LIBRARY,
A & M COLLEGE,
CAMPUS.

R69-237-12m

TEXAS AGRICULTURAL EXPERIMENT STATION
A. B. CONNER, DIRECTOR
COLLEGE STATION, BRAZOS COUNTY, TEXAS

BULLETIN NO. 539 APRIL, 1937

DIVISION OF AGRONOMY

SMALL GRAIN AND RYE GRASS FOR WINTER PASTURE

LIBRARY
Agricultural & Mechanical College of Texas
College Station, Texas.

AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
T. O. WALTON, President

[Page Blank in Bulletin]

Wheat, rye, barley, oats, and rye grass are proving to be valuable for winter pasture in Texas and worthy of planting for their grazing value alone, although these same crops are also, with the exception of rye grass which is an entirely different species from rye, dependable producers of grain. They produce forage when the native grasses are more or less dormant and act as soil conserving crops in preventing erosion of the soil as well as leaching of soil fertility. The forage is high in feed value, usually analyzing from 3 to 5 per cent fat and about 25 per cent protein at the beginning of the season. The percentage diminishes as the season advances.

Yields per acre measured in pounds of dry matter during the four years of these experiments have ranged up to 5000 pounds for barley, 6300 pounds for wheat, 4600 pounds for oats, 4400 pounds for rye, and 6900 pounds for rye grass at Denton; up to 1679 pounds for oats and rye grass at Angleton; and at Lubbock around 3000 pounds per acre for rye and almost as much for wheat, oats, and barley. Barley produced far more fall and early winter grazing than the other crops but Italian rye grass produced by far the largest amount of grazing in the months of March and April and May. Wheat, oats, and rye produced the best grazing for the midwinter months. The difference in rate of growth of the various crops indicates that maximum pasturage may be obtained by planting a mixture of the several crops. Wheat and rye grass, more resistant than oats and rye to extreme cold, are to be preferred in north and northwest Texas, where grazing the wheat fields is already a common practice.

Grazing from these small grains becomes available in the fall just as the grazing from Sudan grass is fading out and lasts well into the spring when the native grass pastures are ready for grazing. In fact, it is usually quite possible to make the change to native grass pasture from wheat and oats in plenty of time to avoid a reduction of the grain yields expected of these crops. Experiments at Denton showed that grazing up to March 1 improved the yields of grain and could have been continued 20 days in the case of oats without damage to yields. At Lubbock where 82 per cent of the rainfall occurs between April and October, small grain for pasture is planted early in September and almost always yields some grazing, but generally it pays to withdraw the stock from pasture occasionally to allow the crop to recover.

Rust epidemics have prevented paying yields of grain from the small grains during most years in the Gulf Coastal areas and they are planted only for grazing. As a rule wet soil limits the number of days of grazing in this area but grain sown on old cotton ridges is not so badly trampled in grazing. Italian rye grass can be successfully sown on sod land where the grass is short enough for the animals to graze the rye grass without getting too much dry grass. The sod aids in holding up the animals in wet weather. On this account, rye grass is becoming the popular winter grazing crop of the Gulf Coast area, and rye grass seed is being sold by the carload where a few years ago it was unknown.

Considering the uniformly good yields of grazing produced by these small grains, there is obviously in Texas the opportunity for large increases in the carrying capacity of farms for dairy cattle and beef cattle as well as practically all classes of livestock. With the uniform success of Sudan as a grazing crop in summer and fall and with these winter grazing crops, the farmer has within his grasp a potential constant supply of green grazing supplying abundant proteins and vitamin A.

CONTENTS

BULLETIN NO. 539 APRIL, 1937

SMALL GRAINS AND RYE GRASS FOR WINTER PASTURE

R. H. Stansel,[1] P. B. Dunkle,[2] and D. L. Jones.[3]

Farmers in regions where small grains are regularly grown as part of the cropping system have long recognized that these crops are extremely valuable for the winter grazing which they furnish. Only recently, however, has there been any great tendency to grow them for their grazing value alone in regions where grain crops are not dependable. In Texas, where the winter weather is usually mild and the soil is seldom frozen, the small grains seldom go into a dormant period, and growth continues almost throughout the winter; moreover, a wider variety of crops can be grown than in the northern states. All of these factors contribute to providing an unusual opportunity for growing temporary winter pastures at a time when native pastures are more or less dormant.

In developing the widespread use of winter pastures it is essential not only to know which species produce the maximum forage, but also to understand the growth characteristics with particular reference to the time at which the growth is made. It is also desirable to have some information on the chemical composition of the forage produced by these crops. On all these subjects very little definite experimental evidence is available and the experiments herein reported were initiated primarily for the purpose of supplying some of this long needed information.

REVIEW OF LITERATURE

Although, as previously stated, there is but little experimental information showing the relative merits of the different small grains for winter pasture and practically none showing the actual yields of forage that are produced, there are many isolated references having a bearing on the problem. Since this is, so far as the writers are aware, the first publication dealing extensively with small grains for winter pasturage, it seems desirable to bring together, primarily for the benefit of other research workers, all the literature of the subject which the writers have discovered in the course of this investigation.

Carleton (22) says, "In the southern states, a mixture of oats and vetch is employed both for pasture and hay." Duggar (19) states that small grain may be pastured with the following precautions: (a) keeping stock off of the land while wet, (b) discontinuing pasturing early enough to afford abundant time for the plants to tiller and head, and (c) avoiding too close pasturing while there is danger of severe freezes. He further states that pasturing early sown oats may be a distinct advantage in preventing too early formation of stems with resultant freeze injury. Rye and barley are chiefly used for pasturing and soiling

1 Superintendent Substation No. 3, Angleton, Texas.
2 Superintendent Substation No. 6, Denton, Texas.
3 Superintendent Substation No. 8, Lubbock, Texas.

in the South. Redding (9) states that in Georgia barley and rye are sown almost exclusively for pasturing. Barley is more valuable on rich soils, is more nutritious, and is relished more by animals. Rye is better adapted to poor soils. Dodson (6) found in Louisiana that oats furnish winter pasturage from December to the first of March and a good grain crop in May. Barley, if sown in early October, grows rapidly and makes a good winter pasture. Rye is the most commonly used cereal as a pasture crop. Lloyd (8) recommends turf or winter oats in Mississippi to be sown in August or September. It will furnish excellent grazing from November to the middle of May, but the stock should be removed in April to produce a grain crop.

In Tennessee, Soule and Vanatter (10) found that winter cereals prevent the leaching out of valuable fertilizer constituents and the washing of fields by winter rains. Winter rye, planted from the middle of August to the middle of September, furnishes excellent pasture from October until Christmas, or through the entire winter if the season is mild. They state that rye furnishes one of the best pastures for the winter season and withstands the effect of tramping. Minkler (24) recommends oats with peas and clovers for an early fall pasture for hogs in New Jersey. Rye was a good early spring pasture for brood sows. Arkansas workers (28) found that winter rye has furnished more pasture, both in winter and spring, than either winter oats or winter wheat. Finnell (33) in Oklahoma found that winter barley yielded 67 per cent more pasture on summer fallowed land and 72 per cent more on stubble land than wheat in the fall and winter and early spring of 1930-31. These results were obtained where one cutting was made by hand. Wasson (32) recommends oats for south Louisiana and rye for north Louisiana as the most popular winter and early spring grazing crops in that state. Lush (46) reports that oats were found more valuable than Abruzzi rye or winter barley for milk production in north Louisiana in five years' results at Calhoun. Rye was best during cold winters. Canadian workers (41) found that oats are superior to the other cereal grains in yield of dry matter per acre, percentage of protein, total yield of protein, and number of cuttings per season where the plants were cut at various stages to simulate grazing conditions. They conclude that young oats herbage may be regarded as a highly concentrated protein feed. All the small grains are recommended for pasturage in various parts of the southern United States. Oats seems to be the preference in most cases, but rye is generally recommended further north and on the poorer soils.

The effect of pasturing cereals on the subsequent grain yield has been investigated by a number of workers. Oklahoma workers (14) report that three years' results show little or no reduction in the yield of grain from judicious pasturing of wheat in winter, when pasturing was not carried beyond March 1. Heavy pasturing or late pasturing reduced the grain yield. Pasturing was beneficial when wheat was making a heavy growth. Georgeson and others in Kansas (3) found that when the wheat plants were grazed to the ground during the first part of April, with no other pasturing, the yield of grain was reduced. In a

later report (7), it was recorded that grazing wheat in the fall or spring had little effect on the yield of the wheat. The spring grazing in this case was uneven and not so close as in the fall. Shelton (1), also in Kansas, found that grazing had little effect on the grain yield. Swanson (44), in later work in Kansas, reports that approximately 65 per cent of the Kansas wheat acreage is pastured to a greater or lesser extent, and that if wheat is making a rank growth, moderate winter grazing will not materially reduce the yield of grain and may increase it. Moderate grazing can be continued until the plants show a strong tendency to make erect growth in preparation to jointing, which is usually about April 10 at Hays, Kansas. When conditions are unfavorable for a vigorous growth of the wheat plant and when moisture is limited, grazing results in a reduction of grain yield. In Indiana, where wheat was cut with a mower when the plants were six inches high in the spring, Latta (4, 5) found that the yield of grain was reduced. Hastings (21) found at San Antonio, Texas, that oats can be pastured up to January without injury to the hay crop, but severe winter and early spring pasturing results in reduced yield of hay or grain. In Mississippi (13), wheat grazed for one month produced 1210 pounds of hay per acre as compared with 1812 pounds where it was not grazed.

In Australia (20), Perkins and Spafford made the following recommendations and observations on wheat, oats, and barley: (a) hay yields suffer from judicious grazing; (b) to avoid lodging where growth is rank, graze off as rapidly as possible; (c) do not pasture in wet weather, late in the season, or in frosty weather; (d) percentage of smut in grain is reduced by pasturing. At the McNeill branch station in Mississippi (18) oats and wheat pastured in the winter resulted in a reduced hay yield some years and had little effect in other years. At the Oklahoma Panhandle station (31), Finnell found that grazing wheat to April 1 had little effect on the plant or grain yield. Grazing to April 26 and later reduced the grain yield. Welton and Morris (34) in Ohio found that clipping wheat or oat plants tended to reduce the number and height of culms and prevented lodging but this was not completely successful because of the uncertainty of the character of the subsequent seasonal conditions. These results indicate that pasturing of cereals will usually have little effect on the grain yield where the plants are making a rank growth, provided the pasturing is not severe and is not continued too late in the season. Severe pasturing or late pasturing will almost certainly result in a reduced yield of grain or hay.

The cereal grains produce a very nutritive herbage, especially during the early part of the growing season. At San Antonio, Texas, in 1917, Letteer (25) obtained a total gain of 243 pounds from two steers pastured on two acres of oats from January 24 to February 23 and from April 11 to June 7. Later (26) Letteer reported that two steers on one and one-half acres of oats for 34 days made a daily gain of 2.5 pounds each, and he concluded that winter oats make a satisfactory pasture crop for beef cattle. In 1919, Ratliffe (27) at San Antonio, Texas, reported that two steers on two acres of oats from November 20 to May 11 made an average daily gain of 1.6 pounds each and that the steers were in

good finish. Rust injured the oats that year. In Tennessee, Neel (43) reported a three-year average of 169 days pasturing per acre for one steer on Balbo rye, with an average animal gain of over 300 pounds per acre. In Kansas (44) the custom rate for wheat pasture is based upon the price per head per month and has been approximately $1.00 per head per month for growth cattle since 1929; it was higher previous to that time, when higher cattle prices prevailed. The carrying capacity varied greatly, depending on seasonal conditions. During the fall 3 to 7 acres may be required to carry an adult animal and during the spring 2 to 4 acres are required. Winter cereals during the early stages of growth contain 18 to 30 per cent protein and can be considered a rich source of protein and minerals. Protein and mineral supplements are dispensed with by most stockmen in Kansas as these are considered sufficient for livestock requirements when a heavy growth of green wheat is being grazed. Gains of 1.3 to 1.7 pounds per day were obtained from cows pastured on winter wheat, supplemented by a limited supply of dry roughage. Lush (37) reports a gradual decrease in the protein content of succulent grasses as the season advanced. He (35) also found that in the early spring rapidly growing oat plants were quite similar to clover samples in analysis. A comparison of oats, rye, and barley, each with vetch, at the North Louisiana Experiment Station showed 33, 28, and 22 days grazing, respectively, per animal per acre for an average of four winters with returns of $13.56, $8.91, and $7.15 per acre in butterfat at 30¢ per pound (40). From these results there is no doubt that the cereals produce a very nutritious pasture and that early in the season in the South they are very high in protein.

