Technical Report TR 18-5

Agricultural Experiment Station

Colorado State University

College of Agricultural Sciences Department of Soil & Crop Sciences Extension

Making Better Decisions

2018 Colorado Dry Bean Variety Performance Trials

Crops Testing

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Acknowledgments

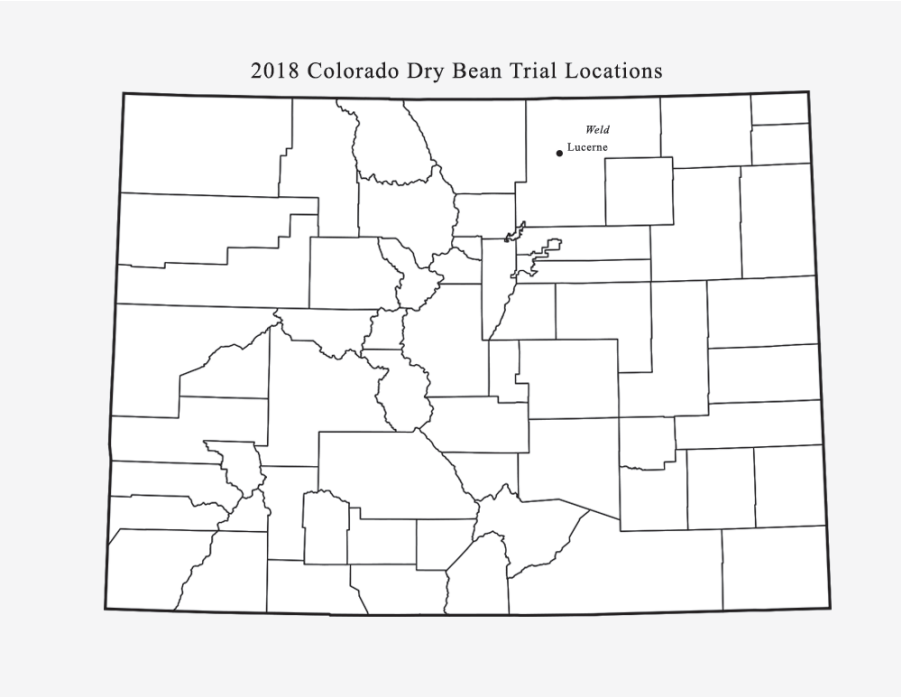
The Colorado State University dry bean improvement team wishes to express their gratitude to the Colorado farmers who voluntarily and generously contributed the use of their land, equipment, and time to facilitate the 2018 dry bean variety trial. We are thankful to the collaborating farmer, Ed Croissant at Lucerne. This trial is evidence of bean check off dollars at work. It would not be possible without research support provided by the Colorado Dry Bean Administrative Committee and the Colorado State University Agricultural Experiment Station. We are also thankful to Larry Lande and Dean Larsen from Northern Feed and Bean in Lucerne, CO, for their help with the trial.

2018 Colorado Dry Bean Performance Trials

The Colorado State University Crops Testing Program provides unbiased, current, and reliable variety performance results and information to help Colorado dry bean producers make better planting decisions. Our uniform dry bean variety trials serve a dual purpose of screening experimental lines from CSU's Bean Breeding Program as well as testing them alongside commercially available varieties. This allows the breeding program to make variety advancement decisions and helps our program make informed recommendations for Colorado bean producers. Colorado State University promotes crop variety testing as a service to crop producers and seed companies who depend on us for crop variety performance information. The dry bean variety trial is made possible by funding received from Colorado dry bean producers and handlers via the Colorado Dry Bean Administrative Committee, and the CSU Agricultural Experiment Station.

Dry bean production in Colorado for 2018 was 774,000 hundredweight, down 30 percent from the 1,092,000 hundredweight produced a year earlier. Yields are expected to average 2,150 pounds per acre, up from 2,000 pounds per acre last year. Growers harvested 36,000 acres this year, down 18,500 acres from the 54,500 acres harvested last year.

One eastern Colorado pinto bean trial was planted at Lucerne in 2018. Thirty-two varieties with diverse origins, maturities, disease resistance, growth habits, and adaptability were tested at the irrigated trial location. The results table for this trial is presented in the following pages. Plot sizes were ~ 300 ft^2 and all trials were planted at 85,000 seeds per acre. Seed yields and seed sizes for all trial varieties are reported in the tables. Yields are adjusted to 14% seed moisture content.



