and soil. Hence in every wheat-growing district where the manufacture of flour for the making of light bread is the end in view, questions relative to factors of growth which make for or against high protein content are scarcely less important than those which make for or against high yield. Fortunate indeed is that wheat-producing section whose leading varieties are not only capable of a satisfactory performance in the estimation of growers from the standpoint of yield but are equally satisfactory to millers from the viewpoint of quality! Broadly speaking, that combination in the United States prevails uniformly only in what has come to be recognized as the hard spring-wheat and the hard winter-wheat districts of the northern and middle western states—districts which set the standard for milling wheats the country over.

Vast quantities of wheat are produced in the intermountain and Pacific coast states—the so-called irrigated and white-wheat districts—and the acreage within these districts devoted to wheat growing is constantly increasing. There are perhaps no other wheat-growing districts in the United States where a larger number of both fall and spring-sown varieties are grown, or where so many varieties are grown indiscriminately as both winter and spring wheat, or where greater changes are seen in climatic and soil environments, and therefore, in yield and quality of grain for milling purposes, as one passes from one wheat-growing section to another. The crop is grown at eleva-

tions ranging from a few hundred feet to six thousand or more, with irrigation and without irrigation under rainfall ranging from ten to twenty-five inches, in sections where extremes of temperature occur between winter and summer, in sections where frosts may be expected almost any month of the year and in sections where winter temperatures rarely go below freezing and high summer temperatures prevail, on sandy soils and clay soils and on all types of soil intervening, on soils rich in limestone and on soils acid in reaction to litmus, on soils rich in alkali salts and on soil practically devoid of alkali salts, on raw sagebrush soils and on soils of the same type enriched with organic matter from the growing of clover and alfalfa, on timber soils and on soils of the open prairie type. When one takes note of these facts together with the strong tendency on the part of growers in these districts to give preference to the soft white wheats thru indifference or in the belief that they are capable of the most satisfactory performance in the matter of yields, it is not at all strange that in the markets of the world where wheat-growing districts come to be designated by the physical characteristics of the major portion of their marketed crops, these districts have come to be known as the producers of wheats relatively low in milling values and that flour manufactured from them is absorbed largely by markets whose retail trade cares but little for strength in wheat flour or by markets whose retail trade cannot afford to pay the price strong flours command. Nor is it strange that here and there within these districts, unless as a section they have become known, growers of really hard wheats have seen their crops absorbed without adequate compensation for the enterprise, foresight and skill exercised in producing them.

When work was commenced at the Idaho Station a few years ago which had for its ultimate object the determination of factors which control protein formation in the wheat kernel, extremely pessimistic views prevailed among the millers and growers of wheat regarding the possibility of producing really hard wheats or wheats of high protein content in the northwest. The argument advanced was that when introduced, because of unfavorable climatic or soil conditions or a combination of both, varieties known elsewhere as hard wheats quickly lost their characteristic hardness and were then of no greater value for milling purposes and sold for no more in the open markets than other well-established varieties that were at least fairly satisfactory for local consumption and for sale on markets where

they did not come into keen competition with the hard wheats. Indeed it was claimed that these introduced varieties sometimes were cut in price because of their peculiar spotted appearance which to both growers and millers was an outward evidence of deterioration in milling quality. There was a great deal of evidence to support the argument advanced, but it was foreseen that in the increasing diversity of conditions under which wheat would be grown in these districts there was danger that a statement too general in character was being formulated regarding possibilities in raising the milling value of the wheat crop as a whole thru the introduction of well known and thoroly tested varieties of hard wheats. After a thoro investigation of the wheat-growing sections of the State, there appeared to be no adequate reason why at least some of them should not repeat the experience of Kansas and Nebraska where the thoro displacement of the soft wheats with hard ones was an event of comparatively recent occurrence. In any event earnest attempts to improve milling quality might result in bringing to the front, in those sections where the hard red varieties proved unsatisfactory, the harder varieties belonging to the white class which do not generally exhibit under favorable conditions of growth the much despised spotted appearance exhibited by deteriorating hard red wheats. There is now abundant evidence that extensive areas of wheat lands in Idaho are capable of producing hard wheats that will hold their own in competition with the best product of the hard-wheat districts of the middle western states and that almost any of the wheat-growing districts of the State can produce with success the harder white wheats or white wheats much richer in protein than many that are now being grown.

EXPERIMENTAL

The plan of work for testing out the behavior of hard wheats when grown under the varying conditions peculiar to Idaho was not elaborate. It involved only the bringing into the State the varieties chosen, growing them under the different conditions of soil and climate year after year, harvesting and threshing them in the usual manner of the sections in which they were grown, grinding in a small roller mill of lots reserved for milling purposes, performance of analytical work on wheat and flour samples, and the baking of light bread from the different lots of flour secured in the milling work.

The varieties chosen were those which at the time the work was started were most prominent in the states from which they were obtained and unquestionably set the standard for milling wheats in those states. The Turkey Red variety was obtained from the Fort Hays branch of the Kansas Experiment Station and from the North Platte branch of the Nebraska Experiment Station. A strain of the same variety found growing near Genesee, this state, was also secured. These strains of Turkey Red wheat will hereafter be referred to as the Kansas, Nebraska and Idaho Turkey Reds. Minnesota Bluestem (Minnesota No. 169) and Glyndon Fife (Minnesota No. 163) were secured from the Minnesota station from seed grown at University Farm.

It will be noted that this selection of varieties includes one winter and two spring varieties. They were introduced on the central station at Moscow first, the Turkey Reds from Kansas and Nebraska in the fall of 1908, the Bluestem and Fife in the spring of 1909. The Idaho strain of Turkey Red was first grown on the station farm in 1907. As opportunity offered they were sent from the central station to the substations. After introduction they were maintained on the different farms from locally grown seed retained at harvest time. One other variety, Marquis, might have been introduced with profit and there might also have been a wider distribution of the varieties chosen. Our attention at that time had not yet been sharply directed towards the Marquis variety and working conditions on the substations prevented earlier and more extended distribution of seed. Up to this time the several strains of Turkey Red and Bluestem and Fife have been grown at the central station where conditions of climate and soil are typical of a large portion of that wheat-producing section of the northwest locally known as the Palouse, at the Aberdeen substation where conditions fairly represent large areas of irrigated and dry-farmed land of the higher altitudes in the Snake river plains, and at the Clagstone substation under soil and climatic conditions as adverse perhaps as can be found in any section of the State, for the soil there is of the gravelly silt loam type which is peculiar to a section that extends across the 'Panhandle' in northern Kootenai and southern Bonner counties, and the climate is raw and cold during much of the growing season because of the nearness of snow-covered mountains. The Bluestem and Fife have been grown at the central station and at the Aberdeen and Gooding substations; at Aberdeen under both dry-farmed and irrigated conditions and at Gooding under irrigated conditions only.

YIELDS

At the time these varieties were introduced our principal concern was with their ability to maintain in their new environment their characteristic hardness and their very satisfactory content of protein. Their relative capacity for yield was a matter of secondary importance. It is possible, however, from the records of the Department of Farm Crops of the central Experiment Station and from the annual reports of the superintendents of the substations, to record yields that are fairly indicative of the relative yielding capacity of these wheats and the more prominent varieties of the white classes. Advantage was taken of this fact in compiling Table I.

TABLE No. I.— Wheat Yields in Bushels per Acre Reported by the Department of Farm Crops for the Central Station at Moscow.

Varieties	1910	1911	1912	1913	1914	1915	1916	Average
Winter								
Turkey Red, Idaho	.....	40.3	43.3	28.0	38.0	43.3	64.5	42.9
Turkey Red, Kansas	.....	43.5	39.0	21.6	38.0	42.1	69.5	42.3
Turkey Red, Nebraska	.....	47.5	49.0	22.6	38.0	48.3	64.3	44.9
*Turkey Red	41.6	.....	49.0	29.2	32.7	49.1	.....	40.3
Red Russian	32.6	47.6	49.6	32.0	38.2	51.3	55.8	43.9
Little Club	40.8	50.9	.....	.....	.....	41.7	32.1	41.4
Forty Fold	48.9	37.2	46.2	.....	23.0	32.6	.....	37.5
Spring								
Minnesota Bluestem (Minn. No. 169)	29.0	28.0	49.0	35.2	25.3	30.0	51.4	35.4
Glyndon Fife (Minn. No. 163)	33.1	30.3	47.8	34.8	24.2	36.1	55.8	37.4
Palouse Bluestem	38.6	29.2	47.2	37.1	22.0	34.3	57.9	38.0
Little Club	31.5	34.1	48.8	43.0	23.3	.....	52.8	38.9
Sonora Red Chaff	34.9	27.9	33.7	35.0	20.3	25.4	47.3	32.1
Marquis	.....	.....	.....	.....	19.5	31.7	53.1	34.8

*Grown independently by the Department of Farm Crops.

TABLE No. I. (*Continued*)—Comparative Yields in Bushels Per Acre Reported by the Superintendent of the Aberdeen Substation.

