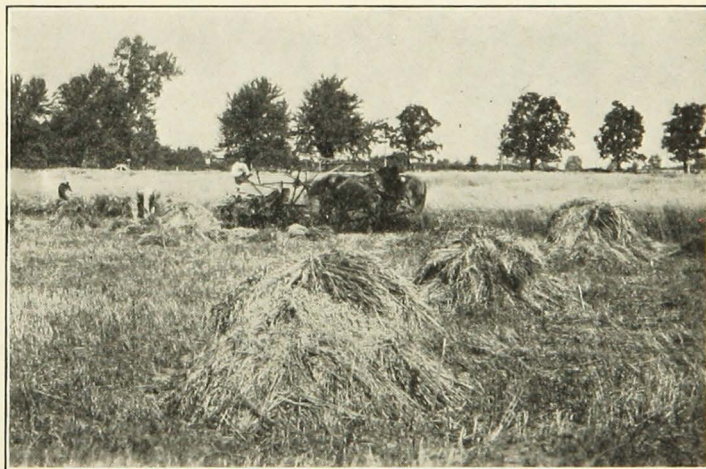


AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF MINNESOTA

Comparative Values of Farm Crops Grown at the Central and Branch Stations in Yield Trials

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COMPARATIVE VALUES OF FARM CROPS GROWN AT THE CENTRAL AND BRANCH STATIONS IN YIELD TRIALS¹

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INTRODUCTION

Varietal trials of farm crops have been carried on at the central and branch stations of the University of Minnesota for many years and it seems reasonable to conclude that station yields of the various crops are indicative of what may be expected by farmers in various regions of the state.

These varietal trials are conducted, as a rule, on fields that are under a system of rotation in common use by the more progressive farmers, and the most uniform land available at the various stations is used in making the experiments. As a rule, the field used for varietal trials is planted to a bulk crop every other year to equalize possible soil differences that might result from the trials. While tests of different crops are not necessarily made on the same field, because of lack of space, the most satisfactory fields are used and an effort is made to carry on the work so that the yields will be comparable. The comparisons are made on the basis of yield per acre, cash value, and total digestible nutrients.

METHODS OF STUDY

Only varieties that were believed to be of possible commercial importance were included in the trials. Yields per acre were computed for each variety on the basis of actual yields of three 1/40-acre plots. Before harvest, border rows were removed and the entire plot harvested, or the yield was computed from a uniform number of square-yard samples taken from each plot. The yield of each crop for each of the years is the average yield for all varieties of that crop grown in the varietal trial.

The cereals and flax were grown each year of the trial, with a few exceptions that will be mentioned in connection with the station summaries. Soybeans and field peas were tested as a rule for a much shorter period. In no case is a crop discussed unless it was grown for

¹ Acknowledgment is made to agronomists and superintendents at the branch stations—R. S. Dunham, Crookston; R. O. Bridgford, Morris; R. E. Hodgson, Waseca; O. W. Swenson, Grand Rapids; M. J. Thompson, Duluth, and A. C. Arny, H. K. Wilson, LeRoy Powers, I. J. Johnson, and C. W. Doxtator of the Division of Agronomy and Plant Genetics, University Farm, who kindly made available the data from varietal trials used in this study.

at least a three-year period. Barley and oats were grown in each of the 12 years. When a crop was grown for a shorter period, its yield is corrected on the basis of the average yield of barley and oats for the same period in relation to the average yield of barley and oats for the entire period. If a crop, for example soybeans at Crookston, was grown only during the period from 1921 to 1924, inclusive, its weighted yield for the period from 1921 to 1932 was computed as follows:

Average yield of barley and oats 1921-24: average yield of barley and oats 1921-32 = average yield of soybeans 1921-24: x or weighted yield of soybeans 1921-32, inclusive.

Average prices for the 12-year period, for all crops except wheat, were obtained for 1921-30, inclusive, from Minnesota State Department of Agriculture Bulletin No. 6, Minnesota Annual Crop Report, 1929-30, and for 1931 and 1932 from Crops and Markets, Vols. 8 and 9. Estimated prices for the three classes of wheat were obtained from Crops and Markets and were corrected by subtracting 16 cents from the cash grain prices in Minneapolis, giving Minnesota farm prices.² The prices listed for the three months including the greatest volume of sales for each crop were averaged, giving the seasonal price, and then averages for the 12-year period were computed. For soybeans and field beans, prices were taken from the U. S. Department of Agriculture Year Books. Prices of field peas were estimated at \$3.00 per bushel.

The number of pounds of digestible nutrients in 100 pounds of feed of the various crops compared in this bulletin is summarized here on the basis of results given by Henry and Morrison.

Digestible Nutrients in 100 Pounds*

	Crude protein	Carbohydrates	Fat
Wheat	10.0	66.3	1.15
Oats	9.7	52.1	3.8
Barley	9.0	66.8	1.6
Rye	9.9	68.4	1.2
Corn	7.5	67.8	4.6
Soybeans	33.2	24.7	16.1

* From Henry and Morrison, 18th edition, Table 3, appendix.