There is some objection to rye and wheat as pastures for dairy cattle since they have a tendency to flavor the milk. Barley has less effect on milk flavor than wheat or rye, while oats have little effect on the flavor of milk. Babcock (29) found that green rye fed after milking had little effect on the flavor or odor of milk produced at the next milking, but when fed before milking, did affect the flavor and odor of the milk.

The importance of an adequate supply of vitamin A in the ration of dairy cattle and poultry is pointed out by Texas workers. Copeland and Fraps (36) have shown that where dairy cows are pastured for a large part of the year, sorghum silage may carry them through the dry lot feeding period without any noticeable effects of an undersupply of vitamin A on the health of the animal. Pasture supplied sufficient vitamin A to produce butterfat of a high potency in vitamin A while sorghum silage did not. Fraps, Copeland, and Treichler (42) say, "The feed of cows must be high in vitamin A potency in order for the animal to continue to produce butter high in vitamin A potency. Silage and ordinary hays and fodders apparently will not supply enough vitamin A potency to maintain a high content of the butterfat. Green growing pasture grasses appear to be needed to maintain the production of butterfat high in vitamin A." Fraps and Treichler (38) say, "Green pastures are the best sources for enabling animals to produce milk or eggs high in vitamin A or to store a reserve of vitamin A to tide them

over periods of scarcity. Dry feed high in vitamin A may lose a great portion of this vitamin during storage. Drying moist foods results in a loss of vitamin A." Sherwood and Fraps (39) conclude that "rations usually fed laying hens apparently do not supply enough vitamin A for maintenance and high egg production unless the hens have access to green grass or similar feed. It seems probable that laying fowls which do not have access to green feed and fed many of the ordinary laying feeds are likely to break down from a deficiency of vitamin A during the second and third year, or possibly sooner." Since the winter season is the period when there is usually little or no pasturage available, the need of a succulent green pasture for dairy cattle at this time, in order to produce butterfat high in vitamin A, is apparent. Cereal pastures should furnish the needed green feed at this time.

CONDUCTING THE EXPERIMENTS

The small grain and winter grasses in this test were planted in plats 17 inches wide and 6 feet 9 15/16 inches long, or 9.6 square feet in area. The yield in grams per plat multiplied by ten gave pounds per acre. In order to obtain yields throughout the season at Angleton each plat was cut with a lawn mower and the clippings were caught in a grass catcher. In order to cut each plat at the same height and to provide for the clippings regardless of soil conditions, wooden tracks were built for the wheels of the lawn mower to run upon. These tracks on each side of the plat consisted of 1 x 4 inch strips of lumber which were sunk level with the surface of the ground and fastened with a crosspiece at each end of the plat. The strips extended about 18 inches beyond the edge of the plats in order to allow a runway for stopping and starting the mower. High winds and sandy soil at Lubbock and high winds at times at Denton made it difficult to use a lawn mower, so that shears were used to clip the plats at these places.

The seed were planted in two rows in each plat. The planting rate was 60 pounds per acre for all the small grains and 30 pounds per acre for the grasses. Where a mixture of the two varieties was planted, each was planted at one-half the respective rate where planted alone. Where three varieties were planted in a mixture, the rate of each was one-third of the rate where it was planted alone.

Too frequent clipping injured the plants, so the plats were cut only when they were from 4 to 6 inches high instead of at any regular time intervals. The small grains made a more upright growth than the Italian rye grass and it was not possible to cut the latter close enough to severely injure it. The removal of practically all of the leaf surface of the small grains at frequent intervals was probably the cause of the injury to these plants.

The green weight of the clippings from each plat was obtained as soon as the samples were collected and brought to the laboratory. The green clippings from all plats of each variety or mixture were next placed in an ordinary jute sack and dried in the sun for several days,

then placed in the laboratory until they reached a constant weight, before the air-dry weight was determined.

The chemical analyses were made by the Division of Chemistry of the Texas Agricultural Experiment Station.

It is not known how closely the results obtained by clipping the plants agree with those obtained under actual grazing conditions. It is probable that the clipping was more uniform and more severe than grazing would have been. However, the data obtained should give comparable data on the pasture value of the crops tested, although the yields are probably somewhat higher than would be obtained under grazing conditions.

RESULTS AT ANGLETON

Practical Problems in Connection with Winter Pastures in the Gulf Coast

Because of the severe rust epidemics in this section of the State, small grains seldom produce paying yields of grain, although occasionally, when there is only light rust infection, the yields are satisfactory. For this reason small grains are planted almost entirely for the pasturage produced. They are usually broadcast on a prepared seed bed, but in many cases are sown on the top of old cotton ridges so that the livestock, in grazing, do not tramp on the plants. This is very advantageous during a wet winter. As a rule, the wet condition of the soil will limit the number of days of grazing obtained from a small grain winter pasture on prepared soil in the humid Gulf Coast Prairie. Italian rye grass can be successfully grown on sod land where the grass is short enough for the livestock to graze the rye grass without getting too much old mature grass, and the sod will aid in holding up the animals in wet weather. Italian rye grass has lately become a popular winter grazing grass with dairymen in the Gulf Coast Prairie of Texas.

Soil Conditions

Texas Substation No. 3 is located at Angleton, Brazoria County, in the Gulf Coast Prairie. The soils are largely of the Lake Charles and Edna series, which are gray to black in color and range from clay to fine sandy loam, with the clay predominating. They have gray to black heavy subsoils. The topography is generally flat, with a fall of about one and one-half feet per mile. The drainage is slow and almost entirely from the surface, the tightness of the soils and subsoils preventing percolation into the lower strata. The water table is within a few feet of the surface. The experimental work at this station was located on Lake Charles clay loam soil.

Climatic Conditions

The climatic conditions at the Angleton Station are characterized by heavy rainfall, which is somewhat erratic in distribution, and usually by mild winters with occasional severe freezes. The meteorological data are presented in Table 1 for the years during which the test was con-

Table 1. Rainfall and temperature data at Angleton

Year	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total
Rainfall,										
1930-31	3.61	9.79	4.93	3.75	4.28	4.73	3.12	1.27	2.59	38.07
1931-32	.96	3.99	3.07	9.07	5.85	4.24	1.12	5.58	2.40	36.28
1932-33	5.66	2.71	1.66	2.73	2.18	4.87	2.92	.40	2.96	26.09
1933-34	3.87	3.45	2.24	3.77	9.59	3.24	4.17	4.95	4.09	39.37
1934-35	5.31	.47	10.30	4.57	1.87	5.14	1.95	3.62	5.01	38.24
Temperature										
Maximum:										Extreme
1930-31	97	89	84	72	77	77	77	86	89	97
1931-32	100	92	87	82	79	83	86	90	90	100
1932-33	93	88	82	78	78	80	84	95	95	95
1933-34	96	95	84	85	79	79	80	89	92	96
1934-35	92	93	92	81	84	80	85	88	89	92
Minimum:										
1930-31	59	39	29	28	32	35	30	35	46	28
1931-32	55	39	40	33	32	36	23	37	55	23
1932-33	59	39	29	24	25	15	37	37	55	15
1933-34	61	49	36	30	27	30	27	47	50	27
1934-35	55	48	34	24	17	22	35	38	53	17
Mean:										Mean
1930-31	78.8	69.2	60.4	51.6	52.5	57.9	54.7	63.3	71.0	62.2
1931-32	80.9	74.6	67.1	57.3	58.3	65.0	57.4	67.9	74.0	66.9
1932-33	77.7	67.7	55.7	53.2	60.7	55.8	64.5	70.3	78.5	64.9
1933-34	81.4	72.6	63.5	64.6	56.9	55.4	59.5	69.2	73.4	66.3
1934-35	77.3	73.1	64.3	56.8	54.8	57.7	61.4	68.2	74.2	65.3

ducted. The rainfall during the growing period was ample at most times, but at times became excessive, so that it stunted the growth of the plants. The warm winters were quite favorable for the growth of the small grain and winter grasses, but low temperatures following long warm periods often severely injured the plants. In 1932-33, the temperature of 15 degrees F. in February killed the oats. In the winter of 1934-35, the temperature of 17 degrees F. in January killed all the varieties to the ground, with resulting low yields.

Yields of Forage

In 1930-31, the first year of the test at Angleton, five varieties were planted in triplicate on November 28 and a good stand was obtained. This planting date was too late for maximum yields. The yields obtained are presented in Table 2. Italian rye grass made the highest yield,

Table 2. Acre yield of green and air-dry forage, 1930-31, at Angleton

Variety	Acre yield forage, pounds								% Dry matter
	Air-dry							Green	
	Date of cutting						Total		
	3/3	3/12	3/25	4/3	4/20	5/16			
Italian rye grass	216	46	46	66	607	864	1845	7748	24
Wheat	442	102	178	60	125	73	980	4273	23
Barley	282	103	198	104	155	34	876	3669	24
Oats	269	102	170	136	242	316	1235	5724	22
Rye	248	72	164	66	114	26	690	2963	23

followed in order by oats, wheat, barley, and rye. The small grains made the most rapid growth in the late winter, while Italian rye grass made the greatest growth during May and June.

The varieties were planted in triplicate on October 12 in 1931-32, with the exception of emmer and spelt, which were planted in duplicate. The emmer and spelt seed were old and no germination was obtained. The other varieties had a good stand. Because oats and Italian rye grass made high yields in 1930-31, but also made their maximum growth at different times of the year, it was thought desirable to include a mixture of the two. In addition, a mixture of Italian rye gass, oats, and wheat was planted on one plat and a mixture of oats and wheat on another plat in order to get some data on the behavior of a mixture. The yields obtained are presented in Table 3. The mixtures gave a higher yield

Table 3. Acre yield of green and air-dry forage, 1931-32, at Angleton

Variety	Acre yield forage, pounds							% Dry matter
	Air-dry						Green	
	Date of cutting					Total		
	2/25	4/8	4/25	5/2	5/19			
Italian rye grass	577	258	233	127	155	1350	4985	27
Wheat	392	363	260	42	73	1130	4134	27
Barley	843	437	82	20	17	1399	4355	32
Oats	760	770	218	33	20	1801	8366	22
Rye	367	423	195	50	38	1073	4240	25
English rye grass	720	367	222	167	177	1653	6993	24
Rescue grass	220	357	117	87	38	819	2382	34
Italian rye grass and oats	815	472	318	107	157	1869	8129	23
*Italian rye grass, oats, and wheat	1000	1170	270	110	160	2710	13357	20
*Oats and wheat	950	1610	360	45	40	3005	14295	21

* One plat only.

than any variety planted alone. Oats made the highest yield, followed by English rye grass, barley, Italian rye grass, and wheat, in the order named. Rye and rescue grass made the lowest yields of air-dry forage.

The varieties were again planted in triplicate in 1932-33 on December 5, and an excellent stand was secured. A minimum temperature of 16 degrees F. on February 8 and 15 degrees F. on February 9 killed the oats outright, but apparently did little damage to the other varieties planted. This indicates that oats are more easily damaged by low temperatures than the other varieties of small grain or Italian rye grass. The yields obtained are presented in Table 4. Wheat made the highest yield, followed in order by the Italian rye grass and oats mixture, Italian rye grass, and rye. Barley and oats made the lowest yields. The clippings from the mixture of Italian rye grass and oats consisted entirely of Italian rye grass after the first clipping, which probably accounts for the fact that the mixture did not make the highest yield this year.