2018 Irrigated Pinto Bean Variety Performance Trial at Lucerne

Variety	Source	Yield[a]	Moisture	Seeds/Pound
		lb/ac	percent	count
GTS-904	Gentec Inc	3706	9.8	1106
StayBright	Trinidad-Benham	3578	13.1	1350
PT16-9	USDA-ARS Prosser, WA	3465	11.4	1148
CO 34628-5	Colorado State University	3379	11.4	1163
Monterrey	ADM Seedwest	3353	10.8	1216
Centennial	Colorado State University	3310	11.5	1210
Long's Peak	Colorado State University	3254	11.4	1253
Torreon	ADM Seedwest	3179	10.9	1184
CO 32123-13	Colorado State University	3179	12.4	1271
GTS-907	Gentec Inc	3168	9.6	1163
Radiant	ADM Seedwest	3150	9.6	1169
CO 34399-14	Colorado State University	3109	11.0	1123
Sundance	Preator Bean Company	3080	11.6	1239
CO 33503-5	Colorado State University	3026	10.3	1191
Mariah	Seminis	3007	10.0	1296
PT11-13	USDA-ARS Prosser, WA	3004	10.3	1243
CO 41767-15	Colorado State University	2985	11.2	1117
ND-Palomino	North Dakota State University	2979	9.8	1233
Vibrant	ADM Seedwest	2847	10.0	1253
Montrose	Colorado State University	2834	9.6	1219
Cowboy	ADM Seedwest	2756	10.5	1274
El Diablo	Gentec Inc	2744	10.2	1203
DR Wood	Colorado State University	2732	10.8	1300
CO 32330-14	Colorado State University	2716	12.7	1145
CO 52646-14	Colorado State University	2715	10.0	1131
Scout	USDA-ARS Prosser, WA	2698	11.0	1213
Croissant	Colorado State University	2627	10.4	1391
CO 43732-1	Colorado State University	2622	11.0	1274
CO 53676-3	Colorado State University	2434	10.2	1236
CO 15015	Colorado State University	2391	11.0	1055
PT9-5-6	USDA-ARS Prosser, WA	2376	9.8	1358
Wyoming 50	Preator Bean Company	1819	11.2	1271
Average		**2944**	**10.8**	**1219**
[b]LSD (P<0.30)		342		

[a]Yields corrected to 14% moisture.

[b]If the difference between two variety yields equals or exceeds the LSD value, there is a 70% chance the difference is statistically significant.

Plot Size: 10' x 30'

Site Information

Cooperator:	Ed Croissant
Planting Date:	May 29, 2018
Harvest Date:	September 10, 2018
Fertilizer:	N at 110, P at 40, K at 20, and S at 5 lb/acl
Herbicides:	Eptam at 2 qt/ac and Dual at 1.5 pt/ac
Fungicide:	Copper 3L at 1.25 pt/ac sprayed twice

10-Year Summary of Pinto Bean Variety Performance in Colorado

Every year CSU personnel conduct pinto bean variety performance trials in different locations across eastern Colorado. Variety entries and locations change from year to year. The following table summarizes variety performance over multiple years. In the table, yield performance by variety has been averaged over locations within each of ten years. Entries reported are public and commercial named varieties common to all trials for a year. Experimental lines are not included in this summary. The number of locations per year varied from one to six. The trial average at the bottom of each year's yield column is a simple average of the yields of reported varieties for that year. Average variety yield over years is shown in the column at the far right. Varieties are ranked according to highest average percent of average yield across each year they were tested.

10-Year Summary of Pinto Bean Variety Performance in Colorado Variety Trials from 2007-2018.

