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DOMINION OF CANADA—DEPARTMENT OF AGRICULTURE

CRESTED WHEAT GRASS

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and S. E. Clarke

DIVISION OF FORAGE PLANTS
EXPERIMENTAL FARMS BRANCH

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CRESTED WHEAT GRASS

Crested wheat grass is a native of the steppe region or prairie plains of Russia and Western Siberia. Growing on those cold, dry, wind-swept plains it has developed a tolerance of drought and of extremes of temperature that makes it well adapted to the climatic conditions of Western Canada. This grass was introduced to America in 1898 by the United States Department of Agriculture, and was then tested at many different stations. It did not receive much attention until recent years, when it was found to give good results under dry conditions in the tests at Dakota and Montana stations.

In 1915, a small quantity of seed was obtained from the United States Department of Agriculture by the University of Saskatchewan and planted in experimental plots. Following this, introductions were obtained from Russia and Siberia, and also from Mandan, North Dakota. In 1927, seed was obtained from Montana by the Dominion Range Experiment Station at Manyberries, Alberta, and planted in test plots at that station. In recent years a large number of samples of seed have been distributed throughout Western Canada in order that this grass might be tested under a wide range of soil types and climatic conditions.

GENERAL CHARACTERISTICS

Crested wheat grass is a long-lived perennial. While chiefly of a bunch grass habit it develops short underground stems, by means of which the bunches enlarge to a considerable size. This grass is closely related botanically to slender wheat grass (*Agropyron tenerum*)* and western wheat grass or blue joint (*A. Smithii*), both of which are native to Western Canada. Crested wheat grass has a very extensive root system, penetrating to a depth of 8 feet provided the soil is moist to that depth. The root system of a single spaced plant is often from 1½ to 2½ feet across and is of great density, having a greater absorbing surface than the roots of either slender wheat grass or brome grass. At the University of Saskatchewan, several square foot columns of soil were excavated on adjacent plots of crested wheat grass and slender wheat grass in a test which had been down for four years. These were taken to a depth of 24 inches, and the grass roots washed free from soil, dried and weighed. It was found that the crested wheat grass possessed over twice as much dry matter, the main root mass extended twice the depth and the system of fibrous roots was much more extensive than in slender wheat grass. The fibrous roots of crested wheat grass were much stronger and lighter in colour than those of slender wheat grass.

The seedlings usually appear above the ground in from 8 to 12 days after planting; at first they are very fine and the leaves are very narrow. After the first 3 weeks the young plants grow much more rapidly and produce more leafage. After about 6 weeks the plants begin to tiller, new stalks arising from the basal nodes. The culms are erect and leafy and under reasonably favourable conditions grow to a height of from 2½ to 3½ feet. The leaves are abundant, of medium width and are slightly darker in colour than those of slender wheat grass. Both stems and leaves retain their green colour until after the seed is ripened. New growth in the spring appears from the base of old stalks and from new buds arising at nodes on underground stems which spread laterally for a short distance before they emerge.

* *Agropyron tenerum* is commonly called "western rye grass" in Canada. The correct name, however, is "slender wheat grass," and this designation has been used consistently throughout the pamphlet.

The spike or head of crested wheat grass is from 2 to 4 inches long, being wide and more or less fan-like or crested, while in slender wheat grass the spikelets lie close to the axis, forming a long slender spike. The seeds look much like those of slender wheat grass but they are much smaller, there being from 250,000 to 300,000 seeds in a pound. The seeds of some plants have rather long awns while those of others are almost awnless. There are about 22 pounds in a measured bushel of seed. The seed usually germinates from 85 to 95 per cent and if properly stored will germinate satisfactorily for four or five years.

Crested wheat grass is remarkably free from diseases such as stem rust and ergot. In this respect it is superior to slender wheat grass.

Figure 1.—Heads of crested wheat grass in bloom.

ADAPTATION

Crested wheat grass is adapted to a wide range of soil types. It has given good results on soils ranging all the way from light sandy loams and silt loams to medium chocolate loams and heavy clay. It appears to do best on medium types of soils that are not lacking in lime and it is somewhat tolerant of alkali. Crested wheat grass is highly resistant to drought and to extremes of temperature and is, therefore, well adapted to climatic conditions prevailing over large

areas of Western Canada. In comparison with other grasses it shows up best where the annual precipitation is between 10 and 18 inches and where the evaporation is excessive, although heavy yields, up to 3 tons per acre, have been obtained under more humid conditions. It has proved to be a valuable grass in southeastern Alberta where the annual precipitation is only slightly over 11 inches and the evaporation from an open tank is about 36 inches for the seven months from April 1 to November 1.

This grass is extremely winter-hardy and has never been known to show frost injury. Since it is a cool climate plant it is able to make a rapid growth very early in the spring while moisture conditions are usually somewhat favourable, and it often produces a good yield of grass before the beginning of the