It will be noted that wheat and rye are similar in their content of digestible nutrients, that barley is slightly lower in digestible crude protein, that oats is higher in fat content than other small grains and somewhat lower in carbohydrates, that corn is somewhat lower in digestible crude protein than the small grains and higher in fat content, and that soybeans excel in digestible crude protein. In fact, they compare rela-

² This correction was suggested by Dr. R. H. Black, Federal Grain Supervisor, Minneapolis, and is based on No. 1 Dark Northern Spring, No. 2 Dark Hard Winter, and No. 2 Amber Durum.

tively favorably with concentrated feeds such as gluten feed, linseed meal, or cottonseed meal.

The percentages of digestible nutrients for the various crops from Henry and Morrison, *Feeds and Feeding*, were used to calculate average yields of digestible crude protein, carbohydrates, and fat on an acre basis. Flax was included for comparison purposes even tho it is not recommended as a farm feed.

RESULTS OF COMPARISON

The results obtained at each station will be presented in two short summary tables, the first giving the years included in the trial, the range in yields per acre and weighted yield, average price per bushel 1921-32, and value per acre based on yields obtained and price per bushel; the second, the calculated yield of digestible nutrients on an acre basis.

Northwest Experiment Station, Crookston

Table 1 gives data for the Crookston station. Oats, barley, hard red spring and durum wheat, flax, and corn were each grown every year from 1921 to 1932. Rye was grown from 1921 to 1929, inclusive, giving an average yield of 17 bushels and a weighted yield of 17.2 bushels.

Soybeans grown for the 4-year period from 1921 to 1924 gave an average yield of 9.2 bushels, while its weighted yield for the 12-year period was 9.8 bushels.

Table 1
Comparative Yields, Prices per Bushel, and Value per Acre of Crops Grown in Varietal Trials at the Crookston Station

Crop	Years grown	Range in yield, bu.	Weighted yield, bu.	1921-32 av. price per bu.	Value per acre
Oats	1921-1932	34.0-86.2	61.6	\$0.29	\$17.86
Barley	"	00.0-53.5	33.9	0.46	15.59
Hard red spring wheat	"	11.6-32.7	23.4	1.06	24.80
Durum wheat	"	11.7-38.3	27.7	0.95	26.32
Flax	"	7.5-19.1	12.9	1.91	24.64
Corn	"	9.8-52.4	32.6	0.55	17.93
Rye	1921-1929	8.7-38.2	17.2	0.65	11.18
Soybeans	1921-1924	3.7-11.7	9.8	2.12	20.78

Durum wheat gave a higher yield than hard red spring wheat each of the 12 years included in the trials, except 1932, and exceeded hard red spring by a little more than 4 bushels per acre on an average. Durum wheat led the crops in value per acre, with a computed value of \$26.32. It was followed by hard red spring wheat, with a value of \$24.80; flax, \$24.64; soybeans, \$20.78; corn, \$17.93; oats, \$17.86; barley, \$15.59, and rye, \$11.18.

Yield of digestible nutrients per acre, based on the average yield of each crop, is given in Table 2. In this and other tables giving digestible nutrients, the actual calculated yield of digestible fat is multiplied by 2.25 to place it on the same energy value as the carbohydrates. Among the small grains, oats led with a yield of total digestible nutrients of 1,386.74 pounds. The yield of digestible nutrients is slightly greater for oats than for other small grains. The yield of crude protein per acre for oats was 191.21 pounds, being exceeded only by soybeans with a yield of crude protein of 195.22 pounds. On the basis of the data given, corn was not an outstanding crop at the Crookston station, and rye was definitely lower in yielding ability than other small grain crops.

Table 2

Yield of Digestible Nutrients per Acre, Based on Average Yields of Crops at the Crookston Station

Crop	Years grown	Weighted yield, lb.	Yield of nutrients, lb.			
			Crude protein	Carbo-hydrates	Fat	Total
Oats	1921-1932	1,971.2	191.21	1,026.99	168.54	1,386.74
Barley	"	1,627.2	146.45	1,086.97	58.58	1,292.00
Hard red spring wheat.....	"	1,404.0	140.40	930.85	47.39	1,118.64
Durum wheat.....	"	1,662.0	166.20	1,101.91	56.09	1,324.20
Flax	"	722.4	148.81	122.81	471.37	742.99
Corn	"	1,825.6	136.92	1,237.76	188.95	1,563.63
Rye	1921-1929	963.2	95.36	658.83	26.01	780.20
Soybeans	1921-1924	588.0	195.22	145.24	213.00	553.46

Soybeans with a yield of 9.7 bushels per acre could be used to advantage in some cases in supplying protein and fat.