Varieties	1913	1914	1915	1916	Average
Irrigated: Fall-sown					
Turkey Red, Idaho	29.5	38.0	39.6	43.3	37.6
Turkey Red, Kansas	25.6	28.4	35.1	55.2	36.1
Turkey Red, Nebraska	28.8	27.8	36.0	46.6	34.8
Irrigated: Spring-sown					
Haynes Bluestem (Minn. No. 169)	36.0	27.4	35.1	.....	32.8
Galgalos	36.6	38.0	.....	.....	37.3
Palouse Bluestem	42.0	38.9	60.3	54.0	48.8
Early Baart	.....	38.8	31.5	54.0	41.4
Dicklow	61.5	38.0	56.7	52.0	52.1
Little Club	41.3	36.6	49.8	50.0	44.4
Defiance	55.6	41.2	47.9	48.0	48.2
Hybrid No. 143	.....	39.4	49.5	.....	44.4
Marquis	33.3	38.9	56.7	52.0	45.2
Minnesota Bluestem (Minn. No. 169)	.....	40.3	42.3	34.6	39.1
Glyndon Fife (Minn No. 163)	.....	42.3	49.0	41.3	44.2
Dry Farmed: Fall-sown					
Turkey Red, Idaho	14.5	25.3	10.6	9.8	15.1
Turkey Red, Kansas	20.8	35.1	15.3	23.0	23.6
Turkey Red, Nebraska	17.6	30.0	8.5	20.5	19.2
*Turkey Red	22.3	32.8	20.0	6.3	20.4
Alberta Red	19.2	36.2	20.7	.....	25.4
Gold Coin	17.4	33.9	18.9	3.7	18.5
Koffoid	.....	23.3	12.5	.....	17.9
Dry Farmed: Spring-sown					
Minnesota Bluestem (Minn. No. 169)	.....	13.2	5.4	8.0	8.9
Glyndon Fife (Minn. No. 163)	.....	6.4	4.5	9.0	6.6
Palouse Bluestem	.....	27.5	9.0	12.3	16.3
Early Baart	.....	31.1	7.5	9.7	16.1
Dicklow	.....	18.3	6.3	7.3	10.6
Little Club	.....	22.9	7.2	8.3	12.8
Defiance	.....	19.7	6.3	8.6	11.5
Hybrid No. 143	.....	19.7	2.7	.....	11.2
Marquis	.....	21.5	6.3	11.3	13.0

* Grown independently by the Superintendent.

It will be noted that at the central station the three strains of Turkey Red under test varied somewhat in the different years in the matter of yield but for the term of years differences in average yields are small. The average of each of the three strains for the six years is somewhat higher than the average

yield of the strain of Turkey Red grown independently by the Department of Farm Crops for five years. Red Russian, a soft red wheat, is credited by the Department of Farm Crops, and by wheat growers in the Palouse country generally, as being among the heaviest if it is not the heaviest yielding variety of winter wheat grown in north Idaho. It is evident from the data recorded on yields that Turkey Red under conditions which prevail in the Palouse is a close second to it, Little Club and Forty Fold following very closely in the order named.

At the Aberdeen substation no other varieties of winter wheat, red or white, have been grown extensively under irrigation. In the surrounding country too, the common practice is to give preference to spring wheats on irrigated farms. In view of the fact that the Aberdeen station during the years these yields were being secured was being reduced from the raw sage brush condition to one of cultivation wherein soil improvement has not yet figured largely, the yields secured there under irrigation must be regarded as very satisfactory. Moreover, altho these strains of Turkey Red wheat have never been grown on the Gooding substation, the Turkey Red variety from other seed has been grown on that station. In a two years' variety test of winter wheat conducted on that station by its superintendent Turkey Red stood second with an average yield of 52.4 bushels per acre as against 53.6 bushels for Jones' Fife, the highest-yielding variety, and 42.8 bushels for Koffoid, the next highest-yielding variety. Superintendent Welch in Bulletin No. 93 of the Idaho Experiment Station expresses the belief that winter wheat can be grown to advantage on at least a portion of the irrigated lands of south Idaho, especially in sections where the supply of water is likely to be somewhat deficient. For such localities he especially recommends that Turkey Red should be given first consideration.

On the dry-farm portion of the Aberdeen station, only the data recorded by Superintendent Aicher for the strain of Turkey Red grown independently by him are strictly comparable with data recorded by him for the yields of other varieties of winter wheat. The Idaho, Kansas and Nebraska strains were grown on larger plats on portions of the farm more or less distant from those given over to strictly variety tests. In taking note of yields recorded for the dry farm, it is to be remembered that it, too, during the years mentioned was being reduced from the raw sagebrush condition to one of cultivation wherein it has been impossible up to this time to take advantage of the possi-

bilities of soil improvement by rotation with such crops as alfalfa or sweet clover. It is, moreover, not out of place to note here that in 1915 and 1916 much heavier yields than those recorded in Table I for these varieties were secured from what is called rowed-culture wheat, wheat sown in rows twenty-one inches apart to permit of spring and early-summer cultivation. Turkey Red unquestionably in the dry-farm sections of this State will give an entirely satisfactory accounting in the matter of yields in comparison with well-known varieties belonging to the white classes of winter wheat. Superintendent Aicher of the Aberdeen station recommends that it be given preference over all other varieties of winter wheat on the dry farms of south Idaho.[a]

No record of yields was possible for the several crops of Turkey Red grown on the Clagstone substation because of the lack of suitable threshing machinery. Seed and samples for milling were secured by use of the flail and the fanning mill.

Rigid comparisons of yields obtained with the Minnesota Bluestem and Glyndon Fife are not possible for either the central station or the substations. These varieties altho grown by the Department of Farm Crops at the central Experiment Station were never grown by that department in variety tests, strictly speaking, nor have they been grown by the superintendents of the substations in variety tests. On the central station and the substations they were frequently grown under somewhat different conditions as regards soil and irrigation than prevailed on other portions of the farms where variety tests were conducted. Nevertheless reasonable comparisons in the matter of yield are possible for the central station with Palouse Bluestem, Little Club, and Sonora Red Chaff, all varieties belonging to the white classes. In order of yield from highest to lowest, they arrange themselves as follows: Little Club, 38.9 bushels; Palouse Bluestem, 38 bushels; Glyndon Fife, 37.4 bushels; Minnesota Bluestem, 35.4 bushels; Sonora Red Chaff, 32.1 bushels. In view of the heavy yields recorded in 1916 for other varieties of white wheat as Jenkins' Club, Defiance, and Early Baart, it is probably safe to state that these two varieties of hard red wheat, Minnesota Bluestem and Glyndon Fife, are not

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a Farmers' Bulletin No. 769 "Growing Grain on Southern Idaho Dry Farms."

quite the equal in capacity for yield of several varieties belonging to the white classes all prominent in north Idaho.

Under the conditions prevailing on the dry farm at Aberdeen, in the matter of yield, these hard red spring wheats do not show up well in comparison with several of the heavier-yielding varieties belonging to the white classes. Whether they are capable of making a better showing under less adverse conditions of soil can be conjectured only. It is well to note again that they are being grown on the Aberdeen station on what is practically still raw sagebrush soil. The other varieties mentioned have had some advantage in the matter of soil improvement derived thru rotations. If one notes in this connection the yields recorded for Marquis which are strictly comparable with those recorded for white wheats, it is apparent that heavy yields under dry-farm conditions are not necessarily peculiar to wheats of the white class.

Under irrigation on the Aberdeen station fortunately the superintendent has grown one of these varieties independently in his variety tests under the name Haynes Bluestem but from seed of a different origin. Yields per acre have been calculated from actual yields obtained from 1-54 acre plats. The average yield reported for 1913, 1914 and 1915 is decidedly less than the average yield reported for Minnesota Bluestem and Glyndon Fife grown on 1-10 acre plats for the Department of Agricultural Chemistry. From the data given, it is apparent that several varieties of white wheats are heavier yielders under irrigation, but again, if the yields for Marquis, which are strictly comparable with the yields for the white wheats, are considered, it would seem that under conditions which prevail in the Aberdeen section under irrigation the heaviest yields are not necessarily peculiar to varieties belonging to the white class.

On the Gooding substation the average yields of these two varieties of hard red spring wheat under irrigation for the three years, 1914 to 1916 inclusive, were 41.6 and 36.4 bushels per acre respectively for Glyndon Fife and Minnesota Bluestem. Fortunately in the variety tests of spring wheats conducted on the Gooding station during the years 1909 to 1916 inclusive, two hard red spring wheats are represented, Marquis and Saskatchewan Fife. Marquis heads the list with an average yield for four years of 53.2 bushels per acre. It is followed by Dicklow, College Hybrid No. 143, Saskatchewan Fife, Defiance, Palouse Bluestem, and Galgalos in the order named with 46.1 bushels

per acre as an average for six years, 43.8 bushels for three years, 41.6 bushels for three years, 39.4 bushels for five years, 37.6 bushels for four years, and 35.3 bushels for four years respectively.

From the best information obtainable, then, it would seem that in capacity for yield these two varieties of hard red spring wheat under conditions that prevail in the irrigated sections of the Snake River valley probably are excelled by two or three varieties belonging to the white classes. In comparison, however, they rank well, and moreover the fact must not be overlooked that a variety belonging to the hard red class ranks first in extensive variety tests of spring wheats conducted on the Gooding substation.