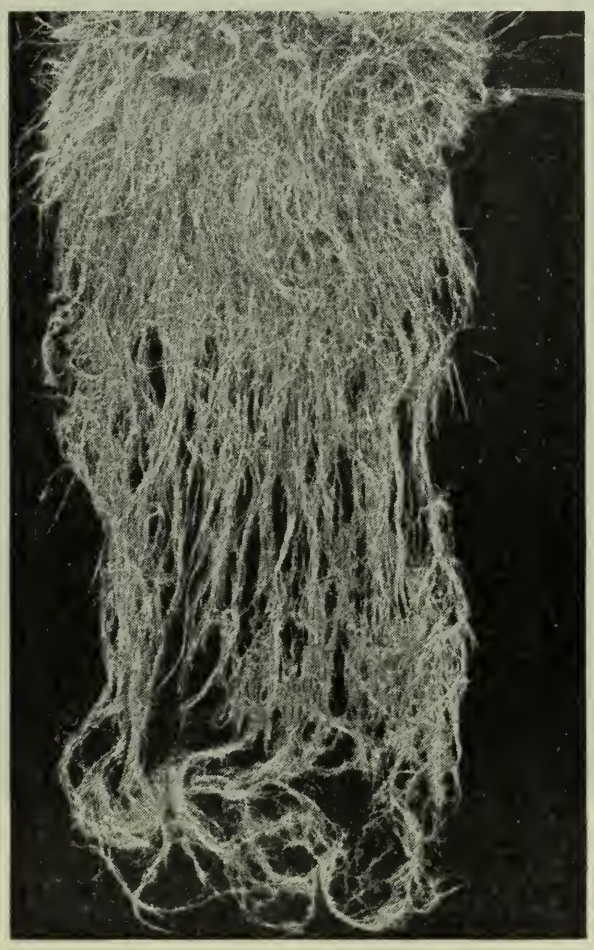

Figure 2.—Root system of crested wheat from a square foot of soil 24 inches deep taken from a drilled plot.

hot, dry periods of late June and July. During the extreme drought and high temperatures that often prevail during midsummer, this hardy grass remains dormant and then starts growth again, furnishing considerable pasture when rains and cooler weather come during the fall months. Crested wheat grass is well adapted for pasturing by virtue of its remarkable ability to withstand close grazing and severe tramping. An abandoned field near the Dominion Range Experiment Station was seeded to this grass and a good stand was obtained. This field was closely grazed from early spring until late fall for five years in succession without apparent injury to the grass cover. The soil on this field was heavily infested with weed seeds, chiefly Russian thistle and mustard, yet the grass took possession to the almost complete exclusion of the weeds. Owing

to the extenive root system, which takes up all the moisture, weeds cannot grow in competition with it. It was found too that weed growth was controlled to a marked extent by crested wheat grass grown in rows spaced 3 feet apart.

On account of its adaptation to dry conditions, its winter hardiness, its ability to withstand close grazing and severe tramping, and its ability to compete successfully with plants of other species, crested wheat grass is a very suitable crop for feed production on the dry land areas of Western Canada.

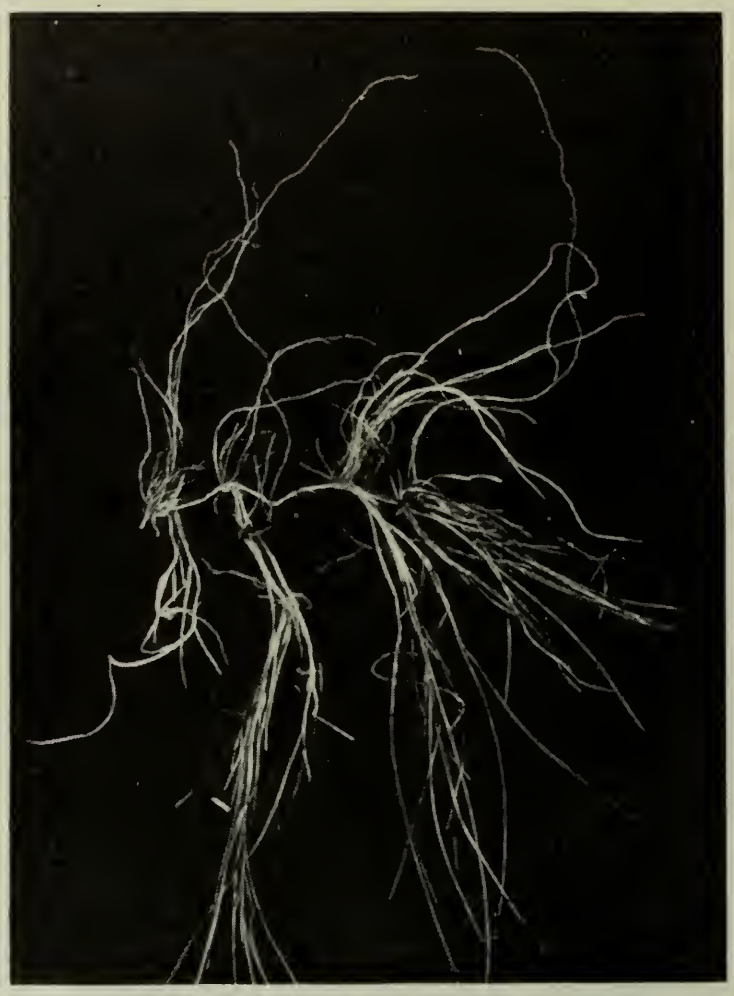

Figure 3.—Underground stem of "Fairway" crested wheat grass showing method of spreading in the field.

COMPARISON WITH OTHER GRASSES

Crested wheat grass is relished by all classes of live stock. Horses are especially fond of it. The fine, green-coloured stems and abundant leafage, make a hay that equals or surpasses all of our other grasses in palatability. Even the straw of crested wheat grass that has been harvested for seed is readily eaten. Crested wheat grass is also very nutritious. At the Dominion Range Experiment Station, samples of the more common grasses are collected each year. Collections are made in various growth stages and on a number of areas having different soil and climatic conditions. These samples are analysed by the Division of Chemistry, Central Experimental Farm, Ottawa. In Table 1 is presented the chemical composition of crested wheat grass and of the principal native range grasses as collected in the leaf stage and also in the flowering or 'hay' stage. In Table 2 is presented the chemical composition of crested wheat grass hay as compared with that of slender wheat grass and brome grass as harvested from experimental plots at the University of Saskatchewan during the years 1927 to 1930 inclusive.

