Breeding Superior Forage Plants for the Great Plains

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The Age of Exploration, 1900-1935

About the turn of the century serious consideration began to be given to the development of superior forage materials for the newly settled Great Plains area. N. E. Hansen of South Dakota was designated plant explorer in 1897 by Secretary Wilson and sent to Siberia (Hansen, 1909). Turkestan alfalfa was one of the importations from that trip. Hansen also brought back samples of crested wheatgrass, but so far as records indicate, these particular lots did not lead to our present sources of crested wheatgrass.

Hansen made other trips in 1906 and 1908 and shortly thereafter made available source strains of alfalfa such as Cherno, Cossack, Orenburg, Omsk, Obb, and Semipalatinsk (Hansen, 1913). One of the early workers with these materials was W. A. Wheeler, who also discovered the Baltic types from farmer introductions near Baltic, South Dakota (Dillman, 1910; Graber, 1950). Grimm alfalfa had been introduced a half-century earlier, but its special qualities of hardiness were just then coming to be appreciated. Ladak was introduced in 1910 from northwestern India and other sources assembled to provide a large genetic variance which later alfalfa breeders could exploit successfully.

The introductions which led to our present sources of both standard and fairway crested wheatgrass were presented by Vasili S. Bogdan, Director, Experiment Station, Valuiki, Samara government, Russia in 1906 (Dillman, 1946). A number of other introductions have been made from time to time including those resulting from the H. L. Westover-C. R. Enlow expeditions of 1934 and 1936 and the author's Turkish expedition of 1948. Nevertheless our commercial sources as well as all improved varieties have been derived from the 1906 material.

Sudangrass was introduced into the Great Plains in 1909, largely through the efforts of C. V. Piper (Vinall, 1921). H. N. Vinall, Piper, Westover, Oakley, McKee and other early forage crops workers were largely responsible for introducing a large number of species for trial in the region. Only a very few have been really important. The forage and fodder of the Great Plains is largely provided by native grass, small grains, sorghums, alfalfa, and crested wheatgrass. Bromegrass is used on favored sites together with

several other introduced species. Intermediate wheatgrass is of some importance and our selected varieties as well as most common stocks can be traced to material presented by N. I. Vavilov in 1932. Seed lots of both tall wheatgrass and pubescent wheatgrass were obtained from Vavilov as well as the Westover-Enlow expeditions. These are relatively minor items in Great Plains forage production.

The Age of Discovery, 1931-1940

The disastrous drouth and depression of the 1930's with their social and political adjustments, family uprootings, dust storms and farm abandonment brought great and unexpected changes to the Great Plains. Some consequences of the disaster pertinent to our discussion are :

1. Crested wheatgrass was "discovered." It alone of all the grasses not only withstood the drouth well, but under favorable conditions produced seed in such quantity and established stands with such ease that it could be used to reseed the millions of acres of abandoned farmland in the northern Great Plains.

2. The disaster "discovered" men. In order to regrass the enormous acreages of abandoned land in the plains, unprecedented supplies of grass seed were needed. The largest grass seed collection program in history was established and directed largely by the U. S. Department of Agriculture. The seed collection work turned out to be one of the greatest training schools of all time for grass-minded agronomists. Many of these men are still in some phase of the grass business today and many are members of the American Society of Range Management. Few who participated in this program would trade the experience for anything.

3. Native grasses were "rediscovered." In the central and southern plains, where crested wheatgrass is not especially well adapted, the native species appeared to offer the greatest opportunities for regrassing abandoned farmland. But, unlike crested wheatgrass, most native species are poor and erratic seed producers, their seedlings are small, slow growing and grow at a time of year when they receive maximum competition from weeds. While the job of regrassing was virtually accomplished in 10 years in the north, there remain some 12 million acres to be seeded in the southern plains. Native grasses are adapted, but they lack certain essential qualities for a major regrassing effort.

4. The need for improved varieties of useful species was "discovered." Most of the modern forage plant breeding programs now in operation in the Great Plains were established in the 1930's or early 1940's. Generally speaking the objective was to supply better materials for establishment on abandoned cultivated land. Programs for the improvement of cultivated forage crops also received a considerable stimulus at this time.

5. We "discovered" we were backward. Closer contact with grassland workers in other parts of the world, notably western Europe, New Zealand, and Australia revealed that we were far behind in understanding grassland management. We are still behind in some respects, but the discovery of our backwardness was an important stimulation toward advancement.

The First Cycle of Breeding, 1934-1959

Intensive plant breeding programs got underway very slowly in the Great Plains. Single plant selection work was conducted at Highmore, and Belle Fourche, South Dakota and Akron, Colorado and Fargo, North Dakota in the first decade of this century and occasional nurseries were established elsewhere for the purpose of selecting better materials. The methods used were crude and inefficient and few useful varieties came from this early work, but important sources of germ plasm were preserved for the more intensive work which came later.

H. M. Tysdal used more sophisticated methods and released Ranger alfalfa in 1942. His success with synthetics prompted other alfalfa breeders and many grass breeders to follow similar procedures. Buffalo alfalfa was produced by C. O. Grandfield at about the same time. Both varieties were selected for resistance to bacterial wilt. Although their resistance is not especially high, they are very substantial improvements over previously available varieties. Several new varieties have been released in the last 10 years, but these two varieties remain the major contributions of the plains to alfalfa breeding at the present time. The latest release is Teton from South Dakota.

