

Introduction and Early Use of Crested Wheatgrass in the Northern Great Plains

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ABSTRACT: The first introductions of crested wheatgrass [*Agropyron cristatum* (L.) Gaertn., *A. desertorum* (Fisch.) Schult., and related taxa] to North America were made by N. E. Hansen in 1898. Additional introduction, intensive early testing and distribution took place primarily in the northern Great Plains of United States and Canada by individuals who recognized the potential of crested wheatgrass for use in this arid and semi-arid climate. The drought years of the 1930's prompted widespread use of this new grass. Government programs in the United States and Canada provided impetus to seeding large acreages to stabilize the land and the economy. Much of these seeded lands remain productive today. Crested wheatgrass has been and will probably continue to be one of the most important forage grasses for the northern Great Plains of the United States and of the Prairie Provinces of Canada.

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INTRODUCTION

The impact of World War I and of disastrous drought on a newly settled area caused tremendous social and political problems in the northern Great Plains of North America early in the 20th century. Much has been written about a strong people who

implemented recovery from what seemed at the time to be a hopeless situation, and about government programs that helped restore the dignity of a people while renewing and preserving the soil, water, and grassland resources.

Some of the major components for making this recovery successful have received less specific attention. Among these was crested wheatgrass. Crested wheatgrass, like the settlers of the plains, was an immigrant. In the beginning, only a small group of dedicated, observant scientists and technicians recognized the great potential crested wheatgrass held for use in the northern Great Plains of United States and Canada. Those individuals saw the potential before the great need arose, so when the problems became greatest, a relatively short time was required to increase, distribute and plant crested wheatgrass on millions of acres of dry, wind blown soil. For much of the land seeded to crested wheatgrass from the late 1920's to the present time, the seeding has become a permanent repair job. I dedicate this historical presentation to those pioneer forage workers and producers who recognized the potential and promoted the use of crested wheatgrass in the northern Great Plains.

SETTLEMENT OF THE NORTHERN GREAT PLAINS

One cannot embark on a history of crested wheatgrass in the northern Great Plains without becoming involved in history of settlement of new lands, demands for wheat production during WWI, rapidly expanding cropland acreage, eventual wheat surpluses, depression, drought and government farm programs. By turns, prosperity and depression, shortage and surplus, success and failure, were encountered by agriculture on both sides of the United States/Canadian border early in this century.

Early history of the agricultural settlement of western Canada included the Selkirk Settlements in Manitoba beginning with the large grant of land to the Fifth Earl of Selkirk in 1811. The slow western movement of these agricultural peoples for the next 60 years was then accelerated by invention of the steel mouldboard plow, barbed wire and the introduction of awnless brome grass (*Bromus inermis*).

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In 1879, the last buffalo herd was driven into Montana by prairie fires in Canada. Indians in Canada then hunted the antelope and other grazers to near extinction. During the early 1880's, grass was lightly grazed for a number of years. Good growing conditions and prairie fires contributed to production of a grass cover the likes of which had never before been seen. This situation was short-lived due to the rapid influx of settlers and livestock. An indication of a changing situation appeared in the 1889 annual report from Brandon, Manitoba. S. A. Bedford, the first superintendent of that station wrote:

"Because native hay meadows are becoming exhausted, considerable attention is being paid to experiments with grasses and fodder plants" (Heinrichs 1969).

At this time there was also an influx of cattlemen from United States into southern Saskatchewan and Alberta. By 1919-20, the range was fully stocked. Soon farmers and ranchers were trying to occupy the same area. Much of the land plowed was extremely marginal for cereal crop production. Good growing conditions in the early part of the twentieth century allowed for prosperity. However, the boom was soon to "bust" with the onset of the 10-year drought from 1928 to 1937 in which 7 of the 10 years were below the long-time average precipitation. The drought was accompanied by severe soil drifting, heavy insect infestations, acute shortages of feed for livestock, serious depletion of herds, and other calamities usually associated with severe climatic cycles. Soon there were more than 4 million acres (1.6 million hectares) of abandoned farm lands plus many millions more on which the owners could not survive unless action was taken to help them stabilize the soil and their economy. This acreage (hectarage) included marginal cropland as well as millions of acres (hectares) of severely overgrazed grassland.

Kilcher (1969) described the situation for Canada, but it can be applied equally well to the northern Plains of the United States:

"During the first two decades of this century, very little, if any, attention was devoted to considerations of cultivated forage crops in western Canada. Indeed there was little reason for consideration, since untapped virgin land and the limited livestock population had not yet created a demand for controlled fodder production. The coincidental occurrence of drought, land devastation, and economic depression in the thirties resulted in a rather sudden increased awareness that, among other things, the need for grass and forage crops may have been a costly oversight. These then were the first real set of factors which turned man's attention to forage crop establishment and production in western Canada. Admirable credit must be given to that small handful of dedicated scientist and producer innovators who accomplished a monumental task of reseeding and stabilizing vast areas of eroded land. Their accomplishments were even more astounding when one considers the limited crop choice, the lack of refinement in available equipment, and the limitation of power commensurate with that time. Much of their seeding was done in late fall and early winter or on frozen ground which allowed

shallow seeding. The principle grass used was crested wheatgrass, a species which to this day is the king of tolerance to adversities to establishment."

Dillman (1946) discussed the same situation from the United States side of the border:

"The demand for wheat before and during the First World War brought about a marked change in agriculture of the great plains. Several million acres of native grasslands in the Northern Great Plains area of the United States and Canada were broken up and seeded to wheat during the period of 1905 to 1920. There appeared to be no need for a new dryland grass at that time. Finally the dry years of the middle thirties came on and abandoned wheat lands were in urgent need of grass. One could hardly have foreseen the heroic role that crested wheatgrass was to play in this living drama of the dry plains. It was the only grass available that would adequately fulfill this role. Already it's hardiness, productiveness, and longevity had been proved by experiments of the U. S. Department of Agriculture and state agricultural experiment stations."