In summation of this portion of the work it may with fairness be stated that the Turkey Red variety has a capacity for yield that warrants its favorable consideration from that standpoint under all conditions thus far tried out in Idaho. It probably shows up best in comparison with other varieties in sections of limited rainfall—the so-called dry farm sections of the State—and in the irrigated sections where only a limited amount of irrigation water is available. The one weakness of Turkey Red is its inability to stand up under conditions of soil and climate which induce rank growth. In point of yield the two hard red spring varieties introduced show up splendidly, comparatively speaking, under all conditions under which they have been grown, with the possible exception of those which prevail on the dry farms of the Snake River plains. In view of the fact that Marquis, a hard red spring variety grown independently by the Department of Farm Crops of the central station and by the superintendents of the substations, shows in comparison with these and in comparison with other varieties belonging to the white wheat classes, some remarkably good yields, the statement is warranted that the hard red spring wheats are not necessarily decidedly inferior in this State to the white wheats in the matter of yield.

MILLING DATA—FLOUR YIELDS

From the time of their introduction, milling data on yields of flour, bran, and shorts have been kept. Their importance in connection with this report hardly warrants their presentation. It will be sufficient merely to state that these hard wheats are remarkably easy to grind and readily permit of a good clean-up of bran and shorts. The same cannot be said of the white

wheats, particularly of the soft varieties. Yields of flour ranging from seventy to seventy-five per cent on the Turkey Reds and from sixty-seven to seventy-two percent on the spring wheats were the rule. One grade of flour only was made from each lot of wheat ground. It may be called a straight grade and consisted of the entire amount of flour loosened in the process of grinding and reduction. It was bolted thru the finest silks of the bolting machine.

EXAMINATION OF WHEAT AND FLOUR

At harvest time samples of each variety and strain were reserved at the several stations for the analytical and milling work. Samples sufficiently large for milling and representative of the 1914, 1915 and 1916 crops grown at Fort Hays, Kansas, North Platte, Nebraska, and University Farm, Minnesota, from which places seed was originally introduced into Idaho, were also secured. Inasmuch as our concern is mostly with the quality of grain as indicated by physical tests and its content of protein, in Table II are recorded only results from weight of grain and from determinations of moisture and crude protein in grain and flour. The figures represent graphically the percentage of protein of the wheat samples reduced to a moisture-free basis.

At any one station under the same conditions of growth, differences between the different strains of Turkey Red in weight per thousand kernels and in weight per bushel were so small as to be of practically no significance. Wheat grown in north Idaho under climatic conditions as nearly humid as any within the wheat-growing sections of the State was practically of the same weight as that grown in the semi-arid climate on the Aberdeen station with irrigation. The samples grown under dry-farm practice at Aberdeen were by far the lightest in weight of all produced in Idaho and approximated rather closely the weights of samples grown at Fort Hays, Kansas. Samples grown at North Platte, Nebraska, were intermediate in weight between those grown at Aberdeen with dry-farm methods and those grown on the same station with irrigation.

At any station under the same conditions of growth, differences in protein content between different strains of Turkey Red and the flours made from them were so small as to be of practically no significance in determining their relative value for milling and bread-making purposes. The dry-farmed wheats and the flours made from them were each year much the highest

of all samples produced in Idaho in protein content. Their average content of protein, too, for the four years they were grown on the dry farm at Aberdeen was greater than the average protein content of the samples secured from Fort Hays and North Platte for three years. The samples grown at Aberdeen with irrigation in 1915 and 1916 are noteworthy in that they were richer in protein than samples grown on the central station at Moscow—those in 1916 substantially so, approaching very closely, in fact, the protein content of the Fort Hays, Kansas, and the North Platte, Nebraska, samples. From all of which it would seem: (1) That Turkey Red produced under dry-farm conditions in this State is entitled to the highest rank in milling centers where Turkey Red of a quality similar to that produced in western Kansas and Nebraska is accepted as the standard for milling wheats; (2) that Turkey Red produced with irrigation is not, contrary to the expressed belief of many millers, necessarily woefully deficient in protein—that most essential constituent of all bread wheats.

Minnesota Bluestem (Minnesota No. 169) and Glyndon Fife (Minnesota No. 163) are so nearly alike, insofar as characteristics under consideration in this connection are concerned, that they need not be separately discussed. It is not out of place to remark again that they for many years have been considered the standard hard red spring wheats of Minnesota and the Dakotas.

In average weight per thousand kernels and in average weight per bushel, the samples grown at Aberdeen under dry farm conditions were much lighter than samples grown on the central station at Moscow or on the Gooding and Aberdeen stations with irrigation. So also with one exception were the average weights of samples grown at University Farm, Minnesota.

Some remarkable and exceedingly important results appear in the tabulation of data on the protein content of the samples under discussion. Those grown on the central station at Moscow were erratic in their content of protein. In 1909 it was practically identical with the protein content of the original seed; in 1910 it was decidedly lower; in 1911, 1912 and again in 1916 it compared very favorably not only with the original seed but with representative samples grown in Minnesota the same years. The average protein content for the eight years was not substantially less than that of the original seed, it being exactly one per cent less in the case of the Bluestem, and .69 per cent in the case of the Fife, with percentages reduced to the dry basis.

The particularly remarkable occurrences in the growth of these hard red spring wheats in Idaho lies in their behavior under irrigation. A study of the results in Table II and of Figures 7, 8 and 9 bring out facts worthy of most careful consideration. The samples returned from the irrigated portion of the Aberdeen station were not only each year substantially richer in protein than the 1913 crop grown at Moscow from which seed was secured for the Aberdeen and Gooding stations but were practically identical in 1914 and 1915 both with the original seed grown at University Farm, Minnesota, in 1908, and with samples shipped from that station as representative of the 1914 and 1915 crops. In 1916 the irrigated samples from the Aberdeen station substantially exceeded in protein both the original seed and the samples grown in Minnesota. The samples returned from the Gooding station at no time in the three years they were grown there fell to the level of the protein content of the original 1908 seed. In 1915 they were practically identical in protein with the samples of the Minnesota-grown crops, but in 1914 and again in 1916 they substantially exceeded in protein the Minnesota samples of the same years and approximated very closely the extremely high protein content of the dry-farm samples at Aberdeen. The protein content of the flour ground from these samples was practically of the same order as that in the wheat in all cases. The logical deduction from these statements is that inasmuch as these wheats were grown at Aberdeen and at Gooding under conditions of irrigation that might easily be duplicated by any wheat grower in those sections of the State, the claim so frequently made that the hard red wheats under irrigation quickly lose the most essential characteristic of hardness—a high protein content—should have less importance attached to it than heretofore.

In this connection it is well worth while to seek an adequate explanation for the occurrences noted above. It lies, we believe, in the fact that on both the Aberdeen and the Gooding stations the constant effort of the superintendents has been in bringing raw sagebrush land to conditions of high fertility to get all experimental plats under a definite system of rotation that is both practical and promising of results when measured in terms of productiveness. Figure 7 clearly shows a uniformly increasing milling value as measured by the rise in protein content of the crops grown at Aberdeen with irrigation. In his report for 1916, the superintendent of the Aberdeen station writes under the heading "Treatment of the Irrigated Land," "A uniform ro-

tation is now in operation on the irrigated land on the Aberdeen station. In this rotation, potatoes follow clover or alfalfa plowed under; cereal varieties follow potatoes; peas follow cereal varieties; clover or alfalfa follow peas and this is turned under in the fall." In conditions thus created for the enrichment of soils naturally deficient in organic matter and in the characteristic activity of nitrifying organisms in semi-arid soils, is sufficient explanation for this extraordinary and unlooked for performance on the part of these wheats. They simply had under the conditions of growth provided them the advantage of an abundance of soil nitrates and made good use of it in the storage of an unusual amount of protein in the grain. This statement is amply justified by results of work conducted on the Gooding station for a number of years which had for its object the determination of fundamental reasons for what is commonly reported as the adverse influence of irrigation on quality of wheat.

An adequate explanation for the exceptionally high protein content of all dry-farmed samples secured in the course of this work cannot be advanced with equal confidence. The explanation may, however, lie in a combination of several facts. Because of their relatively low weight the dry-farmed samples perhaps should not be considered normal in development; a greater proportion of protein to starch and other ingredients of the wheat kernel follows as a natural consequence. The soil of the dry farm has been improved to some extent in organic matter by the application of manures, the practice of rotation, and the turning under of crop residues. During the early part of the growing season soil conditions favor rapid nitrification of organic matter. Perhaps, too, there is an appreciable amount of nitrogen fixation in progress during the growing season. It is to be remembered, however, that the high protein content of these spring wheats from the dry farms has not the same practical significance for wheat growers as has the high protein content of the Turkey Reds grown on the dry farm. For reasons that need not be discussed here, the growing of spring wheat is a practice that is not to be encouraged in the really dry-farmed areas of the State.

LABORATORY BAKING TESTS

The baking of flour samples secured in the course of this work constituted a very appreciable portion of it. It is consid-

ered unnecessary at this time to burden the tables with the baking data inasmuch as they confirm the statements made in former publications relative to the importance of reasonable amounts of gluten in the making of light bread. Very few of the flour samples could be adversely criticised because of failure on their part to make loaves of satisfactory lightness. Those few were ground from the Turkey Reds grown at Moscow and Clagstone. For the most part lightness of loaf was an especially noteworthy characteristic. Flours ground from the samples grown at Clagstone were highly unsatisfactory from another standpoint. Loaves made from them were invariably decidedly unattractive in appearance because of their failure in baking to develop that rich brown color that is so characteristic of a perfectly scoring loaf; no housewife would accept them as the product of good bread flour. It will be remembered that the soil on which the Clagstone samples were grown is perhaps the poorest for grain-growing purposes of any to be found within the State. While lightness of loaf and attractiveness of appearance as a rule go hand in hand, it is apparent from the exceptions that there are some as yet ill-defined factors in flour which contribute to quality in the finished loaf.