Table 3

Comparative Yields, Prices per Bushel, and Value per Acre of Crops Grown in Varietal Trials at the Morris Station

Crop	Years grown	Range in yield, bu.	Weighted yield, bu.	1921-32 av. price per bu.	Value per acre
Oats	1921-1932	37.2-90.3	59.1	\$0.29	\$17.14
Barley	"	28.3-48.7	34.3	0.46	15.78
Hard red spring wheat.....	"	10.8-30.1	22.2	1.06	23.53
Durum wheat.....	"	13.8-32.6	26.0	0.95	24.70
Winter wheat.....	"	00.0-39.6	16.4	0.96	15.74
Rye	"	14.2-44.4	28.5	0.65	18.53
Corn	"	28.9-62.6	44.2	0.55	24.31
Flax	1924-1932	9.8-25.4	14.6	1.91	27.89
Soybeans	1921-1925	14.4-23.7	18.3	2.12	38.80
Field beans.....	1921-1924	11.5-17.4	16.1	3.33	53.61
Field peas.....	1926-1929	8.6-24.8	18.1	3.00	54.30

West Central Experiment Station, Morris

Oats, barley, hard red spring wheat, durum wheat, winter wheat, rye, and corn were grown each year of the 12-year period; flax was grown from 1924-1932; soybeans from 1921 to 1925; field beans from 1921 to 1924, and field peas from 1926 to 1929. Weighted yields, the range in yields, average prices per bushel, and computed value per acre are given in Table 3.

The average return per acre, if the crop had been sold, is in descending order: field peas \$54.30, field beans \$53.61, soybeans \$38.80, flax \$27.89, durum wheat \$24.70, corn \$24.31, spring wheat \$23.53, rye \$18.53, oats \$17.14, barley \$15.78, and winter wheat \$15.74. Yields of wheat, oats, and barley did not differ greatly from those at the Crookston station. Rye, however, gave good yields at Morris, excelling barley and oats in value per acre. Winter wheat was a total failure 3 out of the 12 years and yielded more than spring wheat in only 3 years. Flax gave average yields of 14.6 bushels and in value exceeded durum wheat, the small grain crop with greatest acre value, by \$2.15 per acre. Corn was a fairly satisfactory crop, giving an average yield of 44.2 bushels per acre, while soybeans with an average yield of 18.3 bushels per acre, with a range of from 14.4 to 23.7 bushels, seemed well adapted to conditions in west central Minnesota. Field beans yielded well, giving an average of 16.1 bushels per acre. The calculated yields of digestible nutrients are given in Table 4.

Table 4
Yield of Digestible Nutrients per Acre, Based on Average Yields of Crops at the Morris Station

Crop	Years grown	Weighted yield, lb.	Yield of nutrients, lb.			
			Crude protein	Carbo-hydrates	Fat	Total
Oats	1921-1932	1,891.2	183.45	985.32	161.70	1,330.47
Barley	"	1,646.4	148.18	1,099.80	59.27	1,307.25
Hard red spring wheat.....	"	1,332.0	133.20	883.12	44.96	1,061.28
Durum wheat.....	"	1,560.0	156.00	1,034.28	52.65	1,242.93
Winter wheat.....	"	984.0	98.40	652.39	33.21	784.00
Rye	"	1,596.0	158.00	1,091.66	43.09	1,292.75
Corn	"	2 475.2	185.64	1,678.19	256.18	2,120.01
Flax	1924-1932	817.6	168.43	138.99	533.48	840.90
Soybeans	1921-1925	1,098.0	364.54	271.21	397.75	1,033.50
Field beans.....	1921-1924	966.0	181.61	495.56	17.39	694.56
Field peas.....	1926-1929	1,086.0	206.34	606.00	14.66	827.00

Among the small grains, oats led with a yield of 1,330.47 pounds of digestible nutrients, producing 183.5 pounds of digestible crude protein per acre or nearly 20 pounds more than any other small grain crop. Barley, durum wheat, and rye gave approximately 100 pounds more of

carbohydrates per acre than oats, while oats excelled in digestible pounds of fat, producing more than 100 pounds more per acre than other small grain crops.

Soybeans gave a yield of 364.54 pounds of digestible crude protein per acre and also excelled in fat. Soybeans are of value as a source of protein for feeding purposes, being markedly superior to field beans and field peas in this respect.

Corn produced slightly more crude protein per acre than oats, was much higher in total carbohydrates, and produced more pounds of digestible fat per acre than any of the small grain crops. The cost of growing corn is greater than for small grains and may offset its greater feeding value.

Southwest Experiment Station, Waseca

Hard red spring wheat, durum wheat, winter wheat, oats, and barley were grown for the entire period from 1921-1932; rye was grown except in 1924 and 1930; corn from 1925 to 1932; flax from 1928 to 1931, and soybeans from 1921 to 1924, inclusive. The weighted yields did not greatly change the averages—rye was changed from 33.9 bushels to 34.2, corn from 56.4 to 57.0, flax from 16.4 to 16.0, and soybeans from 13.6 to 13.3. The period in which each crop was grown, the range in yield, average weighted yield, price per bushel, and computed value per acre are given in Table 5.

