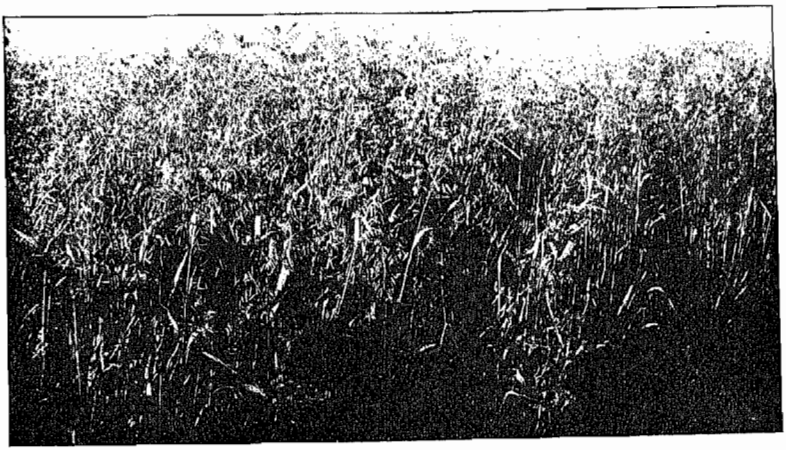
BULLETIN

OF THE

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OF THE

UNIVERSITY OF TENNESSEE



VIRGINIA GRAY WINTER OATS AND HAIRY VETCH GROWN FOR HAY—
YIELD 1.60 TONS PER ACRE

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WINTER CEREALS AND LEGUMES

KNOXVILLE, TENNESSEE

THE AGRICULTURAL EXPERIMENT STATION

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WINTER CEREALS AND LEGUMES

ANDREW M. SOULE AND PHARES O. VANATTER

INTRODUCTION

There is a degree of difference in the hardihood of the various winter cereals which is not generally recognized. Rye and wheat are more generally and successfully cultivated than any of the other cereals because of this fact. Winter oats and barley are more delicate in nature and that probably accounts for the indifferent success met with in their culture on the farm. While these crops may succeed when sown quite late in the season, it is very important that they be seeded early—from the first to the middle of September. It is true that they often succeed sown as late as the middle of October, but the chances of failure are greatly enhanced by late seeding, and the loss of the seed and the crop together is too great a risk to incur. If winter rye is desired for a fall and winter pasture, it is necessary that it be sown from the middle of August to the middle of September. It can often be sown in the corn field after the last cultivation and as it makes a quick and vigorous growth, furnishes an excellent pasture from October until Christmas, or through the entire winter if the season is mild.

VALUE OF WINTER CEREALS

The utilization of winter cereals enables the farmer to keep his land covered, thus preventing the leaching out of valuable fertilizing constituents and the washing and eroding of his fields by the winter rains. Where the crops are intelligently handled, the pasture obtained would of itself pay for the cost of the seed and the time and labor involved in putting in the crop. On good land winter cereals will yield from 30 to 70 bushels of grain of high feeding value which can be utilized effectively in the compounding of rations for feeding farm stock. When grain is not desired, they will yield in conjunction with winter legumes from two to three tons of good hay, rich in digestible nutrients.

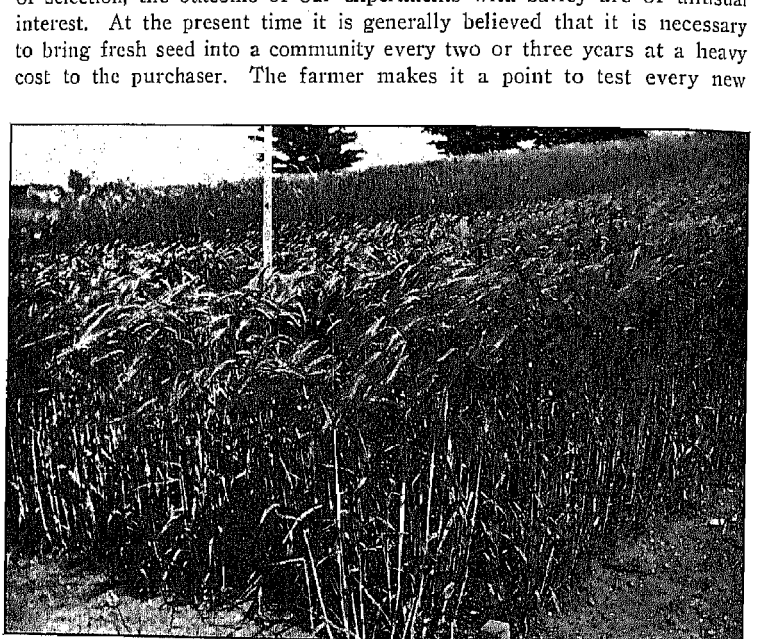
The successful culture of winter cereals means the development of stock industries commensurate with the needs of the southern farmer, and the reclaiming and profitable culture of thousands of acres of waste lands. Besides the manifest advantage of occupying the land during the winter season, winter cereals and legumes can be removed from the land so as to permit the culture of a second crop, such as corn, cowpeas, soja beans, etc., the same season. They are ready for harvesting before spring sown cereals and are not so subject to the attacks of rust and insect pests because of their vigor when the spring opens up.

SEED SELECTION WITH WINTER BARLEY

From the accompanying tables it is evident that barley lends itself readily to improvement through the medium of selection. The original seed of the variety of barley used in these trials was obtained from different sections of Tennessee. It was generally known as winter

barley, but as it was important that it have a more definite name, we have termed it Tennessee winter barley. Granting that the culture of barley has not always been carried on after the best method, it is evident that the yields obtained can be improved upon, and as seed selection can be successfully prosecuted on every farm, the value of this method of improving grain interests every one.