From the data presented in Tables 1 and 2 it is evident that crested wheat grass equals or surpasses slender wheat grass, brome grass and the best of our native grasses in nutritive value. There appears to be considerable uniformity in the chemical composition of the species listed. In one respect at least, crested wheat grass is superior to all the others and that is in its phosphoric acid (P_2O_5) content. This is very important, since our native grasses, in their cured condition, are somewhat deficient in this nutrient.

TABLE 1.—CHEMICAL COMPOSITION OF CRESTED WHEAT GRASS AND OF THE PRINCIPAL NATIVE RANGE GRASSES

Name of grass	Growth stage	Percentage composition of dry matter					
		Crude protein	Carbo-hydrates	Fibre	Total ash	Phos-phorus P_2O_5	Calcium CaO
		p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
Crested wheat grass *(Agropyron cristatum)*..	Leaf.....	18·20	48·18	23·00	10·62	0·701	0·600
Western wheat grass *(Agropyron Smithii)*...	"	17·00	48·09	26·91	8·00	0·500	0·520
Grama grass *(Bouteloua gracilis)*.....	"	15·60	47·63	25·97	10·80	0·477	0·659
Long awned needle grass *(Stipa comata)*....	"	18·16	49·88	23·73	8·23	0·584	0·541
Five principal native grasses*—Average for 4 years.....	"	18·00	48·50	24·30	9·20	0·510	0·570
Crested wheat grass *(Agropyron cristatum)*.	Flowering..	10·31	52·70	29·86	7·13	0·514	0·500
Western wheat grass *(Agropyron Smithii)*...	" ..	9·10	51·86	31·00	8·04	0·333	0·409
Grama grass *(Bouteloua gracilis)*.....	" ..	9·56	51·37	31·35	7·72	0·426	0·461
Long awned needle grass *(Stipa comata)*....	" ..	9·23	51·96	32·62	6·19	0·436	0·410
Five principal native grasses*—Average for 4 years.....	" ..	9·50	51·70	31·80	7·00	0·370	0·430

*June grass *(Koeleria gracilis)* and Meadow grass *(Poa Buckleyana)* are the other two native grasses included in the group of five.

TABLE 2.—CHEMICAL COMPOSITION OF CRESTED WHEAT GRASS, SLENDER WHEAT GRASS AND BROME GRASS HAY. FOUR YEAR AVERAGE 1927-1930 INCLUSIVE.

Name of grass	Percentage composition of dry matter					
	Crude protein	Carbo-hydrates	Crude fat	Crude fibre	Total ash	Ash on fibre
	p.c.	p.c.	p.c.	p.c.	p.c.	p.c.
Crested wheat grass.....	9·73	51·48	2·02	30·04	6·73	0·61
Slender wheat grass.....	9·18	48·11	2·11	34·14	6·46	0·37
Brome grass.....	10·27	51·43	1·66	28·60	8·04	0·43

TABLE 3.—YIELD COMPARISONS OF CRESTED WHEAT GRASS, SLENDER WHEAT GRASS, AND BROME GRASS FOR 1927 TO 1931 INCLUSIVE. SEEDED IN 1926, 1-20 ACRE PLOTS IN DUPLICATE.

Crop	Cured hay per acre					
	1927	1928	1929	1930	1931	Average
	lb.	lb.	lb.	lb.	lb.	lb.
Crested wheat grass.....	3,576	2,627	1,580	734	1,106	1,925
Slender wheat grass.....	3,060	3,186	1,458	482	811	1,799
Brome grass.....	2,103	3,044	1,470	784	1,040	1,689

Experimental tests for yield of hay have been conducted for several years at the University of Saskatchewan. In Table 3 the hay yields of crested wheat grass are given together with those of slender wheat grass and brome grass for a five-year period. The differences in yield are not great, but are sufficient to indicate that crested wheat grass yielded at least equally as well as either of the other two grasses.

In Table 4 are presented yields of hay obtained from two strains of crested wheat grass and three strains of slender wheat grass for the seasons 1928 to 1933 inclusive. On the average for the five-year period crested wheat grass gave higher yields than slender wheat grass, the difference being greatest when

Figure 4.—Upper: Three-year-old plants of (left) crested wheat grass and (right) slender wheat grass at the end of a very dry season. The latter have been killed by drought. Lower: Four-year old plots of crested wheat grass (left) and slender wheat grass (right) showing growth of green herbage on the former one month after growth started in a dry spring.

no nurse crop was used. The seasons 1931 and 1933 were very dry and during these years crested wheat grass greatly outyielded the other variety. Strain No. 1350 outyielded strain No. 997 but the difference was not large. Likewise, the three different strains of slender wheat grass yielded very much alike.

From these tests it would appear that under conditions which existed at Saskatoon, crested wheat grass will yield at least as well as slender wheat grass or brome, and that under conditions of severe drought it will greatly outyield either of the other grasses.

Crested wheat grass is especially valuable as a pasture crop. Since it is a cool climate plant it makes a quick growth very early in the spring, thus providing splendid spring pasture. Its extensive root system enables it to take advantage of occasional light showers of rain. During periods of extreme drought and high temperatures it goes into a dormant stage and as soon as moisture is available it makes a fresh growth. For this reason it often provides good pasturage for the fall months. The young herbage is very palatable and as shown in Table 1 it is also highly nutritious.