SUMMARY.

1. The work reported here is a part of a project undertaken several years ago which has for its object the determination of factors which control protein formation in the wheat kernel.

2. Varieties of hard red wheats were secured for growth in Idaho under widely varying conditions of soil and climate. The varieties chosen are those which set the standard for milling wheats in the northern and middle western states where they are extensively grown.

3. The Turkey Red variety from whatever source secured proved to be highly satisfactory wherever grown from the standpoint of yield in comparison with varieties of the white class. Excepting the crops grown on the dry farm at Aberdeen, the hard red spring varieties proved to be very satisfactory too from the standpoint of yield. It is doubtful, however, if the varieties chosen for this work are the equal of some of the well known varieties of the white class in capacity for yield.

4. Of the Turkey Red samples returned each year for analytical and milling work, those from the dry farm at Aberdeen were much the richest of all in protein. They averaged higher in protein for four years than did samples of the same variety representing three crops grown at Fort Hays, Kansas, and North Platte, Nebraska.

5. Turkey Red grown on the station at Aberdeen with irrigation reached a high level of protein with the crop of 1916 under conditions of growth which point to an intimate connection between the soil's content of available nitrogen and the power of protein elaboration on the part of the wheat plant.

6. A low-protein content need not be characteristic of the Turkey Red variety under irrigation.

7. The protein of the hard red spring varieties grown on the station farm at Moscow varied widely from year to year but the average for eight years was but slightly less than that of the original Minnesota-grown seed.

8. Protein reached its highest level in the hard red spring varieties in crops grown on the dry farm at Aberdeen.

9. Protein was maintained at a high level in all crops of the hard red spring varieties grown with irrigation. Samples returned from the crops grown at Aberdeen in 1914 and in 1915 were practically identical in protein with the original Minnesota-grown seed and with crops of the same years grown in Minnesota. In 1916 the irrigated crop at Aberdeen substantially exceeded the Minnesota-grown crop of that year in protein. At no time did the protein of the crops grown on the station at Gooding fall to the level of that of the original Minnesota-grown seed. In 1914 and again in 1916 it substantially exceeded the protein in the Minnesota-grown wheats of the same years and approached rather closely the extremely high protein content of the crops grown at Aberdeen under dry-farm conditions.

10. Hard red spring wheats of the highest quality can be grown in south Idaho with irrigation if other conditions of growth are satisfactory. Evidence that conditions which favor the rapid nitrification of soil organic matter also favor the manufacture of protein by the wheat plant is accumulating.

TABLE II.—COMPOSITION OF WHEAT AND FLOUR. TURKEY RED—GROWN AT MOSCOW.

IDAHO STRAIN.

Year	Lab. No.	WHEAT: Weight 1000 kern'ls grams	WHEAT: Weight per bu. lbs.	WHEAT: Moisture, per ct.	WHEAT: Crude prot'n N x6.25 per ct.	FLOUR: Moisture per ct	FLOUR: Crude prot'n N x 5.7 per ct	FLOUR: Gluten wet per ct	FLOUR: Gluten dry per ct
1906 ..	*1	.....	.....	10.12	11.50	.....	.....	.....	.....
1907 ..	5	.....	63	13.00	10.50	.....	.....	.....	.....
1908 ..	29	29.60	56	9.27	12.25	.....	.....	.....	.....
1909 ..	164	.....	63	11.04	10.04	12.94	8.48	26.96	8.73
1910 ..	228	.....	63	9.50	10.15	11.09	7.82	31.11	9.84
1911 ..	447	29.18	60	10.41	10.53	11.23	9.10	28.93	10.45
1912 ..	492	35.80	62	10.60	9.04	15.01	7.12	25.60	8.50
1913 ..	637	37.28	60	11.28	13.11	13.92	10.62	37.70	10.98
1914 ..	665	35.44	62	10.67	10.38	12.57	9.04	27.70	9.91
1915 ..	798	31.84	61	10.81	10.49	13.51	9.34	28.15	9.90
1916 ..	872	39.94	62	9.74	11.08	12.93	8.01	24.75	8.33
Average	.....	34.15	61	10.63	10.76	12.90	8.69	28.86	9.58

KANSAS STRAIN

1908 ..	*28	35.20	60	10.27	12.94	.....	.....	.....	.....
1909 ..	165	.....	62.5	11.11	10.87	12.54	8.63	28.51	9.35
1910 ..	227	.....	62	10.00	10.88	11.00	8.74	35.38	10.81
1911 ..	445	32.24	59	11.30	11.41	11.06	9.06	29.66	10.54
1912 ..	490	38.50	60.5	10.28	10.00	14.77	8.16	30.12	10.22
1913 ..	635	38.32	60.0	11.31	13.97	14.52	11.46	42.38	11.34
1914 ..	663	35.94	61	10.72	11.87	11.99	10.92	35.60	11.85
1915 ..	796	34.70	60	10.44	10.05	13.42	8.62	25.40	8.80
1916 ..	870	39.71	61.5	9.85	11.27	13.00	8.15	22.40	8.00
Average	.....	36.57	60.8	10.62	11.29	12.79	9.22	31.18	10.11

NEBRASKA STRAIN

1908 ..	*27	35.40	61.5	10.10	13.21	.....	.....	.....	.....
1909 ..	166	.....	62.0	11.30	9.79	12.76	7.64	24.19	8.15
1910 ..	229	.....	62	9.61	10.92	11.14	8.56	31.71	10.01
1911 ..	446	32.36	60	10.02	10.53	10.93	9.80	34.50	11.81
1912 ..	491	38.10	60	10.71	9.92	14.76	7.84	28.25	9.22
1913 ..	636	38.82	60.5	11.25	13.09	14.54	10.94	42.62	12.71
1914 ..	664	37.52	61	10.31	11.34	12.13	8.94	27.85	9.68
1915 ..	797	33.19	60	10.48	9.33	13.63	8.15	23.18	8.14
1916 ..	871	36.37	63	9.56	11.73	12.92	8.70	26.10	9.15
Average	.....	36.06	61	10.40	10.83	12.85	8.82	29.80	9.86

*—Original seed, not in the averages.

TABLE II.—(Continued) TURKEY RED, GROWN AT CLAGSTONE. IDAHO STRAIN.

Year	Lab. No.	WHEAT: Weight: 1000 kern'l's grams	WHEAT: Weight: per bu. lbs.	WHEAT: Moisture, per ct.	WHEAT: Crude prot'n N x 6.25 per ct	FLOUR: Moisture, per ct.	FLOUR: Crude prot'n N x 5.7 per ct	FLOUR: Gluten: wet per ct	FLOUR: Gluten: dry per ct
1912 ..	495	39.34	56	13.45	11.25	15.90	8.82	31.75	10.37
1913 ..	631	37.12	59	11.40	9.70	14.88	7.70	23.08	7.62
1914 ..	668	34.57	62	10.68	10.77	13.15	8.47	27.10	9.23
1915 ..	818	30.71	61.5	12.36	9.24	13.74	7.63	21.40	7.83
Average		35.44	59.6	11.97	10.24	14.42	8.16	25.83	8.76
KANSAS STRAIN									
1912 ..	493	36.60	56	13.49	9.94	15.70	7.83	26.37	8.87
1913 ..	629	35.06	58	10.96	10.71	13.83	8.80	27.01	8.81
1914 ..	666	36.10	62	10.42	11.25	12.84	8.98	28.90	9.88
1915 ..	816	32.29	61	11.14	10.07	13.78	8.45	23.20	8.65
Average		35.01	59.3	11.50	10.49	14.04	8.52	26.37	9.05
NEBRASKA STRAIN									
1912 ..	494	38.14	59	12.55	10.73	15.23	8.51	32.25	10.67
1913 ..	630	38.82	60.5	11.23	10.29	14.37	8.31	25.81	8.29
1914 ..	667	35.30	62	10.64	11.08	12.54	8.86	28.50	10.01
1915 ..	817	31.60	61	11.35	9.87	13.88	7.89	22.30	8.02
Average		35.97	60.6	11.44	10.49	14.01	8.39	27.22	9.25
TURKEY RED GROWN AT ABERDEEN—DRY FARMED IDAHO STRAIN									
1913 ..	625	23.64	56	9.45	18.13	12.80	15.50	55.62	15.60
1914 ..	686	27.44	58	9.99	17.91	12.96	14.57	55.65	16.13
1915 ..	830	17.68	49	9.75	15.28	12.26	12.10	37.65	13.13
1916 ..	943	25.19	57	9.40	17.25	12.64	14.24	54.40	16.65
Average		23.49	55	9.64	17.14	12.66	14.10	50.83	15.38
KANSAS STRAIN									
1913 ..	623	26.01	57	9.28	18.10	12.65	13.50	50.07	13.81
1914 ..	684	27.44	58	9.83	18.78	12.87	14.24	56.00	16.62
1915 ..	828	19.17	55	10.45	16.05	13.56	13.46	45.05	15.19
1916 ..	941	24.28	57.5	9.90	17.56	11.58	13.98	53.65	16.10
Average		24.22	56.9	9.86	17.62	12.66	13.79	51.19	15.43
NEBRASKA STRAIN									
1913 ..	624	26.86	57.5	9.18	18.28	12.79	15.13	55.61	15.46
1914 ..	685	26.34	58.5	9.88	18.56	12.25	15.59	61.80	22.85
1915 ..	829	21.36	56	11.01	16.33	11.55	13.32	43.85	14.26
1916 ..	942	25.55	58	9.70	16.33	12.06	13.30	49.30	14.19
Average		25.03	57.5	9.94	17.37	12.16	14.33	52.64	16.69
TURKEY RED GROWN AT ABERDEEN—IRRIGATED IDAHO STRAIN.									
1913 ..	622	39.32	61.5	10.18	11.06	13.22	9.02	31.95	9.54
1914 ..	683	36.22	60	10.44	11.76	12.47	9.72	33.75	10.15
1915 ..	823	34.48	61	12.33	11.89	13.75	10.48	31.85	11.31
1916 ..	940	30.25	60	10.45	13.81	11.47	12.06	41.45	12.68
Average		35.07	60.6	10.85	12.13	12.73	10.32	34.75	10.92