EARLY DEVELOPMENT OF CRESTED WHEATGRASS IN UNITED STATES AND CANADA

A. C. Dillman (Fig. 1) presented the early history and documented the Seed and Plant Introduction (SPI) numbers of the first introductions of crested wheatgrass [*Agropyron cristatum* (L.) Gaertn., *A. desertorum* (Fisch.) Schult., and related taxa] into the United States (Dillman 1946). I have drawn heavily from these earlier papers and other sources in an attempt to place in one document the pre-1942 history of crested wheatgrass in the northern Great Plains, including the Prairie Provinces of Canada. Most of the post-1942 history is well documented in the



Figure 1.--A.C. Dillman in the 1915 planting of S.P.I. 19538 at Mandan. July 16, 1945.

literature and is at least partially summarized in other papers of this symposium.

United States

The first known introduction of crested wheatgrass into North America was made in 1898 by N. E. Hansen of the South Dakota Agricultural Experiment Station as a result of a plant exploration trip to Russia and Siberia for the U. S. Department of Agriculture (USDA). He observed crested wheatgrass under test at the Valuiki Experiment Station on the Volga River about 150 miles (240 kilometers) north of what is now Volgograd. He obtained a small amount of seed of five accessions, S.P.I. Nos. 835, 837, 838, 1010 and 1012. In 1899, he distributed original seed of one or more of these accessions to one recipient each at experiment stations in Alabama, Indiana, Michigan, Colorado, and Washington. No record has been found as to whether or not the seed was planted at those stations. Hansen apparently supplied seed for a planting at Highmore, South Dakota because Dillman (1946) reported that Johnston T. Sarvis (Fig. 2), then Instructor of Botany, South Dakota State College, saw crested wheatgrass growing in W. A. Wheeler's forage crop nurseries at Highmore in 1906. The Highmore station was placed under new management in 1908 and the grass nurseries were plowed. There is no record of any further distribution of seeds from Hansen's first introduction.

Westover et al. (1932) reported:

"Small samples of seed (crested wheatgrass) received from Sweden in 1905 and from the Royal



Figure 2.--J. T. Sarvis in the 1915 planting of S.P.I. 19538 at Mandan. June 27, 1941.

Botanical Gardens, Dublin, Ireland, were sown at the Arlington Experiment Farm, Rosslyn, Virginia in 1906, but failed to germinate".

No other record of this material has been found.

A second importation of crested wheatgrass by Hansen came from the same source as his original collection, and was sent in 1906 through the Moscow Botanical Gardens by Vasili S. Bogdan, Director of the Kostichev Agricultural Experiment Station, Valuiki, Samara Government, Russia. The shipment contained five lots labeled *Agropyron desertorum* (Fisch.) Schult. (S.P.I. Nos. 19537 through 19541, inclusive) and one lot labeled *Agropyron cristatum* (L.) Gaertn. (S.P.I. No. 19536). Seed of one or more of these four to five pound (1.8 to 2.3 kilogram) lots was distributed to 15 experiment stations from 1907 to 1913.

Early tests.--Dillman (1946) presented a brief account of the early tests of crested wheatgrass at the 15 experiment stations that received seed from Hansen's second importation:

"Crested wheatgrass did not prove to be adapted to conditions at Arlington Farm, Virginia, nor at Chico, California, as noted by R. A. Oakley and Roland McKee, respectively, from plantings made in 1907. The seed sent to W. H. Olin, Fort Collins, Colorado, in 1907 was not planted, as no suitable land was available at the time. According to Professor Alvin Kezer, the first work with crested wheatgrass at Fort Collins was begun about 1925. No records are available as to what happened to the seed supplied T. H. Kearney in 1909; or the seed sent to R. E. Bradley, Lincoln, Nebraska, in 1911; to H. J. Webber, Ithaca, New York, in 1912; or to Samuel Garver, Highmore, South Dakota, in 1913. The planting at Chillicothe, Texas, in 1912 failed to germinate; and 'no stand was obtained' at Burns, Oregon, in 1913. This accounts for about one-half of the distribution of S.P.I. Nos. 19536 to 19541."

Six lots of seed of one pound (0.45 kilograms) each of Nos. 19536 through 19541, were sent to Akron, Colo. in 1909, but the planting plans for Akron did not include crested wheatgrass that year and there is no record that the planting was made. Dillman (1946) wrote:

"In 1910, W. G. Shelley planted two rows of crested wheatgrass, Nos. 19540 and 19541. In 1911, G. E. Thompson, then in charge of the forage crop work at Akron, reported that these grasses appeared to be promising. He noted, however, that new plantings made in 1911, including S.P.I. Nos. 19536 and 19538 and forage crops Nos. 956-962, 'failed to germinate'. These F.C. numbers were single plant selections of *A. cristatum* obtained by N. E. Hansen from Professor R. W. Williams, Imperial Agricultural College, Moscow. So far as known, no increase or distribution of crested wheatgrass was made from these early experimental tests at the Akron Station."

Some locations had more success in planting seed supplied by Hansen. Rather extensive plantings were made in 1907 by M. W. Evans, Division of Forage Crops and Diseases, USDA, at Pullman, Washington,

from several of the S.P.I. numbers included in Hansen's second importation. The original plots were plowed in November of 1908. Other plantings were made and continued until 1910 when M. W. Evans was transferred to another location. Plantings were made at Union, Oregon by Robert Withycombe in 1907 and plants were used in an exhibit in 1911 and in 1913, but there is no record of any increase or distribution of seed from Union. Plantings were made in 1913 at Moro, Oregon. Apparently there was considerable seed distributed from Moro, and definite enthusiasm over the success of the plantings. Dillman (1946) wrote:

"A grass nursery of several species was planted in single 8-rod rows at Moro, May 2, 1913, but only two species germinated. These were A. cristatum, S.P.I. 19540 (A. desertorum or 'Standard' type) and A. imbricatum (Bieb.) R. et S., S.P.I. 24467 (from Manchuria). In his report for 1914, D. E. Stephens, Superintendent, wrote: 'The row of A. cristatum planted in 1913 seeded abundantly, but the row was not harvested until the seed had shattered badly. After autumn rains, the shattered seed germinated and a thick stand of grass was obtained for a distance of 6 feet from the row. This variety which seems to seed freely and spread readily from seed may prove to be of some use as a pasture grass.' In 1916, 15 pounds of seed were harvested from this plot; about 290 pounds per acre. This plot, enlarged by later plantings, is still maintained in production according to M. M. Oveson, the present superintendent of the Moro Station."