TABLE 4.—YIELD COMPARISONS OF TWO STRAINS OF CRESTED WHEAT GRASS AND THREE STRAINS OF SLENDER WHEAT GRASS FOR THE SEASONS OF 1928 TO 1933 INCLUSIVE. (SEEDED JUNE 1928. 1-20 ACRE PLOTS IN TRIPLICATE.)

Grass seeded with nurse crop of wheat	Strain No.	Cured hay per acre (Moisture 15 per cent)							
		1928	1929	1930	1931	1932	1933	Average 1929-1933	Average of strains
		lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Crested wheat grass.....	1,350	*	2,500	2,850	1,393	2,465	1,230	2,088	2,049
Crested wheat grass.....	997	*	2,244	2,988	1,393	2,486	933	2,009	
Slender wheat grass.....	8	*	2,380	2,727	840	2,275	580	1,760	
Slender wheat grass.....	16	*	2,791	2,817	830	2,413	623	1,895	1,843
Slender wheat grass.....	Commercial	*	2,521	2,828	968	2,354	696	1,873	
Seeded without a nurse crop									
Crested wheat grass.....	1,350	† 1,931	5,147	2,667	1,478	1,957	1,140	2,478	2,392
Crested wheat grass.....	997	2,121	5,034	2,036	1,352	2,056	1,049	2,305	
Slender wheat grass.....	8	3,313	4,749	2,027	664	2,191	469	2,020	
Slender wheat grass.....	16	3,056	4,617	2,241	659	2,392	645	2,111	2,030
Slender wheat grass.....	Commercial	2,407	4,262	2,121	614	2,206	598	1,960	

*Nurse crop cut green for feed yielded 8,648 pounds cured hay per acre.
†Fall cutting of grass in year of seeding (not included in averages).

The tendency of crested wheat grass to form a sod, together with its ability to compete successfully with weeds and its tolerance of close grazing and severe trampling, adds greatly to its value as a pasture crop. At the Dominion Range Experiment Station, an area of about 3 acres on an abandoned field was seeded to crested wheat grass in 1928. Here the average annual precipitation is only 11·2 inches and the evaporation rate is extremely high. Horses and cattle had access to this field all summer, from early spring until late in the fall. As the crested wheat made such an early growth, the stock were attracted to this patch early in April, with the result that it was severely tramped and closely grazed. Although this patch has been closely grazed for five years the crested wheat still persists and the stand appears to be as good as ever.

This same experiment also demonstrates the value of crested wheat in the reseeding of abandoned fields. Slender wheat grass, sweet clover and brome were seeded alongside the crested wheat grass at the same time. To-day, there is no sweet clover to be found, only an odd plant of slender wheat grass remains and very little brome grass. This of course is a severe test, and it shows that, when once established, crested wheat is an extremely hardy pasture grass.

Crested wheat is the best grass we have for the reseeding of depleted range lands in semi-arid districts. The United States Forest Service has obtained good results with this grass in reseeding range lands in northern areas, while in Oregon, crested wheat is reported to be giving better results than other grasses

in the reseeding of depleted range pastures. Recently crested wheat grass has been tried in the reseeding of depleted range pastures near Kamloops, B.C., and the results obtained have been very promising.

The ability to produce a good yield of high-quality seed is an important factor in forage crop production. Crested wheat grass is very satisfactory in this respect. Under most circumstances it will produce a greater yield of seed than either brome or slender wheat grass. At the University of Saskatchewan, under very favourable conditions, crested wheat has yielded 900 pounds per acre, while 800 pounds of cleaned seed per acre have been obtained from spaced rows, under slightly less favourable conditions. Five hundred pounds of seed were obtained from one acre of land seeded in 1926 in cultivated rows spaced 3 feet apart. This might be considered a normal yield under favourable conditions. Under average conditions, however, about 300 pounds of clean seed per acre are considered a very fair yield.

Under dry land conditions, rows spaced 3 feet apart will produce more seed per acre than will a close-drilled seeding, and the yield of seed can be increased by cultivating between the rows. At the Range Experiment Station in 1931 only one inch of precipitation was received during the two months of April and May. Under these conditions of extreme drought crested wheat grass seeded in rows 3 feet apart and given one cultivation yielded 300 pounds of seed per acre. On an adjacent plot which had been close-drilled the grass headed out but virtually no seed was produced because the available soil moisture had been exhausted by the time the flowering stage was reached. The yield of seed depends chiefly upon the reserve moisture in the soil and the precipitation received during the months of April and May. For this reason the seed should be sown on clean summer-fallow and, if sown in rows spaced 3 feet apart and given some cultivation, a fair yield of seed can be obtained even in districts receiving very little rainfall.

SEEDING AND CULTIVATION

Crested wheat grass seed should be sown on a well-prepared seed-bed. The soil should be reasonably free from weeds, it should contain some reserve moisture at the time of seeding, and should be as level and as firm as it is practical to get it. Summer-fallow or land that was used for corn or other intertilled crops during the previous year is the best. If stubble land is used it should be ploughed early and then harrowed and packed before the soil dries out.

As a rule it is better to seed crested wheat grass without a nurse crop. If a nurse crop is used the grain should be sown at about half the usual rate of seeding and cut early for green feed: the grain should be sown first at the usual depth, and the grass seed sown immediately afterwards, going over the field crosswise. Where the soil drifts badly it is a good practice to sow the field to wheat or other grain in rows spaced 3 or 4 feet apart and then to sow the grass seed as soon as the grain is 3 or 4 inches in height.