In spite of the numerous varieties of winter barley, it is a difficult matter to obtain one well adapted to a given section of the country, and believing as we do that a variety only fairly well adapted for culture in a given locality can soon be improved at but little cost through the medium of selection, the outcome of our experiments with barley are of unusual interest. At the present time it is generally believed that it is necessary to bring fresh seed into a community every two or three years at a heavy cost to the purchaser. The farmer makes it a point to test every new



"UNION" WINTER BARLEY—YIELD 77.7 BUSHELS PER ACRE.

variety that comes along and pay fancy prices for the seed, believing that he will presently strike a bonanza. In the majority of cases, these so-called varieties prove unsatisfactory and the amount of money wasted in the purchase of such seeds is appalling. If selection proves feasible, it can certainly be carried on on every farm at an insignificant cost as compared with the money now so lavishly spent in the testing of seeds of unknown value. A variety of grain well adapted to a community comes in the nature of a Godsend and its virtues should be jealously guarded. Once a community can secure a variety that meets its needs, it should devote all its energies to the selection, improvement and preservation of that variety. It is a mistake to suppose that a variety runs out. Give it proper treatment and use judgment in selecting it and it can be kept in-

violate for an indefinite time. The question of variety is one of burning import to the farmers of the south and if it can be demonstrated that

TABLE I Showing the Original Method of Seed Selection from Tennessee Winter Barley, 1900

Method of Selection Practiced	No. of Grains	Average Number of Grains per Head	Average Number of Grains per Ounce	Total Weight of Grain Lbs—Ounces	Character of Grains Planted	No. of Grains per Ounce of Seed Sown	Grains Sown per Plat No.	Grains Sown per Plat Weight Ounces
400	.....	.....	.....	.....	Large...	638	7656	12.0
Large Heads	22,515	58.8	753	1.13	Small...	821	7656	9.3
600	.....	.....	.....	.....	Large...	697	7656	11.0
Medium Heads	19,888	33.2	808	1.9	Small...	910	7656	8.4
900	.....	.....	.....	.....	Large...	745	7656	10.2
Small Heads	22,955	25.5	876	1.11	Small...	925	7656	8.2
General Selection								
Large Grains	.....	.....	.....	.....	Large...	638	7656	12.0
Medium Grains	.....	.....	.....	.....	Medium.	787	7656	9.8
Small Grains	.....	.....	.....	.....	Small...	1114	7656	7.0

they can improve ordinary varieties, it will mean the saving of hundreds of thousands of dollars.

Tables I and II give the results of the investigations to date with winter barley. The experiments reported are the result of one year's

TABLE II Seed Selection with Tennessee Winter Barley, 1901

Plat No.	Method of Selection Practiced	Date of Ripening	Height of Crop in inches	Total weight of Crop per Acre.—Lbs.	Yield per Acre of Grain—Lbs.	Yield per Acre of Straw—Lbs.	Yield per Acre of Grain—Bushels	Yield per Acre of Straw—Tons	Ratio of Grain to Straw in Crop—Lbs.	Average Number of Grains Per Head	Average Number of Grains Per Oz.
I	*Large Heads.*	June									
1	Large Grains.	14	30	4752	2560	2192	53.3	1.10	1: .86	31.5	900
2	Small Grains.	14	28	3936	2000	1936	41.7	.97	1: .96	25.4	898
II	*Med'm Heads*										
1	Large Grains.	14	31	4512	2160	2352	45.0	1.18	1:1.08	31.0	866
2	Small Grains.	14	28	3696	1568	2128	32.7	1.06	1:1.36	30.1	896
III	*Small Heads.*										
1	Large Grains.	14	32	4496	1872	2624	39.0	1.31	1:1.40	29.1	900
2	Small Grains.	14	29	4032	1840	2192	38.3	1.10	1:1.18	30.2	868
IV	*Gen'l Select'n*										
1	Large Grains.	14	31.5	3440	1744	1696	36.3	.85	1: .97	35	876
2	Commercial sample...	14	29.0	3200	1168	2132	24.3	1.07	1:1.82	21.2	900
3	Small Grains.	14	29.5	3680	1376	2304	28.7	1.15	1:1.68	29.1	920
4	Sample boug't	14	28.0	3040	1248	1792	26.0	.90	1:1.43	22.3	892
V	*Union Barley*										
1	Large Grains.	7	37	14160	3728	10437	77.7	5.22	1:2.80	29.4	925
2	Commercial sample...	8	34	13488	2944	10544	61.3	5.27	1:3.58	27.2	930
3	Small Grains.	10	33	13312	2736	10576	57.0	5.29	1:3.86	26.7	977

trial. The selections have been carried on with grain obtained by hand-picking from large heads, medium heads and small heads. Two varieties of barley have been under experiment, the Tennessee winter barley already referred to and Union barley, a variety from Canada. The general selection was made by means of sieves, as described in the bulletin on winter wheat, and as a check against all the other selections, a sample of winter barley was bought in the open market. It appears from Table I that 400 large heads contain 21,515 grains; 600 medium heads 19,888 grains; and 900 small heads 22,955 grains, or an average of 53.8 grains for large heads, 33.2 grains for medium heads and 25.5 grains for small heads; while the grains from 400 large heads weighed 2 ounces more than from 900 small heads. This is surely a wonderful variation and clearly demonstrates the importance of securing large and uniform heads. It required 753 grains from large heads to weigh an ounce and 876 from small heads, indicating that the largest and plumpest grains are in the large heads. The average of all trials with the large grains resulted in a yield of 50.3 bushels and with the small grains, 39.7 bushels, a difference of 10.6 bushels in favor of the large grains. The good yields made by the