Table 5

Comparative Yields, Prices per Bushel, and Value per Acre of Crops Grown in Varietal Trials at the Waseca Station

Crop	Years grown	Range in yield, bu.	Weighted yield, bu.	1921-32 av. price per bu.	Value per acre
Oats	1921-1932	52.1-98.5	72.6	\$0.29	\$21.05
Barley	"	39.8-69.8	52.1	0.46	23.97
Hard red spring wheat	"	16.4-39.5	23.3	1.06	24.70
Durum wheat	"	24.8-35.1	29.2	0.95	27.74
Winter wheat	"	9.9-46.0	30.0	0.96	28.80
Rye	1921-23; 1925-29; 1931-32	23.8-43.0	34.2	0.65	22.23
Corn	1925-1932	36.6-78.2	56.4	0.55	31.02
Flax	1928-1931	14.5-18.3	16.0	1.91	30.56
Soybeans	1921-1924	7.0-16.9	13.3	2.12	28.20

The value in dollars per acre was considerably greater, on an average, at the Waseca station than at Crookston or Morris. Comparative computed values were not greatly different for flax, corn, soybeans, winter wheat, and durum wheat, ranging from \$31.02 for corn to \$27.74 for durum wheat. Winter wheat gave a computed value of \$28.80, being \$4.10 higher than for hard red spring wheat. Barley, spring

wheat, rye, and oats were of similar computed value, ranging from \$23.97 for barley to \$21.54 for oats, with rye and spring wheat in an intermediate position.

The computed yields of digestible nutrients are given in Table 6.

Table 6
Yield of Digestible Nutrients per Acre, Based on Average Yields of Crops
at the Waseca Station

Crop	Years grown	Weighted yield, lb.	Yield of nutrients, lb.			
			Crude protein	Carbo- hydrates	Fat	Total
Oats	1921-1932	2,323.2	225.35	1,210.39	198.63	1,634.37
Barley	"	2,500.8	225.07	1,670.53	90.03	1,985.63
Hard red spring wheat....	"	1,398.0	139.80	926.87	47.18	1,113.85
Durum wheat.....	"	1,752.0	175.20	1,161.58	59.13	1,395.91
Winter wheat.....	"	1,800.0	180.00	1,193.40	60.75	1,434.15
Rye	1921-23; 1925-29; 1931-32	1,915.2	189.60	1,310.00	51.71	1,551.31
Corn	1925-1932	3,192.0	239.40	2,164.18	330.35	2,733.93
Flax	1928-1931	896.0	184.57	152.32	584.64	921.53
Soybeans	1921-1924	798.0	264.94	197.12	289.08	751.14

Barley gave a total computed yield of 1,985.63 pounds of digestible nutrients per acre, 351.26 pounds more than its highest competitor among the small grains. Both oats and barley gave about the same computed yield of crude protein as corn, with yields of 225.35, 225.07, and 239.40, respectively. On the basis of yield of digestible nutrients, barley and oats seem definitely superior to other small grains. Winter wheat, the most satisfactory class of wheat for south central Minnesota, was lower than barley in calculated pounds per acre of crude protein, carbohydrates, and fat by 45.07, 477.13, and 29.28, respectively. Corn with an average yield of more than 56 bushels was outstanding in yield of carbohydrates and fat, while soybeans gave a yield of 264.94 pounds of digestible crude protein per acre.

Central Experiment Station, University Farm, St. Paul

Each of the small grain crops, as well as corn and flax, was grown at University Farm for the 12-year period from 1921 to 1932, inclusive. Soybeans were grown from 1921 to 1925, field beans from 1921 to 1923, and field peas from 1926 to 1929. Weighted yields changed the yield of soybeans from 16.3 bushels to 16.5, field beans from 17.9 to 18.5, and field peas from 22.5 to 20.7. The years in which each crop was grown, range in yields, average yield, price per bushel, and value per acre are given in Table 7

Table 7

Comparative Yields, Prices per Bushel, and Value per Acre of Crops Grown at the Central Station, University Farm

Crop	Years grown	Range in yield, bu.	Weighted yield, bu.	1921-32 av. price per bu.	Value per acre
Oats	1921-1932	32.5-85.1	62.2	\$0.29	\$18.04
Barley	"	29.0-57.3	40.5	0.46	18.63
Hard red spring wheat	"	14.7-31.4	25.7	1.06	27.24
Durum wheat	"	16.5-47.3	27.0	0.95	25.65
Winter wheat	"	0.0-42.5	28.2	0.96	27.07
Rye	"	14.0-38.6	28.4	0.65	18.46
Corn	"	18.4-59.7	39.8	0.55	21.89
Flax	"	0.0-22.2	11.6	1.91	22.16
Soybeans	1921-1925	9.0-19.5	16.5	2.12	34.98
Field beans	1921-1923	14.3-18.9	18.5	3.33	61.61
Field peas	1926-1929	14.4-34.4	20.7	3.00	62.10

