Advancements from 90 Years of Grass Breeding and Genetics in USDA-ARS

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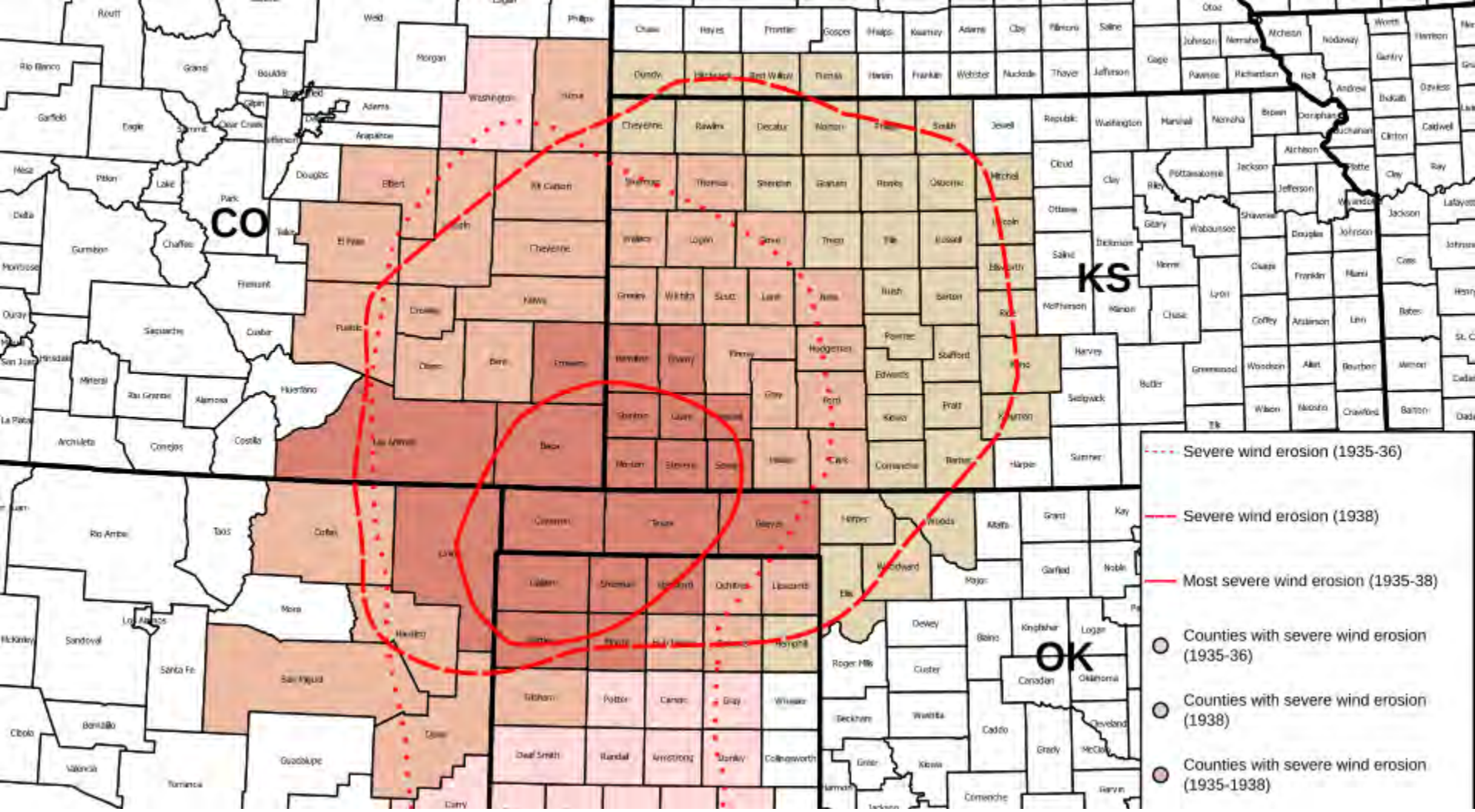
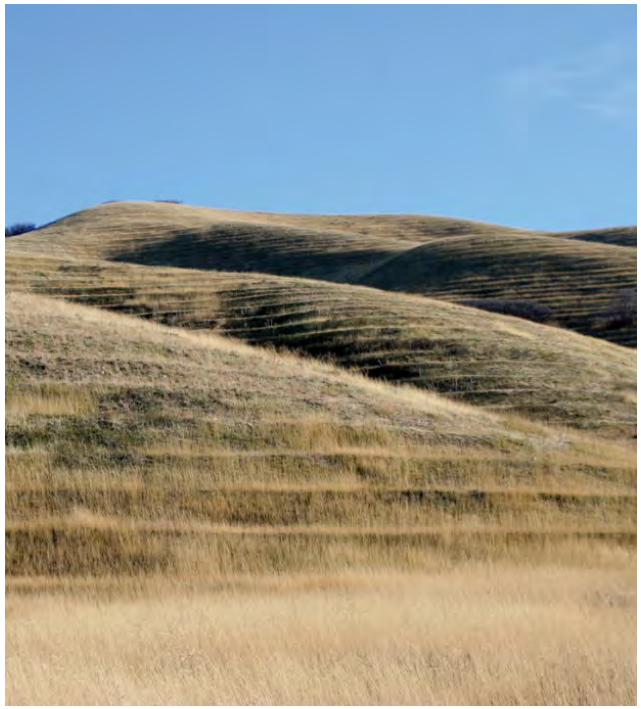


Government encouragement to settle the Great Plains.
Farmers and families unfamiliar with dryland agriculture.
Severe and prolonged drought – massive wind erosion.

90 Years Ago
The Dust Bowl: ~1934 - 1939



Initial Grass Breeding in the USA

Millions of acres in need of revegetation to prevent continued wind erosion of soil.