TABLE III Dates of Seeding with Tennessee Winter Barley, 1901

Plat No.	Date of Seeding	Date of Ripening	Height of Crop—ins.	Total Weight of Crop per Acre—lbs.	Yield per Acre of Grain Bushels	Yield per Acre of Straw Tons	Per cent. of Grain in Crop
1	September 17..	June 10..	27	3299	30.4	.92	1:1.26
2	September 24..	June 11..	26	2859	27.9	.76	1:1.13
3	October 4..	June 12..	25	2696	21.6	.83	1:1.60
4	October 15..	June 15..	25	2638	20.8	.82	1:1.65
5	October 25..	June 22..	25	1892	19.0	.49	1:1.22
6	November 5..	June 24..	24	1880	20.0	.46	1:1.96
7	November 15..	June 26..	19.5	902	8.8	.24	1:1.14

large and small grains from small heads is worthy of observation, though the returns are not nearly so satisfactory as with the large and medium heads. The commercial sample and the sample bought illustrate very nicely the importance of selection and of using a sieve in preparing grain for seeding. The results to date indicate that it will pay the farmer to sow only the choicest and largest grains which can be obtained by selecting out the best heads from the field grown crop. A few bundles sufficient for seed can be picked out in a very short time. It will pay to do this.

DATES OF SEEDING WITH TENNESSEE WINTER BARLEY

In order to determine the influence of dates of seeding on the yield of barley, an experiment has been conducted for two years, the results for 1901 being shown in Table III. The barley was sown every 10 days from September 17 to November 15, seven dates in all. The dates of ripening varied a good deal, there being an extreme variation of 14 days with the barley seeded September 17 and that seeded November 15. The height of the barley also uniformly decreased from the early seeding until the late

seeding, there being a difference of 7.5 inches in favor of the early seeding. Naturally, the weight of the crop, the yield per acre and the size of grain varied proportionately. The best yield of barley was with that seeded

TABLE IV Intertillage with Tennessee Winter Barley, 1901

Plat No.	Method of Culture Practiced	Date of Ripening	Height of Crop—ins.	Total Weight of Crop per Acre—lbs.	Yield per Acre of		Ratio of Grain to Straw in Crop —Lbs.
					Grain Bushels	Straw Tons	
1	Narrow rows not harrowed.....	June 10 . .	37.5	7360	55.0	2.36	1:1.40
2	Narrow rows harrowed in fall...	June 10 . .	36.5	6540	50.0	2.07	1:1.73
3	Narrow rows harrowed in fall and spring	June 10 . .	38.0	7203	50.9	2.38	1:1.95
4	Wide rows not harrowed	June 10 . .	36.5	6452	51.1	2.00	1:1.63
5	Wide rows harrowed in fall ..	June 10 . .	37.0	6687	48.9	2.17	1:1.85
6	Wide rows harrowed in fall and spring	June 10 . .	37.0	5411 .	30.4	1.76	1:1.84

September 17, 30 bushels, and the poorest with that seeded November 15, 19 bushels. This indicates pretty clearly that early seeding is essential if good results are hoped for.

INTERTILLAGE WITH TENNESSEE WINTER BARLEY

The influence of seeding barley in narrow and wide rows and cultivating in the fall and spring is shown in Table IV. The barley was all seeded on October 13 on uniform land of good quality on which cowpeas had been plowed under. The height of the crop was quite uniform. The best yield was obtained from the narrow rows not harrowed, 55 bushels, and the next best yield from

TABLE V Growing Winter Barley and Fulcaster Wheat on Good and Poor Soil, 1901

SET I GOOD SOIL

Plat No.	Variety Grown	Date of Ripening	Height of Crop—inches	Total Weight of Crop—lbs.	Yield per Acre of		Ratio of Grain to Straw in Crop—lbs.
					Grain—bushels	Straw—tons	
1	Union.....	June 8	41.5	7532	71.1	2.06	1:1.24
2	Tennessee.....	14	40.0	8127	58.9	2.65	1:1.87
3	Fulcaster Wheat.....	.....	.....	.....	44.5	.....	.....

SET II POOR SOIL

1	Union.....	6	27	2860	27.1	.78	1:1.19
2	Tennessee.....	12	29	4640	30.0	1.60*	1:2.22
3	Fulcaster Wheat.....	.....	.....	.....	37.0	.....	.....

*The straw was very damp at time of threshing.

wide rows not harrowed, 51.1 bushels. The narrow rows harrowed in the fall and also in the fall and spring gave about the same yields, while the wide rows harrowed in the fall and spring made only 39.25 bushels. The table indicates that narrow rows without cultivation will give the most satisfactory results with winter barley if seeded on good land.

GROWING WINTER BARLEY AND FULCASTER WHEAT

Table V shows the result of growing winter barley on good and poor soil in 1901. The productivity of a soil largely depends on the amount of humus it contains and the availability of the plant food. Barley is a crop requiring the soil food supplies to be in condition for quick assimilation and when put on such soil and properly treated, it will give a correspondingly better result than wheat. For example, plats containing Union and Tennessee barley on rich soil made a yield of 71.1 bushels and 58.9 bushels, while wheat made 44.58 bushels. The same varieties sown on poor soil made a yield of 27.1 and 30 bushels respectively, while wheat made 37 bushels. In view of the fact that barley will make larger yields than wheat and owing to its excellent quality when combined with corn for feeding cows and hogs, and to a limited degree for horses, it is strange that a larger per cent of so valuable a cereal has not hitherto been cultivated in Tennessee. If larger areas were devoted to the growth of winter barley, the question of the economic feeding of beef cattle in the winter season in Tennessee would be much easier of solution. In view of the important relation of stock husbandry to the agricultural welfare of the state, it is important that more attention be given to the subject of growing barley.

