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FIELD BEAN PRODUCTION WITHOUT IRRIGATION IN COLORADO

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COLORADO AGRICULTURAL EXPERIMENT STATION
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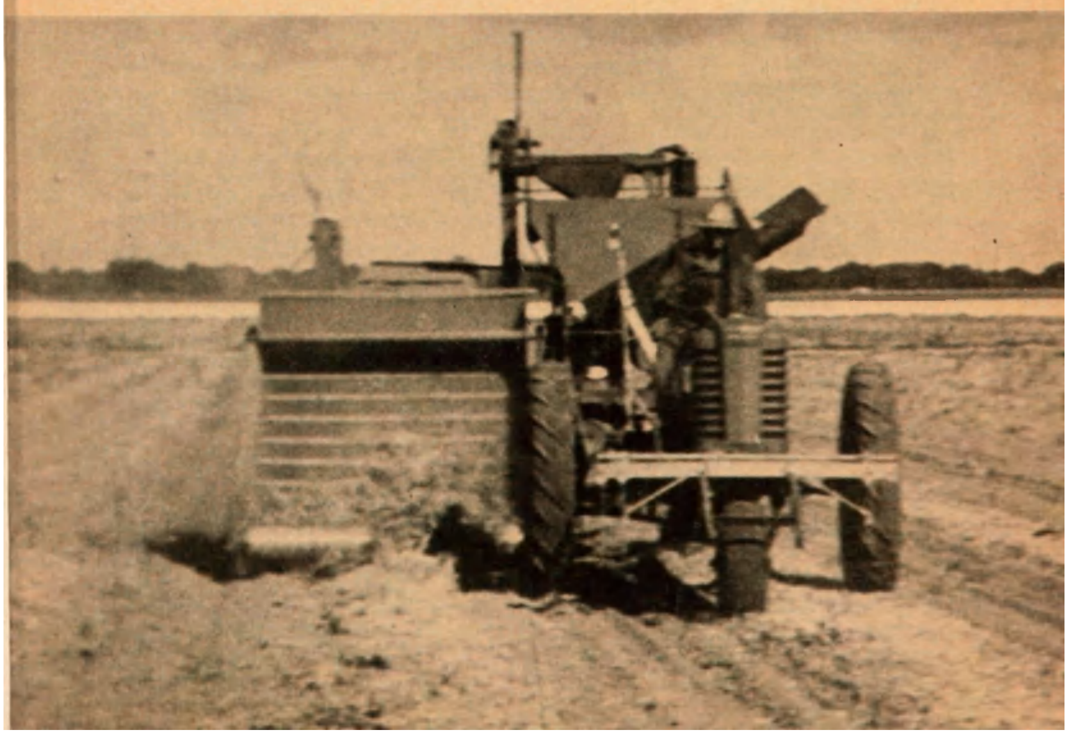

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Field Bean Production Without Irrigation in Colorado

J. F. Brandon, D. W. Robertson, A. M. Binkley, and W. A. Kreutzer[1]

FIELD BEANS are an important crop in Colorado. They provide a concentrated type of vegetable protein food that is especially in demand during times of stress such as are induced by total war. Of all the wartime crops designated as necessary, beans are best adapted to climatic conditions in eastern Colorado. The average non-irrigated acreage of dry beans in Colorado for the 10-year period ending in 1942 was 218,800[2] acres with an average yield per acre of 250 pounds.

While important and relatively reliable, beans do not fit readily and safely into plains farming practices because they leave the soil surface in the fall especially susceptible to wind erosion. Soils after a dry bean crop present a greater hazard to wind erosion than soils after small grains, millet, corn, or sorghums. However, bean land can be handled so that it will not present a wind erosion problem. Better farming methods are necessary, however, than with any of the other adapted and commonly grown Colorado non-irrigated crops.

Adaptation

Dry field beans are well adapted to those sections of Colorado where the season is long enough to permit maturity. They are in no sense resistant to drought, but like proso, are a comparatively short-season crop and may escape drought damage. In its ability to wait for sufficient soil moisture during the fruiting stage, the bean is not unlike the well-adapted sorghums.

Beans are better adapted to the more sandy soils of the non-irrigated sections. Good yields, however, can be obtained on the so-called hard lands when conditions are normal or near normal. Also hardland soils are safer for bean production because after harvest they are more easily put in a condition to resist wind erosion.

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[2] Colorado Agricultural Statistics, 1941. Issued by Colorado Cooperative Crop and Livestock Reporting Service, Denver, Colo.

[3] The U. S. Dry-Land Field Station, located near Akron in northeastern Colorado at an altitude of about 4,500 feet, is operated by the Division of Dry Land Agriculture of the Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U.S.D.A., in full cooperation with the Colorado Agricultural Experiment Station.