Table 4. Acre yield of green and air-dry forage, 1932-33, at Angleton

Variety	Acre yield forage, pounds						% Dry matter
	Air-dry					Green	
	Date of cutting				Total		
	2/2	3/21	4/10	5/9			
Italian rye grass	273	207	153	590	1223	5970	20
Wheat	260	363	360	790	1773	7010	25
Barley	377	140	133	25	675	3710	18
Oats	307	*	*	*	307	2480	12
Rye	247	390	217	273	1127	4700	24
Italian rye grass and oats	321	167*	167*	687*	1342	6700	20

* Oats killed by freeze February 8-9, 1933.

In 1933-34, the varieties and mixtures were planted in quadruplicate on October 25. A poor stand of rye and rescue grass was obtained, and two subsequent plantings at increased rates failed to give a good stand. There was an excellent stand on all the other plats. Purple vetch was added to one of the mixtures. The yields are given in Table 5. The

Table 5. Acre yield of green and air-dry forage, 1933-34, at Angleton

Variety	Acre yield forage, pounds								% Dry matter
	Air-dry							Green	
	Date of cutting						Total		
	12/5	12/22	2/6	3/6	4/11	4/27			
Italian rye grass	470	200	640	155	440	298	2203	9955	22
Wheat	278	118	255	65	175	70	961	3173	30
Barley	335	188	590	183	340	3	1639	6075	27
Oats	468	183	440	165	268	5	1529	6683	23
Rye	0	0	10	8	68	5	91	285	32
Rescue grass	0	88	130	55	150	30	453	1305	35
Italian rye grass and oats	620	235	678	190	595	255	2573	11023	23
Italian rye grass, oats, and wheat	570	220	540	120	323	260	2033	9353	22
Oats and wheat	545	168	340	88	238	38	1417	5988	24
Oats and purple vetch	408	213	468	173	265	40	1567	6505	24
Oats, wheat, and purple vetch	475	213	505	178	358	53	1782	7315	24

mixture containing the purple vetch had considerable vetch in the first cutting, but this clipping apparently destroyed the plants and no vetch was obtained in the subsequent cuttings. This year the Italian rye grass, in mixture or alone, gave the highest yield. Barley and oats ranked next, in order named, with wheat making a poor yield. Partly because of the poor stand, rye and rescue grass made very poor yields.

In 1934-35, the planting was made on November 13. Six plats of each variety or mixture were planted. A good stand was obtained on all plats. A minimum temperature of 17 degrees F. on January 22

killed to the ground all the plants in this test. A minimum temperature of 22 degrees F. on February 27 further injured the plants when they were beginning to recover from the earlier freeze, and the resulting yields were low. The yields are presented in Table 6. Italian rye grass

Table 6. Acre yield of green and air-dry forage, 1934-35, at Angleton

Variety	Acre yield forage, pounds						% Dry matter
	Air-dry					Green	
	Date of cutting				Total		
	1/4	3/28	4/20	5/20			
Italian rye grass	83	133	233	282	731	3325	22
Wheat	95	168	127	108	498	1690	29
Oats	262	110	78	92	542	2523	21
Italian rye grass and oats	210	187	128	208	733	3062	24
Italian rye grass, oats, and wheat	140	165	120	258	683	2782	25
Oats and wheat	152	115	102	95	464	2093	22
Italian rye grass and wheat	83	132	198	297	710	3200	22

made the highest yield, followed in order by a mixture of Italian rye grass and wheat, a mixture of Italian rye grass and oats, and a mixture of Italian rye grass, oats, and wheat. Oats made a slightly higher yield than wheat, although a mixture of the two produced the lowest yield.

The total acre yield of green and air-dry forage for each year and the average for the period are presented in Table 7. Of the three varieties tested all years, Italian rye grass made an average yield of 1470 pounds of air-dry clippings per acre as compared with 1083 pounds for oats and 1068 pounds for wheat. For the three years, 1932-34, a mixture of Italian rye grass and oats made an average yield of 1928 pounds per acre, followed by Italian rye grass with 1592 pounds. Wheat, barley, and oats made yields ranging from 1288 to 1212 pounds per acre.

In Figure 1, where the monthly yields for the years 1932-34-35 are given, the mixture of oats and Italian rye grass gives a greater spread of high yields, there being an abundant supply of forage from December through May. In this and the other graphs shown, the month when the growth occurred is used in calculating the monthly yield, and not necessarily the date the clipping was made. The fact that oats produces the maximum amount of forage earlier than Italian rye grass may be of importance where the crop is grown as a winter cover crop or as a winter pasture to be turned under and followed by a crop in the spring. In such a case the oats will produce a higher yield of forage by March. Where the winter pasture or cover crop can be allowed to remain until late April or May, the Italian rye grass will produce the highest yields.

Variety	Acre yield forage, pounds												
	Green						Air-dry						
												Average	
	1931	1932	1933	1934	1935	Ave.	1931	1932	1933	1934	1935	1932-34	Comparable all years*
Italian rye grass	7748	4985	5970	9955	3325	6397	1845	1350	1223	2203	731	1592	1470
Wheat	4273	4134	7010	3173	1690	4056	980	1130	1773	961	498	1288	1068
Oats	5724	8366	2480	6683	2523	5155	1235	1801	307	1529	542	1212	1083
Barley	3669	4355	3710	6075	....	....	876	1399	675	1639	....	1238	1018
Rye	2963	4240	4700	285	....	....	690	1073	1127	91	....	764	660
English rye grass	....	6993	....	....	....	....	....	1653	....	....	....	....	1398
Rescue grass	....	2382	....	1305	....	....	....	819	....	453	....	....	513
Italian rye grass & oats	....	8129	6700	11023	3062	....	....	1869	1342	2573	733	1928	1679
Italian rye grass, oats, and wheat	....	13357	....	9353	2782	....	....	2710	....	2033	683	....	1829
Oats and wheat	....	14295	....	5988	2093	....	....	3005	....	1417	464	....	1646
Oats and purple vetch	....	....	....	6505	....	....	....	....	....	1567	....	....	1209
Oats, wheat, and purple vetch	....	....	....	7315	....	....	....	....	....	1782	....	....	1375
Italian rye grass and wheat	....	....	....	....	3200	....	....	....	....	....	710	....	1452

* Obtained by using as standard varieties the first three listed varieties that were grown all the years of the test. The comparable yield of the other varieties is obtained by multiplying the percentage rating by the average yield of the standard varieties for all years. Percentage rating of a given variety is obtained by dividing the total yield for the years grown by the total average yield of the standard varieties for the same years as those of the given variety.

Table 8. Chemical analyses expressed in percentage of pasture clippings, 1933-34, at Angleton

Date cut	Variety	Protein	Fat	Crude fiber	Nitrogen-free extract	Water	Total ash	Lime	Magnesia	Insoluble ash	Total phosphoric acid
12/5	Barley	28.65	3.93	17.10	27.00	7.03	16.29	.62	.63	5.82	.74
	Wheat	25.80	4.71	17.58	30.38	6.93	14.60	.51	.52	5.73	.71
	Oats	24.07	4.51	19.67	29.84	7.54	14.37	.41	.45	4.58	.68
	Italian rye grass	23.06	4.68	18.73	30.43	7.14	15.96	.76	.54	5.27	.62
	Oats and Italian rye grass	23.47	4.52	19.30	30.11	7.38	15.22	....	....	....	....
	Oats and vetch	26.47	4.21	18.87	29.94	7.52	12.99	....	....	....	....
	Oats, wheat, and vetch	26.20	4.22	18.68	28.46	7.58	14.86	....	....	....	....
	Oats, wheat, and Italian rye grass	23.48	4.56	19.12	30.11	8.38	14.35	....	....	....	....
	Oats and wheat	23.22	4.39	19.52	30.62	7.64	14.61	....	....	....	....

(Continued on next page)

Table 8. Chemical analyses expressed in percentage of pasture clippings, 1933-34, at Angleton—Continued

12/22	Barley	24.23	3.10	17.53	26.17	7.18	21.79	.49	....	11.48	.83
	Wheat	23.01	3.23	16.51	31.48	6.55	19.22	.37	....	12.92	.84
	Oats	21.25	3.15	18.51	29.81	7.75	19.53	.39	....	11.77	.95
	Italian rye grass	22.08	3.24	17.43	27.50	6.73	23.02	.68	....	12.73	.76
	Rescue grass	21.44	3.69	17.46	37.10	6.98	13.33	.60	....	6.08	.46
	Oats and Italian rye grass	22.93	3.58	19.10	29.03	7.43	17.93	....	....	....	....
	Oats and vetch	24.86	3.22	18.42	27.82	8.43	17.25	....	....	....	....
	Oats, wheat, and vetch	26.08	3.14	16.04	28.75	6.86	19.13	....	....	....	....
	Oats, wheat, and Italian rye grass	22.72	3.28	17.03	29.78	6.99	20.20	....	....	....	....
	Oats and wheat	22.37	3.22	17.33	31.10	7.24	18.74	....	....	....	....
2/6	Barley	13.78	2.99	20.73	37.93	7.55	17.02	.36	....	9.79	.47
	Wheat	13.60	3.63	19.68	41.01	7.25	14.83	.36	....	9.49	.58
	Oats	12.39	3.08	18.82	45.68	7.68	12.35	.38	....	6.62	.64
	Italian rye grass	12.58	3.26	18.52	42.81	7.27	15.56	.58	....	7.92	.66
	Rescue grass	10.92	3.05	18.37	46.81	6.89	13.96	.63	....	8.38	.45
	Oats and Italian rye grass	12.56	3.58	18.33	43.26	8.26	14.01	.51	....	7.00	.64
	Oats and vetch	12.23	3.08	18.07	44.46	8.07	14.09	....	....	....	....
	Oats, wheat, and vetch	13.51	3.32	18.18	42.49	8.09	14.41	....	....	....	....
	Oats, wheat, and Italian rye grass	12.25	3.63	17.99	44.02	7.66	14.45	....	....	....	....
	Oats and wheat	13.02	3.45	17.56	44.48	7.34	14.15	....	....	....	....
3/6	Barley	14.11	3.48	19.40	49.97	7.02	16.02	.45	....	9.28	.75
	Wheat	16.80	3.89	18.65	40.91	6.39	13.36	.47	....	9.14	.92
	Oats	15.90	3.69	18.23	39.83	7.27	15.08	.51	....	8.02	1.31
	Italian rye grass	13.85	3.94	17.33	40.83	6.39	17.66	.57	....	9.70	.97
	Rescue grass	12.90	2.59	20.59	43.53	6.29	14.10	.80	....	7.84	.68
	Oats and Italian rye grass	15.57	3.94	18.48	38.79	7.57	15.65	....	....	....	....
	Oats and vetch	15.50	3.47	18.56	40.54	7.37	14.56	....	....	....	....
	Oats, wheat, and vetch	16.24	3.68	19.13	39.13	7.06	14.76	....	....	....	....
	Oats, wheat, and Italian rye grass	15.10	3.77	18.20	40.87	6.69	15.37	....	....	....	....
	Oats and wheat	16.47	3.75	18.19	40.43	6.86	14.30	....	....	....	....
4/11	Barley	10.10	3.52	24.92	36.11	7.38	17.97	.40	....	12.80	.68
	Wheat	12.32	4.11	20.19	37.55	7.46	18.37	.41	.47	13.61	.71
	Oats	12.06	3.51	21.34	37.80	8.05	17.24	.47	.40	8.49	.98
	Italian rye grass	9.92	3.88	18.57	40.98	7.32	19.33	.61	.62	13.04	.76
	Rescue grass	8.78	2.83	23.99	40.09	7.80	16.51	.58	.42	11.14	.58
	Oats and Italian rye grass	9.79	3.79	18.47	42.00	8.07	17.88	....	....	....	....
	Oats and vetch	11.65	3.43	21.16	37.52	8.14	18.10	.45	.24	13.57	.94
	Oats, wheat, and vetch	12.14	3.55	21.81	37.22	7.26	18.02	....	....	....	....
	Oats, wheat, and Italian rye grass	9.98	3.76	19.41	40.35	7.73	18.77	....	....	....	....
	Oats and wheat	11.52	3.70	21.41	37.53	8.02	17.82	....	....	....	....
4/27	Wheat	18.41	3.70	19.32	33.27	6.59	18.71	.56	.51	12.13	1.36
	Italian rye grass	13.16	3.48	20.10	30.79	7.08	25.34	.70	.62	15.77	1.21
	Rescue grass*	13.88	2.39	....	....	7.38	16.54	.63	....	10.30	.85
	Oats and Italian rye grass	13.56	3.43	19.98	33.26	7.20	22.57	.68	.61	15.12	1.30
	Oats and vetch*	18.02	3.11	....	....	8.07	17.29	.58	.54	10.55	1.32
	Oats, wheat, and vetch*	18.51	3.21	....	....	7.71	19.22	.55	.51	13.59	1.24
	Oats, wheat, and Italian rye grass	14.09	3.41	20.43	31.85	7.25	22.97	.65	.61	14.61	1.23
	Oats and wheat*	13.84	3.08	....	....	7.68	19.06	.61	....	17.49	1.28