CULTURAL TESTS WITH WINTER OATS

But little work has been done along cultural lines with winter cereals. To ascertain the influence of broadcasting and drilling oats at various depths, the experiment shown in Table VI was undertaken. The oats were seeded uniformly at the rate of 2.5 bushels per acre. They were broadcasted and harrowed in drills 8 inches apart, 16 inches apart and 2 inches deep, 16 inches apart and 2.5 inches deep, and 16 inches apart

TABLE VI Methods of Seeding Culberson Winter Oats, 1901

Plat No.	Method of Seeding Practiced	Date of Ripening	Height of Crop—ins.	Total Wt. of Crop per Acre—Lbs.	Yield per Acre of		Ratio of Grain to Straw in Crop—Lbs.
					Grain Bus.	Straw Tons	
1	Broadcast 2½ bus.....	June 15..	38.5	4110	45.0	1.29	1:1.68
2	Drilled 8″ 3½ bus.....	June 15..	43.0	6945	73.7	2.22	1:1.77
3	Drilled 16″, 2″ deep, 2½ bu.	June 15..	43.5	9339	64.7	2.07	1:1.88
4	Drilled 16″, 2½″ deep, 2½ bus.....	June 15..	40.0	4840	50.2	1.57	1:1.82
5	Drilled 16″, 3½″ deep, 2½ bus.....	June 15..	39.5	4604	47.2	1.50	1:1.86
6	Broadcast { Oats 2¼ bus.. Barley ¼ bus.	June 15..	42.	6800	2540*	2.13	1:1.67
7	Broadcast { Oats 2¼ bus.. Wheat ¼ bus.	June 15..	36.5	6510	2190*	2.16	1:1.96

*Being a mixture of oats and barley, the yield in bushels can not be given.



VIRGINIA GRAY WINTER OATS—YIELD 42 BUSHELS PER ACRE

and 3.5 inches deep. The stand was uniform and from general appearance one would have thought the drilled oats in wide rows would make the best yield. While the yield was satisfactory in every instance, the best results were obtained by drilling eight inches apart, the yield being 73.7 bushels per acre. The next best results were with those drilled 16

inches apart and 2 inches deep, 64.7 bushels per acre. Broadcasting gave the poorest results.

DATES OF SEEDING

The importance of early seeding with oats is clearly brought out in Table VII. The best yield obtained was 68 bushels from the seeding of October 3. The seedings made after this date gradually decreased, that of November 5 making a yield of 38.2 bushels, or a little more than one-half of that from the seeding of October

TABLE VII Dates of Seeding with Culberson Oats, 1901

Plat No.	Date of Seeding	Date of Ripening	Height of Crop—ins.	Total Wt. of Crop per Acre —Lbs.	Yield per Acre of		Ratio of Grain to Straw in Crop—Lbs.
					Grain Bus.	Straw Tons	
1	October 3	June 15..	43.0	6892	68.0	2.29	1:1.98
2	October 15	June 21..	42.5	5180	50.0	1.74	1:2.04
3	October 25	June 25..	38.0	3880	40.6	1.25	1:1.81
4	November 5	June 28..	38.0	3798	38.2	1.25	1:1.92

3. The importance of early seeding on well prepared land for winter oats can not be emphasized too strongly. The root growth of oats is not so vigorous as with wheat, the plants are more delicate, and it is necessary that they become firmly established in the soil before the cold weather approaches or they will winter kill.

VARIETIES OF WINTER OATS

Five varieties of winter oats were grown the past year. (S e Table VIII). They were all seeded on October 1 and made a uniform stand. The growth was vigorous and the average height of the crop varied between 42 and 37.5 inches. The best yield was obtained with Culberson, 53.5 bushels, the next with Virginia Gray, 45.3, followed by Winter Turf, 44.1, Winter Turk, 43.3 and Common Gray 32.9. The variation in the yield of the oats was quite remarkable, the more so as they were on uniform ground. The Common Gray winter oat made a yield of 39.3 bushels in 1900, so that it did not do so well in 1901. It may be that it is hardier than some of the other varieties, as Winter Turf, Winter Turk and Virginia Gray, are all ahead of it, though only yielding between 20 and 22 bushels in 1900.

TABLE VIII Varieties of Winter Oats, 1901

Plat No.	Name	Date of Ripening	Height of Crop in inches	Total Weight of Crop in inches	Yield per Acre of		Ratio of Grain to Straw in Crop—lbs.
					Grain—bushels	Straw—tons	
1	Common Gray	July 1	37.5	3388	32.9	1.11	1:1.97
2	Winter Turf	1	39.0	5599	44.1	2.05	1:2.76
3	Winter Turk	1	39.0	4380	42.3	1.47	1:2.04
4	Virginia Gray	1	42.0	6200	45.3	2.33	1:3.02
5	Culberson	Jun.15	41.0	5600	53.5	1.89	1:2.07

The Culberson winter oat is a new variety and has made an exceptionally fine showing, yielding 53 bushels in the variety tests, and in no instance less than 38 bushels. The highest yield was obtained in the methods of seeding, 73.7 bushels. The variety has some special advantages in that it matures about two weeks earlier than the ordinary winter oat, and will ripen with winter barley or wheat. It does not lodge readily, is a strong, thrifty grower and presents a very handsome appearance. The grain was also well filled and of superior quality. As this is its first year, what it may do in the future is still a matter of conjecture, but if it does nearly as well as it did the past year, it is undoubtedly one of the best varieties of winter oats. It is an oat worthy of trial and should receive consideration, but only limited areas should be seeded the first year until its general utility has been better established.