Crested wheat grass seed should be sown as early in the spring as possible. This is an important point which cannot be emphasized too strongly. Spring frosts do not damage the young seedlings but they are easily injured by heat. Although the grass is exceedingly drought resistant when once established, the young plants will often succumb in hot dry weather when they are getting started. For this reason it is not advisable to take a chance on seeding too late. Crested wheat grass must be seeded very shallow, and for this reason also early seeding is necessary while moisture is still present close to the soil surface.

The next best time to sow crested wheat grass is in the fall of the year during the first half of September. Moisture conditions are not always favour-

able at this time but the weather is cooler, and if moisture is present in the soil, the plants will grow readily and come through the winter in excellent condition.

Dates of seeding tests, made every two weeks throughout the season over a period of three years at Saskatoon, Sask., have shown that good stands have been obtained in every month of the year, but seed sown between June 15 and August 15 frequently fails to produce a crop. Successful stands obtained during this time have resulted only when the seed has been sown right after a rain and when the weather has remained comparatively cool for some time afterwards.

The seed should not be sown more than half an inch deep. A field test to determine the effect of different depths of seeding on the stand of crested wheat showed clearly that in both spring and fall seedings best stands were obtained from the half-inch depth of seeding and the stands became relatively poorer as the depth was increased. Placing the seed a little too deep has been responsible for many failures with this crop.

In order to secure additional data on depth of seeding with crested wheat grass an experiment was started in the greenhouse on January 25, 1934. Each depth of seeding was represented by 400 seeds planted in 10-inch pots. This test was more accurate than field tests in that the depth of seeding could be fully controlled as well as moisture and other factors favourable for germination and growth. The soil was mellow and easily penetrated by the young seedlings.

TABLE 5.—DEPTH OF SEEDING CRESTED WHEAT GRASS

Depth of seeding	Date of seeding	Date of emergence	Percentage stand on February 13
¼ inch	January 25	January 30	98
½ "	"	" 30	100
¾ "	"	" 31	86
1 "	"	" 31	60
1½ inches	"	February 3	21
2 "	"	" 6	1
2½ "	"	.....	0
3 "	"	.....	0

Not only did the percentage of plants decrease rapidly at depths greater than one-half inch, but at 1 inch and lower the plants that did emerge were spindly, showed general lack of vigour, and the leaves were yellowish in colour. Seedlings which did not emerge from 2 inches and greater depths were carefully separated from the soil and examination showed that in all cases the plants were about 1½ inches in length. Only two seedlings out of 200 plants measured attained a length of 2 inches, and many of the latter showed a tendency to bend or twist at the tips. At the 2-inch depth of planting most of the seedlings grew to within one-half inch from the soil surface and were unable to go any further. Seedlings from 3 inches in depth grew to within 1½ inches from the surface and stopped.

If the ground is reasonably firm crested wheat grass seed can be sown with an ordinary grain drill seeder. For small plots a garden seeder can be used. In case the seed cannot be sown shallow enough with the grain seeder it should be sown broadcast on the surface and then harrowed in. When the grain seeder is used care must be taken to see that the seed keeps running and does not clog in the cups of the seeder. When grown for seed production it should be sown in rows spaced about 3 feet apart. This can be done by sowing through one spout of the seeder, stopping up the next four or five spouts and sowing through the next, and so on. Some prefer to sow in double rows, as there is then less likelihood of a miss in the row. This of course can be done by sowing through

two adjacent spouts of the seeder and then stopping up the next four or five spouts. If grown for hay or pasture purposes the seed should be sown close-drilled, that is through every spout of the seeder. When sown in rows spaced 3 feet apart, about 3 pounds of seed per acre for single rows or 5 pounds for double rows is sufficient. When sown close-drilled, 15 pounds of good seed per acre is enough. If sown broadcast on the surface and harrowed in, about 20 pounds of seed per acre should be used.

Under semi-arid conditions, as found in parts of southwestern Saskatchewan and southern Alberta, crested wheat grass should not be sown too thickly. Here the rates of seeding given above should be reduced by almost one-third. There is only a limited amount of moisture available and if the stand is too thick this

Figure 5.—Harvesting a crop of crested wheat grass seed.

meagre supply of moisture is soon used up and the grass makes a very short growth, and little or no seed is produced. On the other hand, if the plants are further apart they continue to grow for a longer period of time and make a taller growth, and a bigger yield of hay or seed is obtained. At the Range Experiment Station for the three years 1931 to 1933 inclusive, crested wheat grass grown in rows spaced 2½ feet apart outyielded the close-drilled plots by an average of 824 pounds of hay per acre.

When close-drilled or sown broadcast crested wheat grass will control weed growth. There may be considerable weeds during the first year before the grass becomes established. These weeds may be clipped high with a mower before they go to seed. Early the next spring, the weeds should be raked up, hauled off the field and burned. When grown in rows spaced 3 feet apart the grass will control the weed growth fairly well after the first two years, but higher yields can be obtained by cultivating between the rows two or three times each season.

HARVESTING, THRESHING, AND CLEANING OF SEED

When harvested for hay, crested wheat grass should be cut with a mower as soon as it is fully headed. Since the grass cures readily, it should be raked soon after it is cut. After lying in the windrow for a short time it is ready to be stacked. When harvested for seed it should be cut with a binder

when the heads are mostly brown but still showing a slight greenish coloration. At this time the seeds will be full and solid but not hard and brittle. They should buckle rather than break when pressed endwise between the thumb and forefinger. Since the seeds shatter readily, if the weather is dry and hot, it is better to cut only during the forenoon while the grass contains more or less moisture. When sown in rows there is a tendency for the first crop to fall over and lie somewhat flat as it approaches maturity. In this case it is advisable to use the special, long guards on the binder, arranged in such a way that one of them runs along either side of each row. If this is done practically all the heads will be picked up. The sheaves should be placed in long narrow stooks running north and south. If the weather is warm and dry the crop will be ready for threshing about ten days after being cut.