Association with Other Crops

Beans on non-irrigated lands should be grown in alternate strips with other crops which leave a good anchoring stubble as added protection against soil blowing, and in no larger acreage than the operator is willing and able to list or otherwise surface-work immediatcly after the bean crop has been removed. The strips should preferably be at right angles to the direction of the prevailing winter and spring winds of the region. The physical nature of the surface soil determines the widths of the strips of beans and alternating crops. The strips vary from 1½ to 6 rods wide. Plains soils must be protected from blowing.

Figure 1.—Strip cropping of beans with corn.

Quality in beans is not often correlated with yield, so it is independent of their association with other crops or their sequence position in the rotation. Good quality beans are produced with yields of 1 to 3 bushels per acre at the U. S. Dry Land Field Station, Akron, Colo.

Preparation of the Seedbed

Fallow is undoubtedly the best preparation for beans, but the increased yield from that preparation over stubble land has not been determined definitely in Colorado. There is every reason to believe, however, that beans at present wartime prices would return as large a net return as would winter wheat on that preparation. However, by strip cropping, there would be only about half as much acreage in beans as there would be in winter wheat. A sorghum is recommended for the companion strip-crop with beans. The planting of fallowed land with beans and sorghum, instead of wheat, may be justified now as a wartime practice, since beans fit well into a rotation as a cash crop following a small-grain crop.

Small-grain stubble land intended for beans should be worked early in the spring and kept free of weeds up to planting time. If the stubble and weed debris is dense, the disk or "one-way" is probably the only implement practical to use. Such a weedy condition, however, may indicate that the stubble should have been worked the preceding fall, immediately after harvest. Later spring workings on the stubble land should aim to destroy weeds and to keep the surface open and receptive, preferably "pock-marked", to trap any hard beating rains. Rainfall the last of April and through May is likely to be torrential, and subject to heavy run-off from all smooth surfaces. It is well to remember that rainfall which runs off the land being prepared for crops is not stored in the seedbed where it is needed. It is equally well to remember that weeds growing on such a seedbed take up part of the moisture already in the soil. The rainfall on the plains is hardly sufficient to support one crop per season. Weeds are a competing crop and draw heavily on soil moisture. *Keep them off!*

Early fall working of stubble land at the time of harvest or immediately after may be necessary if weeds are present. Experiments at the U. S. Dry Land Field Station at Akron show that fall work done no earlier than August 25 is as good as spring work, but no more beneficial to crop yield prospects. Any fall work on stubble land should be earlier than this, and aim to leave the surface as well-conditioned to trap snow and resist soil blowing as the stubble itself. The duckfoot or field cultivator functions very nicely. The lister also qualifies for this work.

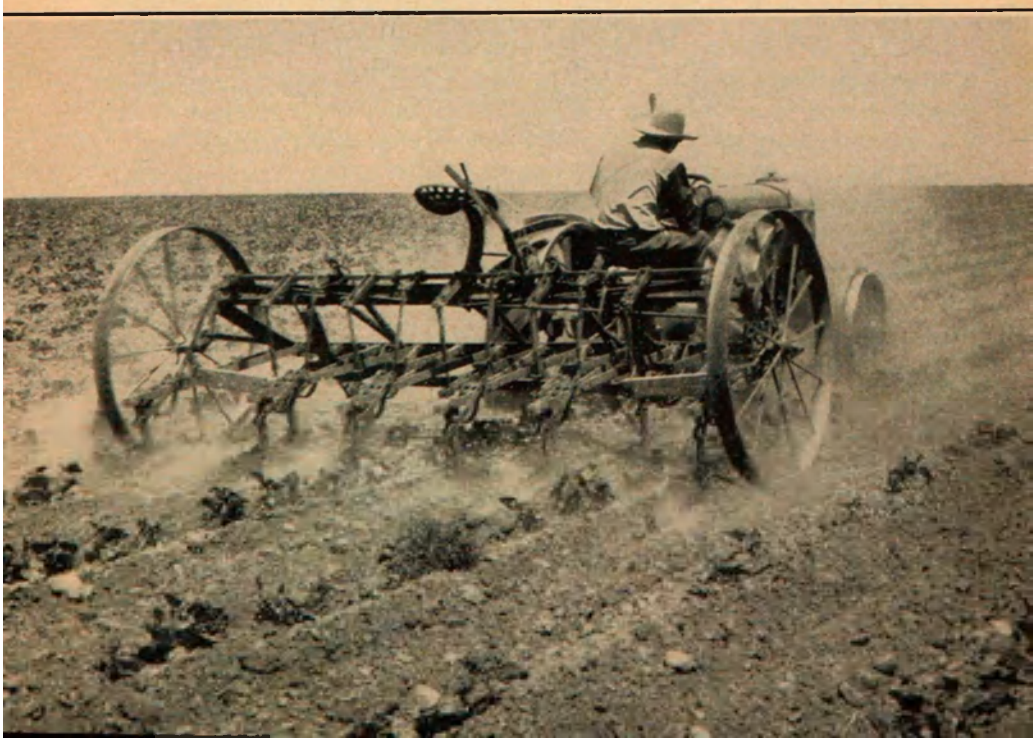
Row-crop land should also be early spring worked, not later than when the first weeds start, and kept free of weeds and in the best surface condition to trap rainfall up to planting time. Sometimes such stubble land, especially when the row crop has been harvested close to the ground, will present a wind-erosion problem and actually start to blow. In such cases, the seedbed culture for the next crop should be in the fall, or when the blowing starts, and of such nature as to up-end the root clumps. The duckfoot or field cultivator is an excellent implement for such jobs. The disk in such cases may give temporary relief, but it pulverizes the soil and may leave it in a condition favorable for blowing.