New cultivars were required to support revegetation of dust bowl soils.

In 1936, USDA established the first grass breeding and genetics programs at Lincoln, NE, Mandan, ND, and Logan, UT.

These two programs developed >80 new cultivars of 18 different species.

These grasses led to major advancements in soil conservation and improvement in grazing land productivity.

Grass Breeding at Tifton, GA

- Glenn W. Burton was appointed grass breeder and geneticist in 1936, the same year that Larry Newell started in Lincoln, NE.
- He started with germplasm collection, selection, and crossing of one of the South's worst perennial weeds, bermudagrass.
- Over the course of 61 years, he transformed bermudagrass into a highly desirable and productive pasture grass and a highly persistent and stress tolerant turfgrass for golf courses and athletic fields.

Transformative Grass Breeding

- Glenn Burton transformed the field of grass breeding, developing bermudagrass hybrids that could be vegetatively propagated to preserve their hybrid vigor.
- Coastal bermudagrass was the first of many hybrids and it often credited with doubling forage production in the South.
- His pearl millet hybrids helped to make massive increases in food production across the world in countries without the necessary plant breeding resources, e.g. Pakistan and several African nations.

Breeding for Increased IVDMD

- Rapid and small-scale lab procedure developed by Tilley and Terry (1963).
- First proposal to use in grass breeding was at the Welsh Plant Breeding Station, Wales, UK, in 1967.
- This research led to the first applications of the IVDMD lab procedure in the USA.
- Glenn Burton was the first breeder, worldwide, to put this procedure into routine use in a grass breeding program, leading to numerous new bermudagrass cultivars with increased livestock performance.

Additional Research at Tifton, GA

- Wayne W. Hanna conducted fundamental genetic research on male sterility systems, chromosome behavior, and interspecific hybridization.
- He developed numerous high-quality and desirable cultivars for both turf and forage applications.
- To quote from Wayne,
  - “A lady calls me from north Atlanta and says, ‘Wayne, TifBlair has given me the prettiest lawn I’ve ever had.’”
  - “Or you have a cattleman from Texas that says, ‘This grass that you developed has made me more money than anything I’ve ever done.’”
  - Says Wayne, “That’s the best award you can get.”

Improving Livestock Performance

- Building on the work of Glenn Burton, Ken Vogel incorporated the IVDMD procedure into the breeding program for warm-season grasses.
- Simultaneous selection for increased IVDMD and increased forage production led to significant improvements in both switchgrass and big bluestem.
- Basic research on cell-wall structure showed that lignin was the most significant factor causing decreased IVDMD. Most genetic improvements in IVDMD were the result of reduced lignin in the cell wall (collaboration with Hans Jung, St. Paul, MN).

Improving Livestock Performance

- New cultivars with higher IVDMD and forage yield than standard cultivars
- Bonanza big bluestem
  - 16% higher average daily gains
  - 14% higher beef production per hectare
  - Increase of $37/ha net return compared to Pawnee
- Trailblazer switchgrass
  - 6% increase in IVDMD
  - 23% increase in beef production per hectare compared to Pathfinder

Intermountain West: Logan, UT

- Douglas R. Dewey conducted pioneering research on genomic classification of the perennial Triticeae, long before we had the genomic tools of today.
- Because the perennial Triticeae are broadly adapted throughout central and northern Asia and Siberia, he traveled extensively on exploration and collection trips, developing strong relationships and contacts.
- He rewrote the classification system for these grasses, using genomic makeup determined by cytology and cytogenetics, not morphology. It became the “gold” standard for this tribe of grasses.

Intermountain West: New Cultivars

- Kay H. Asay was hired in the late 1970s and initiated an intensive breeding program to develop new cultivars for problematic soils, especially low-rainfall areas where establishment was particularly difficult.
- ‘Hycrest’ crested wheatgrass was the first hybrid crested wheatgrass that established better than either parent. This made Hycrest the workhorse cultivar for revegetating disturbed (grazing, fire, etc.) rangelands.
- Hycrest survives on as little as 8 inches of annual rainfall, which allows it to stabilize soil resources, provide livestock and wildlife feed and habitat. It was the most planted crested wheatgrass for about 10 years and led the development of further improved culitvars, such as Hycrest II and ForageCrest.

Intermountain West: New Cultivars

- Russian wildrye is more resilient than crested wheatgrass but lacks its establishment ability.
- ‘Bozoisky-Select’ was developed with improved establishment. It excels in extreme aridity, places where even crested wheatgrass struggles, and is an important source of winter grazing on western rangelands.
- Doug Dewey contributed to the development of both ‘Hycrest’ and ‘ Bozoisky-Select’ through cytogenetic studies and germplasm exploration and collection.

Forage and Range Research Unit

- Since the initial successes, the FRR has grown to 11 scientists with nine of them working on breeding, genetics and physiology of perennial forage grasses.
- The remaining two scientists are working on remote sensing and high-throughput phenotyping, both of which are in support of the overall goals for development of new cultivars to solve producers' problems.
- The FRR has released a total of 78 grass and forage cultivars or germplasms, of which 33 are currently in commercial seed production and use.

Forage and Range Research Unit

- Since the early 2000s, it is estimated that 114 million pounds of seed of FRR varieties have been sold, generating $500 million in sales for the seed industry.
- FRR varieties boost forage production of rangelands and pastures by 2- to 3-fold, resulting in $1 billion annually in added forage and grazing value, with an estimated payback on establishment costs of only 1.1-years, and a Return on Investment of 18.5%/yr.
- From 2014 to 2024 the Bureau of Land Management purchased 7 million pounds of seed of FRR varieties of grasses and forbs at a value of $54 million and accounting for 35% of their overall seed buy.