Since the seeds shatter readily, small amounts may be threshed with a flail. For larger amounts a threshing machine should be used. Sheaves should be hauled to the machine in a rack having a tight bottom. The machine should be adjusted as follows:—

1. Remove all teeth from the concaves. The cylinder will thresh out the seed easily without the aid of concave teeth if the crop is in good condition for threshing. Extra teeth will serve only to break up the straw which then tends to form a dense mat over the straw racks and thus to prevent the seeds, which are comparatively light, from being separated from the straw. Such a condition causes much of the seed to go over with the straw and results in serious loss.

2. Reduce the speed of the cylinder if the straw is being broken too finely.

3. If one row of concave teeth is found necessary they should be placed well forward and grates, if available, should be used for the blank concaves.

4. Adjust the air blast to begin with by closing the top sections of the air inlets to the fan. Then adjust the lower part of the air inlets until the blast is sufficient to raise the chaff from the chaffer but not strong enough to carry the light seed over.

5. The adjustable chaffer should be left open enough to permit air to pass freely but not enough to let the straw and chaff pass through it.

6. The adjustable screen should be set so that the chaff will be lifted without carrying the seeds far back over its surface.

7. The weed opening in the bottom of the shoe should be closed.

Except for the separation of certain weed seeds, such as wild mustard, French weed, quack grass, etc., the seed of crested wheat grass can be easily cleaned with the ordinary fanning mill, provided the necessary sieves are available. The following is a list of sieves which have given satisfactory results in cleaning crested wheat grass seed:—

Top Sieve or "Riddle"	"Fairway" strain	Commercial seed
Zinc, oblong openings	3 /64" by ¼"	4 /64" by ½"
" "	3 /64" by ½"	4½/64" by ½" (or ¼" x ¼")
" "	3½/64" by ¼" (or 1/18" x ¼")	5 /64" by ¼"
" "	4 /64" by ¼"	
Bottom Sieve or "Screen"		
Zinc, circular openings	2½/64" (or 1/24")	3 /64" (or 1/22")
" "	3 /64" (or 1/22")	3½/64" (or 1/18")
Wire	2 by 18	2½ by 16
"	3 by 18	3 by 16

NOTE.—The size of mesh in the wire screens is indicated by giving the number of wires per inch in both directions.

Wire screens are not recommended for use in cleaning crested wheat grass seed but are listed here in case the proper sizes in zinc sieves are not available. The wire sieve blocks up readily with seed and refuse and requires a great deal of time and labour to keep it clean.

All zinc sieves are quoted in sixty-fourths of an inch. Sieves are all listed in this way at the present time. Formerly odd fractions such as one-eighteenth inch or one-fourteenth inch were used and in some cases these have been indicated here as equivalent to certain sizes listed in sixty-fourths. If growers have these sizes on hand they will be quite satisfactory.

Figure 6.—Seeds of slender wheat grass (left) and "Fairway" crested wheat grass (right). Twice normal size.

A range in sizes of sieves and screens has been listed. This is necessary because the seed varies in size from season to season, and it is also necessary to use different sieves for removing different materials from the seeds.

It will be noted that a separate set of sieves has been listed for Fairway and for commercial strains. This is necessitated by the different sizes of seed. The Fairway strain produces very much smaller seed than do the commercial sorts.

The following results on experiments to determine the number of seeds per pound in these strains, as compared with western rye grass, will serve to illustrate this fact. (Five samples of one gram each were counted and averaged for each variety.)

Strain or variety	Number of seeds per pound
Western rye grass (Mecca No. S1)	184,671
Crested wheat grass (Commercial)	229,368
" " (Forage No. S11)	255,724
" " (Fairway No. S10)	452,443

The seed samples from which these counts were made were all grown in 1933 under similar conditions.

It is not possible to remove certain weed seeds, such as those listed above, from crested wheat grass seeds with the ordinary fanning mill. It has been found that the indent disk type of machine will remove all such material which is considerably shorter than the crested wheat grass seeds and also material such as bits of straw which are considerably longer than the grass seeds.

VARIETIES OR STRAINS

The individual plants of crested wheat grass are extremely variable. They differ widely in height, shape of head, character of awns, size of seed, number of seed-bearing shoots, habit of root growth, and in many other respects. This lack of uniformity is easily understood in view of the fact that this grass is highly cross-pollinated. Experiments have shown that only a small proportion of the plants produce a little selfed seed when the heads are enclosed in bags of various kinds or when the entire plant is covered with a cotton cage. The latter method has been most successful.

Two strains have been developed at the University of Saskatchewan. One of these, called "Fairway" (S-10), has proved to be a superior variety for hay and pasture, and as a grass for farm lawns under dry conditions where water cannot be applied artificially. The other strain is the product of a single plant selection. Recent tests have shown the majority of plant types in this strain (S-11) to be less desirable than the shorter but leafier and more spreading plant types which are characteristic of the "Fairway" variety. The plants are much more tufted in habit of growth, less leafy, and also less productive.

Although the variety "Fairway" is extremely variable, the plants are uniformly a little shorter and more leafy than those grown from commercial seed or than the numerous introductions that have been under observation. The heads are typically short and broad. The plants are not tufted but rather spreading in habit of growth. In other words they have a natural tendency to spread by means of short underground stems and thus to form a good turf free from tuftedness. This characteristic is considered of great value for pasture and lawn purposes. The seed which carries a short slender awn is relatively small.