TABLE II.— (*Continued*). TURKEY RED GROWN AT ABERDEEN. IRRIGATED—KANSAS STRAIN.

Year	Lab. No.	WHEAT: Weight: 1000 kern'ls grams	WHEAT: Weight: per bu. lbs.	WHEAT: Moisture, per ct.	WHEAT: Crude prot'n Nx6.25 per ct.	FLOUR: Moisture per ct	FLOUR: Crude prot'n N x 5.7 per ct	FLOUR: Gluten: wet per ct	FLOUR: Gluten: dry per ct
1913 ..	620	39.60	61	10.04	11.10	13.52	9.72	29.01	9.62
1914 ..	681	39.64	60	11.08	11.30	12.41	9.36	31.40	11.15
1915 ..	821	35.44	59	10.65	11.58	12.98	10.08	31.20	10.59
1916 ..	938	34.75	61	10.24	13.57	11.65	11.30	38.80	11.91
Average		37.36	60.2	10.50	11.89	12.64	10.11	32.60	10.82
NEBRASKA STRAIN									
1913 ..	621	40.54	61.5	9.75	12.22	13.69	9.52	33.17	10.04
1914 ..	682	35.80	59.5	11.01	11.73	12.04	9.38	33.60	11.07
1915 ..	822	37.58	61.5	9.39	11.73	13.19	10.58	36.10	11.98
1916 ..	939	30.92	59	11.28	13.75	11.71	11.50	36.70	12.15
Average		36.21	60.4	10.61	12.36	12.66	10.25	34.89	11.31
TURKEY RED GROWN AT FORT HAYS, KANSAS.									
1914 ..	711	20.42	54	10.43	17.25	12.14	9.92	44.60	13.95
1915 ..	819	22.24	57	11.60	16.16	12.98	12.94	44.20	14.55
1916 ..	922	28.58	60	8.98	15.70	12.21	12.76	41.45	12.64
Average		23.74	57	10.33	16.37	12.44	11.87	43.42	13.71
TURKEY RED GROWN AT NORTH PLATTE, NEBRASKA.									
1914 ..	712	25.63	58.5	10.65	18.83	12.26	15.57	52.40	15.95
1915 ..	820	29.92	57.5	11.13	12.94	12.84	10.76	32.05	11.19
1916 ..	923	27.75	61.0	9.42	14.43	11.99	12.52	39.70	11.78
Average		27.77	59	10.40	15.40	12.36	12.95	41.38	12.97
MINNESOTA BLUESTEM (Minn. 169) GROWN AT MOSCOW.									
1908 ..	*31	29.79	.....	10.62	13.07	.....	.....	.....	.....
1909 ..	169	.....	60	10.88	12.72	12.82	10.32	31.95	11.01
1910 ..	225	31.40	56.5	11.35	9.79	11.05	8.06	25.41	8.43
1911 ..	449	31.50	58.5	10.12	14.56	11.28	11.82	43.50	17.72
1912 ..	496	37.30	56	14.06	14.21	15.25	11.36	43.12	14.40
1913 ..	590	35.70	59.5	11.86	10.25	14.81	7.99	25.15	8.49
1914 ..	659	32.50	57	10.84	10.66	11.65	8.66	25.10	9.19
1915 ..	799	32.14	58	9.80	11.95	13.66	9.74	29.15	10.85
1916 ..	866	35.18	60	9.99	12.74	13.15	9.76	27.95	9.98
Average		33.68	58.2	11.11	12.11	12.96	9.71	31.41	11.26
GROWN AT ABERDEEN—DRY FARMED.									
1914 ..	694	22.34	55	9.97	20.82	11.96	16.31	60.40	20.98
1915 ..	(Lost)								
1916 ..	955	24.36	54	8.84	19.13	11.67	15.39	58.30	18.02
Average		23.35	54.5	9.40	19.98	11.81	15.85	59.35	19.50
GROWN AT ABERDEEN—IRRIGATED									
1914 ..	695	32.22	59	9.09	12.70	13.13	10.82	34.20	14.30
1915 ..	825	26.37	53.5	10.95	15.32	12.65	12.62	39.45	14.12
1916 ..	953	27.02	53	11.02	16.64	12.03	14.14	50.85	16.13
Average		28.54	55.2	10.35	14.89	12.60	12.53	41.50	14.85

*—Original seed, not in the averages.

TABLE II.—(Continued) GROWN AT GOODING—IRRIGATED.

Year	Lab. No.	WHEAT: Weight 1000 kern'ls grams	WHEAT: Weight per bu. lbs.	WHEAT: Moisture, per ct	WHEAT: Crude prot'n Nx6.25 per ct	FLOUR: Moisture per ct.	FLOUR: Crude prot'n N x 5.7 per ct	FLOUR: Gluten wet per ct	FLOUR: Gluten dry per ct.
1914 ..	672	32.30	57	10.17	17.67	12.36	14.45	49.50	15.03
1915 ..	806	36.08	58	10.25	14.84	13.15	11.16	37.25	13.19
1916 ..	932	37.07	60	8.88	16.89	12.32	12.90	44.25	13.46
Average		35.15	58.3	9.76	16.47	12.61	12.84	43.66	13.89
GROWN AT UNIVERSITY FARM, MINNESOTA.									
1914 ..	718	28.02	56.5	11.77	12.74	12.94	11.12	28.80	10.96
1915 ..	795	30.75	57.0	12.26	13.68	13.82	11.52	34.60	11.87
1916 ..	924	24.51	57.5	11.86	13.27	12.30	10.64	31.65	11.17
Average		27.76	57.0	11.96	13.23	13.02	11.09	31.68	11.33
GLYNDON FIFE (Minn. 163) GROWN AT MOSCOW.									
1908 ..	*30	25.53	56.5	10.28	12.71	.....	.....	.....	.....
1909 ..	170	.....	60.5	10.77	12.81	12.32	10.21	33.27	11.51
1910 ..	226	32.30	58.5	10.14	9.69	11.45	7.74	25.73	8.99
1911 ..	450	33.96	57	10.90	14.65	11.55	12.14	43.49	16.43
1912 ..	497	35.70	58	12.86	14.83	15.44	11.12	44.87	14.16
1913 ..	591	33.44	60	10.44	10.00	14.95	8.12	25.61	8.69
1914 ..	661	33.74	58	10.13	10.46	11.62	8.53	25.28	9.64
1915 ..	801	31.38	59	11.26	11.25	13.78	9.22	28.35	10.66
1916 ..	868	34.89	61.5	9.60	12.54	12.46	9.74	28.70	10.33
Average		33.63	59.1	10.76	12.03	12.94	9.60	31.91	11.29
*—Original seed, not in the averages.									
GROWN AT ABERDEEN—DRY FARMED.									
1914 ..	697	22.62	55	9.21	19.88	12.91	13.18	43.35	17.19
1915 ..	(Lost)								
1916 ..	954	23.72	54	8.45	18.96	11.77	14.39	49.30	15.29
Average		23.17	54.5	8.83	19.42	12.34	13.78	46.33	16.24
GROWN AT ABERDEEN—IRRIGATED									
1914 ..	696	32.58	60	9.02	13.22	12.81	10.64	33.45	13.93
1915 ..	827	31.88	59	12.82	13.77	13.94	11.16	38.40	13.67
1916 ..	952	29.45	58	11.15	15.87	12.01	13.23	45.20	14.80
Average		31.30	59	10.99	14.29	12.92	11.67	39.02	14.13
GROWN AT GOODING—IRRIGATED.									
1914 ..	676	29.10	58	9.40	17.91	12.67	14.47	52.40	16.93
1915 ..	810	34.22	58	11.77	14.05	12.81	11.76	35.30	12.69
1916 ..	936	34.73	60	10.09	17.47	12.09	14.16	52.10	15.83
Average		32.68	58.7	10.42	16.47	12.52	13.46	46.60	15.15
GROWN AT UNIVERSITY FARM, MINNESOTA.									
1914 ..	717	22.26	56.0	10.53	12.74	12.76	10.22	29.90	11.06
1915 ..	794	27.06	57.0	12.91	14.10	13.80	11.58	34.35	11.70
1916 ..	925	25.05	57.5	11.97	12.68	12.18	10.22	30.80	11.19
Average		24.79	56.8	11.80	13.20	12.91	10.67	31.68	11.32

Reported in Bulletins 131 and 143 of the Minnesota Station by C. H. Bailey.