Variety[a]	2007	2008	2009	2010	2011	2012	2013	2014	2017	2018	Long Term Average	
	lb/ac											% of avg.
Montrose	2587	4854	3569	3261	2660	3675	1869	3470	3450	2834	3223	105
GTS-904	3118	3513	2634	3091	2468	3854	2055	3598	3671	3706	3171	105
Sinaloa					2799	3574	1881	3338	3447		3008	104
Bill Z	2796	4910	3273	3418	2305	3518	1610				3119	103
Centennial							2193	2854	3418	3310	2944	103
Mariah			3033	3105		3798	1982			3007	2985	103
La Paz	2586	3804	2177	2917	2700	3676	2416	3558			2979	101
Windbreaker			3415	3316		3358	1615				2926	101
Durango	2390	4457	3136	3244	2301						3106	100
Long's Peak			2973	2786	2684	3329	1842	3117	3165	3254	2894	98
GTS-907							1413	3411	3762	3168	2938	98
Stampede	2502	4015	3100	3081	2280		1843				2804	98
Grand Mesa	2429	4450	3132	2864	2204						3016	97
ND-307			2735	2949	2298		1899				2470	96
Croissant			2855	2792	2479	3236	2079	3250	3133	2627	2806	96
Medicine Hat			2902	2877		3267	1940	2851			2767	95
Lariat	2528	4472	3010	3123	2204		1463				2800	95
Othello				3020		3411	1534	2778			2686	91
Average	2617	4309	2996	3056	2449	3518	1852	3223	3435	3129	2924	

[a]The following varieties were only tested for a few years during the ten year period, and are not included in this performance summary: Baja, Buckskin, Buster, Kimberly, Rally, Shoshone, and Sonora.

Pinto Bean Variety Descriptions

Centennial Centennial (tested as CO 91212-4) was released in 2015 by the Colorado Agricultural Experiment Station. It is a high-yielding pinto that combines resistance to common rust and bean common mosaic virus, excellent seed quality and size, and semi-upright architecture. Centennial possesses the Ur-3 and Ur-6 alleles that condition resistance to strains of rust found in the High Plains and western US. Centennial is consistently 3 to 5 day earlier than La Paz and 2 to 3 days later than Croissant. Centennial seed yield was similar to La Paz, but higher than Croissant. In addition, Centennial seed weight is (was) higher than those of La Paz and Croissant.

Croissant A pinto variety released in 2008 from Colorado State University. Croissant combines several desirable commercial pinto bean traits including excellent seed color and size, high yield potential, resistance to prevalent strains of rust in the High Plains, and resistance to bean common mosaic virus (BCMV) and bean common mosaic necrotic virus (BCMNV). Croissant has medium harvest maturity (93 to 98 days) and semi- upright plant architecture in most environments, however, it can lodge in soils with high nitrogen and soil moisture content.

DR Wood DR Wood is a pinto bean cultivar released by Colorado State University Experiment Station with high yield potential, excellent seed color and size, resistance to foliar rust, BCMV and BCMNV. It is a full season (97 to 100 d) cultivar with semi-upright architecture (Type II). It possesses important molecular markers linked to disease resistance alleles for resistance to US strains of BCMV and BCMNV; resistance to endemic strains of bean common bacterial blight, and resistance to all endemic strains of foliar rust in the Central High Plains and western US.

El Diablo A pinto variety released by Gentec, Inc. It is an upright short vine plant type and is a medium to early maturity.

GTS-904 A pinto variety released by Gentec, Inc. It is a tall, semi-determinate bush plant that holds pods off the ground and has fair to good lodging resistance. GTS-904 has good yield potential and an upright growth habit which could be suitable for direct harvest. It is a mid-to-full season variety.

GTS-907 A pinto variety released by Gentec, Inc. It is a medium maturity plant with an upright vine plant type.

Long's Peak A pinto variety released in 2011 from Colorado State University. Long's Peak combines several desirable commercial pinto bean traits including excellent seed color and size, high yield potential, resistance to prevalent strains of rust in the High Plains, and resistance to BCMV and BCMNV. Rust resistance is derived from a single recessive gene that allows small rust pustules to form on the leaves late in the growing season. Long's Peak has upright plant architecture in most environments and medium plant maturity (94-98 days).

Mariah A full-season pinto bean with an indeterminate and short vine. Mariah has less breakage for better canning quality. It is well-suited to narrow rows and direct harvest. It is 93-97 days to maturity and has resistance to rust and BCMV.

Montrose A pinto variety released in 1999 from Colorado State University. Montrose was released to provide a high yielding pinto variety with improved resistance to rust. It is a medium season variety (94-97 days) with a semi-vine type growth habit. Montrose is resistant to all known races of rust in the High Plains and western US. It has excellent seed quality and possesses resistance to CTV, BCMV, BCMNV, and it has tolerance to Fusarium root rot. It is highly susceptible to white mold.