Table 6 gives the result of a carefully planned test of crested wheat grass strains at the Dominion Forage Crops Laboratory, Saskatoon, Sask. Slender wheat grass was included also for comparison:—

TABLE 6.—COMPARISON OF YIELDS OF THREE STRAINS OF CRESTED WHEAT GRASS AND SLENDER WHEAT GRASS AT SASKATOON, SASK.*

Species	Strain	Hay yields—lbs. per acre					
		1932	1933	1934	1935	1936	Avge. 1932-36
Crested wheat	Fairway	1,290	3,204	1,964	3,042	1,226	2,142
"	S-11	955	2,513	2,0[illegible]0	2,994	1,303	1,957
"	Commercial	1,394	2,852	2,047	3,320	1,564	2,235
Slender wheat	Mecca	1,392	2,340	1,650	2,364	773	1,704

*Seeded in the spring of 1932.

The yields reported in Table 6 are for 5 years of below-average precipitation. The Fairway and commercial strains of crested wheat grass are not significantly different in yield over the 5-year period. Both have yielded more hay per acre than strain S-11 and slender wheat grass. The plots of Fairway have shown a definite tendency to increase the density of the turf as the stand becomes older. The grass on these plots has consequently been comparatively short in growth, but the greater density has resulted in relatively high yields of fine, leafy, high-quality hay. This same tendency has been noted also, but to a lesser extent, in the plots of commercial crested wheat grass. No such tendency has been noted in the plots of S-11. These plants are still relatively tall growing, coarse and sparsely leaved. The slender wheat grass has been killed out to a large extent, and there is at present not more than 40 per cent of the original stand on these plots.

The following quotation is taken from a bulletin prepared by the senior author (2) in 1931: "The only really distinctive strain which we have observed

so far is the mass selected variety mentioned above (Fairway) which consists of a high percentage of fine leafy types. In this respect it is quite outstanding, so much so that its possibilities for farm lawns, golf course fairways, and town boulevards are being investigated. The characteristics of this strain, however, do not detract from its value as a hay and pasture crop. It is a question whether any other strain will excel the finer variety in yield of forage." Subsequent studies since this was published have fully justified these statements.

Figure 7.—Original experimental lawn of crested wheat grass. This has never been watered and it has been close clipped since 1930.

Figure 8.—Experimental crested wheat grass lawns.

CRESTED WHEAT AS A LAWN GRASS

Crested wheat grass was tested for the first time as a turf grass in 1930 at the University of Saskatchewan. Its use for this purpose was suggested by the fact that a satisfactory grass for farm lawns was not available to the farmer living in the drier sections of the Prairie Provinces. Crested wheat grass seemed

to offer possibilities for this purpose because of its great drought resistance, ability to control weeds, and tolerance of close clipping. Further encouragement was given to try the experiment by having a strain with fine leafy stems and practically free from the tufted habit of growth. This original lawn has been close clipped with a lawn mower during four successive seasons. At time of writing the stand is as good as ever with no evidence of thinning. Weeds have never been able to invade the lawn and it has always presented an attractive appearance except in hot dry weather. It is the first patch of green to appear in the spring and the last to disappear in the fall. The lawn has never been watered even in the driest periods.

Since the first lawn was established a considerable number of experimental lawns have been laid down. Tests have been made on the effect of seeding at different times throughout the season and on cutting at different stages of growth. Early spring and fall seeding have been best. Stage of clipping seems to make very little difference. The grass will tolerate close clipping, or less frequent cuttings may be made without materially affecting the lawn. The seed should be broadcast evenly on a very well prepared seed-bed and plenty of seed should be used. Best results have been obtained by sowing 1 pound of seed per square rod.

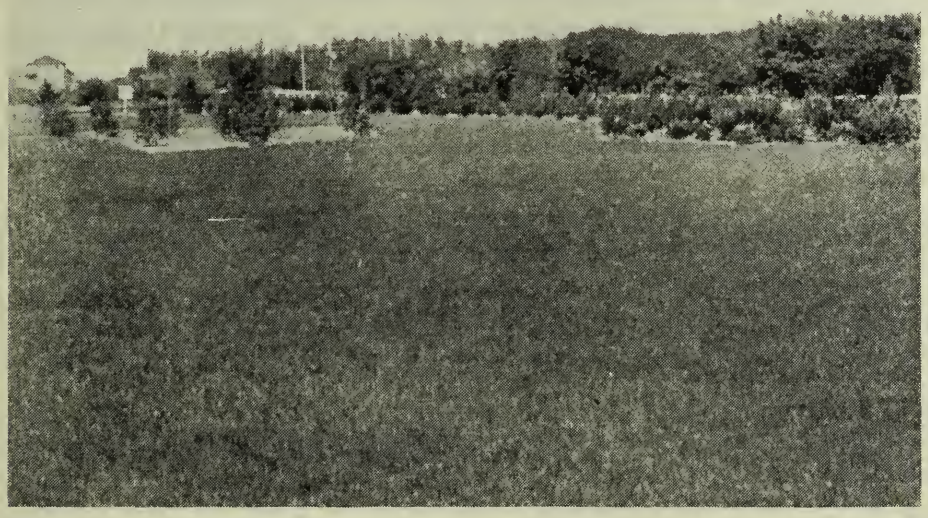

Figure 9.—Crested wheat grass lawn at the University of Saskatchewan. This lawn is three years old and it has survived in excellent condition without watering during the most severe periods of drought ever experienced.