COMPARING THE YIELDS OF THREE WINTER CEREALS

Previous reference has been made to the importance of securing a large amount of grain to supplement the excellent variety of forage crops that may be produced for the winter feeding of stock. An experiment was commenced with this end in view with wheat, barley and rye. It is hoped next year to include some other grains, and a number of other mixtures. Three crops were grown on uniform ground, the yields being, Poole wheat, 37.5 bushels; Excelsior rye, 51.6 bushels; and Tennessee barley, 39.3 bushels per acre. (See Table IX.) Considering the amount of protein, carbohydrates and fat produced by the three as a fair basis on which to estimate their feeding value, we have the following statement:

DIGESTIBLE NUTRIENTS

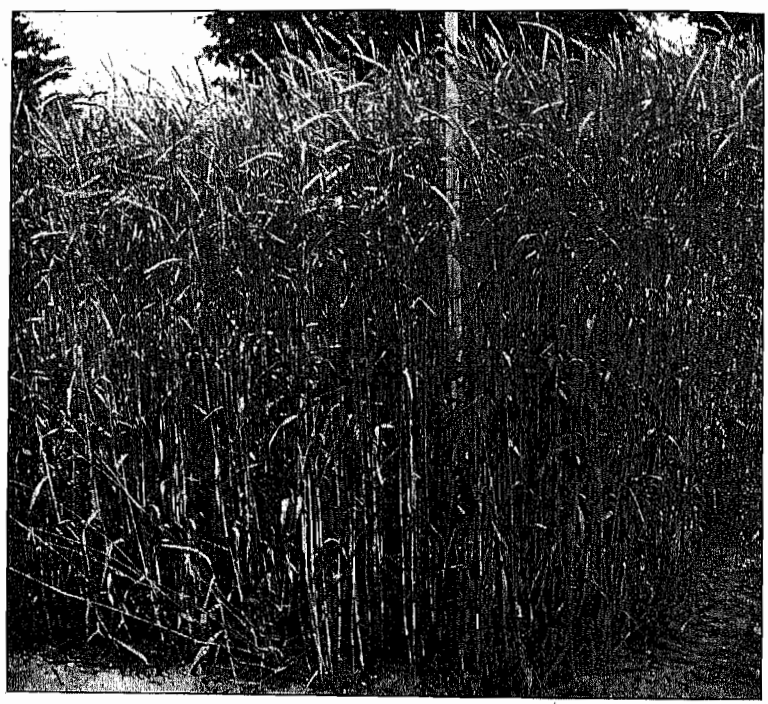
Crop	Amt. Grown Lbs.	Protein	Carbohydrates	Fat
Wheat	2250	229.5	1547	38.25
Rye	3096	306.5	2092.9	34.05
Barley	1886	164	1237.2	30.17

The largest amount of protein or muscle builder and carbohydrates or energy producer was furnished by the rye, followed by wheat and barley. If proper combinations are made, a fine blending of food constituents when ground for winter feeding can be obtained.

TABLE IX Comparing the Yield of Three Winter Cereals, 1901

Plat No.	Class of Grain	Date of Ripening	Height of Crop in inches	Total Weight of Crop per Acre—lbs.	Yield per Acre of		Ratio of Grain to Straw in Crop—lbs.
					Grain—bushels	Straw—tons	
1	Poole Wheat	June 22	40	6400	37.5	2.08	1:1.84
2	Tennessee Barley	10	33	6697	51.6	2.11	1:1.71
3	Excelsior Rye	28	59	7218	39.3	2.43	1:2.20

WINTER RYE Rye furnishes one of the best pastures for the winter season and withstands the effects of tramping. On an average it will outyield wheat and it forms a very excellent food stuff. The draft on the soil is not greater than with other cereals and it matures so that a good crop of cowpeas or northern corn can be grown after it has been harvested. Besides being useful as a pasture and a grain crop, it can be plowed under to furnish humus to the soil. It supplies a large amount of humus when turned under and thus rapidly assists in improving the mechanical condition of the land. Three varieties were grown the past year, Table X, the 20th Century leading with a yield of 42.5 bushels, White



TWENTIETH CENTURY WINTER RYE—YIELD 42.5 BUSHELS PER ACRE

and Excelsior Winter following with a yield of 38.5 and 37.7 bushels respectively. Rye, like other crops, is susceptible to good treatment and in order to get the best results should be seeded early, about the middle of September, or as early as the first of September if it is desired as a fall pasture. When seeded late it does not make such a vigorous growth, the roots are not so well distributed through the soil, less pasture is furnished, and the yield of grain is quite considerably reduced. Where Excelsior rye was seeded on October 4 and 25, that sown on October 4 yielded 32.5 bushels and that on October 25, 18.3 bushels.

HAIRY VETCH The hairy vetch is a winter growing legume and thus forms a most desirable addition to the crops that may be grown for hay and pasture through the winter season. It is very rich in food constituents and makes a most excellent hay if cut in full bloom. It combines well with winter barley, winter oats or winter wheat for the making of hay and the yields obtained when sown alone and in conjunc-

TABLE X Experiments with Winter Rye, 1901

VARIETIES

Plat No.	Name of Variety	Total Weight of Crop—lbs.	Yield per Acre of Grain—bushels	Yield per Acre of Straw—tons	Ratio of Straw to Grain—lbs.
1	Twentieth Century	8170	42.5	2.81	1:2.20
2	White	8110	38.5	2.90	1:2.75
3	Excelsior Winter	7402	37.7	2.57	1:2.27