Jackman et al. (1936) reported on the research at Moro and Union, Oregon:

"In both the station and field trials, it was apparent at once that crested wheatgrass was an outstanding dry-land grass. In all of the real dry locations other grasses usually died quickly, but wherever stands were obtained the crested wheatgrass survived".

By 1936, there were 3,000 acres (1215 hectares) of crested wheatgrass in small trial plots in eastern Oregon. Jackman et al. continued:

"Cool weather suits it best, and it shows the most promise at elevations above 2,500 feet. So far as the writers know, there are no cases of death of crested wheatgrass plants due to cold. In one high valley where 50 below zero occurred twice during the life of a planting, a stand of crested wheatgrass has taken it and liked it."

Dillman (1946) described the early plantings of crested wheatgrass at Moccasin, Montana:

"The first planting of crested wheatgrass at Moccasin, Montana, was made in 1915 by Leroy Moomaw. This included S.P.I. Nos. 19536, 19537, and 19540. There is some uncertainty as to the source of the seed. In his annual report for 1915, Moomaw noted the source of seed as "Akron, Colo., 1909". It is possible that seed used at Moccasin was a part of the original seed sent to Akron in 1909. These were one-pound lots of Nos. 19536-19541, inclusive. It is quite certain that the seed was not planted at Akron, and it may have been sent on to Moccasin, with

the original address tags stamped 'Akron, 1909'. It is more likely, however, that the seed was grown at the Belle Fourche Station. In the planting plans for 1915 at the Judith Basin Station, Moccasin, prepared by H. N. Vinall, Division of Forage Crops, the following grasses were included: S.P.I. 19536 A. cristatum (D.R. No. 67); S.P.I. 19537 A. desertorum (D.R. No. 68); S.P.I. 19540 A. desertorum (D.R. No. 72); and S.P.I. 25348 A. elongatum (D.R. No. 71)."

The D.R. numbers are Dillman's accession numbers for seed grown at the Belle Fourche Station in 1909 or later. The probability that the seed came from the Belle Fourche Station is substantiated by the fact that the planting at Moccasin included S.P.I. 25348 (D.R. No. 71) which was grown in the Belle Fourche nursery from 1910 to 1915. Cooperative work between Moccasin and Havre, Montana involved plantings at Havre beginning in 1917, but there were no stands established until 1920.

S.P.I. No. 19537 was chosen as the standard for Montana and at that time it was the only crested wheatgrass registered by the Montana Seed Growers Association. Reitz et al. (1936) described it as being tall and vigorous with rather long slender spikes. Twenty-four types of crested wheatgrass were selected from the material growing at Moccasin in 1923, but none were released as commercial varieties.

Although Hansen's second importation of crested wheatgrass was tested in several states, the greatest enthusiasm for its potential use in the United States occurred among scientists at stations in the northern Great Plains, in particular North and South Dakota. During the early years following the second importation by Hansen, plantings made at the Belle Fourche Experiment Station, Newell, South Dakota, the Northern Great Plains Field Station, Mandan, North Dakota, and the Dickinson Substation, Dickinson, North Dakota, were the basis for establishment of seed-increase fields in the northern Great Plains.

The first planting of crested wheatgrass at the Belle Fourche Station (Fig. 3) was made in May of 1908 and included S.P.I. No. 19536 (A. cristatum) and S.P.I. Nos. 19537-19541 (A. desertorum). Another planting was made from the same seed supply in 1909 (Dillman 1910). In 1910 a planting was made using a mixture of seed harvested from the 1909 planting of Nos. 19539 and 19540. In 1913, two 8-rod (40-meter) rows each of five of the original entries from seed produced from the earlier plantings were established. No. 19539 was omitted from the 1913 planting. In 1915, two 8-rod (40 meter) rows each of S.P.I. Nos. 19537 through 19541 were planted. Dillman (1946) reported:

"In 1909 the following notes were recorded: 'The grass nursery, planted in 1908, was continued this season. S.P.I. Nos. 19536-19541, inclusive, came through the winter without any winterkilling, and were very early in beginning growth in the spring. This characteristic might make this species valuable as a pasture grass if it should prove to be valuable otherwise. There has been no effective test of drought resistance so far'. From 10 to 40 pounds of seed were harvested at

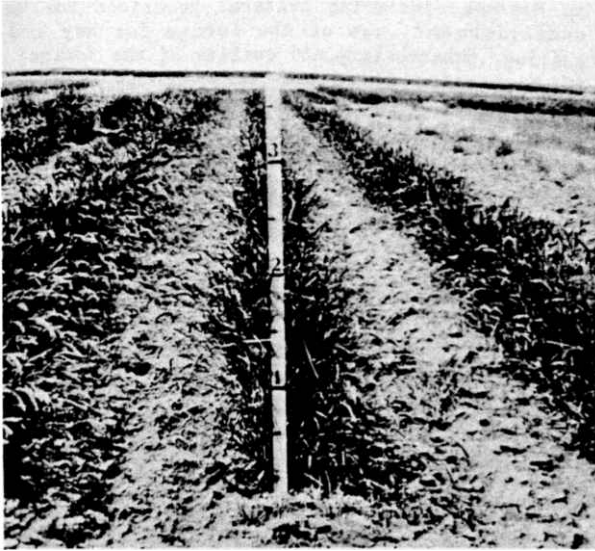


Figure 3.--First known picture of crested wheatgrass grown in North America. Taken at the Belle Fourche Experiment Station, Newell, South Dakota, July 22, 1909. Rows planted in May of 1908. Left to right, S.P.I. Nos. 19541, 19539, 19537.

the Belle Fourche Station each year during the period 1909 to 1918. At that time there was little or no demand for the seed except for experimental plantings. Seed of each S.P.I. number (19536 to 19541, inclusive) was forwarded to the Division of Forage Crops as early as 1910 or 1912. Seed was supplied for planting a nursery of about 1/10-acre at the Ardmore (South Dakota) Field Station in 1913, and for two 1/10-acre drilled plots in 1916. In 1915, seed of S.P.I. 19538 was supplied for planting 1/10-acre in rows at the Northern Great Plains Field Station, Mandan, North Dakota, and in 1918, two lots of 27 and 19 pounds were supplied for field plantings at Mandan. These larger lots were composites of S.P.I. Nos. 19537-19541, inclusive. From his first observation of the mature plants in 1909, the writer considered these numbers similar or identical strains of the A. desertorum type and distinct from S.P.I. 19536, A. cristatum."