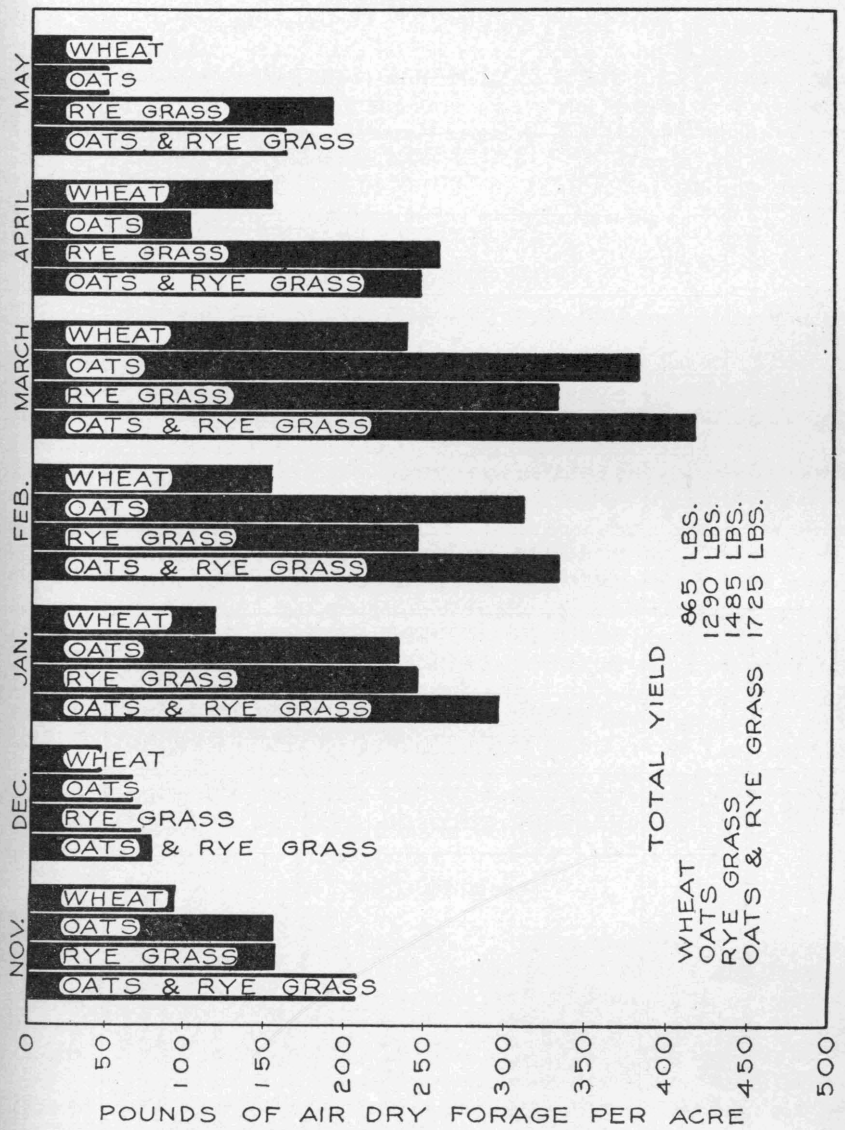

Fig. 1. Average Monthly Yield per Acre of Air-Dry Forage for the Years 1932-34-35 at Angleton.

Chemical Analyses of Forage

The analyses of the various clippings from the 1933-34 and the 1934-35 crops are presented in Tables 8 and 9. The protein content is high early in the season but gradually decreases in each subsequent cutting. There was little difference in the composition of Italian rye grass, wheat, and

Table 9. Chemical analyses expressed in percentage of pasture clippings, 1934-35, at Angleton

Date cut	Variety	Protein	Fat	Crude fiber	Nitrogen-free extract	Water	Ash	Lime	Magnesia	Insoluble ash	Total phosphoric acid
1/4	Oats	20.48	3.37	20.79	33.55	7.64	14.17	.30	....	5.77	.90
	Wheat	24.50	3.79	17.01	30.13	9.51	15.06	.38	....	6.18	.76
	Italian rye grass	20.15	4.38	17.42	34.29	8.60	15.16	.62	....	5.89	.83
	Oats and wheat	20.88	4.08	19.11	33.36	9.37	13.20	....	....	....	....
	Oats and Italian rye grass	20.53	3.65	20.48	33.18	7.73	14.43	.38	....	5.34	.90
	Oats, wheat, and Italian rye grass	20.53	3.64	19.96	33.40	8.26	14.19	.42	.21	5.23	.96
	Wheat and Italian rye grass	23.03	3.97	17.43	31.53	8.77	15.27	.54	.62	5.46	.85
3/28	Oats	12.45	4.49	19.13	38.56	11.02	14.35	.53	.56	7.73	.68
	Wheat	12.65	4.85	20.22	40.77	8.42	13.09	.59	.45	6.96	.53
	Italian rye grass	11.28	4.28	18.99	38.92	9.53	17.00	1.01	.58	9.19	.64
	Oats and wheat	12.39	4.42	19.24	40.35	9.74	13.86	.47	.41	7.66	.68
	Oats and Italian rye grass	12.03	4.18	18.73	40.27	9.20	15.59	.69	.53	7.90	.69
	Oats, wheat, and Italian rye grass	12.10	4.27	19.37	39.66	9.17	15.43	.73	.58	8.26	.74
	Wheat and Italian rye grass	12.23	4.40	18.93	39.68	9.09	15.67	.70	.62	8.08	.62
4/20	Oats	14.13	3.79	21.96	37.92	9.92	12.28	.45	.41	6.51	.85
	Wheat	14.73	4.00	21.49	38.62	8.84	12.32	.30	.32	6.86	.81
	Italian rye grass	13.50	4.24	20.15	34.07	8.55	19.49	.81	.71	11.02	.87
	Oats and wheat	13.98	3.55	24.36	34.81	9.25	14.05	.39	.35	6.84	.91
	Oats and Italian rye grass	13.70	3.79	21.03	34.48	8.86	18.14	.69	.72	9.84	.92
	Oats, wheat, and Italian rye grass	14.40	4.37	20.03	37.37	8.35	15.48	.59	.63	9.05	.93
	Wheat and Italian rye grass	14.25	3.94	22.09	35.28	8.90	15.54	.62	.64	9.25	.82
5/20	Oats	11.22	3.00	25.84	40.96	8.54	10.44	.35	.38	5.70	.69
	Wheat	9.85	3.18	24.91	42.26	8.43	11.37	.30	....	7.37	.61
	Italian rye grass	13.78	3.80	21.99	37.90	8.77	13.76	.59	.57	7.10	.87
	Oats and wheat	10.28	3.08	25.58	41.49	8.52	11.05	.35	.32	6.32	.67
	Oats and Italian rye grass	14.65	3.71	21.78	36.63	8.72	14.51	.62	.57	7.60	.91
	Oats, wheat, and Italian rye grass	13.82	3.54	22.37	37.13	8.60	14.54	.54	.50	7.89	.89
	Wheat and Italian rye grass	13.31	3.42	22.54	37.56	8.93	14.24	.58	.58	7.56	.84

oats cut at the same period of time, with the exception of the protein content of wheat, which is slightly higher than that of the oats or Italian rye grass. There was little difference in the lime or phosphoric acid content for the different clippings or for the various crops. However, the amount of lime in some cases is less than is usually considered adequate for livestock needs. The total amount of insoluble ash shows great variation from cutting to cutting, but has a tendency to increase during the latter part of the growing season.

RESULTS AT DENTON

Practical Problems in Connection with Winter Pastures at Denton

Wheat is the principal small grain planted for winter pasture although volunteer oats occupy as much as 75 per cent of the acreage devoted to grain pasture during the fall and winter months on the black lands of Central and North Texas. The volunteer oats and a small acreage of volunteer wheat and barley ordinarily come up about a month earlier than the planted grains and are ready for pasturing about the first to the middle of October. Pasturing of volunteer grain continues until about mid-winter, when the land is plowed or listed in preparation for cotton or other row crops. The planted grains are pastured until about the middle of March. All grains planted and intended for grain production should not be grazed too heavily at any time, particularly during the fall and winter months when the plants must establish sufficient root systems to withstand hard winter freezes. In seasons when rainfall is deficient and fall and winter growth is poor, heavy pasturing may cause considerable injury by pulling out the plants, or so exposing the crowns that freeze injury is more likely. Also, pasturing during wet periods may be very injurious because of the trampling of the plants into the mud and the severe packing of the surface soil.

Soil Conditions

Texas Substation No. 6 is located 5½ miles northwest of Denton, Denton County, Texas, in what is known as the Fort Worth Prairie Region of North Texas. The soils of this prairie region are largely of the Denton, San Saba, and Houston series, which vary in color from brown to black and in depth from one to eight or ten feet. The topography is gently rolling, the soil in the depressions being deeper and more fertile than on the higher ground. Outcroppings of lime rock are frequent on the higher elevations of this black prairie region. The experimental work at this station was located on San Saba silty clay loam.

Climatic Conditions

The average annual rainfall at this Station is 33.03 inches, of which 24 per cent falls in September, October, and November; 20 per cent in December, January, and February; and 32 per cent in March, April, and May. The rainfall is usually ample for good growth of small grains dur-

ing the winter and spring months, but is occasionally deficient during the fall months. The data on the rainfall and temperatures during the period covered by this experiment are presented in Table 10. Lack of

Table 10. Rainfall and temperature data at Denton

Year	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total
Rainfall,										
1931-32.....	.33	4.16	2.11	2.17	7.12	4.15	.61	1.96	4.57	27.18
1932-33.....	2.08	1.33	.04	5.60	3.33	1.68	3.41	2.24	5.22	24.93
1933-34.....	1.91	1.26	.59	1.54	1.25	1.85	3.75	4.19	4.24	20.58
Temperature										
Maximum:										Extreme
1931-32.....	103	96	83	72	75	85	91	88	94	103
1932-33.....	97	92	85	80	72	87	90	92	95	97
1933-34.....	99	89	84	84	76	80	87	89	97	99
Minimum:										
1931-32.....	53	36	35	27	23	25	15	33	52	15
1932-33.....	57	34	16	5	25	1	28	33	47	1
1933-34.....	63	41	30	22	18	17	24	40	49	17
Mean:										Mean
1931-32.....	82.2	71.1	59.4	48.9	46.6	55.1	51.3	65.4	70.8	61.2
1932-33.....	76.1	64.9	50.8	41.9	52.3	46.0	58.4	64.9	74.1	58.8
1933-34.....	81.3	69.0	57.2	51.9	47.9	47.6	52.9	65.6	72.4	60.6

moisture during the fall of 1932 severely retarded growth of small grains, and clippings in this experiment could not be obtained until January 27, 1933. Likewise deficient rainfall in the fall of 1933 retarded growth, and the first clipping was not made until December 8. Moisture conditions were ideal in the fall of 1931 and clipping started October 29. Temperatures varied considerably during the months of December, January, and February, hard freezes often occurring after warm growing periods and severely damaging growth. A hard freeze on March 5, 1932, severely damaged oats and barley on all plats and also the non-pastured plat of wheat. Italian and English rye grasses were not injured by this freeze and subsequent growth was exceptionally good. Because of freeze injury to wheat, oats, and barley, heading was very poor and irregular and yields of grain were not obtained. In 1933, a low temperature of 1 degree F. on February 8 killed the top growth on all plats and materially reduced the stand, particularly for oats and barley. The dead top growth was clipped on February 28 and recorded as the dry weight of forage. Recovery of the plants following this freeze was slow and the clipping weights were low until near the end of the season. In 1934, a clipping on March 15 left the plats exposed to more than normal damage by a hard freeze on March 19. Barley and oats were severely frozen back and the stand reduced on some plats. Therefore, the yields of forage obtained after March 15 were much below normal.