MINNESOTA BLUESTEM (Minn. 169)

Year	No. of Samples	Weight per 1000 kernels	Moisture per cent	Protein $N \times 6\frac{1}{4}$ per cent
1911	8	.....	12.17	14.37
1912	17	25.91	11.95	13.87
1913	8	28.70	12.78	13.25

GLYNDON FIFE (Minn. 163).

1911	2	.....	11.47	15.50
1912	3	27.83	11.03	15.07
1913	3	32.05	12.96	14.06

TABLE III.—SUMMARY OF AVERAGES

STRAIN, WHERE AND HOW GROWN.	WHEAT					FLOUR			
	No. crops averaged	Weight		Moisture per ct	Crude prot'n N x6.25 per ct.	Moisture per ct	Crude prot'n N x 5.7 per ct	Gluten	
		1000 kern'ls grams	per bu. lbs.					wet per ct	dry per ct.
TURKEY RED.									
Idaho, Moscow	10	34.15	61.0	10.63	10.76	12.90	8.69	28.86	9.58
" Clagstone	4	35.44	59.6	11.97	10.24	14.42	8.16	25.83	8.76
" Aberdeen, dry farmed	4	23.49	55.0	9.64	17.14	12.66	14.10	50.83	15.38
" Aberdeen, irrigated	4	35.07	60.6	10.85	12.13	12.73	10.32	34.75	10.92
Kansas, Moscow	8	36.57	60.8	10.62	11.29	12.79	9.22	31.18	10.11
" Clagstone	4	35.01	59.3	11.50	10.49	14.04	8.52	26.37	9.05
" Aberdeen, dry farmed	4	24.22	56.9	9.86	17.62	12.66	13.79	51.19	15.43
" Aberdeen, irrigated	4	37.36	60.2	10.50	11.89	12.64	10.11	32.60	10.82
" Fort Hays, Kansas	3	23.74	57.0	10.33	16.37	12.44	11.87	43.42	13.71
Nebraska, Moscow	8	36.06	61.0	10.40	10.83	12.85	8.82	29.80	9.86
" Clagstone	4	35.97	60.6	11.44	10.49	14.01	8.39	27.22	9.25
" Aberdeen, dry farmed	4	25.03	57.5	9.94	17.37	12.16	14.33	52.64	16.69
" Aberdeen, irrigated	4	36.21	60.4	10.61	12.36	12.66	10.25	34.89	11.31
" North Platte, Nebraska	3	27.77	59.0	10.40	15.40	12.36	12.95	41.38	12.97
MINNESOTA BLUESTEM (Minn. 169).									
Moscow	8	33.68	58.2	11.11	12.11	12.96	9.71	31.41	11.26
Aberdeen, dry farmed	2	23.35	54.5	9.40	19.98	11.81	15.85	59.35	19.50
" irrigated	3	28.54	55.2	10.35	14.89	12.60	12.53	41.50	14.85
Gooding, irrigated	3	55.15	58.3	9.76	16.47	12.61	12.84	43.66	13.89
University Farm, Minnesota	3	27.76	57.0	11.96	13.23	13.02	11.09	31.68	11.33
GLYNDON FIFE (Minn. 163).									
Moscow	8	33.63	59.1	10.76	12.03	12.94	9.60	31.91	11.29
Aberdeen, dry farm	2	23.17	54.5	8.83	19.42	12.34	13.78	46.33	16.24
" irrigated	3	31.30	59.0	10.99	14.29	12.92	11.67	39.02	14.13
Gooding, irrigated	3	32.68	58.7	10.42	16.47	12.52	13.46	46.60	15.15
University Farm, Minnesota	3	24.79	56.8	11.80	13.20	12.91	10.67	31.68	11.32

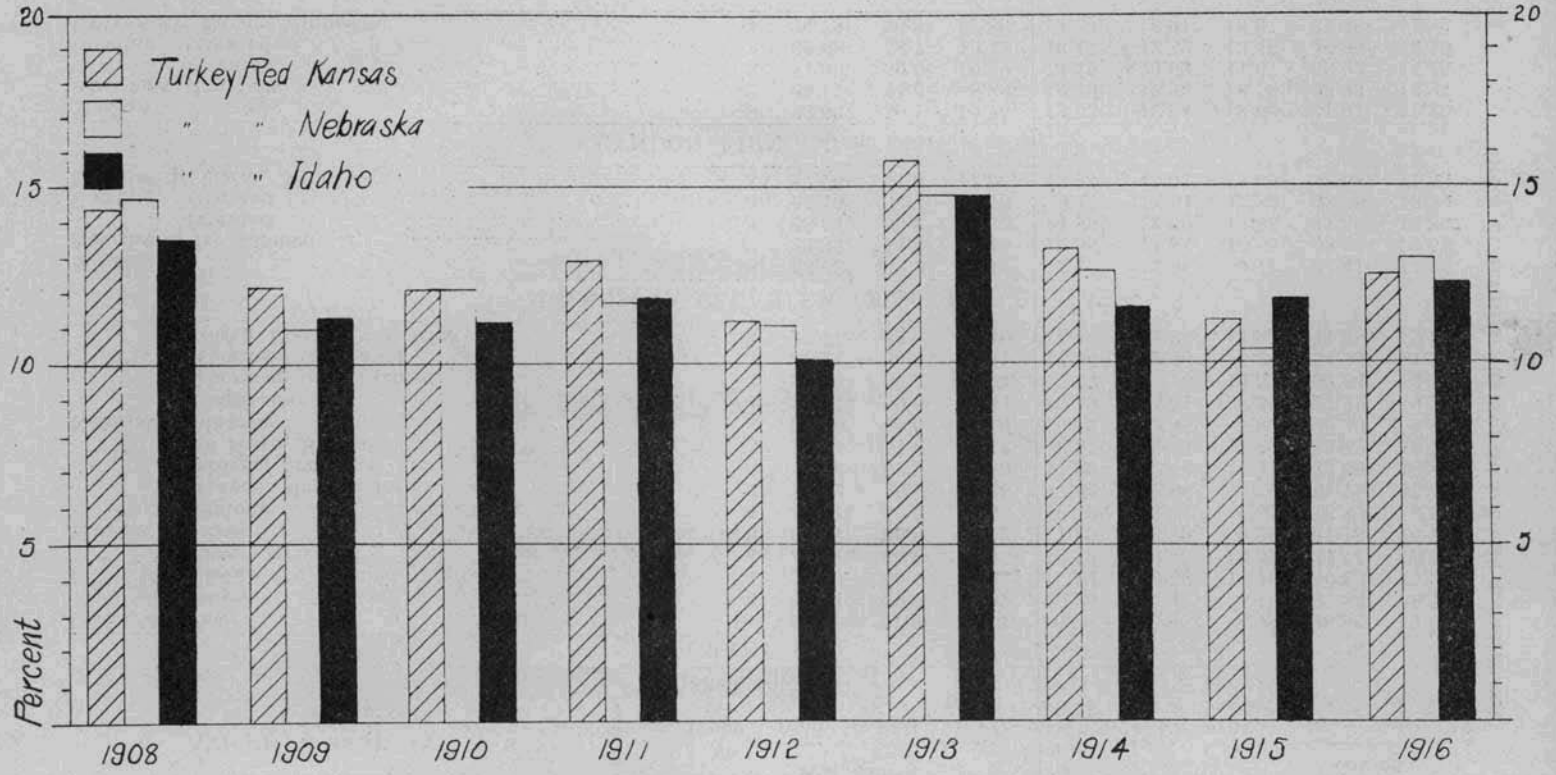

Fig. 1. Percentages of protein, on the dry basis, of Kansas, Nebraska and Idaho strains of Turkey Red grown side by side on the central station at Moscow, 1909-1916 inclusive. See Table II.

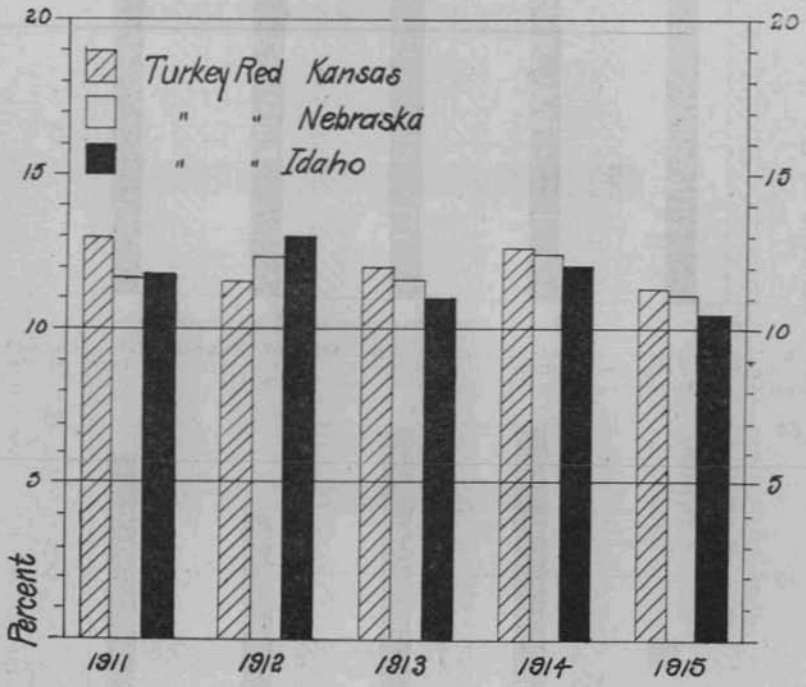

Fig. 2. Percentages of protein, on the dry basis, of Kansas, Nebraska, and Idaho strains of Turkey Red grown side by side on the substation at Clagstone, 1912-1915 inclusive. See Table II.