The beginning of a forage research program at the new U.S. Northern Great Plains Field Station, Mandan, North Dakota, in 1915 provided an opportunity for another testing location for crested wheatgrass (Fig. 4). The above quotation from Dillman (1946) documented the first plantings at Mandan. The 1915 planting of S.P.I. 19538 has remained productive to the present time, and the long-term plan is to maintain these rows as long as possible. Between 1918 and 1930, 2700 pounds (1225 kilograms) of seed were distributed from the Mandan Station: 1200 pounds (545 kilograms) directly to farmers, 500 pounds (227 kilograms) to farmers through county extension agents, 500 pounds to experiment stations in United States and Canada, and 500 pounds to USDA for further distribution.

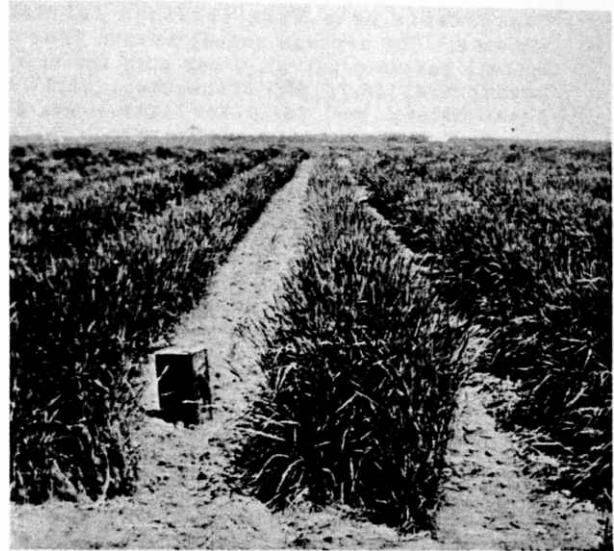


Figure 4.--Planting of S.P.I. 19538 made at Mandan, North Dakota in 1915. June 18, 1919. Size of the planting was reduced in later years, but has been maintained to the present time.

Sarvis (1941) reported that in 1917, a small quantity of seed was produced at Mandan, and that in 1918, seed was sent to M. L. Wilson, County Agent Leader in Montana. Wilson distributed the seed to 15 county agents in Montana. Seed harvest continued at Mandan, and in the spring of 1921, seed was sent to A. J. Ogaard, the Extension Agronomist in Montana for distribution to farmers. Within a few years, a farmer in Montana offered seed for sale, which was perhaps the first attempt to sell crested wheatgrass seed in the United States, but no one wanted it, so he gave some to his neighbors. In 1928, he was able to sell seed to Oscar H. Will Seed Company in Bismarck, North Dakota. In 1929 they listed the seed in their catalogue at \$28 per 100 pounds (45 kilograms). This was the first offering of crested wheatgrass for sale by a commercial seed firm.

Another early producer of commercial seed in United States was Leroy Moomaw at Dickinson, North Dakota. He became interested in crested wheatgrass while he was working for the USDA at Moccasin, Montana. His interest continued when he transferred to the Dickinson Substation in 1919. In 1926, he started a seed increase field on his land near Dickinson. When the demand for seed came in 1933, he had 200 acres (81 hectares) in production. He erected a grass seed processing plant in 1937 when he had over 400 acres (162 hectares) of crested wheatgrass in rows for seed production.

Forage production and grazing studies.--Forage production tests of crested wheatgrass showed the great promise the species held for the northern Plains. In 1923 the first pasture experiment of record involving crested wheatgrass was begun at the Ardmore Field Station. This experiment was designed to compare the carrying capacity and value of native grasses, crested wheatgrass, bromegrass, and sweet

clover using milk production of dairy cows as the measure of production. Dillman (1946) summarized the results of this study:

"Comparable data were obtained for three seasons. The average annual return from the several pastures was \$7.70 per acre for crested wheatgrass, \$6.75 for bromegrass, \$6.63 for sweetclover, and \$4.45 for native grasses. Crested wheatgrass provided the earliest pasturage in the spring and somewhat the longest pasturing season."

The field plantings of Nos. 19537-19541 made in 1918 at Mandan were used as a pasture for a few cows beginning in 1920. The first grazing study using crested wheatgrass for beef production was started at Mandan in 1932 (Fig.5). Its success led to a very extensive long-term breeding and evaluation program at Mandan, including continuation of the pasture established in 1932 (Sarvis, 1941). This pasture has been grazed each year, and the long-term plan is to maintain this pasture as a standard for evaluation of other grazing trials at Mandan.

Seed was sent to L. R. Waldron at the Dickinson Experiment Station in 1909. Although Dillman (1946) reported that there was no record that the 1909 plantings were made, Westover et al. (1932) reported that crested wheatgrass was seeded at the Dickinson station in 1909. Other records of the rapid increase of crested wheatgrass plot area and seed production at the Dickinson Station would indicate that these 1909 plantings must have been made and that additional plantings were made through the years¹. The first well-documented planting of crested wheatgrass at Dickinson was made in 1920 from seed provided by the Division of Forage Crops, USDA, as part of a hay production comparison with other species. In 1922, a field of 2 or 3 acres (0.8 or 1.2 hectares) was planted in rows 42 inches (107 centimeters) apart for seed increase. Part of this seed was of S.P.I. 19538 from the Northern Great Plains Field Station and from the Redfield, South Dakota Field Station. During the period 1922 to 1930, more than 10,000 pounds (4536 kilograms) of crested wheatgrass seed was distributed from the Dickinson Station to 13 states and 4 Canadian Provinces. Through the years, exchange of seed between the Dickinson and Mandan Stations occurred regularly, particularly in relation to the breeding and testing program that led to the release of the cultivar 'Nordan' in 1954. Nordan is a tetraploid, *A. desertorum* type, developed at Mandan from a selection made in 1937 from an old nursery at Dickinson (Rogler 1954) (Fig. 6).