ND-Palomino (SF103-8) is a slow darkening variety derived from the cross Santa Fe/PS08-108. ND Palomino has an upright indeterminate (short vine) growth habit (Type 2A), white flowers, and matures in approximately 102 days. It is resistant to BCMV, but susceptible to both rust and anthracnose diseases. Canning tests were performed by two major canning companies in which they use only two ratings: acceptable or unacceptable. Both companies rated the final canned product as acceptable but warned against mixing/comingling regular darkening with slow darkening beans in the same canning line because the final color of the beans will be very different.

Radiant Radiant is a slow darkening line from ADM Seedwest. It is an indeterminate plant that is upright in architecture. It is about three days later in maturity when compared to Poncho. It is resistant to rust and BCMV.

StayBright StayBright (tested as COSD 35) is a slow darkening (SD) seed coat pinto bean variety released by the Colorado Agricultural Experiment Station. The slow darkening allele was derived from the germplasm line SDIP-1 by the University of Idaho in 2006. StayBright is resistant to endemic strains of foliar rust in the High Plains and all strains of bean common mosaic virus (BCMV). StayBright has semi-upright architecture. Harvest maturity is 96 to 99 days in the High Plains region.

Sundance Sundance (tested as COSD 07) is a slow darkening seed coat pinto bean variety released by the Colorado Agricultural Experiment Station. The slow darkening allele was derived from the germplasm line SDIP-1 by the University of Idaho in 2006. Sundance is resistant to endemic strains of foliar rust in the High Plains. Sundance has resistance to all strains of bean common mosaic virus (BCMV) and has semi-upright architecture. Harvest maturity is 92 to 95 days in the High Plains.

Vibrant Vibrant is a slow darkening line from ADM Seedwest. It is an indeterminate, upright architecture plant. The maturity for Vibrant is about two days later than Poncho. It is resistant to rust and BCMV.

White Mold of Dry Beans

Dr. Kirk Broders

One of the most important diseases impacting dry beans in eastern Colorado is white mold caused by the fungus *Sclerotinia sclerotiorum*. Losses from this disease have averaged as high as 20%, with a few individual fields having losses in excess of 65%.

Disease Identification

Symptoms of white mold are first observed as wet, soft spots or lesions on infected leaves, branches, stems and pods. These lesions enlarge into watery, rotten mass of tissue that is covered by a white moldy growth. Infection of stems and branches will cause affected plant parts to wilt and later die, taking on a bleached and dried appearance. This bleaching symptom is characteristic of white mold infected pinto and great northern types and differs from normal tan color resulting from senescence or other diseases. Black and irregularly-shaped sclerotia (survival structures of the fungus) form on and within infected plant parts. These sclerotia can then survive on or in the soil until the next cropping season.

Disease Cycle

The fungus *S. sclerotiorum* has a wide host range and is able to infect numerous crops such as alfalfa, potato, pepper, soybean and sunflower. In addition, weeds including amaranths, lambsquarter and pigweed can serve as hosts. The white mold disease cycle starts with sclerotia located near the upper 2-cm of soil surface germinate and produce a mushroom-like structure which produces millions of spores over several days (Fig. 1). Multiple apothecia can sprout from the sclerotia over the course of several weeks. These spores can be dispersed locally and only rarely are dispersed to other locations. Under some conditions sclerotia may germinate and produce thread-like hyphae, which infect plant roots, crowns, and other low-lying plant parts.

Germination of sclerotia occurs under cool (50-68°F) periods typically following heavy rains or irrigation. A 16-48 hour wet period is required for the production of spores, which are forcibly discharged and moved by air currents to susceptible plant tissue (Figure 1). Infection often takes place on flowers and once inside the plant, the fungus grows and produces stem lesions that eventually girdle the stem. Sclerotia form in or on plant tissues, where they eventually fall from plants or overwinter inside senesced stems on the soil surface (Figure 1).

Unlike foliar diseases such as bean rust, white mold only produces one set of infective spores per season. Plant- to-plant spread is possible if adjacent plants come into contact with diseased plants, particularly under humid conditions. Development of white mold ceases when temperatures reach around 90^{0}F or the environment dries out. Moderate air temperatures, frequent rain or irrigation, and high humidity from flowering through pod development also favors disease development. In addition, beans with dense canopies or rapid canopy closure tend to be most susceptible to the disease. Yield loss is often associated with disease incidence in the field.