Yields of Forage

In 1931-32, the first year of this test at Denton, six varieties were planted in duplicate on October 3. All plantings emerged on October 12 and growth during the fall and winter was exceptionally good, because of abundant moisture. The first clipping was made on October 29 and

subsequent clippings were made at intervals of about two weeks. The yields obtained are presented in Table 11. Barley and oats produced abundant forage in less than a month from planting, whereas wheat did not produce well until mid-winter. Italian and English rye grasses were slow in getting started and did not produce much forage during the fall and winter, but during the late spring they produced much more than any of the cereal crops. No grain yields were obtained because of severe injury by the freeze on March 5.

In 1932-33, six varieties were planted in duplicate on October 8. All plantings were watered immediately after planting to insure uniform germination. Exceptionally dry weather during the fall retarded growth to the extent that no clippings could be made before January 27. Because of this poor fall growth and the effect of the freeze on March 8, the yields of all plats, except the continuously clipped plats, are very low. Wheat produced much more forage than the other cereals because of its greater cold resistance and ability to grow in cold weather. The next highest yield was made by barley. The rye grasses were slow in getting started and were severely injured by the freeze, the total yield being largely made in the last cutting on June 8. The yields for all varieties are presented in Table 12. The yields of grain presented in Table 16 are not what would normally be expected, because of the effect of the hard freeze on March 8. The very succulent growth on the unclipped plats was almost completely killed, whereas the clipped plats had less top growth and were injured much less. Wheat grazed to March 1 yielded more than wheat grazed to February 15, indicating that grazing is beneficial up to March 1.

In 1933-34, the same six varieties were planted in duplicate on October 9 and emergence occurred on October 14. Because of dry weather in November, all varieties made very poor growth and the first clipping could not be made until December 8. Thereafter cold weather retarded growth until near the end of February, only two clippings being obtained during this period (Table 13). The fourth clipping made on March 15 left the plats exposed to more than normal damage by the hard freeze on March 19. The yields of forage after March 15 are much below normal, but should be considered, inasmuch as winterkilling may occasionally be expected at this late date. From planting time until February 15, barley and oats made the highest yields, but during the period February 15 to the end of the growing season, they made considerably less than the other varieties. Wheat made the highest total yield of dry forage, followed by oats, Italian rye grass, barley, English rye grass, and rye, in the order named.

In the period of years 1932-34, English rye grass and Italian rye grass yielded slightly more forage than wheat, and all three yielded approximately one-third more than oats, barley, or rye. These data are presented in Table 14.

Table 11. Acre yield of green and air-dry forage, 1931-32, at Denton

Variety	Acre yield forage, pounds												% Dry matter
	Air-dry											Green	
	Date of cutting										Total		
	10/29	11/12	11/25	12/22	1/28	2/24	3/2	4/13	5/5	5/23			
Wheat	105	53	157	96	540	1519	510	2227	3031	0	8238	34324	24
Oats	171	134	384	428	1471	2125	456	246	0	0	5415	25786	21
Barley	353	297	280	235	1459	2791	894	60	0	0	6369	27691	23
Rye	169	129	177	251	954	1477	348	1002	1056	0	5563	26490	21
Italian rye grass	54	59	148	168	630	1951	330	2101	3871	3031	12343	61715	20
English rye grass	44	62	135	154	834	2245	372	2113	3505	3241	12705	66868	19

Table 12. Acre yield of green and air-dry forage, 1932-33, at Denton

Variety	Acre yield forage, pounds										Green	% Dry matter
	Air-dry											
	Date of cutting								Total			
	1/27	2/28	3/16	4/3	4/17	5/2	5/17	6/8				
Wheat	14	339	519	1137	646	975	258	0	3888	16471	24	
Oats	9	370	32	149	45	442	478	569	2094	7266	29	
Barley	122	1435	235	569	320	384	135	0	3200	11817	27	
Rye	45	483	307	912	271	452	145	0	2615	11143	23	
Italian rye grass	0	0	9	104	0	0	0	2261	2374	8478	28	
English rye grass	0	0	23	135	0	0	0	2396	2554	8807	29	

Table 13. Acre yield of green and air-dry forage, 1933-34, at Denton

Variety	Acre yield forage, pounds								% Dry matter
	Air-dry							Green	
	Date of cutting						Total		
	12/8	1/24	2/16	3/15	4/10	5/5			
Wheat	1068	852	580	1060	1881	1401	6842	28508	24
Oats	1505	1252	576	520	620	2021	6494	30924	21
Barley	2005	1385	704	420	360	660	5534	26352	21
Rye	544	608	588	800	1401	1221	5162	22443	23
Italian rye grass	832	712	484	680	1160	1741	5609	28045	20
English rye grass	492	648	476	800	780	2281	5477	30428	18

Table 14. Period of years summary, 1932-34, acre yields of forage at Denton

Variety	Acre yield forage, pounds							
	Green				Air-dry			
	1932	1933	1934	Ave.	1932	1933	1934	Ave.
Wheat	34324	16471	28508	26434	8238	3888	6842	6323
Oats	25786	7266	30924	21325	5415	2094	6494	4668
Barley	27691	11817	26352	21953	6369	3200	5534	5034
Rye	26490	11143	22443	20025	5563	2615	5162	4447
Italian rye grass	61715	8478	28045	32746	12343	2374	5609	6775
English rye grass	66868	8807	30428	35368	12705	2554	5477	6912

The comparative monthly yields of the two species of grasses and four varieties of small grain, for the years 1932-33-35, are presented in graphic form in Figure 2. This graph clearly shows two distinct peaks of production for all varieties, the first coming in February just ahead of severe freezes usually occurring near the end of February or the first part of March. The second peak of production was somewhat more variable, that for wheat and rye occurring in April, while that for the two rye grasses and oats occurred one month later. Barley failed to make a spring growth peak, the yields of forage gradually decreasing from March until the end of the season.

Effect of Length of Grazing Period upon Production of Grain

Since small grains in North Texas are grown primarily for grain production, the question of when to stop grazing by livestock in the spring is of considerable importance. Opinions on this question among stock farmers vary considerably, some believing that pasturing after March 1 will lower production, while others believe that pasturing up to March 15, or later, does not reduce yields. All stock farmers seem to agree that pasturing small grains by livestock during the fall and winter reduces winterkilling and increases production of grain. In order to

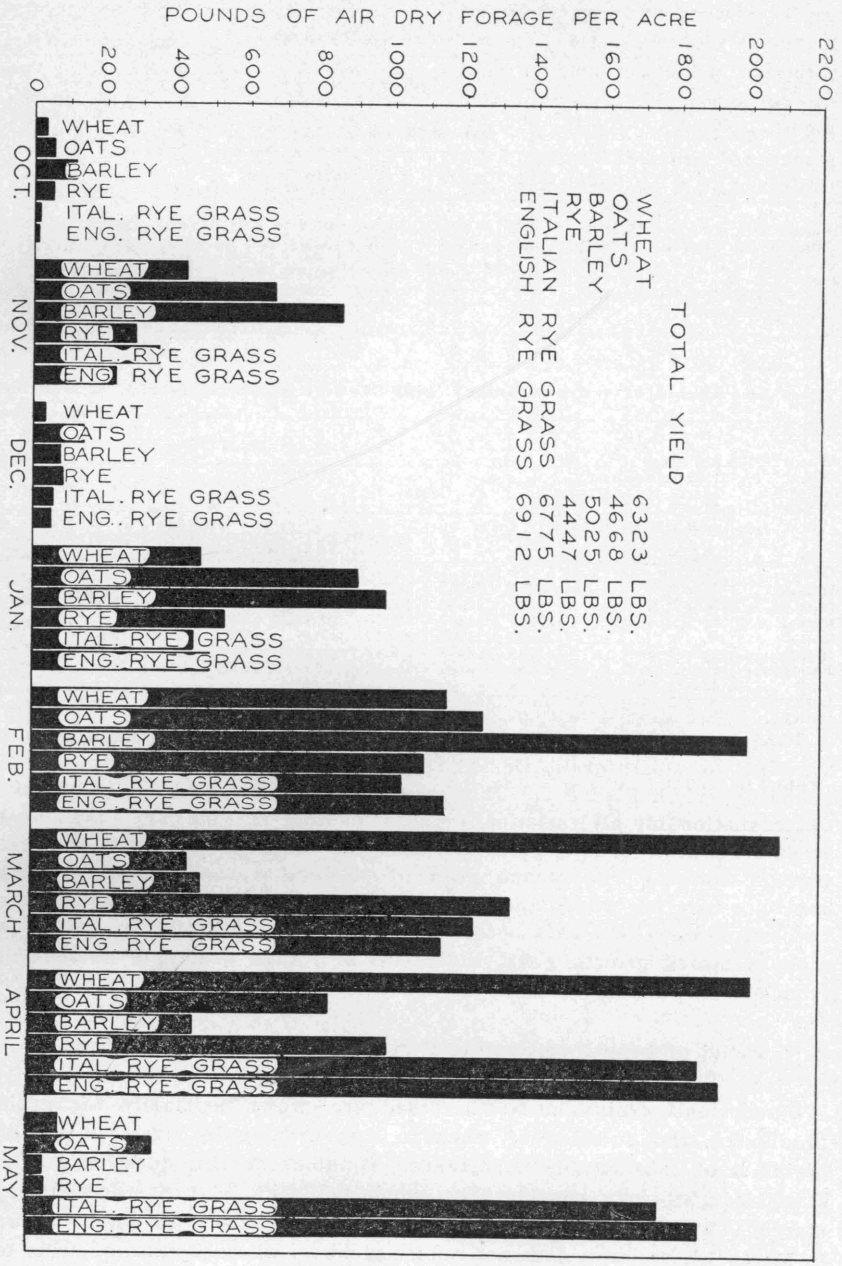

Fig. 2. Average Monthly Yield per Acre of Air-Dry Forage at Denton.

obtain experimental information on the best time to discontinue grazing in the spring, duplicate plats of wheat, oats, and barley were planted in four different series as a part of the regular clipping experiment. Clippings were discontinued in the first series on February 15, in the second series on March 1, in the third series March 15, while in the fourth series the plats were not clipped at all. The average yields of forage and grain for each of the three years, 1932-34, are presented in Tables 15, 16, and 17, and the period of years summary appears in

Table 15. Effect of length of grazing period upon the production of forage and grain, 1931-32, Denton

Crop	Date clipping discontinued	Acre yield air-dry forage, pounds		
		Total to Feb. 15	Feb. 15 to end of grazing period	Seasonal total
Wheat	not clipped	....	....	0
Wheat	February 15	2767	....	2767
Wheat	March 1	2344	462	2806
Wheat	March 15	2739	378	3117
Wheat	End of growing period	2470	5768	8238
Oats	not clipped	....	....	0
Oats	February 15	5111	....	5111
Oats	March 1	5396	576	5972
Oats	March 15	4941	648	5589
Oats	End of growing period	4713	702	5415
Barley	not clipped	....	....	0
Barley	February 15	4728	....	4728
Barley	March 1	5112	648	5760
Barley	March 15	5027	504	5531
Barley	End of growing period	5415	954	6369