There was extensive testing of the early introductions, especially those of Hansen's second acquisition. Prior to 1942, several reports and bulletins and many journal articles were published describing various aspects of crested wheatgrass. A few examples of these publications are reviewed here. Development and morphology of the seedling

¹Personal communication with Thomas J. Conlon, Superintendent, Dickinson Branch Station (formerly Substation), Dickinson, North Dakota on August 23, 1983, and Annual Reports of the Dickinson Substation.

and of the mature plant, including information on the seed and the root system, were published by Love and Hanson (1932). Rietz et al. (1936) described early testing and evaluation of crested wheatgrass in Montana, including cultural practices for stand establishment, use of the forage for hay and/or grazing, palatability and quality of the forage, use in regrassing abandoned farm land, insect and disease pests, and seed production. Jackman et al. (1936) published all available information on the culture of crested wheatgrass in eastern Oregon. Their bulletin included 14 testimonial letters which described the procedures used and the experiences of individual farmers in establishing stands. They stated in the foreword to the bulletin that eastern Oregon farmers bought seed and prepared to plant 25,000 acres (10,125 hectares) of crested wheatgrass in the fall of 1936. Westover et al. (1932) also described in detail crested wheatgrass culture and management for hay and pasture. Many more journal articles, bulletins, and reports of research and practical use of crested wheatgrass have been published from 1942 to the present, an indication of the continued interest and use of this species.

Later introductions.--A few other early introductions that may or may not be in the current crested wheatgrass genetic pool are worthy of note. I found no further record of them, but others may know whether or not these have influenced crested wheatgrass development in the United States and Canada. Hansen collected seed identified as S.P.I. Nos. 24466-24468 during a plant collection trip to northern and central Asia in 1908. He classified these as *A. imbricatum*, whose diploid and tetraploid forms cross readily with *A. cristatum* and *A. desertorum*. In his notes, Hansen stated "A grass of very wide distribution in northern Asia and European Russia. Highly recommended as one of the best grasses in the Volga River region, where it was brought into culture by the experiment station at Valuiki near Rowno, south of Saratov". This material was identified in the United States and Canada as S-2284 from Saskatoon (Rogler, 1960). Knowles (1955) described this material.

Hansen sent S.P.I. No. 28306 *A. cristatum* from Russia in 1910, and he also sent the first introduction of *A. sibiricum*, as S.P.I. No. 28307, with the note "A native of the dry steppes of eastern European Russia and western Siberia. The present lot is selection No. 1, grown from a single plant, by Prof. R. W. Williams, Imperial Agricultural College, Moscow, Russia". These and other introductions made from 1910 through the 1920's apparently did not receive as wide distribution as did the earlier introductions.

During the 1930's when the real value of crested wheatgrass was being realized for regrassing programs in United States and Canada, several plant exploration expeditions collected crested wheatgrass and related species. The main sources were: The Westover-Enlow expedition to Russia, Turkey, and Turkestan in 1934; the Wellman-Westover expedition to Turkey in 1936; the MacMillan-Stephens expedition to China and Manchuria in 1934; the Roerich expedition to Manchuria in 1934; the Kazakstan Institute of Agriculture in 1935; and the Institute of Plant Industry U.S.S.R. in 1934 and 1935. Seed from these sources was increased and the plant material was evaluated at Mandan, and Pullman,



a) Not grazed since July 20, but no regrowth due to severe drought, 8 inches of precipitation in 1934. Note uniform stand of grass. October 11, 1934.



c) Fourteen steers on seven acres for 40 days. June 26, 1943.



b) Had been grazed for 46 days, by seven steers on seven acres. Total precipitation was 18.3 inches in 1935. Note vigorous growth and patchy grazing. July 16, 1935.



d) The pasture was more than 30 years old in 1965 and remains very productive after more than 50 years of good grazing management. June 21, 1965.

Figure 5.--First beef cattle grazing study on crested wheatgrass in North America. Seeded at Mandan, North Dakota in 1932.



Figure 6.--G. A. Rogler in the 1915 planting of S.P.I. 19538 at Mandan. June 27, 1970.

Washington². Rogler and others working with this material in the late 1930's were soon aware that many of the introduced accessions were badly mixed and in a number of cases misnamed. It took several years to determine whether the mixtures were mechanical or genetic. Since then, several other expeditions have introduced additional accessions of crested wheatgrass into the United States.

Breeding work with crested wheatgrass was intensified when USDA obtained increased appropriations for grass breeding work in 1936. Mandan, North Dakota and Bozeman, Montana were identified as locations for increased breeding work on crested wheatgrass. The major early program in Canada was at Saskatoon, Saskatchewan, and it was intensified in 1938 when Dr. R. P. Knowles joined the staff. At the present time, Mandan, North Dakota; Saskatoon, Saskatchewan; and Logan, Utah are the primary locations doing breeding work on crested wheatgrass.

Canada

The first official introduction of crested wheatgrass to Canada occurred in 1911. According to S.P.I. card files, seed of No. 19536 (*A. cristatum*) and No. 19540 (*A. desertorum*) was sent to Professor John Bracken of the University of Saskatchewan at Saskatoon (Rogler 1960). L. E. Kirk was a graduate student assistant at the University of Saskatchewan in 1916. He planted the seed obtained by Professor Bracken, and in 1927 the cultivar 'Fairway' came from these nurseries.

The second recorded introduction of crested wheatgrass to Canada occurred in 1915 when a small

²Swallen, Jason R. 1943. Preliminary report of the species of *Agropyron* introduced into the United States. USDA Bureau of Plant Industry Mimeo Report, February 23, 1943. 22 p.

quantity of seed was obtained from the USDA by the University of Saskatchewan, and planted in experimental plots (Kirk 1932). Establishment and growth of this plant material was encouraging and the Canadian scientists sought additional material. Kirk wrote:

"In the grass breeding nursery at Saskatoon there are some fifteen strains of crested wheatgrass and about forty-five progenies from single plant selections. The former include eight selections which were sent to us in 1925 by Mr. J. T. Sarvis from the USDA experiment station at Mandan, North Dakota. A few introductions came directly from investigators in Russia, and two strains were developed at Saskatoon."