Field peas and field beans gave similar calculated values of \$62.10 and \$61.61 per acre, respectively. Soybeans, with an average yield of 16.5 bushels and a calculated value of \$34.98 per acre, was followed by hard red spring wheat, winter wheat, and durum wheat, with values of \$27.24, \$27.07, and \$25.65 per acre, respectively. During the 12-year period, winter wheat winter-killed in 1928 and gave relatively low yields in 1921 and 1922. Flax was not harvested in 1922 because of weeds and gave an average yield of only 11.6 bushels. Corn, with a yield of 39.8 bushels, was a little lower in calculated value per acre than flax. Rye, barley, and oats were similar, with average values of \$18.46, \$18.63, and \$18.04 per acre, respectively.

Yields of digestible nutrients are given in Table 8 for University Farm, St. Paul, Minnesota.

Table 8

Yield of Digestible Nutrients per Acre, Based on Average Yields of Crops at the Central Station, University Farm

Crop	Years grown	Weighted yield, lb.	Yield of nutrients, lb.			
			Crude protein	Carbo-hydrates	Fat	Total
Oats	1921-1932	1,990.4	193.07	1,037.00	170.18	1,400.25
Barley	"	1,944.0	174.96	1,298.59	69.98	1,543.53
Hard red spring wheat	"	1,542.0	154.20	1,022.35	52.04	1,228.59
Durum wheat	"	1,620.0	162.00	1,074.06	54.68	1,290.74
Winter wheat	"	1,692.0	169.20	1,121.80	57.11	1,348.11
Rye	"	1,590.4	157.45	1,087.83	42.94	1,288.22
Corn	"	2,228.8	167.16	1,511.13	230.68	1,908.97
Flax	"	649.6	138.82	110.43	423.86	668.11
Soybeans	1921-1925	990.0	328.68	244.53	358.63	931.84
Field beans	1921-1932	1,110.0	208.68	569.43	19.98	798.09
Field peas	1926-1929	1,242.0	235.98	693.04	16.84	945.86

Soybeans, field peas, and field beans gave calculated yields of 328.68, 208.68, and 235.98 pounds of digestible crude protein per acre. Field beans was closely followed by oats, with a calculated yield of 193.07 pounds per acre. On the basis of digestible nutrients, oats are fully as satisfactory a crop to grow as barley, hard red spring wheat, durum wheat, winter wheat, or rye.

North Central Station, Grand Rapids

Years grown, range in yield, average yield in bushels per acre, and value per acre are given in Table 9. Oats and barley were grown each year, spring wheat each year except 1929, durum wheat each year except 1929 and 1931, winter wheat 1924 to 1927 and 1929 to 1932, inclusive, flax 1925 to 1932, field beans 1921 to 1923, and field peas 1926, 1927, and 1929. Corrections based on the yield of barley and oats did not greatly influence the weighted yield of those crops not grown in all years.

Table 9

Comparative Yields, Prices per Bushel, and Value per Acre of Crops Grown at the Grand Rapids Station

Crop	Years grown	Range in yield, bu.	Weighted yield, bu.	1921-32 av. price per bu.	Value per acre
Oats	1921-1932	29.0-78.4	53.7	\$0.29	\$15.57
Barley	"	12.9-42.3	28.8	0.46	13.25
Hard red spring wheat....	1921-28; 1930-32	5.3-25.6	16.6	1.06	17.60
Durum wheat.....	1921-28; 1930; 1932	6.1-25.8	16.1	0.95	15.30
Winter wheat.....	1924-27; 1929-32	0.0-58.8	19.0	0.96	18.24
Rye	1924-1932	19.4-60.8	27.9	0.65	18.14
Flax	1925-1932	0.0-21.0	8.5	1.91	16.24
Field beans.....	1921-1923	12.4-31.8	22.1	3.33	73.59
Field peas.....	1926, 1927, 1929	8.0-28.9	19.8	3.00	59.40

Field beans and field peas were outstanding in calculated return per acre, with values of \$73.59 and \$59.40, respectively. Winter wheat led with a value of \$18.24, followed by rye \$18.14, hard red spring wheat \$17.60, flax \$16.24, oats \$15.57, durum wheat \$15.30, and barley \$13.25.

Yields of digestible nutrients are given in Table 10.

Field beans and field peas were outstanding in digestible crude protein production, with yields of 249.29 and 299.14 pounds, respectively, followed by oats, with a yield of 166.68 pounds. The three types of wheat did not prove especially well adapted to this section. Oats produced 42 pounds more of digestible crude protein than barley and nearly 100 pounds more of digestible fat, but was exceeded by barley in digestible carbohydrates by 28.15 pounds.