Management

No single management method effectively prevents the infection process from occurring; however, research has indicated that several measures can help reduce damage from white mold, thereby minimizing yield losses. The following management practices should be

followed if you have fields with consistent white mold disease pressure:

1. Long rotations to corn, wheat or other small grains can help reduce inoculum by stimulating germination of sclerotia. Short rotations between corn/wheat and beans or other susceptible hosts (sunflower, soybean, potato) can increase the buildup of inoculum over time.
2. Avoid over-fertilization. Thick dense plant growth that results from excessive fertilization causes the canopy to close sooner resulting in cooler more humid condition within canopies, creating an ideal environment for white mold development.
3. Space rows at the widest distance that will maintain maximum yields. It is important to avoid high plant population and narrow rows. This will also cause the canopy to close sooner favoring disease development
4. Avoid excessive irrigation. Efficient use of irrigation water is important since disease development depends on there being moist soil beneath the canopy. Infection can be reduced by keeping the soil surface as dry as possible during pod fill and maturation.
5. Harvest fields with white mold last to avoid introducing the diseased plant tissue or sclerotia attached to equipment into other fields.
6. Timing of fungicide application. This is critical to protect as many blossoms as possible from infection. Fungicides must be applied in sufficient volume of water to provide thorough coverage of all susceptible plant parts.

If a susceptible variety is planted in a field with a history of disease, treatment with a fungicide may be needed. During the season white mold can be managed with the use of fungicides including Thiophanate-methyl (FRAC group 1), Boscalid (FRAC group 7), and/or Prothioconazole (FRAC group 3) groups. Review recent fungicide efficacy trials (https://www.ag.ndsu.edu/carringtonrec/plant-pathology/fungicide-efficacy-testing-results-2013-dry-edible-beans) to compare a more extensive list of compounds currently registered for use on dry beans. These products are most effective if applied at R1 (every plant has one or more open blossoms) growth stage, before symptoms develop. Fungicide applications made later or after disease is detected may not provide adequate disease control. Canopy penetration and coverage are essential to manage white mold with fungicides. Follow all label directions whenever using fungicides

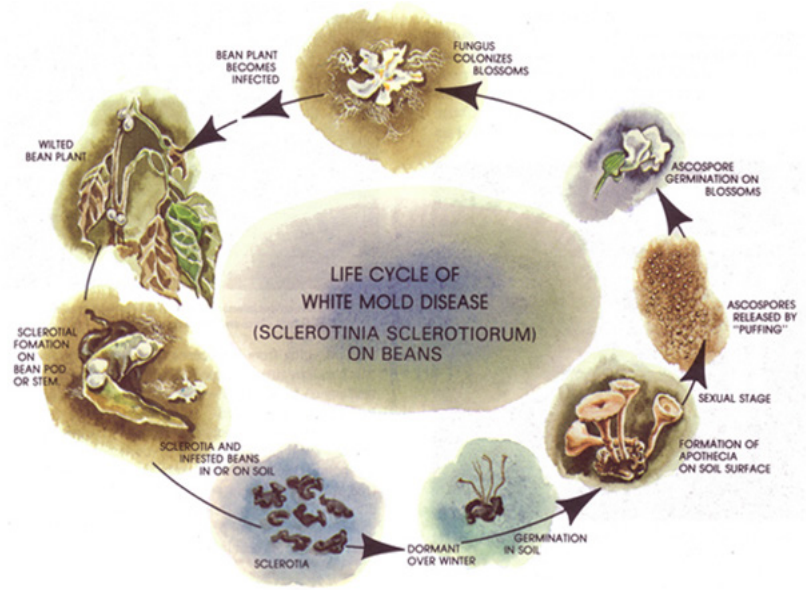


Figure 1. Life cycle of white mold disease (http://extension.colostate.edu/topic-areas/agriculture/white-mold-of-dry-beans-2-918/)

History of Dry Bean Production and Breeding in Colorado

Dr. Mark A. Brick

Appears as published in Oct. 2014

Dry beans have been grown commercially in Colorado for more than 100 years. The primary market class has always been the pinto bean, usually comprising more than 90% of the total crop. Other market classes have been produced, including small red, Anasazi, pink, light red kidney, small white and others. Today, light red kidney is the second largest market class, comprising 5 to 15% of total production.