Kirk (1932) described a disaster in 1925 that delayed development of Fairway:

"Every lot of crested wheatgrass which we have grown has been exceedingly variable in plant type. Some plants were much more desirable than others. These differences suggested the advisability of doing some selection work, as it was apparent that considerable improvement could be effected by saving seed only from the leafy types and eliminating the coarse and sparsely leaved types. In this way a fine leafy strain was secured, which, by 1925, had produced enough seed for plot tests and for distribution to farmers in small quantities. Unfortunately, all of this seed was lost when the building which housed the Field Husbandry Department burned in the spring of 1925. However, the plants were still in the field, and a fresh start was made from seed harvested that year. In 1926, an increase acre plot was seeded in rows which yielded, in 1927, 517 pounds of cleaned seed. During the last four years, seed of this strain has been distributed in two-pound lots for co-operative testing to members of the Field Husbandry Association."

Rogler (1960) obtained seed of Fairway from the University of Saskatchewan in 1944, and seed of S.P.I. No. 19536 from Moccasin, Montana, the only known original planting of this introduction. When grown side by side at Mandan, these two looked identical. Both were diploid forms and very distinct from S.P.I. Nos. 19537 and 19541 which Dr. Kirk also had in his nurseries at the time Fairway was selected.

In 1927, seed was obtained from Montana by the Dominion Range Experiment Station at Manyberries, Alberta, and planted in test plots (Kirk et al. 1934). Seed produced was used to plant some abandoned fields near the station, and by 1935 all reports were favorable for stand establishment, forage production, and palatability to grazing livestock. These tests demonstrated that a complete grass cover could be obtained by seeding into the weed cover. Crested wheatgrass was the most successful species tested. A desirable degree of conservation could be obtained in a relatively short period of time and during the next few years a considerable acreage of abandoned farm land in the vicinity of the station was restored to grass.

Similar trials were conducted at other experiment Stations throughout the drought area of the Prairie Provinces and all confirmed the results obtained at Manyberries (Stevenson et al. 1937).

Canadian scientists L. E. Kirk, T. M. Stevenson, S. E. Clarke, and D. H. Heinrichs were very active in testing and evaluating crested wheatgrass. Major Canadian Department of Agriculture bulletins were issued by Kirk (1932), Kirk et al. (1934), Stevenson et al. (1937), and Clarke and Heinrichs (1941). These pre-1942 bulletins described in detail all known information on crested wheatgrass culture and use at that time. Much information has been published by Canadian scientists since 1942. Kilcher et al. (1956) included crested wheatgrass in their evaluation of pasture and hay crops for the southern Canadian prairies. Knowles (1955 and 1956), and Knowles and Buglass (1971) presented detailed information on adaptation, culture and use of crested wheatgrass in Canada. As in the past, current literature regularly contains papers from Canadian workers dealing with crested wheatgrass improvement, culture and use.

REGRASSING THE NORTHERN GREAT PLAINS

The introduction of crested wheatgrass to United States and Canada was indeed timely. In both countries, the stage was being set for producing a plant hero, who, like the settlers of the prairie, was an immigrant. The rapid settlement of the northern Great Plains of the United States and the Prairie Provinces of Canada between 1866 and 1920, and the demand for wheat during WWI led to plowing and cropping of much land that was not suited as cropland. Concurrent with this was the series of extremely dry years with serious wind erosion problems, and destruction of good soil which led to abandonment of a tremendous acreage (hectarage) of farm land. Crested wheatgrass was soon recognized for having potential to rapidly establish a grass cover on much of this problem land. Its seedling vigor was better than most other species being used to revegetate lands at that time, and it rapidly developed a solid sod capable of supporting grazing or haying operations. It readily produced a seed crop. All these desirable characteristics contributed to its acceptance as a species for revegetating devastated land.

It was also fortunate that seed increase was started at an early date. Several research stations in North Dakota, South Dakota, and eastern Montana increased seed by careful management of very small quantities of seed and small plots. These stations were responsible for providing seed to other research locations and, in a limited way, to growers prior to 1921. There is early record of 2-pound (0.9 kilogram) seed lots being distributed to growers by L. E. Kirk and his associates at the University of Saskatchewan in Canada. Apparently several of the farmers in Canada were successful in increasing these small quantities of seed to establish seed production fields. When the demand for seed developed in the United States in 1934, the Christianson Seed Co. of Minot, North Dakota bought seed in relatively small lots from many Canadian farmers and sold it to the USDA for use in the regrassing program.

Kirk et al. (1934) discussed seed supply in Canada:

"In spite of the fact that there is considerable crested wheatgrass seed being produced in western Canada, the supply is still far short of the demand. This is due in part to severe drought which has visited the prairie sections of Saskatchewan and Alberta during the last few years, since crested wheatgrass has had its widest distribution in that area. These conditions have demonstrated its exceptional drought resistance and ability to produce in a dry climate, but while the plants were able to make a substantial growth on available spring moisture and produce heads, the supply of moisture was frequently insufficient to fill the seed. Demand for seed of the Fairway 'strain' is most insistent. Seed distribution of this variety has been quite general so that although both ordinary crested wheat and the Fairway variety have been grown in the semi-arid sections of the south, the latter has been grown almost exclusively in the northern districts and these have been more favorably situated with respect to moisture. Good seed crops have been obtained therefore of Fairway crested wheatgrass and the seed has sold at a considerable premium over ordinary seed. For these reasons it would appear that seed stocks produced in western Canada will soon consist largely of the improved variety. Data are not available on the quantities of crested wheatgrass seed produced in Western Canada in 1933. Several thousand pounds of seed have been sold and the number of farmers who will grow the crop for seed is rapidly increasing. The bulk of the seed which will be sown in 1934 is the 'Fairway' variety, a considerable proportion of which has been inspected by officers of the Dominion Seed Branch and designated 'elite' stock by the Canadian Seed Growers' Association."