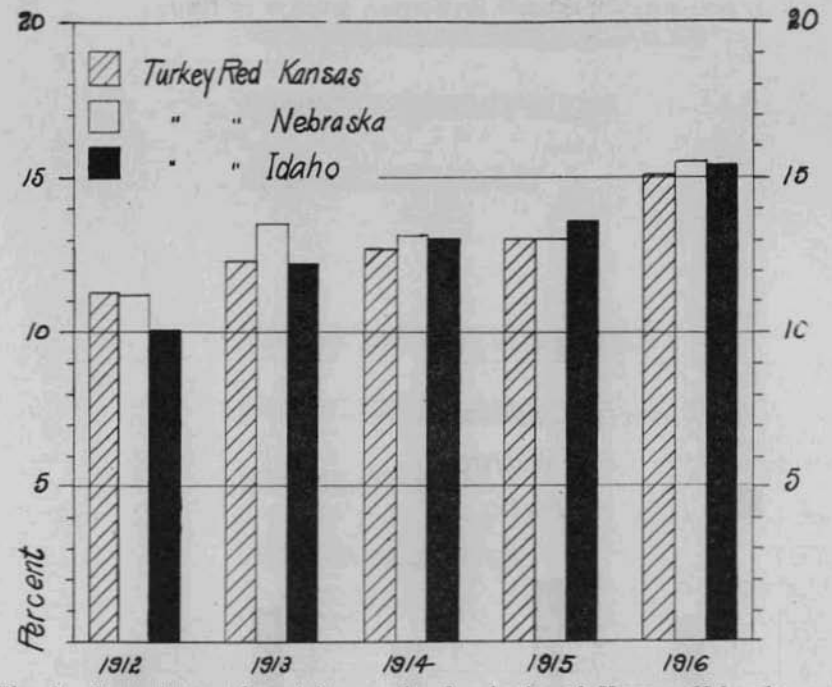

Fig. 3. Percentages of protein, on the dry basis, of Kansas, Nebraska and Idaho strains of Turkey Red grown side by side on the irrigated farm of the substation at Aberdeen, 1913-1916 inclusive. See Table II.

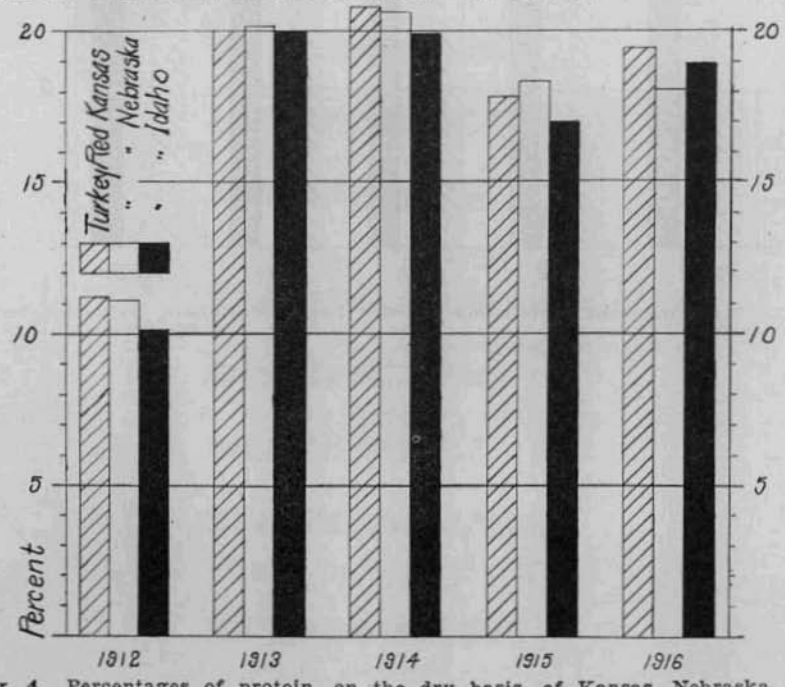

Fig. 4. Percentages of protein, on the dry basis, of Kansas, Nebraska and Idaho strains of Turkey Red grown side by side on the dry farm of the substation at Aberdeen, 1913-1916 inclusive.

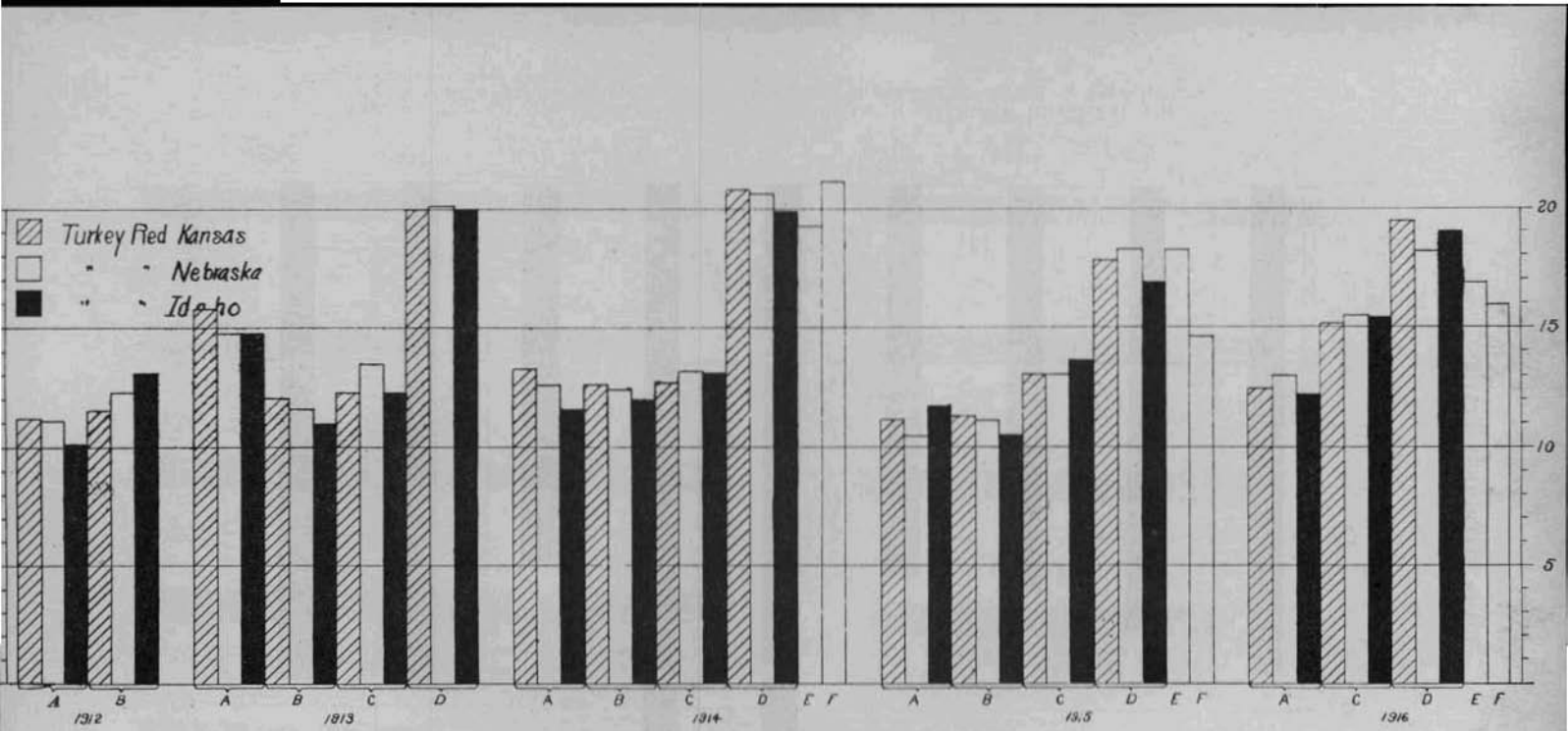

Fig. 5. Protein percentages of Figures 1 to 4 inclusive for crops of 1912-1916 inclusive. Presented for comparison of results by stations and with results on crops grown at Fort Hays, Kansas, and North Platte, Nebraska.

A—Grown at Moscow. B—Grown at Clagstone. C—Grown at Aberdeen with irrigation. D—Grown at Aberdeen on the dry farm. E—Grown at Fort Hays, Kansas. F—Grown at North Platte, Nebraska.