DATES OF SEEDING

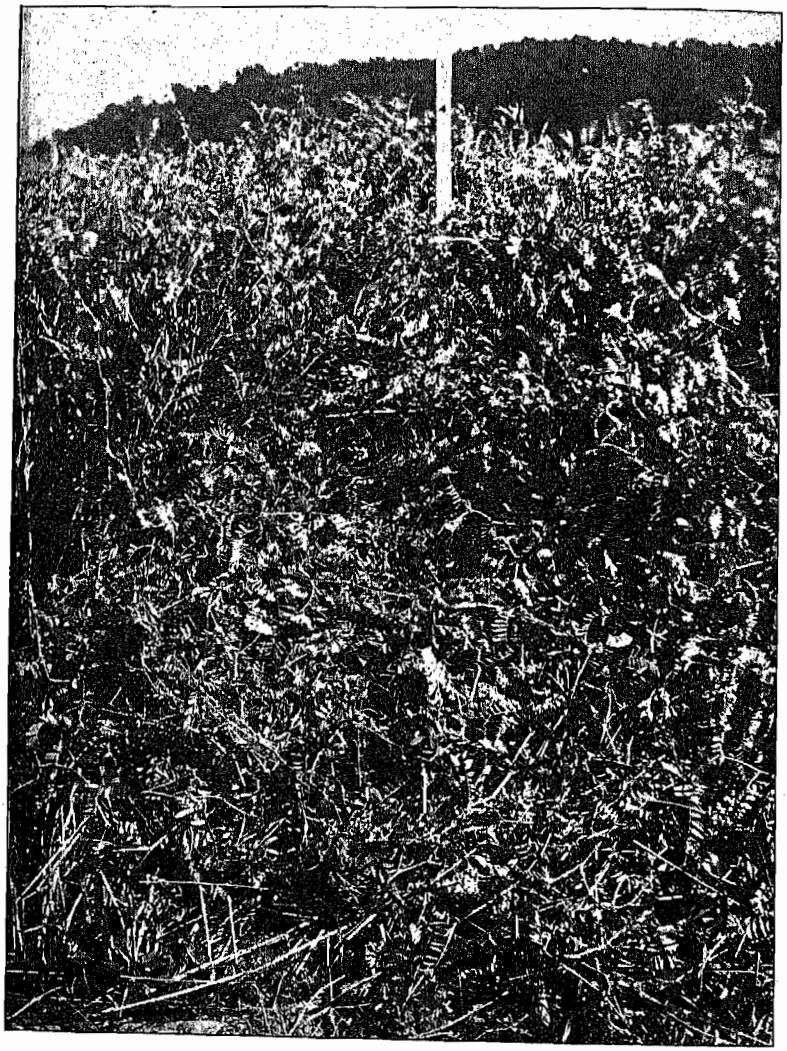
4	Excelsior—October 4	4750	32.5	1.90	1:1.95
5	Excelsior—October 25	3138	18.3	1.04	1:1.85

tion with winter barley are very encouraging, varying from 2.5 to 7.68 tons of green crop and 1.60 to 3.28 tons of cured hay per acre. The vetch in order to do well should be seeded on good soil, carefully prepared, at the rate of about one bushel per acre. It should be seeded early—from the first of September to the first of October, to get the best results. The winter vetch certainly seems to offer a solution of the long-sought but elusive winter legume adapted to Tennessee conditions. Its all-round utility and high feeding value make it an especially desirable addition to

TABLE XI Experiments with Hairy Vetch and Hairy Vetch and Barley, 1901

Plat No.	Name	Date of Ripening	Height of Crop—inches	Yield of Green Crop—tons	Yield of Hay—tons
1	Hairy Vetch	June 6	40	2.50	1.60
2	Hairy Vetch and Barley	June 6	40	3.10	2.15
3	Hairy Vetch	June 6	40	2.85	1.85
4	Hairy Vetch and Barley	June 6	40	2.40	2.00
5	Hairy Vetch	June 5	40	4.64	1.67
6	Hairy Vetch and Barley	June 5	40	7.68	3.28

our farm crops. The vetch yields quite freely and there is no reason why the farmer should not grow his own seed once he has secured a stand. Owing to the manifold uses of the crop and to the great advantage of having a winter legume in the combination of cereals for pasturing and for hay, it is important that the farmers give more attention to growing vetches.



THE HAIRY VETCH—YIELD OF HAY 1.85 TONS PER ACRE

MAKING HAY FROM WINTER CEREALS AND LEGUMES

The question of making hay from winter cereals and legumes is one of unusual interest and importance. The failure of clover in many sections of the state during recent years has forced the farmers to look to some other source for a hay crop. The feeding value of barley, oats, etc., when cut in the dough stage is shown by chemical analysis to be quite high, so that these crops seem to offer the most favorable solution of the difficulty.

The land on which the crops mentioned in the accompanying table were grown was a red clay of good quality and fair texture. It was fertilized at the rate of 260 pounds with 12 per cent mixture of phosphates and a 10 per cent mixture of potash. Owing to the lateness of the summer crop and the wet fall, it was impossible to put in the cereals as early as they should have been. The mild winter of 1900-1901 was very favorable to the growth of these crops and they came through without injury This fact is mentioned because those who read the article may conclude that late seeding is all right for winter cereals, but we can not recommend its general practice to the farmer from the results obtained to date.