Bean Land in Relation to Soil Blowing

Beans are cultivated until late summer, and are harvested in the early fall by under-cutting knives. Thus the soil surface is left loose and pulverized by the action of the cutting knives and in an ideal condition to blow. The harvest knives leave no stubble cover, and no root clumps that can be up-ended to provide a rough cloddy surface as protection against blowing. Thus the land is very susceptible to wind erosion at the beginning of a period when the hardest winds of the year are to be expected. After-harvest rains merely aggravate a bad situation by leveling. They do, however, when heavy enough, simplify proper culture. Generally in the past, after-harvest culture has been inadequate. Thus, there has been widespread blowing of bean-land soil. The U. S. Dry Land Field Station at Akron, Colo., has had success in properly surfacing bean land by using the duckfoot or field cultivator and working deeply. The lister will function as well or better. Some similar fall work is absolutely necessary if beans are to be grown on the plains. This, with the recommended alternating strips of stubble cover at right angles to the prevailing winter and spring wind directions, will make it possible to safely grow beans on non-irrigated soils.

It is not advisable to plant winter wheat on bean land though experiments show good results when beans are followed by any of

Figure 2.—Tractor-drawn bean cultivator.



the small grain crops. The first problem is to re-establish a cloddy condition of the surface. Once it has gone safely through the winter, bean-land soil is in excellent condition for spring-sown barley, oats, or any of the later spring-planted crops. Beans provide as good or slightly better preparation for succeeding crops than corn.

Method of Planting

Beans are planted in regulation-width 40- to 44-inch rows on non-irrigated lands, the same as corn and sorghum. The planting implement is usually the lister. Surface planting is undoubtedly just as successful where equipment for it is available, and it actually has many advantages. A weed-free soil is desirable with any method of planting since the beans never attain much height and it is nearly impossible to cover weeds in the row. There probably is no objection to listing and planting in the same operation, but it is not an approved practice unless the surface has been kept receptive to rainfall and free of weeds up to that time. Where listing and damming has been done earlier in the spring and is an approved practice, the lister should follow and open out the old furrows in planting. Splitting lister ridges on the hard lands at the U. S. Dry Land Field Station at Akron has resulted in a lower yield of corn. If the ridges are weedy, a lister cultivation before planting will save a cultivation that would otherwise be necessary after planting. Some farmers plant and cultivate immediately, before the beans have emerged. Splitting the ridges to destroy a weed crop is not advisable on the hard lands. The small bean plants or seedlings must emerge relatively free of weeds, and the crop must be kept in that condition up to maturity. As previously pointed out, the normal rainfall is not sufficient to maintain two crops on the same land during any one season. Any other competing plants such as weeds, take moisture at the expense of the bean crop. Preparation of the seedbed, planting, and culture of beans are not greatly different from those for corn and sorghums. Any successful grower of non-irrigated corn should have no trouble producing beans.

Date of Planting

Experimental findings at the Akron Station clearly show that the best period for planting beans is between June 10 and June 20. The June 15 planting produced better than the July 1 date, which is too late at 4,500 feet altitude. No yields were obtained from July 15 plantings in 1932, 1933, 1934, and 1935. Four varieties were planted at 15-day intervals from May 15 to August 1. The soil preparation was proso millet stubble land, spring cultivated when the first weeds emerged and kept free of weeds up to the respective planting dates.

The lister was used for planting. The duckfoot cultivator and the spring-tooth harrow were used in the seedbed preparation cultivations. All four varieties gave the highest yield for the June 15 plantings. This experiment shows even more clearly than the variety experiment the superior adaptation of the pinto bean. The results indicate that the later the planting, the better the prospect of a yield provided there is yet time for full maturity. Slightly later planting may be possible and even advisable at lower altitudes and at more southerly points.

This experiment showed that it is possible to render land practically free of current season weeds by about the end of June. Very often it was unnecessary to cultivate plantings made as late as July 15. The June 15 planting required one less cultivation than those made on May 15 and June 1. However, one more pre-planting cultivation was required for the June 15 planting date. The land for the July 15 and August 1 dates had an average of three and one-half cultivations per season before the plantings were made. The May 15 and June 1 dates had one before and an average of two and one-half cultivations per season after the plantings were made. The average yields for the 7 years, 1930-1936, are presented in table 1.