Pinto beans have been an important crop in Colorado agriculture since production statistics were first compiled in 1909. At that time, 5,000 acres were planted that had an average yield of 580 lb/A at a price of $3.60/cwt. Pinto bean production increased rapidly thereafter. In 1914, 20,000 acres were planted and by 1917 production increased to 243,000 acres, of which only 40,000 acres were under irrigation. Annual production in Colorado increased from 180,000 cwt in 1914 to 900,000 cwt in 1917. The industry enjoyed steady growth throughout the 20s and 30s, and saw a record high in 1943 with 460,000 harvested acres. Average yield at that time was 535 lb/A at $5.70/cwt. From 1970 to mid-1990's, acreage fluctuated between 120,000 to 225,000 acres annually, and average yields steadily increased to more than 1800 lb/A. Prices during this period varied from $8.60 to $31.20/cwt. Acreage since the mid-1990s has steadily declined due to low prices. In 2011, the area planted to bean was the lowest since the mid-1910s at 38,000 acres. Prices currently vary between $14 to to 24/cwt. Given that the current cost of production is estimated at $15/cwt, it is clear that the profit margin for the bean crop is minimal and lower prices have reduced the number of acres planted to historic lows.

Dry Bean Improvement and Breeding

Alvin Kezer and Walter Sackett were among the first scientists in Colorado to work with dry beans. In 1918, they reported on dry bean production practices in Colorado during the early 20th century in publication "Beans in Colorado and Their Diseases". Early bean varieties were derived from land races that were grown by Native Americans or imported from other regions, including Mexico. The market class that we recognize today as pinto bean was known by several names during the early years of cultivation including: Mexican, Mexican bean, Mexican tick bean, Colorado bean, army bean, and others. The name pinto was well established by the mid-20th century, and the pinto is now recognized market class according to USDA Agricultural Marketing Standards.

Dry bean breeding activities in Colorado during the early 20th century were primarily focused on single-plant selections from land races and varieties that were brought into Colorado. Kezer and Sackett stated that, "…much progress can be made from selection with pinto beans as is sometimes done with corn in the Midwest". Suggested selection criteria included high individual plant yield, early maturity, uniform ripening of pods, and freedom from disease. The selections were planted in rows, and the highest-yielding rows that had desirable agronomic characteristics were saved for future planting stock. Kezer and Sackett stated that "Preliminary work with bean selection shows that it is easily possible to increase the yield 25% by selection alone". Undoubtedly, these early selections produced both higher yield and better disease resistance that in early varieties.

Pinto beans were also very important in the San Juan Basin of south central Colorado during the early 20th century. Early varieties were also derived from land races imported from other regions, especially the highlands of Mexico. During the 1930's, pinto bean varieties such as San Juan showed severe symptoms of bean common mosaic virus (BCMV) infection. Dwight Koonce, who worked on beans for Colorado A&M at Hesperus, CO, cooperated with a local bean grower Homer Norton to identify and select disease-free plants in the field. Their work led to the release of the variety "San Juan Select", a virus-resistant variety, the most widely grown pinto in the region until the early 1980's, when the pinto variety "Cahone" was released by CSU. Today, a small amount of acreage is still planted to San Juan Select in the San Juan Basin.

Origin of the Breeding Program


Don Wood

The first formal breeding program at CSU was first proposed in 1948 by Donald Wood. Don was hired as an Assistant Professor in 1947 to assist Dr. Warren (Red) Leonard with the barley breeding, and to help teach an undergraduate genetics course in the Department. In a draft proposal titled "A Plant Breeding Program for the Improvement of Pinto Beans in Colorado", Wood stated that "The objectives of the bean improvement program should be to: 1) Further study the bacterial blight organism, 2) Develop and maintain a Colorado pinto bean seed industry, 3) Breedfor resistance to the rust pathogen, 4) Study improved cultural practices, and 5) Breed for improved resistance to bean common mosaic virus and curly top (an aphid transmitted virus disease)".

Don Wood recalled his first years at Colorado A&M as follows:
"My appointment as Assistant Agronomist in Colorado Agricultural Experiment Station began January 1, 1947. I can still remember the beautiful snow that fell during the preceding Christmas holiday as contrasted to the wind-driven blizzards of my Kansas experience. I was assigned to assist Warren H. Leonard in his Genetics classes, develop an MS thesis problem with Ralph Weihing, teach Crops Laboratory, and audit the other crops courses being taught. Two other graduate students joined the Department soon after I came, Ronald Ensign and Robert Osler. We were all pursuing MS degrees. I was under Dr. Leonard's tutelage, Osler was "Scotty" Robertson's student, and Ron Ensign also worked under Robertson on barley".