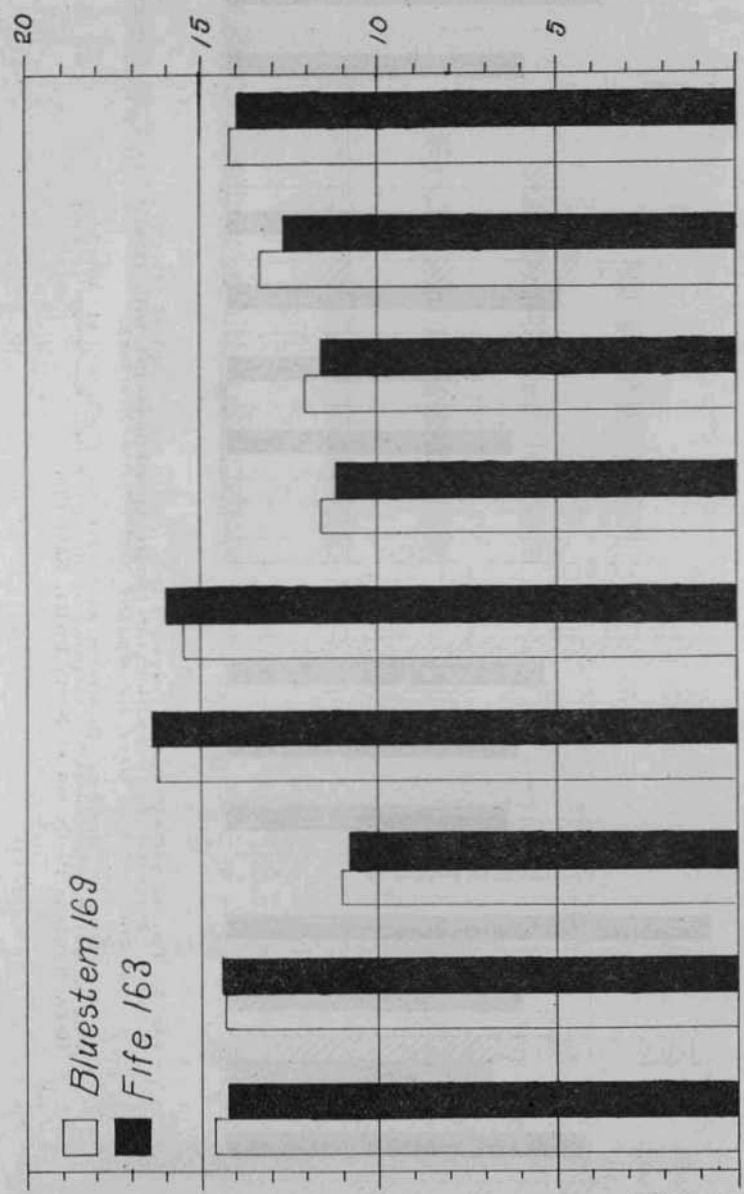

Fig. 6. Percentages of protein, on the dry basis, of Minnesota Bluestem, and Glyndon Fife, grown side by side on the central station at Moscow, 1909-1916 inclusive. See Table II.

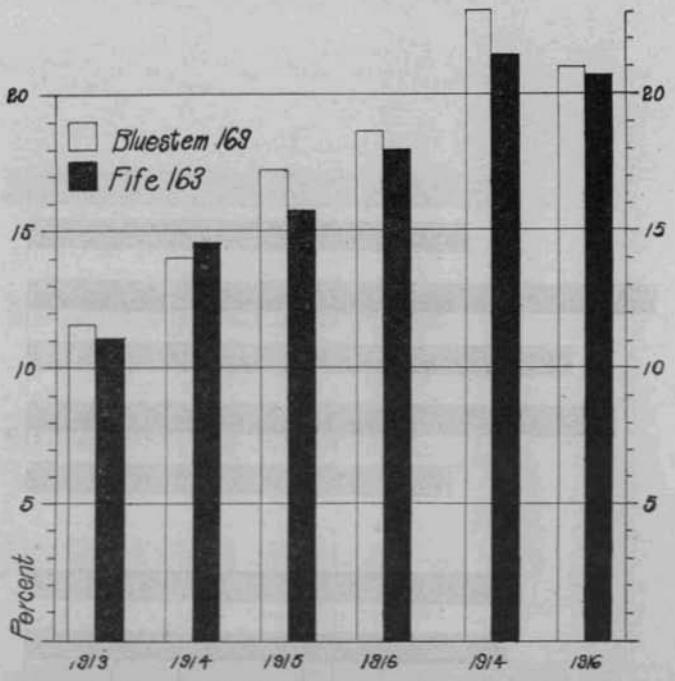

Fig. 7. Protein percentages, on the dry basis, of Minnesota Bluestem and Glyndon Fife, grown side by side on the station at Aberdeen with irrigation (on the left) and without irrigation (on the right), 1914-1916 inclusive. Note the substantial increase in protein with successive years of the crops grown with irrigation and the high level attained with the crop of 1916. See Table II.

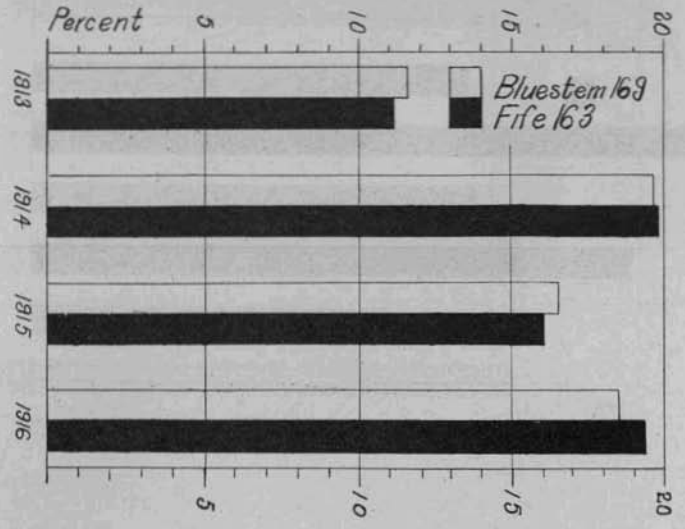

Fig. 8. Protein percentages, on the dry basis, of Minnesota Bluestem and Glyndon Fife grown side by side on the station at Gooding with irrigation, 1914-1916 inclusive. Note the exceptionally high level attained in the crops of 1914 and 1916. See Table II.

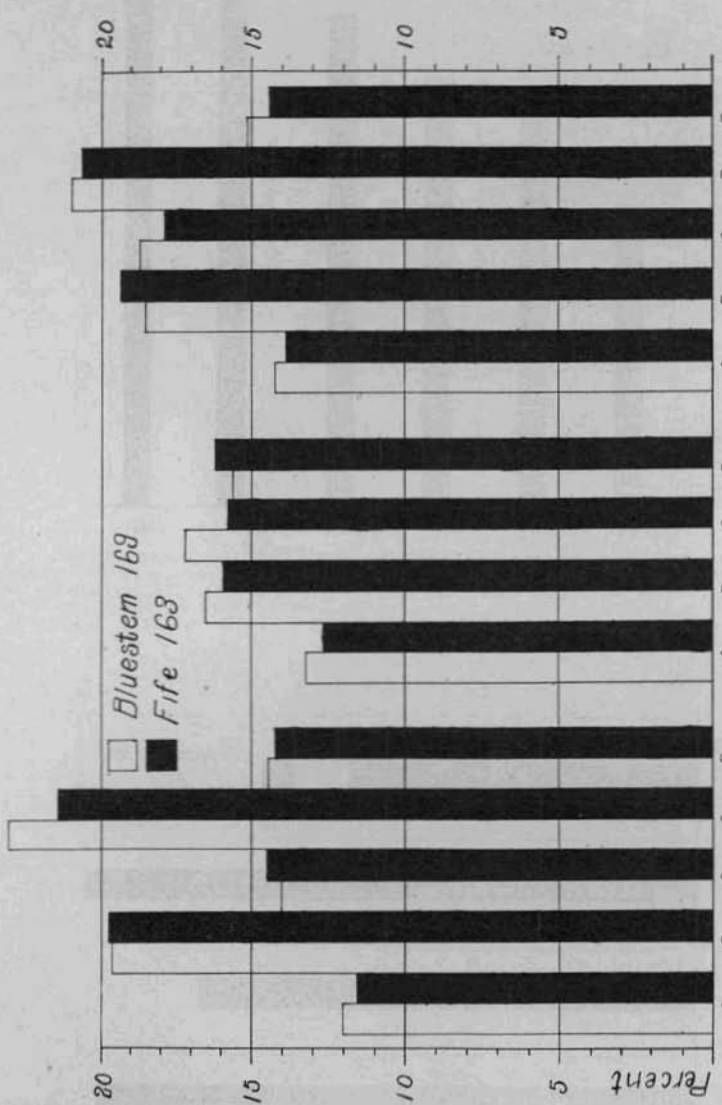

Fig. 9. Protein percentages of Figures 6, 7 and 8 for crops of 1914-1916 inclusive. Presented for comparison of results by stations and with results on crops grown at University Farm, Minnesota.
A—Grown at Moscow. B—Grown at Gooding with irrigation. C—Grown at Aberdeen with irrigation.
D—Grown at Aberdeen on the dry farm. E—Grown at University Farm, Minnesota.