TABLE 1.—*Seven Year Average Yields of Four Varieties of Beans in Bushels per Acre for Six Dates of Planting for the Years* 1930 *to* 1936, *Inclusive, at the U. S. Dry Land Field Station, Akron, Colo.*

Planting Dates	Variety Grown in Bushels per Acre			
	Pinto Sel. 27	Great Northern	Robust Pea Bean	Navy Pea Bean
Middle of May	5.2	2.2	3.7	3.0
First of June	**6.0**	**2.9**	**4.3**	3.4
Middle of June	**7.7**	**3.7**	**5.1**	**5.7**
First of July	4.7	**3.7**	3.1	**4.3**
Middle of July	1.8	.9	.6	1.2
First of August	0	0	0	0

Rate of Planting

An experiment to determine the proper rate to plant beans has been conducted at the U. S. Dry Land Field Station at Akron, Colo., for the 5 years, 1938 to 1942. Plants were spaced 6, 12, 18, 24, 30, 36, and 42 inches apart in 40-inch rows. The seasons varied considerably and no definite spacing can be recommended. The high yields were obtained with spacings from 6 to 30 inches apart, depending upon the season.

Table 2 gives the results of the spacing studies. More data are necessary before definite conclusions can be drawn.

The straw yields from this test were progressively lower from the thickest to the thinnest spaced plants in the row.

TABLE 2.—*Yield of Beans in Bushels per Acre Planted at Different Spacings at the Akron Field Station from* 1938 *to* 1942.

	Approximate spacing in inches between bean plants						
Year	6	12	18	24	30	36	42
1938	3.0	3.6	3.6	4.5	**4.6**	†	†
1939	0	0	0	0	0	0	0
1940	4.5	4.3	5.5	**7.2**	6.8	4.7	4.3
1941	3.5	**4.2**	3.6	3.7	3.9	3.3	3.0
1942	5.4	4.4	3.3	2.9	3.1	2.7	1.9
5-Yr. avgs.	3.3	3.3	3.2	3.7	3.7	..	..
4-Yr. avgs.	3.7	3.2	3.1	3.5	3.5	2.7	2.3

†Not planted in 1938.

Variety Studies

The varietal tests of beans and the rate of seeding experiment were made on oat-stubble land, duckfoot cultivated immediately after harvest, and kept free of weeds up to planting time the following year. Planting in all these experiments was with a corn planter equipped with furrow openers in 40-inch rows. Where such widely different varieties as Tepary and Baby Lima adjoined the other standard bean types, an extra row of each was planted as a guard, harvested, and then discarded. Not less than three, and up to five, replications of each variety were planted and harvested for yield determination. These beans were clean-cultivated.

TABLE 3.—*Yields in Pounds and Bushels per Acre of Five Standard Bean Varieties from* 1924 *to* 1936 *on the U. S. Dry Land Field Station, Akron, Colo.*

Variety	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	13-Year Av. Yields Lbs.	13-Year Av. Yields Bus.
Pinto Sel. 27*	119	100	577	567	160	410	1007	47	40	327	0	272	204	295	4.9
White Mexican	123	75	477	500	153	367	687	40	107	153	6	348	236	252	4.2
Field Wax	133	77	417	517	113	350	820	60	53	193	20	252	212	247	4.1
Mich. Robust	102	27	380	267	103	387	720	40	60	80	13	264	296	211	3.5
Navy Pea Bean	100	67	320	350	47	283	887	28	33	93	6	140	180	195	3.3

*Pinto Sel. 27 is a selection out of Pinto beans.

The Pinto is clearly the best-adapted market variety of field bean for the region. It is followed by an Akron Station strain of Great Northern, identified as White Mexican. This is the best of the white beans. Field Wax is another large colored bean, but is inferior to the

Pinto in its adaptation. Robust, a Michigan Experiment Station selection from Navy, was slightly superior to its parent in this test. However, both the Robust and Navy are inferior in yield to the large white bean identified as White Mexican. Its superior yield over Great Northern is shown in table 4.

TABLE 4.—*Yield in Pounds and Bushels per Acre of Great Northern and the Local Strain of the Same, Identified as White Mexican, for the* 11-*Year Period from* 1926 *to* 1936 *at the U. S. Dry Land Field Station, Akron, Colo.*

Variety	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	11-Year Av. Yields Lbs.	11-Year Av. Yields Bus.
Great Northern‡	350	417	187	243	487	53	53	147	6	228	232	218	3.6
White Mexican	477	500	153	367	687	40	107	153	6	348	236	279	4.7

‡Seed was secured from the Sheridan, Wyo., Experiment Station in 1926.

Several other varieties and selections were tested. Tepary yielded well as will be seen from table 5. However, this variety is not an accepted market bean because of its disagreeable flavor.