Table 10

Yield of Digestible Nutrients per Acre, Based on Average Yields of Crops at the Grand Rapids Station

Crop	Years grown	Weighted yield, lb.	Yield of nutrients, lb.			
			Crude protein	Carbo-hydrates	Fat	Total
Oats	1921-28; 1930-32	1,718.4	166.68	895.29	146.92	1,208.89
Barley	"	1,382.4	124.42	923.44	49.77	1,097.63
Hard red spring wheat....	"	996.0	99.60	660.35	33.61	793.56
Durum wheat.....	1921-28; 1930; 1932	966.0	96.60	640.46	32.60	769.66
Winter wheat.....	1924-27; 1929-32	1,140.0	114.00	755.82	38.42	908.30
Rye	1924-1932	1,562.4	154.68	1,068.68	42.18	1,265.54
Flax	1925-1932	476.0	98.06	80.92	310.59	489.57
Field beans.....	1921-1923	1,326.0	249.29	680.24	23.87	953.40
Field peas.....	1926-27; 1929	1,206.0	229.14	672.95	16.28	918.37

Northeast Experiment Station, Duluth

The years each of the crops was grown, the range in yield, weighted yield, and value per acre for 1921-1932, inclusive, are given in Table 11.

Table 11

Comparative Yields, Prices per Bushel, and Value per Acre of Crops Grown at the Duluth Station

Crop	Years grown	Range in yield, bu.	Weighted yield, bu.	1921-32 av. price per bu.	Value per acre
Oats	1921-1932	44.8-78.4	58.5	\$0.29	\$16.97
Barley	"	25.2-63.3	34.3	0.46	15.78
Hard red spring wheat.....	"	11.7-26.1	19.0	1.06	20.14
Rye	"	9.4-30.3	19.5	0.65	12.68
Durum wheat.....	1921-26; 1928; 1931-32	9.0-25.7	18.3	0.95	17.39
Winter wheat.....	1922-1928	0.0-30.6	10.1	0.96	9.70
Flax	1926-1932	7.2-19.2	14.0	1.91	26.74

Flax grown from 1926-1932 gave yields ranging from 7.2 to 19.2 bushels, averaged 14 bushels, and gave a calculated value of \$26.74. Spring wheat had a calculated value of \$20.14, durum wheat \$17.39, oats \$16.97, barley \$15.78, while rye and winter wheat gave low yields and were poorly adapted to this section.

The calculated yields of digestible nutrients are given in Table 12. Oats, with a yield of 181.58 pounds per acre of digestible crude protein and a total of 1,317.49 pounds of digestible nutrients, are of greatest value as a feed crop but are followed closely by barley, with a total of 1,307.25 pounds of digestible nutrients. At the Duluth station, both oats and barley are much superior to other small grain crops for feeding purposes.

Table 12
Yield of Digestible Nutrients, Based on Average Yields per Acre
at the Duluth Station

Crop	Years grown	Weighted yield, lb.	Yield of nutrients, lb.			
			Crude protein	Carbo- hydrates	Fat	Total
Oats	1921-1932	1,872.0	181.58	975.31	160.60	1,317.49
Barley	"	1,646.4	148.18	1,099.80	59.27	1,307.25
Spring wheat.....	"	1,140.0	114.00	755.82	38.48	908.30
Rye	"	1,092.0	108.11	746.93	29.48	884.52
Durum wheat.....	1921-26; 1928; 1931-32	1,098.0	109.80	727.97	37.06	874.83
Winter wheat.....	1922-1928	606.0	60.60	401.78	20.45	482.83
Flax	1926-1932	784.0	161.50	133.28	511.56	806.34

DISCUSSION OF RESULTS

The comparative desirability of various crops, grown primarily for their seed, when grown for sale and based on average prices during the 12-year period 1921-1932, inclusive, is given in the summary and in greater detail in separate tables throughout the body of the text. On the basis of yields obtained at the various stations and comparative prices, the individual grower in various regions of the state may decide which of the crops is most desirable.

The results given indicate that oats compare very favorably with barley on the basis of yields per acre. Thus oats exceeded barley at Crookston, Morris, Grand Rapids, and Duluth, both in yield of pounds of grain produced per acre and in the calculated yield in pounds of digestible nutrients, while barley exceeded oats in both respects at the Waseca station and exceeded oats in calculated pounds of digestible nutrients at University Farm but gave a slightly lower yield of pounds of grain per acre than oats.

Statistics usually collected are much less favorable to oats than these results would indicate. This may be shown by comparing the station yields with estimated yields obtained in the counties where the experiment stations are located, the estimated yields being taken from Minnesota Annual Crop Reports. The comparative data are given in Table 13.