It is highly probable that much of the seed imported into the United States during this period was of the Fairway variety grown in northern Canada, and used in the regrassing program particularly in Montana and North Dakota.

By 1937, agriculture in the northern Great Plains was in dire straits. The drought and the depression left no one untouched. There were only two head of cattle reported left in Petroleum County, Montana. All other counties in western North and South Dakota and eastern Montana were also in extremely poor condition. A report by the Great Plains Committee made in 1936 states that 7 million acres (2.8 million hectares) of abandoned or eroding land could not be acquired with the funds available that year. Two million of these acres (0.8 million hectares) were at one time under option, which meant that they had been homesteaded or were in private ownership. The report predicted that 24 million acres (9.7 million hectares) in the Great Plains might well be acquired, that 5 million (2 million hectares) had been acquired and that the mechanism was there for acquiring 6 million acres (2.4 million hectares) per year if funding was available. Actual acreages (hectarages), state by state, were hard to confirm, but small bits of information help describe the situation. A report by C. G. Bates for the U.

S. Forest Service in 1930³ stated that McHenry County, North Dakota already owned 178 forties (each forty acres or 16 hectares), acquired through abandonment and tax liens. That occurred even before the major drought struck. Much of this land is now in grass, so presumably it was included in some phase of the regrassing program. Trees were planted on some of the sandy areas to help reduce wind erosion. Incomplete records show that county, state, and federal land acquisition of this type amounted to more than 166,000 acres (67,230 hectares) in North Dakota⁴.

The Agricultural Adjustment Act (AAA) had been passed by the U. S. Congress in 1933. During the next 10 years, there were several programs administered by the AAA that included purchase and establishment of grass on abandoned farm lands (the regrassing programs). Seeding was begun in 1933 under programs by the Resettlement Administration. For several years, all available seed was harvested from native range and seeded grasslands. But the only species that produced enough seed to have much impact on the seeding program was crested wheatgrass. In spite of the severe drought in 1934, seeding continued, primarily using seed from northern Canada where the drought was less severe. Favorable growing conditions in 1935 caused many of the acres seeded to become established. This was not only encouraging to those involved in the seeding programs, but it also provided a source of seed for additional seeding. Another drought occurred in 1936, but 1937 was more favorable and by 1938, there was a tremendous seed crop on all the crested wheatgrass acres, including those seeded in 1935 and 1936.

The Bankhead/Jones Tenant Act of 1937 authorized the Secretary of Agriculture to purchase for the Federal Government lands unsuited for cultivation. These became known as the Land Utilization (LU) lands. They were improved and put back into production as rangeland whenever possible. The idea that the Federal Government should buy up homesteaded farms that had failed or were rapidly failing originated in Phillips County, Montana. The Works Progress Administration (WPA) administered the funding while the Soil Conservation Service supervised various projects to improve these lands. The majority of this land was reclaimed by seeding it to crested wheatgrass, often following some other conservation measure such as establishing dams on drainage ways to control water, and/or furrowing or terracing to control runoff. When crested wheatgrass was seeded on these areas, the program was successful. These lands are now administered by Bureau of Land Management and are generally successfully used for livestock grazing.

The Prairie Farm Rehabilitation Act (PFRA) was the Canadian counterpart of the United States AAA. In 1935, the regrassing program became a main function of PFRA. As part of the PFRA program, community pastures were established in Saskatchewan

and Manitoba. These pastures were located on the poor soil types and many of them contained large areas of abandoned farm land.

It is difficult to determine the acreage actually seeded to grass under this and other Canadian programs. Knowles (1956) reported that between 1935 and 1954, 190,548 acres (77,172 hectares) of crested wheatgrass were seeded by PFRA on their community pasture system which is a relatively small part of the entire grassland system and of the entire acreage of abandoned farm land. Clarke and Heinrichs (1941) discussed PFRA seeding of 64,000 acres (25,900 hectares) in blocks of from 10 to 30 acres (4 to 12 hectares) in cooperation with each of hundreds of farmers and that a high proportion of good stands had been obtained. These figures represent only a very small part of the several million acres regrassed in Canada.

THE PRESENT AND THE FUTURE

A cursory review of the literature from 1942 to the present shows a continuous flow of research reports on crested wheatgrass. Long-range planning at many research locations specifically includes work on some aspects of crested wheatgrass improvement, management, or use. Crested wheatgrass has become an integral part of the grassland grazing system of the northern Great Plains, and of many other rangeland areas of the West. There is no indication that this will change until a plant superior to crested wheatgrass becomes available.

Sarvis (1941) summed up the crested wheatgrass situation for the northern Great Plains to that date:

"Crested wheatgrass has progressed from a promising grass in 1917 at the Mandan Station to the leading and outstanding grass for use as hay and pasture in the northern Great Plains. More seed of it is now produced in the northern Plains than of all other grasses of a similar nature. It was the grass available and proved by trial as well adapted for planting on abandoned land and eroded fields, following the severe drought, as protection against wind and water erosion. Many hundreds of acres of it have been planted in western North Dakota, and in one district in Montana over 200,000 acres of it has been planted on abandoned farmland."

Through the years, the desirable characteristics of crested wheatgrass have been proven by research and demonstrated by practice. It has replaced brome grass (Bromus inermis Leyss.) in many seeding programs in the northern Great Plains of United States and Canada. Following the introduction of brome grass to the United States in 1884, it was widely used and it became an important part of grassland agriculture in both countries. But there remained a need for a more drought resistant grass for the drier sites. Crested wheatgrass was found to produce as much or more forage than brome grass on many sites, and it equalled or exceeded brome grass in seed production, ease and speed of stand establishment, and preference by livestock when grazed or as hay.

³ Bates, C.G. 1930. Forestry in North Dakota. USDA-FS Typed Report in Response to request from Senator Nye (Senate No. 4553) 71st Congress.