TABLE 5.—*Yield in Pounds and Bushels per Acre of Two Strains of Tepary and of Pinto Beans,* 1924 *to* 1934, *U. S. Dry Land Field Station, Akron, Colo.*

Variety	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	11-Year Av. Yields Lbs.	11-Year Av. Yields Bus.
Redfield Tepary Strain	383	135	827	467	303	683	1788	340	407	607	73	547	9.1
Akron Tepary Strain	290	83	553	550	377	550	1583	207	220	630	47	463	7.7
Pinto Sel. 27	119	100	577	567	160	410	1007	47	40	327	0	305	5.1

Forty-two selections to improve the appearance and yield of Pinto beans have been made at Akron. While little gain in yield has been obtained, a more uniform marking has been established. Akron 27 is the best of these selections. Table 6 presents the yield data comparing unselected Pinto and Akron Selection 27.

TABLE 6.—*Comparative Yields in Pounds and Bushels per Acre of Pinto and Pinto Selection No.* 27, 1927 *to* 1937, *U. S. Dry Land Field Station, Akron, Colo.*

Variety	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	11-Year Av. Yields Lbs.	11-Year Av. Yields Bus.
Pinto	633	177	483	1020	73	20	273	13	220	228	24	288	4.8
Pinto Sel. 27	567	160	410	1007	47	40	327	0	272	204	0	276	4.6

Straw Yields

Bean straw production is not heavy per acre, but the straw is generally rated as valuable livestock roughage feed. It is reasonable to expect about 650 pounds per acre from an average appearing field of Pinto beans. The straw yield from Pinto Selection 27, recorded in table 7, varied from a high of 1,460 pounds per acre in 1926 to a low of 193 pounds in 1934.

The Tepary bean again shows its fine adaptation to the environment by producing the most pounds of straw per acre. Effort has been made in the past by some Experiment Station writers to popularize this variety as a green, protein-bearing hay crop. However, where adapted, Sudan grass will outyield it by a wide margin, and experiments have shown that if Sudan grass is cut in the preheading stage it will provide a green hay of comparatively high protein content.

TABLE 7.—*Straw or Stover Yields in Pounds per Acre from Six Varieties of Field Beans from* 1926 *to* 1936, *U. S. Dry Land Field Station, Akron, Colo.*

Variety	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	11-Yr. Aver.
Tepary	1310	1133	297	900	1547	580	687	993	233	740	832	841
Pinto Sel. 27	1460	783	383	520	1133	300	533	440	193	848	576	652
Navy Pea Bean	910	717	297	583	1153	427	373	417	147	1020	524	597
Field Wax	1450	583	230	433	887	480	300	333	167	640	424	539
Mich. Robust	790	810	323	407	967	380	293	240	128	660	668	515
White Mexican	560	500	307	500	820	347	187	300	147	616	528	437

Yield Tests of Pinto Strains from Different Localities in the State

In 1930, Mr. T. G. Stewart, then Extension Agronomist for Colorado, questioned whether the Pinto bean growers of the State were using the best-adapted strains. In order to determine this, samples were collected from several growers and grown in comparative tests at Akron. Results are shown in table 8.

This experiment shows little difference in yield for the Pinto strains tested. The lowest yield over the period, produced by the Cantora, Trinidad, strain is only 8 percent less than that from the Akron Station Selection 27 used as a check. The highest, produced by the Florian, Akron, strain is only 4 percent more than that of the check.

All these strains produced closely similar amounts of straw per acre also. The lowest acre-yield of straw was produced by the Akron Selection 27.

Table 8.—*Yields in Pounds per Acre of Twelve Strains of Pinto Beans. Selections Grown at the U. S. Dry Land Field Station, Akron, Colo., for the 12-Year Period, 1930 to 1941, Inclusive.*

Strain Identification	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	Av. Yield Lbs.	No. Yrs.	Yld. of Pin. 27 Same Yrs.	% Pinto Sel. 27
a	1007	47	40	327	0	272	204	0	198	0	153	306	213	12	213	100
b	1087	40	40	380	6	248	280	0	108	0	140	318	221	12	213	104
c	1100	47	20	347	13	168	236	0	90	0	173	318	209	12	213	98
d	953	40	40	327	6	272	236	0	96	0	220	312	209	12	213	98
e	1053	47	40	327	13	244	216	0	...	0	173	318	221	11	214	103
f	1020	40	40	273	27	220	228	0	114	0	193	366	210	12	213	99
g	1020	47	40	353	13	216	260	0	120	0	200	342	218	12	213	102
h	1040	27	40	300	13	228	200	0	90	0	147	342	202	12	213	95
i	1053	53	40	340	13	180	276	0	102	0	187	...	204	11	204	100
j	893	40	40	327	20	212	268	0	102	0	173	270	195	12	213	92
k	...	60	40	293	33	216	192	0	114	0	173	318	131	11	141	93

a Station Pinto Selection 27.
b Mr. George Florian, Akron.
c Mr. C. C. Powell, Trinidad.
d Mr. G. H. Spalding, Colorado Springs.
e Mr. Barnes, Trinidad.
f Mr. R. B. Golden, Nunn.
g Mr. C. E. Goff, Fleming.
h Mr. D. H. Ernest, Trinidad.
i Mr. H. B. Tregent, Nunn.
j Mr. Cantora, Trinidad.
k Mr. E. E. Zediker, Byers.