Table 16. Effect of length of grazing period upon the production of forage and grain, 1932-33, Denton

Crop	Date clipping discontinued	Acre yield			
		Air-dry forage, pounds			Grain, bushels
		Total to Feb. 15	Feb. 15 to end of grazing period	Seasonal total	
Wheat	not clipped	....	....	0	18.8
Wheat	February 15	487	....	487	17.4
Wheat	March 1	687	....	687	25.3
Wheat	March 15	551	469	1020	20.5
Wheat	End of growing period	353	3535	3888	0
Oats	not clipped	....	....	0	29.9
Oats	February 15	542	....	542	29.3
Oats	March 1	628	....	628	40.3
Oats	March 15	582	63	645	42.9
Oats	End of growing period	379	1715	2094	0
Barley	not clipped	....	....	0	34.4
Barley	February 15	1561	....	1561	28.4
Barley	March 1	1887	....	1887	32.5
Barley	March 15	2193	135	2328	23.7
Barley	End of growing period	1557	1643	3200	0

Table 17. Effect of length of grazing period upon the production of forage and grain, 1933-34, Denton

Crop	Date clipping discontinued	Acre yield			
		Air-dry forage, pounds			Grain, bushels
		Total to Feb. 15	Feb. 15 to end of grazing period	Seasonal total	
Wheat.....	not clipped.....	....	....	0	19.3
Wheat.....	February 15.....	1720	....	1720	29.9
Wheat.....	March 1.....	1684	....	1684	36.0
Wheat.....	March 15.....	1968	640	2608	21.9
Wheat.....	End of growing period.....	2500	4342	6842	0
Oats.....	not clipped.....	....	....	0	53.0
Oats.....	February 15.....	2508	....	2508	56.5
Oats.....	March 1.....	2284	....	2284	72.0
Oats.....	March 15.....	2424	660	3084	92.8
Oats.....	End of growing period.....	3333	3161	6494	0
Barley.....	not clipped.....	....	....	0	52.5
Barley.....	February 15.....	3033	....	3033	34.7
Barley.....	March 1.....	3068	....	3068	38.5
Barley.....	March 15.....	3389	580	3969	16.2
Barley.....	End of growing period.....	4094	1440	5534	0

Table 18. Because of the variable effect of early spring freezes, previously discussed, the yields of grain are perhaps influenced as much by freezing as by grazing. However, the effect of freezing on grazed and on ungrazed grain is perhaps of as much importance as the actual

Table 18. Period of years summary—effect of length of grazing period upon the production of forage and grain, 1931-33, Denton

Crop	Date clipping discontinued	Acre yield						
		Air-dry forage, pounds				Grain, bushels		
		1931–32	1932–33	1933–34	Ave.	1932–33	1933–34	Ave.
Wheat.	Not clipped.....	0	0	0	0	18.8	19.3	19.1
Wheat.	February 15.....	2767	487	1720	1658	17.4	29.9	23.7
Wheat.	March 1.....	2806	687	1684	1726	25.3	36.0	30.7
Wheat.	March 15.....	3117	1020	2608	2248	20.5	21.9	21.2
Wheat.	End of growing period.....	8238	3888	6842	6323	0	0	0
Oats...	Not clipped.....	0	0	0	0	29.9	53.0	41.5
Oats...	February 15.....	5111	542	2508	2720	29.3	56.5	42.9
Oats...	March 1.....	5972	628	2284	2961	40.3	72.0	56.1
Oats...	March 15.....	5589	645	3084	3106	42.9	92.8	67.9
Oats...	End of growing period.....	5415	2094	6494	4668	0	0	0
Barley.	Not clipped.....	0	0	0	0	34.4	52.5	43.5
Barley.	February 15.....	4728	1561	3033	3107	28.4	34.7	31.6
Barley.	March 1.....	5760	1887	3068	3572	32.5	38.5	35.5
Barley.	March 15.....	5531	2328	3969	3943	23.7	16.2	20.0
Barley.	End of growing period.....	6369	3200	5534	5034	0	0	0

effect of grazing. The yields reported can be accepted as indicating that grazing small grains during the fall and winter months is beneficial and increases grain production. Grazing of wheat appears to be more beneficial than grazing of oats and barley. Grazing wheat until March 1

Date cut	Variety	Protein	Fat	Crude fiber	Nitrogen-free extract	Water	Ash	Total phosphoric acid	Insoluble ash	Lime
12/8	Wheat	28.06	3.76	15.64	32.01	8.07	12.46	.83	2.59	1.12
	Oats	28.46	5.53	17.33	28.73	8.70	11.25	.80	.75	.81
	Barley	29.16	3.27	16.55	27.31	8.21	15.50	.75	2.65	1.10
	Rye	31.38	5.50	14.15	27.39	8.66	12.92	.85	1.56	1.24
	Italian rye grass	28.74	4.49	14.34	30.40	8.46	13.57	.79	1.81	1.33
	English rye grass	29.35	4.25	12.96	30.73	7.68	15.03	.74	.....	1.56
1/24	Wheat	32.06	3.44	14.68	26.01	8.46	15.35	1.04	5.54	1.48
	Oats	29.67	3.68	17.63	26.27	9.07	13.68	.98	2.62	.96
	Barley	30.12	2.84	17.07	25.84	9.54	14.59	1.01	2.11	1.17
	Rye	36.06	3.89	13.85	25.70	7.98	12.52	1.26	2.80	1.30
	Italian rye grass	24.78	4.33	13.30	32.12	8.37	17.10	.88	5.18	1.64
	English rye grass	28.91	4.22	13.46	28.63	9.16	15.62	1.04	.....	1.32
2/16	Wheat	34.51	4.17	14.21	25.82	9.56	11.73	.99	3.33	.66
	Oats	30.96	3.86	15.37	27.92	9.67	12.22	.81	3.04	.91
	Barley	31.56	3.23	13.67	27.92	10.00	13.62	.78	3.24	1.06
	Rye	34.56	4.75	14.28	27.09	8.94	10.38	.98	1.61	1.20
	Italian rye grass	22.71	2.03	13.68	29.22	15.70	16.66	.81	7.54	2.11
	English rye grass	26.68	4.37	12.81	31.25	8.57	16.32	.83	.....	1.32
3/15	Wheat	29.30	3.72	17.40	28.69	8.29	12.60	.87	3.89	.80
	Oats	28.23	3.67	15.10	29.90	9.01	14.09	.84	4.97	.88
	Barley	28.17	2.94	15.57	28.42	9.77	15.13	.79	5.35	1.13
	Rye	27.61	4.05	17.11	28.89	9.55	11.79	.94	2.83	1.44
	Italian rye grass	19.30	3.85	15.08	37.45	8.51	15.81	.84	6.31	1.30
	English rye grass	21.74	3.74	15.43	35.04	8.72	15.33	.86	.....	1.19
4/10	Wheat	21.85	2.79	24.17	28.76	7.69	14.74	.95	5.59	.78
	Oats	28.66	4.34	18.44	26.68	9.66	12.22	.85	3.06	.61
	Barley	27.94	3.07	17.38	29.16	9.18	13.27	.80	3.59	.91
	Rye	22.92	3.25	23.13	31.71	8.53	10.46	.89	2.52	1.09
	Italian rye grass	21.48	3.79	19.64	30.98	7.96	16.15	1.00	5.79	1.23
	English rye grass	23.90	3.61	19.68	29.66	7.68	15.47	1.01	.....	1.10
5/5	Wheat	18.68	2.68	24.79	33.89	6.69	13.27	.89	5.96	.65
	Oats	14.61	2.33	28.94	34.95	8.50	10.67	.73	3.24	.73
	Barley	17.43	3.10	24.46	34.53	8.21	12.27	.90	4.66	.72
	Rye	16.04	3.08	29.45	36.56	6.94	7.93	.77	1.76	.78
	Italian rye grass	17.95	3.27	23.81	32.23	7.79	14.95	.98	5.02	1.13
	English rye grass	18.56	2.69	25.04	30.58	7.58	15.55	.92	.....	1.09
Aver.	Wheat	27.41	3.43	18.48	29.20	8.13	13.36	.93	4.48	.92
	Oats	26.77	3.90	18.80	29.08	9.10	12.36	.84	2.95	.80
	Barley	27.40	3.08	17.45	28.86	9.16	14.06	.84	3.60	1.02
	Rye	28.10	4.09	18.66	29.56	8.43	11.00	.95	2.18	1.18
	Italian rye grass	22.49	3.63	16.64	32.06	9.47	15.71	.88	5.28	1.46
	English rye grass	24.86	3.81	16.56	30.98	8.23	15.55	.90	.....	1.26

increased grain production considerably. Grazing that stopped February 15 was apparently too early and subsequent rank growth tended to reduce yields. Grazing until March 15 was apparently too late and injury to the rapidly growing plants resulted. Oats responded to grazing up to March 15. Keeping the oat plants clipped until after early March freezes reduced freeze damage and increased grain production. Grazing was not so important in increasing the yield of barley, the plats not clipped yielding slightly more than the clipped plats. Clipping barley up to March 1 had little effect on the yield, but clipping up to March 15 reduced the yield considerably.

From these results it is believed that over a period of years the stock farmer could safely graze his small grain crops up to March 1 without reducing grain yields. Grazing wheat or barley later than this would not be profitable. Grazing oats for 15 or 20 days longer would not likely reduce yields materially.

Chemical Analyses of Forage

The analyses of the air-dry forage obtained at Denton in 1934 are presented in Table 19. These analyses show that protein is very high in all clippings except the last for all varieties, being particularly high during the fall, winter, and early spring months. There were no significant differences between the different cereals in protein content. The two rye grasses contained approximately the same percentage of protein, but both were significantly lower than any of the cereals. The protein content in all varieties decreased slightly as the spring season advanced. The first four clippings averaged about 30 per cent, while the last two clippings averaged about 20 per cent.

The percentage of fat was somewhat higher in oats, rye, and the two rye grasses than in wheat and barley. The fat content did not vary with the season as did protein. Crude fibre was somewhat higher in oats and barley during the early growing season than in wheat, rye, and the two rye grasses. During the latter part of the growing season the crude fibre was about the same in all grasses. Rye and oats were lower in total ash than the other grasses, while the two rye grasses averaged considerably higher in ash than the cereals. Wheat, barley, rye, and the rye grasses were about equal in lime content, and considerably higher in lime than oats.

The chemical analyses of the different grasses in this experiment clearly show why winter-growing grasses are so valuable to the livestock farmer.

RESULTS AT LUBBOCK

Practical Problems in Connection with Winter Pastures at Lubbock

On account of the normally dry winters and the sandy nature of the soil over a good portion of the South Plains area in Western Texas, small grains are not a profitable crop where grown for grain alone, especially

when compared with the usual row crops. On the heavier soils, and especially farther north where cotton is not grown, yields of small grain are somewhat better. From November to May there is an absence of green feed for stock. Usually Sudan grass becomes available the latter part of May to early June. Consequently, during the above period small grains offer the only source of green feed for livestock.

The customary practice on the small farms is to seed the crop on five to ten acres and begin to graze as soon as the plants begin to stool and are well anchored. This is continued throughout the winter and well into March. If moisture conditions are especially favorable stock are withdrawn and the crop allowed to mature, otherwise grazing is continued and the crop later is plowed under. On strictly wheat farms stock are usually taken off during March.

With 82 per cent of the moisture falling between April and October, inclusive, if the small grain is planted early in September there are few years in which some grazing cannot be obtained. There are also few years when it will not pay to withdraw stock from the pasture in order to allow it to recover. One of the best practices is to allow the stock to graze only sufficiently long each day for them to obtain a "fill." This prolongs materially the life of the pasture as continued trampling in either wet or dry soil in this area is detrimental.