Sudangrass has received rather minor attention up to now. One of the major contributions was the production of sweet sudangrass at Chillocothe, Texas. Other plains varieties are Wheeler, a source strain of common sudangrass from Kansas, Greenleaf, a juicy common type from Kansas, and Lahoma, a uniform sweet type from Oklahoma. No elaborate procedures were used to develop these last named varieties.

Work with native grasses getting underway in the 1930's has resulted in a first set of products as follows:

North Dakota

Green stipagrass
Mandan ricegrass

Nebraska

Nebr. 28 switchgrass
Nebr. 27 sand lovegrass

Trailway side-oats grama
Butte side-oats grama
Nebr. 54 Indiangrass

Kansas

Hays buffalograss
Blackwell switchgrass
El Reno side-oats grama
Kaw big bluestem
Cheyenne Indiangrass

Oklahoma

Tucson side-oats grama
Coronado side-oats grama
Caddo switchgrass
Woodward sand bluestem
Mesa buffalograss

Only a few of these are being used on any substantial scale, but some of them are too new to be well established at present.

The most important contribution to the crested wheatgrass area is Nordan produced by George Rogler. This variety was selected primarily for seed size and seedling vigor in order to improve the chances of obtaining stands. Nordan is an excellent contribution and appears to be headed for success.

What Makes a Variety Successful

To be a success a variety must obviously be adapted and useful, but the area of performance that is most critical appears to be SEED PRODUCTION and SEEDLING HABITS. Although production and quality of forage usually have priority in our testing programs, varieties are not necessarily preferred for reasons of quality or performance. Vernal alfalfa is superior to Ranger in several respects, but it now appears that it will not replace Ranger altogether as originally thought. Ranger is a better seed producer in California and Ranger is the seed that will be on the market. The difference in production is not extreme and both are good seed producers compared to some other varieties, but no advantage in the performance of Vernal is likely to overcome its slight deficiency in seed production.

Green stipagrass, Russian wildrye, selected strains of blue grama, Kaw big bluestem, Texas bluegrass are all valuable forage plants but have not been used to any extent because of seed or seedling problems. Although crested wheatgrass is far superior to most grasses in these respects, Rogler was wise to concentrate his improvement efforts on this critical weak point. Nordan is likely to succeed for this reason.

Coronado side-oats grama, Woodward sand bluestem, and Mesa buffalograss are varieties of native species also selected for better seeding and seedling habits. Whether or not the improvement was adequate remains to be seen. With some quarter century of experience in forage plant breeding in the Great Plains, we can at least conclude that no species or variety is going to be used on any scale unless it can be readily propagated. Superiority of performance must be very great to make up for any deficiency in reproductive efficiency.

How Do You Make a Successful Variety?

The first round of breeding achievements appears to be rather modest to say the least. There are ample technical reasons for this. The plants we deal with are nearly all polyploids and cytogenetically complex. Some species have numerous chromosome numbers and many have meiotic irregularities and tendencies toward sterility. The characters we try to improve are slippery and evasive. Seed production, seedling establishment, herbage production, forage quality, drouth resistance, cold hardiness, etc. are all quantitative characters not understood genetically and extremely difficult to evaluate. How do you test for persistence? How can you tell if a stand will last 10 years without waiting 10 years? Our goals are elusive and our materials genetically unresponsive for the most part. In many respects neither our materials nor our methods are adequate for the task.

In addition to the technical complications, moisture limits performance more often than genetic constitution. In wet years we can grow grass and in dry years we can not. The benefits from improvement are frequently limited to good years or favorable situations provided the varieties are reasonably well adapted. The variety X season or the variety X management interaction is of such a magnitude that one can demonstrate superiority for almost any variety by selecting the season or management practice best suited to it.

In view of these problems it seems advisable to stop and take stock of our programs based upon the last quarter century of experience. Some reevaluation seems to be in order. We need bolder and more imaginative programs. We need larger, more complete and better financed programs. We need the coordinated efforts of breeders, cytologists, physiologists, engineers and soil, plant and animal specialists. We need to raise our sights. The problems are more formidable than we had thought.

What About the Future?

Many wise things have been said about people foolish enough to try to predict the future. Since my reputation for sagacity is not sufficient to place in much jeopardy, I will venture to suggest the following:

1. A much greater effort will be made to exploit heterosis. The trend will be away from synthetics and toward hybirds.

2. Hybrid alfalfa (or 2 clone synthetics if you wish) will come into production. Hansen (1913) recommended transplants for

seed production in 1913 and showed that it could be done. We are in a much better position to do it today than in 1913.

3. With the coming of age of male sterile sorghums, hybrids will be used for forage and they will be more productive than our present sudangrass varieties.

4. Species reproducing by apomixis will be used as another means of exploiting heterosis.

5. Small grain breeders will devote more attention to forage production.

6. Our search for a really good new dryland range legume will fail. Alfalfa will remain the best that we have.

7. Fewer native grass species will be used and most of these will ultimately be replaced by introduced species.

8. There will be a greater interest on the part of private companies in releasing varieties of sorghum and alfalfa. This trend may well extend to other crops as well.

9. Eventually we shall replace native range vegetation with improved materials. Most of our breeding work to date has been directed toward reclamation of abandoned farm land or the improvement of forage crops for cultivated land. The products of breeding programs shall one day spread beyond these two situations and replace rangeland vegetation. We have replaced buffalo with cattle, some day we shall replace wild grasses with tame ones.

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