In 1936, several other selections of Pinto beans from various sources and Baby Lima beans were sent to the Akron Station for testing. Table 9 gives the data on yield obtained from a variety test including the newer selections.

TABLE 9.—*Yields in Pounds per Acre of Pinto Bean Selections and Lima Beans at the U. S. Dry Land Field Station, Akron, Colo., for varying Periods of Years Between* 1936 *and* 1942, *Inclusive.*

Variety	Yield in Pounds per Acre							Av. Yield Lbs.	No. Yrs.	Yield of Pinto 27 Same Yrs.	% Pinto 27
	1936	1937	1938	1939	1940	1941	1942				
Pinto Sel. 27	204	0	198	0	153	306	373	176	7	176	100
Ex. Ea. Hesperus.	232	0	66	0	193	318	393	172	7	176	98
Perterson-Olathe	...	...	...	...	160	276	...	218	2	230	95
New Mexico 247..	...	...	...	...	162	246	433	280	3	277	101
New Mexico 291..	...	...	...	...	184	234	447	288	3	277	104
New Mexico 295..	...	...	...	...	200	228	460	296	3	277	107
Cortez-Colorado .	...	...	...	...	173	306	...	160	3	153	105
Baby Lima	...	...	...	...	127	198	0	108	3	277	39

Several varieties tested for 3 years show promise; however, further tests are necessary before their exact values can be determined. Extra Early Hesperus, at the end of 7 years, is very promising. Not especially early under Akron conditions, it outyielded the Akron Selection 27, used as a check, during 4 of the 5 years that yields were secured. Its low yield in 1938 is not explainable and prevents full recommendation for the strain. From these and previous data the indications are that selection, while obtaining uniformity of type, has not increased yield appreciably. Undoubtedly, Baby Lima is not adapted as a dry bean crop to Akron conditions. The Baby Lima is early and may have some value as a garden bean.

Harvesting

Quality of beans refers to the requirement of market grades. Good quality beans should have a good, natural color and be free from diseased, cracked, or damaged beans and other foreign material.

Quality in dry beans is almost wholly determined by the stage of maturity at fall frost date, and by the weather that prevails after harvest. Normally beans are ready for harvest at Akron by the first week in September. Occasionally beans will continue to set pods until the first killing frost in the fall. This creates a harvest problem. If they are allowed to stand, and the first fall frost is severe, the quality of the threshed product may be damaged. Frozen immature beans are nearly impossible to separate out in the threshing. Beans probably should be harvested by September 20, regardless of the stage of ripeness. Unfrosted immature beans will shrink in drying and can be separated in threshing. Beans are ready for harvest when some of the pods are dry and a large part of the remainder show "striping", a ripening characteristic of the Pinto. Such nearly mature beans will continue ripening in the shock. Too many dry pods will result in heavy shattering when the beans are harvested.

Mechanical pullers are available. They can also be improvised and made. They are generally in units that extend over and pull two rows, windrowing the plants to the center by use of guard rods. Some farmers use the hay rake for bunching the windrowed beans, but the main disadvantages of this practice are shattering and the tendency to make bunches that are too large for proper curing.

Other farmers make small piles or cocks with a fork and combine the small piles into larger piles as the beans cure. There is no question that this method increases labor, but in average seasons weather conditions will not cause loss due to discoloration or spoilage. These larger shocks may be left in the field until dry enough to thresh. This is sometimes hazardous, however, since the bean shock can never be constructed so that it will shed rainfall. When the beans are nearly dry they may be piled in low, narrow, long ricks, topped with some rainfall-shedding material such as grass, hay, or straw. Then the beans can be watched and the piles torn apart and moved if molding and heating sets in.

Figure 3.—Two types of dividers used on tractor-mounted bean pullers.

Figure 4.—Beans piled to cure before threshing.

Still other bean growers field-cure longer and place in stacks or ricks, properly covered, to await threshing. Considerable experience is necessary to know when beans are dry enough to place in these large stacks. Molding and heating are in evidence only when the center begins to sag and by that time the damage already has been done. Molding in the field, and molding and heating in the stack result in low-quality beans.

Of the three methods, hand piling of small cocks and combining them into larger shocks as the beans cure, is probably the safest, best, and most likely to result in regular yearly production of high-quality beans. Beans are relatively troublesome and expensive to harvest and cure properly for threshing.