⁴ Personal communication with Glen Roloff, U. S. Forest Service Office, Bismarck, North Dakota.

recognized as a desirable characteristic of crested wheatgrass (Westover et al. 1932). This led to research on use of crested wheatgrass as the early spring pasture in complementary grazing methods to allow deferment of the native range, which in turn greatly increased the carrying capacity of a given unit of land. The ability of crested wheatgrass to survive under conditions of less than ideal management has also promoted its use.

In Canada, crested wheatgrass has replaced bromegrass in most seeding programs in the southern parts of the Prairie Provinces. For example, community pastures administered by the Provincial Lands Branch required seeding of 21,805 acres (8,830 hectares) in 1982 and 1983. No bromegrass was seeded, but crested wheatgrass was seeded on 7,935 acres (3,214 hectares). Rapid stand establishment and the ability to provide early spring grazing (May 10) were the reasons given for the preference for crested wheatgrass³.

An informal survey of several county Soil Conservation Service offices in western North Dakota showed that in the early 1980's, crested wheatgrass was seeded alone or in mixture with other species on at least 60% of the acres seeded to grass. Potential longevity of the stand, ease of establishment, and need for early spring grazing were the major reasons for seeding crested wheatgrass.

Crested wheatgrass seed production acreage fluctuates in response to demand, therefore, it is difficult to establish reliable seed production figures. In 1983, certified seed fields in Canada totalled 610 acres (247 hectares) for Fairway, 550 acres (228 hectares) for Nordan, and 261 acres (106 hectares) for all other crested wheatgrass cultivars including Summit and Parkway. The total crested wheatgrass acreage for seed production, certified plus common, was estimated by Knowles³ to be more than 2800 acres (1134 hectares) in 1983. The cultivar Summit, an A. desertorum type released by Agriculture Canada in 1953 is not extensively used due to poor seed production characteristics. The cultivar Nordan, an A. desertorum type released by USDA in 1954 has taken the place of Summit in Canada due to its good seed production characteristic and to the active seed market in the United States.

It is difficult to determine how many million acres of crested wheatgrass exist in United States and Canada. One of the confounding factors has been that through the years, some lands that were regrassed under the various government programs were again plowed in another attempt to produce cereal crops. Many failed again, and the revegetation process was repeated. Consequently, using total acres seeded does not provide an accurate estimate of the net acres of crested wheatgrass.

Knowles predicts that crested wheatgrass will have a steady future in Canada, and based on past performance, I see no reason for any decrease in usage in the northern Great Plains of United States.

³ Personal communication from R. P. Knowles, Research Scientist, Research Branch-Agriculture Canada, Saskatoon, Saskatchewan, January 26, 1984.

PUBLICATIONS CITED

- Clarke, S.E., and D.H. Heinrichs. 1941. Regrassing abandoned farms, submarginal cultivated lands and depleted pastures in the prairie areas of western Canada. Canada Dep. Agr. Publ. 720. 24 p.
- Dillman, A.C. 1910. Breeding drought-resistant forage plants for the Great Plains area. USDA Bur. Plant Ind. Bull. 196. 40 p.
- Dillman, A.C. 1946. The beginnings of crested wheatgrass in North America. J. Amer. Soc. Agron. 38: 237-250.
- Heinrichs, D.H. 1969. Forage crops research, past, present and future, p. 51-67. In: K.F. Nielsen (ed.). Canadian Forage Crops Symposium, Edmonton, Alberta.
- Jackman, E.R., D.E. Stephens and D.E. Richards. 1936. Crested wheatgrass in eastern Oregon. Oregon State Exten. Bull. 494. 40 p.
- Kilcher, M.R. 1969. Establishment and maintenance of seeded forage crops, p. 89-104. In: K. F. Nielsen (ed.). Canadian Forage Crops Symposium, Edmonton, Alberta.
- Kilcher, M.R., R.W. Lodge, D.H. Heinrichs and J.B. Campbell. 1956. Pasture and hay crops for the southern Canadian prairies. Canada Dep. Agr. Publ. 980. 22 p.
- Kirk, L.E. 1932. Crested wheatgrass. Saskatchewan Agr. Exten. Bull. 54. 24 p.
- Kirk, L.E., T.M. Stevenson and S.E. Clarke. 1934. Crested wheatgrass. Canada Dep. Agr. Pamp. 157:New Series. 22 p.
- Knowles, R.P. 1955. A study of variability in crested wheatgrass. Canad. J. Bot. 33: 534-546.
- Knowles, R.P. 1956. Crested wheatgrass. Canada Dep. Agr. Publ. 986. 14 p.
- Knowles, R.P. and E. Buglass. 1971. Crested wheatgrass. Canada Dep. Ari. Publ. 1295. 14 p.
- Love, L.D. and H.C. Hanson. 1932. Life history and habits of crested wheatgrass. J. Agr. Res. 45: 371-383.
- Reitz, L.P., M.A. Bell and H.E. Tower. 1936. Crested wheatgrass in Montana: Comparisons with slender wheatgrass and bromegrass. Montana Agr. Exp. Sta. Bull. 323. 54 p.
- Rogler, George A. 1954. Nordan crested wheatgrass. North Dakota Bimon. Bull. 16:150-152.
- Rogler, George A. 1960. Crested wheatgrass - History, adaptation and importance. Western Grass Breeder's Work Planning Conference, June 24-25, 1960. Univ. Saskatchewan, Saskatoon.
- Rogler, George A., and Russell J. Lorenz. 1983. Crested wheatgrass - Early history in the United States. J. Range Manage. 36:91-93.

Sarvis, J.T. 1941. Grazing investigations on the northern Great Plains. North Dakota Agr. Exp. Sta. Bull. 308. 110 p.

Stevenson, T.M., S.E. Clarke and F.M. MacIsaac. 1937. Seeding crested wheatgrass for hay and pasture. Canada Dep. Agr. Publ. 557. 16 p.

Westover, H.L., J.T. Sarvis, L. Moomaw, G.W. Morgan and J.C. Thysell. 1932. Crested wheatgrass as compared with bromegrass, slender wheatgrass and other hay and pasture crops for the northern Great Plains. USDA Tech. Bull. 307. 36 p.

In: Johnson, K. L. (ed.). 1986. Crested wheatgrass: its values, problems and myths; symposium proceedings. Utah State Univ., Logan.