In 1946, a severe rust epidemic occurred in eastern Colorado. At that time, Dr. William (Bill) Zaumeyer, a USDA scientist working on beans at the Potato Research Station in Greeley, Colorado, studied the rust pathogen and conducted a breeding program to improve garden and pinto beans for the western US. Dr. Zaumeyer spent summer months in Greeley conducting field plots and winter months at Beltsville, MD conducting laboratory and greenhouse research. He made crosses during the winter in Beltsville, MD and planted the progeny in Greeley for evaluation and selection. Dr. Zaumeyer planted about three acres of garden beans and one acre of pinto beans in his search to find new sources of resistant genes and improved varieties. After the epidemic, Dr. Zaumeyer requested funding from the Colorado State Legislature to work on control mechanisms for rust and incorporation of rust resistant genes and incorporation of rust resistance into pinto bean. In 1947, Bill Zaumeyer found the perfect stage of rust and convinced the Colorado State Legislature to provide $10,000 to fund bean research. From these funds, research on control methods using sulfur and variety testing were initiated. The following years, economic damage to the bean crop due to bean rust

was significantly reduced due to timely applications of sulfur at the first sign of rust.

Graduate Research Assistant Ron Ensign also conducted a variety testing program that included new lines developed at the University of Idaho and resistant strains from Zaumeyer's program. According to Don Wood, "Bean varieties from Idaho had a growth habit that was attractive to the growers and although susceptible to rust, they soon became the choice of farmers in the eastern irrigated counties". Zaumeyer and his assistant, H. Rex Thomas, worked hard to get an agronomic type equal to the Idaho varieties with rust resistance. During the latter part of the 1940's, Bill Zaumeyer wanted to reduce his travel to Greeley in the summer, so he worked out an agreement with Don Wood to have the USDA package seed of pinto breeding lines and mail them to the Colorado for planting, evaluation, and selection. Eventually, Don Wood planted the entire Zaumeyer nursery. From these efforts the variety "Scout" was released; however Scout was not widely grown because it did not have the agronomic desirability that was available in the pinto varieties released from the University of Idaho, namely UI 71, UI 78 and UI 111.

In 1950, Don Wood pursued a PhD at the University of Wisconsin. Don recalled the day he left for Wisconsin to start his studies; "As I was driving out of town, I heard about the invasion of South Korea by North Korea on the radio. Because I had served in the Marine Corps during WWII, I thought that I may as well turn around and return home because I would be recalled to duty. However, I kept on driving and the recall never occurred." At the UW, Don studied corn genetics and the genetic mechanism involved in variegated seed color. In 1956, he completed the PhD degree and returned to CSU.

Don immediately continued his involvement and cooperation with the USDA on dry bean breeding. In 1957, Dr. Doug Burke was hired as a permanent breeder for the USDA to work at Greeley. However, shortly thereafter, Dr. Burke was transferred by the USDA to Prosser, WA, and the USDA no longer sent breeding material to Colorado. Consequently, Dr. Wood initiated a crossing program with continued emphasis on breeding for improved resistance to common bacterial blight resistance.

With the assistance of Mr. Ballarin, the breeding program became computerized and expanded the number of crosses made each year and subsequently the size of the greenhouse and field nurseries. The size of the field nursery went from approximately five acres in the early 1980s to more than twelve acres by 1989. Mr. Ballarin left the University to pursue other career goals in 1989, when Mr. J. Barry Ogg was hired to replace him. Barry continued upgrading computer utilization on the project and by the early 1990s, the project replaced the use of mainframe computers with desktop computers to keep all records. With Barry's assistance, the project doubled the number of crosses made each year and included field nurseries at three research stations with more than 18 acres of breeding nurseries at ARDEC in Fort Collins. Ogg continues his work on the project today.

Dr. Wood released three important pinto varieties that were widely grown under irrigation in the High Plains and western US. The varieties included, "Ouray" in 1975, the first upright growth habit pinto bean; "Olathe" in 1981, the first rust resistant pinto variety; and "Bill Z" in 1985, the most widely grown pinto in the US throughout the 80s and early 90s. These varieties replaced previous pinto varieties that were susceptible to rust and provided growers withhigher yield potential.