Threshing

Threshing is solely a problem of having the cylinder speed sufficiently slow and having enough concaves removed to prevent cracking the beans. Cracked beans are of low quality. At the same time, the separating mechanism of such machines must be operating at about normal speed. Special auxiliary jacks are available for converting most small-grain separators into bean threshers. However, with all concaves removed it is generally reported they crack the beans. Special bean threshers are available, and are recommended for use. Cracked beans, when used for seed, due to breaking of part of the growing point, may sprout but never advance beyond the two-leaf stage. This condition is known as "bald head."

Description of the Two Leading Varieties

The Pinto bean plant is normally a low-spreading bush. However, when ample soil moisture is available it will develop climbing runners. The bean itself is among the large commercial types. It is about 9/16 of an inch long and about 5/16 of an inch wide. The germ-side line is practically straight, the other forming an ellipse. It is very plump, the width often equalling the breadth, but is more generally slightly flattened. The base color is pinkish white when first shelled, but changes rapidly in storage to a bright rose-tinted brown. The base color is freely splotched by irregularly shaped spots and stripes of rich brown tinted with green. The eye is white, generally surrounded by a bright yellow brow. Pure Pinto beans, however, are heterozygous for eyebrow color. Pintos are a strong-flavored bean compared to the Navy.

Several strains of Pinto beans have been developed in the Western States. Idaho has developed an early strain of Pinto beans which is grown in the irrigated sections of northeastern Colorado. A medium-early strain is also produced in Wyoming. New Mexico has developed several strains, some of which have been tested at Akron, Colo. As previously mentioned, there are several local strains available in different sections of Colorado.

The Great Northern is also a bunch-type bean, but more upright than the low-spreading Pinto. It also produces a large bean, milky white in color. Water striations are visible under the outside coat of the freshly shelled beans. The shape is slightly like that of the kidney type, the germ line dipping in perceptibly at the eye. It is about as long, but not as broad or thick, as the Pinto. In taste and cooking qualities it is more like the mild-flavored Navy. Great Northern enjoys wide recognition as a food bean. Formerly the Great Northern always topped the local market in price. Today it merely shares the top rung of popularity with the Pinto.

Diseases

There are five bean diseases of major economic importance in Colorado. They are bacterial blight, halo blight, rust, root or foot rot, and mosaic. A brief discussion of each of these diseases follows, giving information which should enable a grower to detect the maladies and help to control them.

Bacterial Blight

Bacterial blight is probably the most serious disease of beans in Colorado. Its causal agent is a bacterium, *Phytomonas phaseoli.* The disease is introduced into a bean field by planting infected seed.

The earliest symptoms are usually noted first on the leaves. However, they may be detected also on the stems and the pods if infection has occurred late in the season. These early manifestations consist of the appearance of tiny water-soaked green spots on the leaves, longitudinal water-soaked streaks on the stems, and small sunken water-soaked spots on the pods. As the disease progresses, the spots or streaks may enlarge, soon turning reddish or reddish brown as the affected tissues die. If the seed in diseased pods is examined, sunken water-soaked to reddish-brown spots may be detected on occasional seeds.

During rainy weather blight spreads rapidly from plant to plant. Dry weather prevents spread of the disease. Since the disease is introduced into the field by diseased seed, and a few diseased plants in a field may be sufficient to cause a serious epidemic, care should be taken to plant disease-free seed. There is no spray or dust which will prevent the spread of bean blight. Seed should never be obtained from areas in which blight is prevalent. There are no varieties of beans resistant to the blight disease.

Halo Blight

The halo blight disease is difficult to distinguish from ordinary bacterial blight. Halo blight is caused by the bacterium *Phytomonas medicaginis*, var. *phaseolicola*. The symptoms on leaves, stems, pods, and seeds are very similar to those characteristic of bacterial blight. An important difference, however, is that the diseased spots on the leaves have a yellow to light-green margin or halo. The halo blight symptom is characteristic of cool weather. In hot weather diseased leaves frequently show small angular brown spots, and the leaves have a yellow hue. The halo effect is not so apparent.

As in the case of bacterial blight, halo blight is seed borne. In addition, the bacteria are spread from plant to plant by rain.

The only control for halo blight is to plant disease-free seed. This means the planting of seed which was grown in areas where the disease does not occur.

Rust

The rust disease is also a malady which spreads in wet rainy weather. It is a disease similar to the rusts of grain. It is caused by the fungus, *Uromyces appendiculatus*. The disease may be recognized by the appearance of felty brown-red pustules or eruptions on the leaves and stems. The felty pustule consists of innumerable microscopic spores known as uredospores, which may be carried from plant to plant by wind, insects, rainwater, tools, and animals. These spores bring about infection if they lodge in moist spots on the plants. In the fall and later summer the pustules turn black because of the formation of dark thick-walled spores called teliospores. These are the overwintering spores of the fungus which live over in dead leaves and bean straw and cause infections the following year.