Soil Conditions

Texas Substation No. 8 is located at Lubbock, Lubbock County, near the center of the southern one-half of the Great Plains, known locally as the South Plains. The soils are largely Amarillo fine sandy loam verging into the sandy and clay loams to the east and north. The topography is generally level with the fall to the southeast of about one foot to the mile. There are no drainage outlets so that what water runs off drains into shallow basins. The top soils being sandy, the water penetrates easily and is retarded by the clay subsoil, which is found at depths ranging from four to twelve inches. The clay subsoil acts as a storage reservoir. The soil used in this experiment was the Amarillo fine sandy loam. It can easily be understood that constant grazing will pulverize the soil where cultivated pastures are used, loosen the roots, and hasten wind erosion. Also, if pastured while wet, the soil is inclined to pack.

Climatic Conditions

Rainfall at this point averages 18.60 inches over a period of 25 years, with 82 per cent falling during the period April to October, inclusive. A good portion of this falls in the form of torrential showers. The total yearly rainfall is erratic, varying from 8.73 to 31.61 inches. Normally September and October are the months in which heavy rainfall may be expected, and whenever this does occur good results may be expected from small grain pastures. This is evidenced by the results obtained in 1932-33 when 3.41 inches fell during September. The years 1933-34 and

1934-35 were two of the driest on record and yields naturally reflect this condition (Table 20).

Minimum temperatures of zero can be expected every year with occasional sub-zero temperatures. Usually the colder periods are the

Table 20. Rainfall and temperature data at Lubbock

Year	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Total
Rainfall,										
1932-33.....	3.41	1.29	T	2.48	.37	.95	.02	.06	2.97	11.55
1933-34.....	.71	.42	.99	.06	.06	.06	1.98	1.08	1.26	6.62
1934-35.....	1.86	.28	.55	T	.12	.60	.89	.04	3.49	7.83
Temperature										
Maximum:										Extreme
1932-33.....	94	87	82	74	68	77	85	86	98	98
1933-34.....	97	91	85	81	76	80	87	93	99	99
1934-35.....	100	97	88	73	76	82	86	92	95	100
Minimum:										
1932-33.....	51	29	16	5	17	−17	22	24	35	−17
1933-34.....	59	37	30	12	12	9	19	37	41	9
1934-35.....	44	32	24	17	9	1	8	24	35	1
Mean:										Mean
1932-33.....	56.8	44.4	31.2	23.2	29.3	23.2	37.0	40.4	51.8	37.5
1933-34.....	63.6	48.3	37.1	30.3	25.7	29.1	34.2	46.8	55.9	41.2
1934-35.....	58.0	49.6	38.8	29.2	29.7	29.5	41.5	46.0	52.4	41.6

result of "dry" northers. These strong winds, combined with the normally dry winter soils, are severe on winter pastures.

Yields of Forage

The first year of the test at Lubbock was 1932-33. Four varieties were planted: wheat, oats, rye, and barley. All varieties were seeded September 29, which is about half way between the usual planting dates for pasture and grain purposes. Rapid growth was made, especially with barley, which has the ability to grow rapidly and furnish pasture ahead of the other varieties. The first clipping was made on November 17, or 49 days after planting. In all, seven clippings were made, at intervals of 49, 62, 43, 22, 13, 15, and 17 days apart. Rye made the highest yield, followed by wheat, oats, and barley. Barley was severely injured by a temperature of 5 degrees F. in December; oats were stunted, while both rye and wheat came through in good condition. On February 8, a temperature of −17 degrees F. was recorded; it killed the barley and froze the oats back to the crown. Both rye and wheat were set back by this cold weather. Data are presented in Table 21.

In 1933-34, the test, which contained the same varieties as in the previous year, was planted on September 29. Rainfall amounting to 2.19 inches in August furnished fairly good moisture conditions for planting. The winter as a whole was mild with no severe weather, but wind storms were frequent. The first clipping was made 46 days after

Table 21. Acre yield of green and air-dry forage, 1932-33, at Lubbock

Variety	Acre yield forage, pounds									% Dry matter
	Air-dry								Green	
	Date of cutting							Total		
	11/17	1/18	3/2	3/24	4/6	4/21	5/8			
Barley	2360	530	0	0	0	0	0	2890	11430	25
Oats	1180	830	190	300	480	500	540	4020	14740	27
Rye	990	1260	900	1000	860	590	630	6230	25320	25
Wheat	560	600	770	1340	1160	500	800	5730	20380	28

planting and subsequent clippings were made at intervals of 22, 77, 24, 18, and 17 days (Table 22). These intervals clearly reflect the dry conditions of the soil and the response to the early March snow

Table 22. Acre yield of green and air-dry forage, 1933-34, at Lubbock

Variety	Acre yield forage, pounds								% Dry matter
	Air-dry							Green	
	Date of cutting						Total		
	11/14	12/6	2/20	3/15	4/2	4/18			
Barley	870	350	245	135	104	132	1836	9140	20
Oats	777	214	.....	235	272	363	1861	7890	24
Rye	482	116	.....	210	269	227	1304	5100	26
Wheat	553	104	.....	186	306	166	1315	4700	28

and rain. Oats made the highest yield followed by barley, with wheat and rye considerably lower. It is again noticeable that barley made the most active early season growth.

The 1934-35 seeding was made on September 29, the same date as in previous years, with the same varieties being used. While 1934 was one of the driest years on record, August had 1.66 and September 1.86

Table 23. Acre yield of green and air-dry forage, 1934-35, at Lubbock

Variety	Acre yield forage, pounds							% Dry matter
	Air-dry						Green	
	Date of cutting					Total		
	11/19	12/4	3/8	3/28	4/7			
Barley	610	230	230	330	200	1600	5840	27
Oats	350	90	150	360	240	1190	3660	33
Rye	220	110	520	810	310	1970	6340	31
Wheat	290	40	240	670	320	1560	4530	34

inches of rainfall, which provided rather good soil moisture conditions for the planting. The winter was mild but severe wind and dust storms interfered with normal plant growth and also rapidly exhausted soil moisture. Five clippings in all were made, the first 42 days after planting and the others at intervals of 24, 94, 30, 21, and 11 days. The greatest yield was obtained from rye followed by barley, wheat, and oats (Table 23).

The yield of green and air-dry clippings obtained at Lubbock during the three years are presented in Table 24. Rye produced the highest yield followed, in order, by wheat, oats, and barley. The average monthly yields are presented in Figure 3. There was a high yield in November

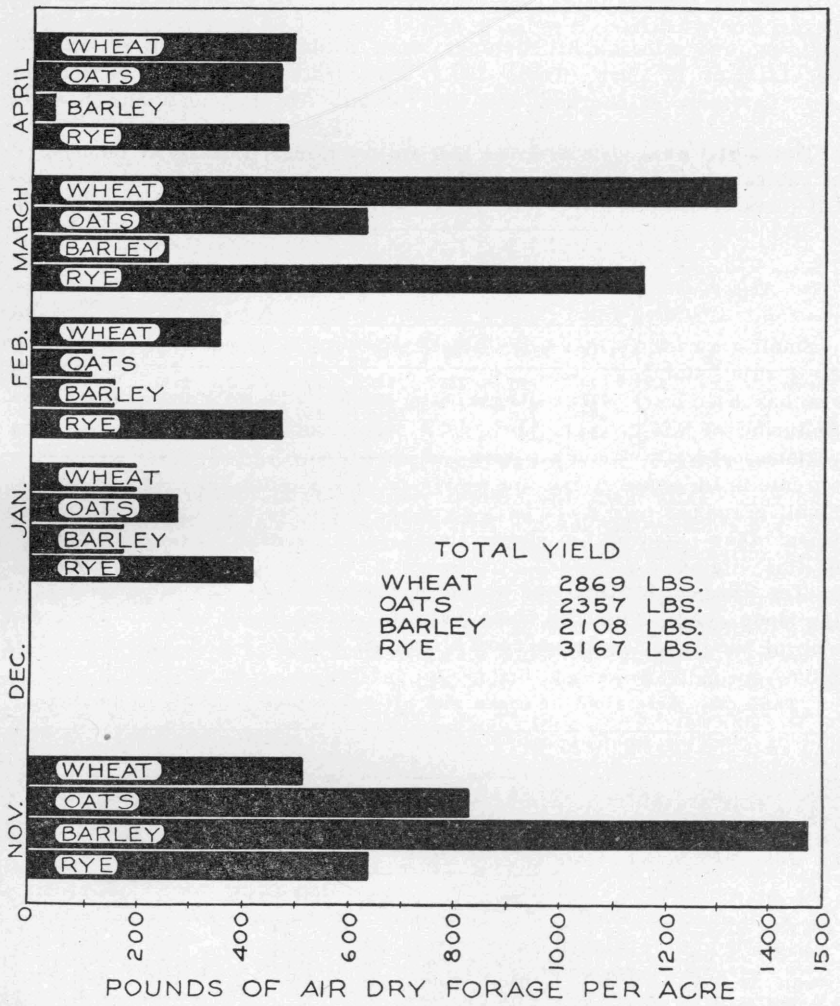

Fig. 3. Average Monthly Yield per Acre of Air-Dry Forage at Lubbock.

Table 24. Period of years summary—1933-35, acre yields of forage at Lubbock

Variety	Acre yield forage, pounds							
	Green				Air-dry			
	1933	1934	1935	Ave.	1933	1934	1935	Ave.
Barley	11430	9140	5840	8803	2890	1836	1600	2109
Oats	14740	7890	3660	8763	4020	1861	1190	2357
Rye	25320	5100	6340	12253	6230	1304	1970	3168
Wheat	20380	4700	4530	9870	5730	1315	1560	2868

but very little growth in December. Barley produced the highest yield early in the season while wheat produced the highest yield later in the spring from February through April.

Chemical Analyses of Forage

The chemical analyses of the clippings of the small grains are shown in Tables 25 and 26. The protein content remains fairly constant throughcut the season of 1934-35 but shows considerable variation in the season of 1933-34.

DISCUSSION

Small grains have long been used as a winter and early spring pasture. As a rule, oats have been recommended for pasture in the south, but rye has been the preference further north and on poorer soils. The pasturing of winter wheat has been customary in the wheat-producing regions, especially during seasons of rank growth, and if not continued too late in the season, does not reduce the grain yield but may increase it. Small grain pastures are a very important source of vitamin A at a time when other pastures are short, since green plants are the chief source of this vitamin. In the South, small grain is excellent for preventing winter erosion or leaching of the soil and where used for pasture in the early spring, gives the permanent pasture a much needed rest. The grazing of green wheat and rye plants may affect the flavor or odor of milk, especially if the grazing occurs just before milking time.

At Angleton, in the Gulf Coast Region, a mixture of Italian rye grass and oats made the highest yield of air-dry forage. Oats may freeze during some seasons, but Italian rye grass rarely freezes in this region. The yields are highest from January through March, with some grazing in November, April, and May. Little grazing is produced in December in this section.