In the comparison of the average station yields of oats and barley in percentage, with barley as 100, the oat yield in each case exceeds that of barley with the single exception of the Waseca station. However, in comparing the county yields, the reverse situation is apparent. Here the oat yields range from 75.7 per cent to 89.8 per cent of the barley yields.

Table 13

Comparison of Oat and Barley Yields at the Experiment Stations, with the Estimated Yields of Oats and Barley in the Counties in Which the Stations Are Located

Location	Yield of oats, lb.		Yield of barley, lb.		Percentage yield of oats with barley as 100		Difference
	Station	County	Station	County	Station	County	
Crookston	1,971.2	908.8	1,627.2	1,200.0	121.1	75.7	45.4
Morris	1,891.2	1,033.6	1,646.4	1,185.6	114.9	87.2	27.7
Waseca	2,323.2	1,216.0	2,500.8	1,353.6	92.9	89.8	3.1
Grand Rapids.....	1,718.4	1,145.6	1,382.4	1,444.8	124.3	79.3	45.0
Duluth	1,872.0	1,161.6	1,646.4	1,478.4	113.7	78.6	35.1
University Farm....	1,990.4	1,113.6	1,944.0	1,377.6	102.4	80.8	21.6

In considering the value of these two crops in a particular locality, this disparity must be taken into account. In experiment station practice the fields are in regular rotation and neither crop is favored by being grown on better land than the other. Most farmers, however, favor barley by according it better land and more thoro preparation of the seedbed; oats are generally put in on the ground that remains after the other crops are planted. As a result, barley yields are higher than those of oats. The results at the experiment stations may be considered as a reliable comparison of the two crops.

The comparative value of various crops as feed for livestock on the farm is of first importance to many Minnesota farmers. Comparative yields per acre of crops at the various stations should help materially to determine which crop or crops are most desirable to grow for feed purposes. Feeding trials, however, are the only sure criterion of the value of various crops.

In general, it is considered advantageous to grind small grain seed before feeding.

While it is not advisable to make too extensive summaries here, it will suffice to give a review of the present viewpoint of investigators who have made feeding trials for various classes of livestock and give to the reader sources of information. As feeding standards are different for the various classes of livestock, it will be necessary to discuss these separately for the various classes. The discussion presented here refers to studies made in Minnesota by the Dairy and Animal Husbandry divisions which appear to have greatest importance in relation to the use of home-grown crops on the farm.

Feeding dairy cattle.—Eckles presented a summary in Bulletin 218 of the Minnesota Agricultural Experiment Station, revised July, 1932. He recommended various combinations of grain rations for dairy cows when fed all the roughage they will eat. If the roughage is a

good one containing soybeans or clover hay, he recommended one pound of the various grain mixtures for each 2½ to 3 pounds of milk for Jersey or Guernsey breeds and one pound for each 3 to 3½ pounds of milk for the larger breeds such as Holstein or Shorthorn. The reader should consult these standards. Several mixtures will be mentioned containing ground farm grains and satisfactory only when good roughage is available. Numbers in parentheses refer to particular mixtures given by Eckles.

(1)	lb.	(4)	lb.	(6)	lb.	(2) & (3)	lb.
Ground oats	200	Ground oats	300	Ground oats	400	Ground oats	100
“ corn	100	“ corn	200	“ corn	300	“ barley	200
“ barley	100	“ wheat	100	“ rye	100	Gluten feed or wheat bran	100

When the roughage is less desirable, standards are given including linseed meal, gluten feed, or cottonseed meal in addition.

Corn is used in nearly all suggested rations, altho equal parts of barley and oats are suggested in mixtures with gluten feed or wheat bran. Rye is somewhat unpalatable, altho it can be used advantageously in mixtures. Ground oats are an excellent feed and are used extensively in all rations. It should be remembered in this connection that oats and barley are adapted to all parts of the state and that oats give somewhat higher yields than barley in northern and north central Minnesota.

Farm grains for hogs.—Ferrin and others reported feeding trials in Mimeographed Statement H48 in 1931 and compared shelled corn with ground grains of barley, durum wheat, oats, and rye. Each grain was supplemented by a concentrate composed of 50 per cent tankage, 25 per cent linseed meal, and 25 per cent finely ground alfalfa meal, and each lot of pigs also received the same mineral ration. The number of pounds of grain, protein supplement, and mineral supplement for each type of feed is summarized here and compared with the yields obtained per acre.