The grass has also been tested on city and farm lawns, and it has never failed to give satisfaction. It is not recommended, however, for locations which receive sufficient precipitation to grow Kentucky blue grass or Chewing's fescue, or for city lawns where artificial watering is possible. This is not to say that crested wheat grass does not respond to watering. As a matter of fact it has given very good satisfaction on city lawns which have been watered regularly. But under such conditions there are other grasses which will produce a finer turf and more pleasing appearance. Crested wheat grass, on the other hand, will stand more rough usage and neglect.

It is on the farms in the drier sections of the country, however, that crested wheat grass is most valuable as a lawn grass because it has no competitor and

because it will stand hard treatment and endure long periods of drought without injury. These characteristics make it suitable also for use on golf course fairways, rural school grounds, and town boulevards where watering is not feasible.

It must not be expected that crested wheat grass will present the fine appearance and finish of a well-watered Kentucky blue grass or Chewing's fescue lawn. During hot dry weather it will turn brown and cease to grow. With the return of moisture, however, it will very quickly become green again. The appearance in spring and fall months is very pleasing and it has never been known to suffer injury from drought or winter temperatures.

Crested wheat grass is being tested also in Eastern Canada as a turf grass, but preliminary experiments have not been promising. It seems to be peculiarly adapted to the drier sections of the western plains area just as blue grass is highly adapted to Ontario and Quebec and bent grasses to the Maritime Provinces.

SEED SUPPLY

Up to the present time the production of crested wheat grass seed in Western Canada has not been sufficient to meet the market demands. Prior to 1936 the bulk of the seed produced was purchased for seeding in Canada. Considerable quantities of seed from the 1936 crop were exported and much more could have been marketed, had it been available.

The abnormally dry conditions which have prevailed throughout the central west plains area of this continent for the past several years have created a heavy demand for the seed of this hardy, drought-resistant species for use in regrassing work in the drier areas and have caused the price of the seed to be maintaind at a high level.

The Canadian demand is largely for seed of the Fairway variety, although seed of the taller growing, coarser and more sparsely leaved types has been sown to some extent.

While crested wheat grass is remarkably drought-resistant, the higher seed yields are obtained where moisture conditions are more favourable; hence the more northerly sections of the Canadian prairie are well adapted to seed production of this crop. Not only are the seed yields higher in the more northern areas, but the plants grow taller and are more easily harvested and the seed is heavier and of excellent quality.

The estimated production of crested wheat grass seed in Western Canada is given below for each of the years indicated.

Year	Pounds
1933	60,000
1934	200,000
1935	400,000
1936	550,000

It has been estimated that more than 85 per cent of the crested wheat grass seed produced in Western Canada in 1936 was of the Fairway variety.

SUMMARY

1. Crested wheat grass is highly adapted to the soil and climatic conditions in Western Canada, especially to the short grass plains area. It is especially suited to semi-arid conditions and will endure long periods of drought without injury. It has never been known to suffer from low temperatures, and thrives on a fairly wide range of soil types.

2. Crested wheat grass is a cool climate crop. Growth begins very early in the spring and the grass thrives best during the cool weather of spring and fall months. Hot weather retards growth, but if moisture is available, the herbage will remain green throughout the season.

3. The root system of crested wheat grass is strongly developed and well adapted to the utilization of small amounts of precipitation. The dry weight of root fibre is more than double that of slender wheat grass (*Agropyron tenerum*) and the main root mass extends to twice the depth. In its natural habitat, no other grass or legume is nearly as efficient in controlling weeds.

4. The palatability and chemical composition of crested wheat grass compares favourably with either brome grass or slender wheat grass both as hay and pasture. The average yield of hay at Saskatoon, Sask., is about the same as for slender wheat grass but it outyields the latter in dry seasons and is much longer lived. It stands up well under close grazing and provides pasture at both ends of the season when it is most needed.

5. Crested wheat excels all other grasses for reseeding abandoned fields in the drier parts of Saskatchewan and Alberta. At the Dominion Range Experiment Station, Manyberries, Alberta, it has given excellent results, being the only kind of grass that has proved satisfactory for this purpose.

6. Crested wheat grass is an excellent seed producer. The yields vary from 100 to 800 pounds per acre, depending chiefly on the supply of available moisture. The seed is easily harvested and threshed with ordinary farm equipment.

7. Seeding should be done only on well-prepared firm soil. Best results are obtained by sowing without a nurse crop, especially in the drier areas. Very early and very shallow seeding are of first importance. About 15 pounds of seed per acre is sufficient and somewhat less than this gives better results under semi-arid conditions.

8. For seed production crested wheat grass should be sown in rows 3 feet apart at 2 or 3 pounds of seed per acre. The rows should be cultivated for the first two seasons at least to control weeds, after which weeds cannot thrive between the rows. A good field will remain productive for several years.

9. Experiments have shown that crested wheat grass makes a very satisfactory turf grass for farm lawns, golf course fairways, town boulevards, rural school grounds, and other places where it is not possible to apply water artificially. The Fairway variety is especially desirable for this purpose.

ACKNOWLEDGMENTS

The results of experiments with crested wheat grass, conducted at the University of Saskatchewan by the senior author previous to September, 1931, and published as Agricultural Extension Bulletin No. 54, have been freely used in the preparation of this bulletin. Since that time the work has been carried forward by Mr. T. M. Stevenson, Agrostologist Specialist, in charge of the Dominion Forage Crops Laboratory located at the university, and in co-operation with the Field Husbandry Department of the College of Agriculture. The observations and data on the value of crested wheat grass under range conditions in southern Alberta are based on experimental work by Dr. S. E. Clarke, Agrostologist, who is in charge of forage crop work at the Dominion Range Experiment Station, Manyberries, Alberta.

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