At Denton, in the small grain section of North-central Texas, the rye grasses produced the highest yields, but their maximum growth occurs in April and May. Wheat made a higher total yield than the other small grains tested, although barley produces more grazing through February. Very little grazing is produced in December and there is little production

Table 25. Chemical analysis of pasture clippings, 1933-34, at Lubbock

Date cut	Variety	Protein	Fat	Crude fiber	Nitrogen-free extract	Water	Total ash	Lime	Magnesia	Insoluble ash	Total phosphoric acid
11/14/33	Rye	26.70	5.09	13.63	29.32	10.03	15.23	.79	.....	5.09	1.40
	Wheat	24.74	4.37	14.50	31.38	10.39	14.62	.57	.....	4.64	1.13
12/6/33	Barley	18.83	4.15	17.47	34.75	9.36	15.44	.65	.....	4.91	.94
	Oats	18.70	4.86	13.71	39.88	10.11	12.74	.55	.....	3.57	.99
	Rye	22.52	5.21	12.87	37.65	8.86	12.89	.68	.....	3.84	1.34
	Wheat	22.11	4.14	11.91	36.94	8.70	16.20	.47	.....	6.33	1.15
2/20/34	Barley	16.59	3.42	17.02	41.78	8.80	12.39	.82	.....	5.52	.63
3/15/34	Barley	18.30	3.74	18.14	38.03	8.61	13.18	.52	.....	5.89	1.11
	Oats	13.97	2.62	21.36	44.63	8.59	8.83	.40	.....	3.41	.80
	Rye	17.17	3.70	18.44	42.99	8.63	9.07	.42	.....	2.37	.97
	Wheat	17.41	2.91	18.81	41.22	8.54	11.11	.46	.....	4.31	.97
4/2/34	Barley	23.51	3.74	17.70	31.61	8.21	15.23	.53	.....	6.08	1.31
	Oats	17.75	3.37	18.87	39.33	8.99	11.69	.44	.....	3.73	1.12
	Rye	19.59	3.90	18.23	39.07	8.41	10.80	.49	.....	3.04	1.24
	Wheat	18.86	3.21	19.19	38.08	8.39	12.27	.46	.....	4.57	1.15
4/18/34	Barley	18.50	2.66	16.54	37.63	8.19	16.48	.65	.....	8.68	1.13
	Oats	15.83	3.26	15.52	45.54	8.64	11.21	.58	.....	4.65	.84

Table 26. Chemical analysis of pasture clippings, 1934-35, at Lubbock

Date cut	Variety	Protein	Fat	Crude fiber	Nitrogen-free extract	Water	Total ash	Lime	Magnesia	Insoluble ash	Total phosphoric acid
11/19/34	Barley	30.68	5.28	13.93	24.18	10.74	15.19	.76	.59	3.01	.63
	Oats	28.40	6.04	12.85	27.17	12.87	12.67	.70	.59	2.67	.64
	Rye	33.15	6.08	11.24	24.45	10.22	14.86	.96	.58	3.55	.95
	Wheat	27.68	5.32	12.88	27.55	11.88	14.69	.75	.56	3.35	.64
12/14/34	Barley	30.28	4.16	11.40	30.88	10.77	12.51	.86	.51	3.23	.72
	Oats	28.13	4.69	11.23	37.04	8.52	10.39	.75	.44	2.23	.69
	Rye	33.11	5.35	9.55	30.58	10.85	10.56	.83	.47	2.13	1.01
	Wheat	29.21	4.60	11.23	35.61	9.56	9.79	.72	.43	2.46	.68
3/8/35	Barley	30.53	1.76	13.08	34.01	7.29	13.33	.81	.....	5.15	.68
	Oats	28.38	2.95	12.62	37.55	8.32	10.18	.67	.....	3.03	.68
	Rye	25.90	4.43	12.29	34.71	8.08	14.59	.51	.....	7.11	.68
	Wheat	29.63	3.77	13.05	36.25	8.38	11.62	.60	.....	5.13	.62
3/28/35	Barley	31.82	4.97	13.33	25.10	6.82	17.96	.88	.....	6.61	.80
	Rye	28.24	4.83	13.43	27.90	7.22	18.38	.65	.....	8.82	1.03
	Wheat	29.36	4.57	14.35	28.21	7.71	15.80	.56	.....	5.86	.92
4/17/35	Barley	25.73	4.20	15.38	33.30	7.75	13.64	.72	.....	5.45	.66
	Oats	23.56	4.02	14.55	37.72	7.50	12.65	.58	.50	5.39	.65
	Rye	26.35	4.07	14.51	33.47	7.16	14.44	.55	.....	6.07	.83
	Wheat	24.24	3.39	14.52	36.05	8.48	13.32	.47	.....	5.39	.77

from the small grains in May, although the rye grasses produce heavy yields during this month. Grazing the small grains to March 1 did not reduce the yield of grain but resulted in an increased yield of oats and wheat. Grazing to March 1 produced more grain than grazing to February 15, probably because the longer grazing season prevented damage from late freezes. Oats could be grazed two or three weeks longer than wheat or barley without reducing the grain yield materially.

At Lubbock, where small grain is grown largely for pasture, barley produced a rapid growth early in the season but it winterkilled more easily than the other small grains tested. Rye produced the largest total yield but, because it flavors milk, is probably not as acceptable to a dairy farmer, or to a farmer for grazing his milk cow, as is oats. All the small grains produce a good pasture in the Lubbock area but the rye grasses are not so well adapted to that part of the State.

SUMMARY

1. A mixture of Italian rye grass and oats produced the highest yield of clippings (1928 lbs. per acre) at Angleton, in the Gulf Coast Prairie.

2. The rye grasses produced the highest total yield (6755 and 6912 lbs. per acre) at Denton, in North-central Texas, but the most of their growth occurs late in the spring.

3. Wheat produced a higher yield of pasture (6323 lbs. per acre) than the other small grains at Denton.

4. Grazing wheat and oats at Denton to March 1 resulted in a slightly increased grain yield as compared with no grazing or grazing to February 15, but the grain yield of barley was not affected.

5. Oats can be grazed to March 15 at Denton without materially reducing the grain yield.

6. Rye produced the greatest total yield (3168 lbs. per acre) at Lubbock, in Northwest Texas.

7. Barley produces a quick growth and high yields early in the season at Lubbock.

8. Chemical analyses show a high feeding value for the small grain clippings at all three points in the State, the protein content running over 30 per cent in some cases early in the spring.

9. The chemical analyses indicate a lower feeding value of the clippings in the humid Gulf Coast Prairie than in north or west Texas.

10. Small grains and rye grasses for winter pasture in Texas are valuable. In general, this is because they produce good yields; the herbage produced is very palatable and nutritious; this pasturage is a cheap feed; they furnish an excellent source of vitamin A; they are excellent for preventing winter leaching or soil erosion; they give the permanent pasture a needed rest in the spring or early summer; a grain

crop can be produced in the small grain growing sections of the State if the pasturing is not too severe and is not continued too late.

ACKNOWLEDGMENTS

The aid of Dr. P. C. Mangelsdorf, Agronomist, Small Grain Investigations, in planning and conducting the experiments and in interpreting the data reported in this bulletin is gratefully acknowledged.

REFERENCES

1. Shelton, E. M. 1888. Experiments with Wheat. Kansas Sta. Bul. No. 4.
2. Phelps, C. S. Forage Crops. Conn. Storrs. Sta. Report for 1891. Pp. 9-13.
3. Georgeson, C. C., Burtis, F. C. and Shelton, W. 1892. Experiments with Wheat at Kansas Station. Kansas Sta. Bul. No. 33.
4. Latta, W. C. 1892. Field Experiments with Wheat. Indiana Exp. Sta. Bul. 41.
5. Latta, W. C. Indiana Sta. Report for 1893, pp. 25-31.
6. Dodson, W. R. Forage Crops, Grasses, Alfalfa, Clovers, Etc. Louisiana Sta. Bul. 72, 2nd Series.
7. Georgeson, C. C., Burtis, F. C., and Otis, D. H. 1896. Experiments with Wheat. Kansas Sta. Bul. 59.
8. Lloyd, E. R. 1898. Winter and Summer Pasture in Mississippi. Mississippi Sta. Bul. 50.
9. Redding, R. J. 1899. Wheat and Oats; Rye and Barley. Georgia Exp. Sta. Bul. 44.
10. Soule, A. M., and Vanatter, P. O. 1901. Winter Cereals and Legumes. Tennessee Sta. Bul. Vol. XIV No. 3.
11. Oklahoma Station Report, 12th Annual Report. 1902-3.
12. Shepperd, H. J. Report on Field Crops. North Dakota Sta. Report. 1904.
13. Mississippi Station Report. 1905.
14. Oklahoma Station Report. 1906. p. 31.
15. Zavitz, C. A. 1908. Experimental Work in Field Husbandry. Annual Report Ontario Agr. Col. and Exp. Farm. 34.
16. Zavitz, C. A. 1909. Experimental Work in Field Husbandry. Annual Report Ontario Agr. Col. and Exp. Farm. 35.
17. Zavitz, C. A. 1911. Experimental Work in Field Husbandry. Annual Report Ontario Agr. Col. and Exp. Farm. 37.
18. Report of Work at McNeill Branch Experiment Station for 1907-1911 Inc. 1912. Mississippi Agr. Exp. Sta. Bul. 158.
19. Duggar, J. F. 1912. Southern Field Crops. The Macmillan Co.
20. Perkins, A. J. and Spafford, W. J. 1913. Experiments Bearing on Feeding off Cereal Crops with Sheep. Jour. Dept. Agr. South Australia. 16 (1913) Nos. 9 & 11. (Exp. Sta. Record. Vol. 30, pp. 633).
21. Hastings, S. H. 1914. The Work of the San Antonio Experiment Farm in 1914. U. S. Dept. Agr. Bur. Plant Industry. Work of San Antonio Exp. Farm.
22. Carleton, M. A. 1916. The Small Grains. The Macmillan Co.
23. Letteer, C. R. 1916. Experiments in Crop Utilization. U. S. Dept. Agr. Bur. Plant Industry. Work San Antonio Exp. Farm.
24. Minkler, F. C. 1916. Field Experiments with Swine. New Jersey Sta. Report.
25. Letteer, C. R. 1917. Experiments in Crop Utilization. U. S. Dept. Agr. Bur. Plant Industry. Work San Antonio Exp. Farm.
26. Letteer, C. R. 1920. Experiments in Crop Utilization. U. S. Dept. Agr. Dept. Circ. 73.
27. Ratliffe, G. T. 1922. Experiments in Crop Utilization. U. S. Dept. Agr. Dept. Circ. 209.
28. Arkansas Sta. 1922. Experiments with Swine at the Arkansas Station. Bul. 181.
29. Babcock, C. J. 1923. Effect of Feeding Green Rye and Green Cowpeas on the Flavor and Odor of Milk. U. S. Dept. Agr. Bul. 1342.
30. Kansas Station Biennial Report. 1927-28.
31. Finnell, H. H. 1929. Grazing of Winter Wheat. Oklahoma Panhandle Sta. Bul. 4, 1929.

32. Wasson, R. A. 1930. Pasture and Forage Crops for Louisiana. La. Ext. Circ. 140.

33. Finnell, H. H. 1931. Winter Grain Pasture Yield and Utilization. Oklahoma Panhandle Sta. Bul. 26.

34. Welton, F. A. and Morris, V. H. 1931. Lodging in Oats and Wheat. Ohio Sta. Bul. 471.

35. Lush, R. H. 1931. Chemical Composition and Yields of Pasture Grasses During 1930. Proc. 32nd Ann. Con. Assn. of Southern Agricultural Workers, pp. 214-218.

36. Copeland, O. C. and Fraps, G. S. 1932. Sorghum Silage as a Source of Vitamin A for Dairy Cows. Texas Agr. Exp. Sta. Bul. 473.

37. Lush, R. H. Seasonal Composition of Pasture Grasses. Journal of Dairy Science, March, 1933. Vol. XVI, No. 2, pp. 149-152.

38. Fraps, G. S. and Treichler, Ray. 1933. Vitamin A Content of Foods and Feeds. Texas Agr. Exp. Sta. Bul. 477.

39. Sherwood, R. M. and Fraps, G. S. 1934. The Amount of Vitamin A Potency Required by Hens for Egg Production. Texas Agr. Exp. Sta. Bul. 493.

40. Lush, R. H. 1934. Dairy and Pasture Results at North La. Exp. Station. Mimeographed Report, 5/15/34.

41. Kirk, L. E., Davidson, J. G. and Hamilton, Stella N. Cereal Crops for Annual Pasture. Sci. Agr. Vol. 14, No. 10, June, 1934.

42. Fraps, G. S., Copeland, O. C. and Treichler, Ray. 1934. The Vitamin A Requirements of Dairy Cows. Texas Agr. Exp. Sta. Bul. 495.

43. Neel, L. R. 1935. Rye for Pasture and Seed in Tennessee. Tennessee Agr. Exp. Sta. Circular 52.

44. Swanson, A. F. 1935. Pasturing Winter Wheat in Kansas. Kansas Agr. Exp. Sta. Bul. 271.

45. Sherwood, R. M. and Fraps, G. S. 1935. The Vitamin A Requirements of Hens for Egg Production. Texas Agr. Exp. Sta. Bul. 514.

46. Lush, R. H. 1936. Pasture Production and Management. Louisiana Agr. Exp. Sta. Cir. 15.