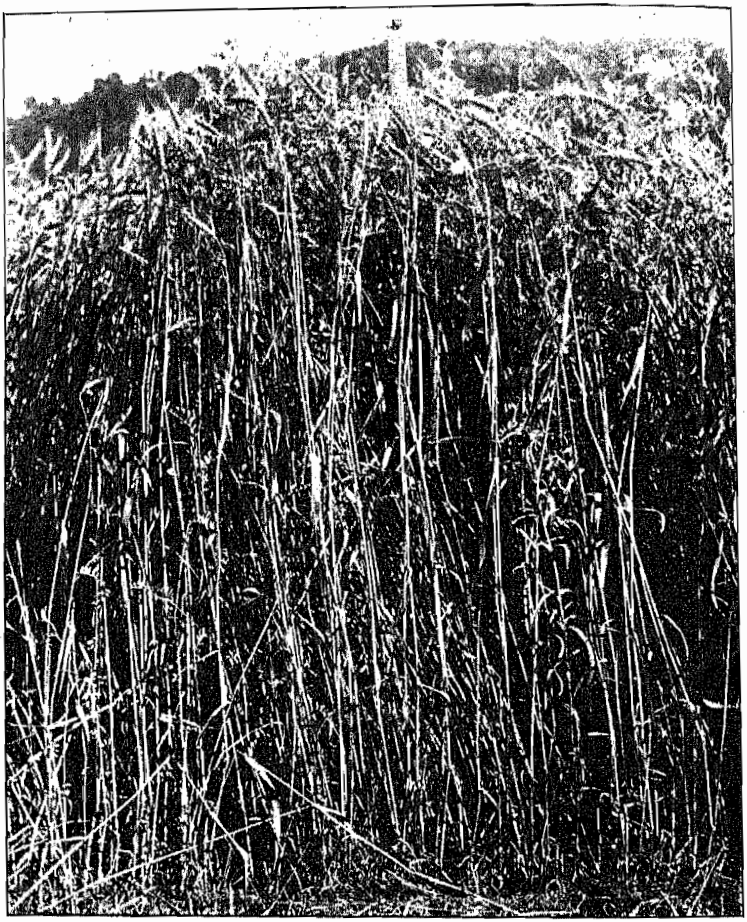
Table XII shows the character of the crops grown, the date and rate of seeding, the amount of fertilizer used, the date of harvesting, the condition when harvested, the yield in tons per acre, the total yield and the yield per acre, and the cost per ton. The highest yield per acre was made with winter wheat and vetch, 3.72 tons; followed closely by wheat with 3.37 tons; wheat, oats and barley followed with 2.96 tons and barley alone 2.30 tons; oats made a yield of 1.65 tons and oats and vetch, 1.60 tons. Spring oats only made a yield of 1.05 tons, showing that any of the winter crops would be better for the purpose of making hay, so far as yield and cost is concerned, than spring oats. The lowest cost per ton of hay was

TABLE XII Yield and Cost of Hay from Winter Cereals and Legumes, 1901

Name of Crop	Date of Seeding 1900	Date of Harvesting—1900	Rate of Seeding Bus.	No. Acres Harvested	Condition of Crop When Cut	Yield per Acre—Tons	Cost of Hay per Ton
Barley	Nov. 18	June 5	1¾	6.13	Dough	2.30	$5.96
Barley	Oct. 11	May 28	2	2.79	Dough	1.42	9.73
Oats	Oct. 11	June 20	3	2.04	Dough	1.65	8.81
Wheat	Oct. 24	June 3	2	2.85	Dough	3.37	4.73
Wheat and Vetch	Oct. 26	June 10	1½ Wheat 1 Vetch	.85	Dough Vetch in bloom	3.72	4.78
Oats and Vetch	Oct. 26	June 20	2 Oats 1 Vetch	.74	Dough Vetch in bloom	1.60	10.65
Wheat, Oats and Vetch	Oct. 26	June 10	¾ Wheat 2 Oats 1½ Barley	1.25	Wheat and Oats dough Barley nearly ripe	2.96	5.37
Spring Oats	April 10	July 2	2½	4.17	Dough	1.05	11.75

made by wheat, $4.73, followed by wheat and vetch at $4.78. A ton of hay was obtained from wheat, oats and barley at a cost of $5.76. Oats alone made a ton at a cost of $8.87; oats and vetch at a cost of $10.65, and spring oats at a cost of $11.75. It appears from these results that a combination of cereals or of the vetch and cereals will reduce the cost of hay per ton

and will also improve the quality of the same. The high cost of oats and vetch is due in part to the great expense of the seed of the vetch which cost about $8 per bushel. Vetch and oats and a number of other combinations of these plants produce a superior quality of pasturage, both for winter and spring grazing. In fact, almost any of the crops mentioned can be grazed to a very considerable extent and also furnish a crop of hay.



WINTER WHEAT AND HAIRY VETCH—YIELD OF HAY 3.72 TONS PER ACRE

The cost of producing a ton of hay from the various crops was obtained by keeping an accurate record of every minute of time, labor and expense attached to preparing the soil, cultivating and harvesting the crops. The entire cost of the fertilizer was charged to each crop, whereas, probably not more than one-half of the plant food contained was used the

present season. It should be stated in fairness to some of the crops that the yield would have been considerably better and hence the cost per ton of hay less, but for the freshet which flooded and destroyed a portion of the hay on several of the plats. While the cost of producing a ton of hay from cereals and legumes may seem abnormally high, bear in mind that everything has been charged in at higher rates than prevail on the average farm, so that the table represents the maximum cost of producing a ton of hay. It costs much more to make a ton of hay from clover or the grasses than one would suspect were an accurate account kept of it as was done in the present instance. It is evident from our results that a valuable hay can be made from winter growing cereals and legumes where other hay crops fail at a reasonable cost.