Feed consumed	Feed per 100 pounds of gain				
	Sh. corn	Gr. barley	Gr. wheat	Gr. oats	Gr. rye
Grain	359.7	523.3	398.4	512.4	495.0
Protein sup.	60.1	33.2	24.6	73.3	50.6
Mineral sup.	0.44	1.02	1.15	1.90	1.28

	Average pounds produced per acre				
	Corn	Barley	Wheat (durum)	Oats	Rye
Morris	2,475	1,646	1,560	1,891	1,596
Crookston	1,826	1,627	1,662	1,971	963
Waseca	3,192	2,501	1,752	2,323	1,915
Average	2,498	1,925	1,658	2,062	1,491

Using these trials as a basis and the relative yields given in the tables, it is possible to compare the value of various grains. For example, ground wheat is the equal of any grain for hogs, based on the average yields at the three stations. If 398 pounds of wheat are used in each 100 pounds of gain and if the average yield of wheat per acre is 1,658 pounds, which was obtained for durum at the three stations, one might calculate how many pounds of barley would be required if it took 523 pounds of ground barley for each 100 pounds of gain. The proportion would be $398:523 = 1,658:x$. In this case $x = 2,179$, and on an average wheat is somewhat more advantageous as a feed for hogs than barley. Barley is somewhat superior to oats, as a greater amount of protein supplement was used by the pigs fed ground oats than by those fed ground barley. Rye is undesirable, while corn, as is commonly recognized, is a relatively satisfactory feed.

Feeding beef cattle.—Peters in Minnesota Agricultural Experiment Station Bulletin 300, 1933, compared oats and barley as a source of grain feed for fattening beef cattle. Barley proved much more satisfactory than oats when supplementary feeds were used, and substituting oats for a part of the barley did not have sufficient advantage to be considered a desirable practice when the two grains are about equal in price, pound for pound. As barley and oats yielded about the same in these trials at the central and branch stations, the conclusion seems sound that barley is a better crop to grow as feed for beef cattle than oats. In feeding trials at the Crookston station it was found that ground wheat proved satisfactory as a feed for cattle “fed alone, ground, or fed in a combination with ground barley and oats.”

SUMMARY

1. The yields of crops in varietal trials from 1921 to 1932, inclusive, at the central and branch stations have been used to make a comparison of the relative values of the various crops for feed purposes on the farm, cash values on the basis of yields, and average prices over a 10-year period.

2. Oats, with a range of 53.7 bushels in average yield at Grand Rapids to 72.6 bushels at Waseca, and barley, with a range of 28.8 bushels in average yield at Grand Rapids to 52.1 bushels at Waseca, are well adapted to all parts of the state.

3. Oats gave the largest return of digestible nutrients of any of the small grain crops at Crookston, Morris, and Duluth, with calculated yields of 1,386.7, 1,330.5, and 1,317.5 pounds per acre, respectively; barley was the leader at University Farm and Waseca, with calculated yields of 1,543.5 and 1,985.6 pounds per acre, respectively, while rye

was the leader at Grand Rapids, with a calculated yield of 1,265.5 pounds. Barley was in second place at Morris and Duluth, while oats was in second place at Waseca, University Farm, and Grand Rapids.

4. Durum wheat yielded several bushels higher, on an average, at Crookston and Morris than hard red spring wheat, while winter wheat yielded more than either durum or hard red spring wheat at University Farm and Waseca.

5. Among the small grains and flax, the highest computed values per acre at the various stations were as follows:

Crookston.—Durum wheat, \$26.32; hard red spring wheat, \$24.80; flax, \$24.64.

Morris.—Flax, \$27.89; durum wheat, \$24.70; hard red spring wheat, \$23.53.

Waseca.—Flax, \$30.56; winter wheat, \$28.80; durum wheat, \$27.74.

University Farm.—Hard red spring wheat, \$27.24; winter wheat, \$27.07; durum wheat, \$25.65.

Grand Rapids.—Winter wheat, \$18.24; rye, \$18.14; hard red spring wheat, \$17.60.

Duluth.—Flax, \$26.74; hard red spring wheat, \$20.14; durum wheat, \$17.39.

On this basis, flax and durum wheat led in the Red River Valley. Flax also led at Waseca and Duluth, hard red spring wheat at University Farm, and winter wheat at Grand Rapids. Winter wheat was second at University Farm and Waseca; hard red spring wheat, second at Crookston and Duluth; durum wheat, second at Morris, and rye, second at Grand Rapids.

6. Soybeans were grown at four stations and gave average yields of 9.8 bushels at Crookston, 18.3 bushels at Morris, 16.5 bushels at University Farm, and 13.3 bushels at Waseca. They are well adapted to the central and southern part of Minnesota and are of considerable interest because of their high content of digestible crude protein.

7. Corn gave average yields of 56.4 bushels at Waseca, 44.2 bushels at Morris, 39.8 bushels at University Farm, and 32.6 bushels at Crookston. The yields at Crookston indicate what may be expected from adapted varieties in the northern part of the state, where early-maturing varieties must be grown.

The total yield of digestible nutrients of corn is compared with that of its nearest competitor at stations where corn was grown regularly. Corn exceeded oats at Crookston and Morris by 176.89 and 789.54 pounds, respectively, while corn exceeded barley by 748.30 and 365.44 pounds, respectively, at Waseca and University Farm.