The dryland pinto breeding program in Southwestern Colorado began at Arboles, Colorado

during the mid-1950s. The program continues today at Southwestern Colorado Research Station at Yellow Jacket, CO. This program was initiated in connection with the Dolores River Project to improve bean yields in the San Juan Basin in cooperation with Howard Morre and Adrian Fisher at the research station in Ariola. Crosses for the breeding program were made by Don Wood at Fort Collins, and progeny were evaluated in southwestern Colorado under non-irrigated field conditions. The project released two important varieties including "Cahone" in 1982 and "Fisher" in 1995. Cahone was the first pinto variety to become accepted in San Juan Basin since San Juan select was released in the 1940s. Today, these varieties encompass essentially 100% if the pinto bean acreage in San Juan Basin.

In 1986, Dr. Wood retired as the leader of the Dry Bean Breeding Project at CSU and Dr. Mark Brick became the project leader. Mark had experience breeding forage crops, particularly alfalfa, and at the time of appointment he served as the Manager of the Colorado Seed Growers Association. The Dry Bean Breeding Program continued emphasis on the improvement of pinto bean varieties that possessed multiple pest resistance for the High Plains and western US. The program initiated crosses for improved varieties in market classes other than pinto bean, specifically black and great-northern beans in 1990. To date, the program released "Fisher" in 1995, "Montrose" in 1999, "Shiny Crow" in 2000 and "Grand Mesa" in 2001. These varieties represent unique varieties for their high yield potential and possessed a new gene for resistance to the rust rust pathogen. Shiny Crow was the first black bean variety released in the US that possessed a shiny seed coat rather than the traditional opaque (dull) seed coat luster. The shiny seed coat is a desirable characteristic for dry packaged black beans. Grand Mesa is semi-upright multiple pest-resistant pinto bean that possesses tolerance to rust, bean common mosaic virus, and white mold pathogen, a first in the pinto market class.

Mark Brick

A major influence on Dry Bean Breeding Program in the 1990s and later was the organization of the dry bean industry to provide funding for research program. In 1986, certified seed producers in western Colorado through the Colorado Seed Growers Association agreed to provide a voluntary contribution to the bean research programs at CSU based on certified seed tag sales. These funds enabled the breeding and plant pathology programs to enhance breeding efforts, especially for greenhouse and field screening efforts to improve and broaden resistance to rust and other diseases. Further, in 1991, the Colorado Dry Bean Administrative Committee formed, based upon a statewide commodity, "check-off" on the commercial sale of dry beans. The money was earmarked for use to support dry bean marketing and research in Colorado. These funds enabled the dry bean programs at CSU to improve research efforts in breeding, variety testing, pathology, and Integrated Pest Management. The funds were especially useful for replacing outdated equipment and hiring students to assist with research efforts.

In 2014, the dry bean research programs at CSU have activities in breeding, variety testing, pathology, seed production, and entomology that take place on campus and at three Agricultural Research Centers throughout Colorado. The emphasis includes breeding, and research to solve environmental, pest, and cultural constraints to production. Scientists cooperating on the dry bean programs today include Drs. Mark A. Brick (breeder) and Jerry Johnson (variety testing), Department of Soil and Crop Sciences; Drs. Howard Schwartz (plant pathology), Scott Nissen (weed science) and Frank Peairs (entomology), Department of Bioagricultural Sciences and Pest Management; Dr. Calvin Pearson and Fred Judson, Western

Colorado Research Center at Fruita; Mark Stack, Southwestern Colorado Research Center, Yellow Jacket; and Dr. Abdel Berrada, Arkansas Valley Research Center, Rocky Ford. Colorado dry bean producers benefit significantly from one of the most diverse and productive dry bean research programs in the US today.

In the mid-2000s, the Dry Bean Breeding Project initiated research on the chemical and nutritional composition of dry bean cultivars. Dr. Henry Thompson of the CSU Cancer Prevention Laboratory is collaborating with Dr. Brick to identify bean cultivars and market classes that have maximal health benefits. The research includes laboratory and pre-clinical trials regarding the ability of beans in the diet to influence the development of cancer, diabetes, and other diseases. Future work will focus on the Identification of the genetic control of the factors that relate to health benefits of bean.

Article available online at: http://beans.agsci.colostate.edu/history.html

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