A COMPARISON OF THE FEEDING VALUE OF SOME STANDARD HAYS, WITH THAT OBTAINED FROM WINTER CEREALS AND LEGUMES

The feeding value of a hay depends on the nature of the digestible nutrients it contains. A comparison of the relative feeding value of timothy, barley, oat, clover and vetch hay is shown in Table XIII. It appears that vetch makes by all odds the richest hay, containing 391.48 pounds of digestible protein and 52.41 pounds of fat. Vetch hay thus contains more than twice as much

TABLE XIII Digestible Nutrients in a Ton of Various Hays

Kind of Hay	Protein Lbs.	Crude Fibre Lbs.	Nitrogen Free Extract Lbs.	Fat Lbs.
Timothy	70.24	278.99	527.43	13.19
Barley Hay	148.92	317.76	501.08	22.23
Oat Hay	106.23	224.46	494.00	50.85
Clover Hay	188.62	171.39	386.88	47.04
Vetch	391.48	303.18	365.37	52.41

digestible protein as clover hay, more than five times as much digestible protein as timothy and four times as much digestible fat. Barley hay contains more than twice as much digestible protein as timothy and nearly twice as much digestible fat. Oat hay does not contain so much digestible protein as barley but more than twice as much digestible fat. It is clear that barley, oat and vetch hay have a high feeding value when compared with such standard hays as timothy and clover. Barley, oats and vetch when grown singly yield as heavy crops as timothy and clover, and they will thus produce more digestible nutrients than these crops. It appears from Table XI that the vetch by itself will yield from one to two tons of hay, and vetch and barley from 2 to 3.28 tons; wheat and vetch, 3.27 tons, and wheat, oats and vetch, 2.96 tons. Nearly one-half of the wheat and vetch and oat and vetch hay grown on the station farm the past year consisted of vetch, so that by referring to Table XIII a fairly accurate estimate can be made of the nutrients produced per acre.

The ease with which these crops can be combined and the enormous

yields of digestible nutrients obtained per acre is just cause for congratulation to the south. There is but a limited section of country where winter cereals and legumes of such excellent quality can be successfully combined and grown for hay, for pasture or for grain. It has been said that it is difficult to establish meadows and pastures in the south. The cry has gone up that we can not develop stock industries because we have no staple hay crops. In view of the facts here presented this does not seem to be well founded. It is doubtless believed by many that nutritious hays of good quality must be derived from either clover or timothy or some of the better known grasses. This is mere prejudice and like many other fallacies has seriously retarded the development of our agriculture.

SUMMARY OF RESULTS

1 The yield and quality of cereals can be greatly improved by means of selection. In the experiments with winter barley an increase of 10.6 bushels per acre was obtained by using large grains from large heads; as great an increase as would ordinarily be obtained from the use of 300 pounds of a complete fertilizer.

2 It is important that winter barley be seeded early. A yield of 30.4 bushels was obtained from the seeding of September 17 and 8.8 bushels from that of November 15.

3 Intertillage experiments with winter barley indicate that sowing in narrow rows without subsequent cultivation is the most satisfactory method.

4 On good soil barley yielded 71.1 bushels, while wheat made but 44.58; on poor soil barley yielded 27.1 bushels and wheat 37 bushels.

5 Several methods of seeding winter oats were tested resulting in favor of drilling in narrow rows at a depth of 2 inches.

6 The Culberson winter oat yielded as high as 73.7 bushels per acre, and as it ripens early with barley and other cereals for hay, it is worthy of trial on Tennessee farms.

7 Twentieth Century winter rye made a yield of 42.5 bushels. In order to get the best results from rye as a pasture it should be sown from the middle of August to the first of September.

8 Hairy vetch is a winter growing legume. Grown singly it made a maximum yield of green crop of 7.68 tons and 1.85 tons of cured hay per acre. Combined with barley it yielded as high as 3.28 tons of cured hay; with wheat, 3.72 tons; and with oats, 1.60 tons. The vetch combines well with oats, wheat and barley for pasture and hay, the principal drawback to its culture being the cost of the seed which ranges from $8 to $10 per bushel. As it is easy to cultivate, there is no reason why every farmer should not produce his own seed and thus obviate the greatest difficulty in the way of its extensive culture.

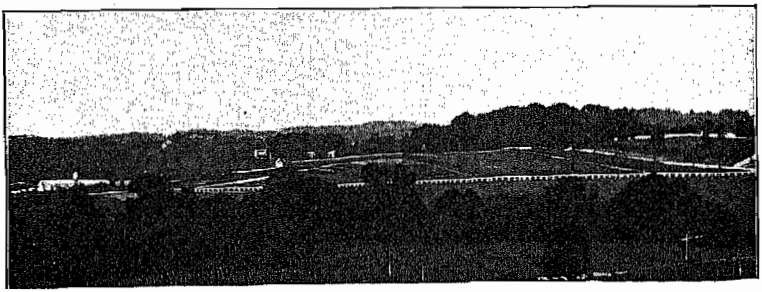
9 Winter cereals and legumes thrive remarkably well in Tennessee and are well adapted for hay making and pasturage. In addition to covering the land in the winter, they are ready for harvest so early that a second crop of corn, corn and peas, sorghum and peas, etc., may be grown on the land the same year.

10 The cost of making a ton of hay from winter cereals and legumes

varied the past year from $4.73 with wheat to $10.65 with oats and vetch. While the cost of hay per ton may seem high, it probably did not cost more in proportion to the yield than hay from timothy and clover were a careful estimate made. Cereal hays can be produced for less on the ordinary farm than the figures presented in this bulletin would indicate, as every item of expense has been charged at higher rates than ordinarily prevail in the country.

11 Protein, the muscle and tissue builder, is the most expensive food nutrient required. It appears that a ton of barley hay contains twice as many pounds of digestible protein as timothy, and a ton of vetch hay twice as many pounds of protein as clover hay. Where the culture of timothy and clover is unsatisfactory, it is evident that a large yield of nutritious hay can be obtained from winter cereals and legumes.

12 The necessity of an abundant roughness and a larger supply of grain have been cited as the principal drawbacks to the extensive development of animal industries. These difficulties can be obviated through the medium of winter cereals and legumes.



EXPERIMENTAL PLATS, UNIVERSITY FARM