There are a number of bean varieties which are resistant to the rust disease. Unfortunately none of these varieties are grown or particularly desired in Colorado. The most effective measure in controlling rust is the use of dusting sulphur, 300 to 325 mesh. When the disease first appears, applications should be made at 2- to 3-week intervals. Fields should not be worked when the plants are wet. A grower troubled with rust should collect and burn the bean straw in the fall.

Root or Foot Rot

In some regions in Colorado the root-rot disease is one of the most serious of bean troubles. It appears that the most of this trouble is caused by the fungus *Fusarium martii phaseoli*.

Plants affected by root rot are stunted, turn yellow, and frequently die. If the roots of diseased plants are examined, sunken reddish to reddish-brown lesions may be seen, especially on the main root or taproot. Frequently lesions coalesce and girdle the root. The pith becomes hollow and the main root may easily be shredded. Small lateral roots are rotted. Yields are small to none when the disease kills plants outright.

The only effective control for this disease is a 5- to 6-year rotation, since the root rot fungus lives in the soil from year to year, actively growing in rotten debris. Dusting or spraying is not effective. There are no resistant varieties of beans yet released. The disease is not seed borne.

Mosaic

Mosaic is a virus disease. It is introduced into a field by planting diseased seed. It is spread by insects, especially the potato aphis *Macrosiphum solanifolii*. The symptoms of mosaic are at first difficult to detect. They may be evident on the earliest leaves as a puckering or slight downward curling of the tips. Later, blotchy or blistered areas of extremely dark green, alternating with lighter green, may become evident. As the plant develops the leaves usually show the typical mosaic or mottled symptom which is an alternating of dark-green and lighter-green areas. Plants which develop from diseased seed or become infected early in their development rarely produce any seed. The seed which is infected is produced by plants which become infected later in their development. Diseased plants do not die.

Since the mosaic disease is seed borne, the most obvious control is the planting of disease-free seed. Experimental studies have shown that at least 50 percent of all seed produced by diseased plants carries the virus of mosaic. Seed should be obtained from fields free from mosaic for the next year's planting.

It is a good plan to rogue out diseased plants as soon as they are observed to prevent field spread of the disease. In addition any measures to reduce the insect population are to be recommended.

Bean Insects[4]

Grasshoppers and the Mexican bean beetle are the most destructive insect pests of the bean under Colorado dry-land conditions. Without efficient control, either of these may make bean production impractical at times.

Grasshoppers

Several species of grasshoppers may attack beans, but since their life histories and controls are so similar we need not discuss them separately. All pass the winter in the egg stage in the soil, with hatching taking place during May and June.

Farmers contemplating planting beans will do well to ascertain from the Experiment Station or the County Extension Agent if grasshoppers are likely to occur in the community in outbreak number. It may be impractical to attempt to grow beans during such seasons.

Since few eggs are deposited in, or hatch from, soils that have been prepared for beans by previous cropping and spring cultivation, the damage will come largely from the hoppers that move into the beans from surrounding lands. Such movement will be the greatest at the time the grain is ripening and the grass lands drying.

The only practical means of control, where all lands cannot be cultivated for egg destruction, is by means of poisoned baits. Since the use of grasshopper baits is so well-known and most counties operate a mixing plant through the County Extension Agent, the preparation of baits will not be discussed. The baits are most effectively used while the grasshoppers are small. However, regardless of early use of baits, all bean growers should watch their fields at the time grains are harvested and grass land is drying. Often the judicious use of bait about the borders of a bean field may prevent serious damage.

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[4] Prepared by George M. List, Associate Entomologist, Colorado Agricultural Experiment Station, Fort Collins, Colo.

Mexican Bean Beetle

The habit of the Mexican bean beetle of wintering largely in the foothills or in the bluffs along such rivers as the Arkansas, tends to limit the pest to certain areas of the State. Severe injury may occur in all of the lower mountain valleys and for a distance of from 20 to 30 miles from suitable hibernating places.

The adult is a light brown, hard-shelled "lady beetle", slightly less than ¼ of an inch in length, with 8 black spots on each wing cover. They move from their hibernating quarters into the fields with the approach of warm weather. At Fort Collins this movement has taken place from June 7 to June 12 for a number of seasons. The adults may do damage, but the principal injury comes from the feeding of the yellowish spiney larvae. The larvae hatch from about June 25 to August 10 from the masses of yellow eggs placed on the under side of leaves. The greatest larval injury occurs during the latter part of July and the forepart of August. There is but one generation per year.

Effective control can be secured through spraying or dusting. The number and, to a certain extent, the time of applications must be determined by the degree of infestation. What appears to be a light infestation early in the summer may result in a marked crop reduction. Any field in which the adults appear at the rate of one to 10 or 12 feet of row should be carefully watched. The larvae hatching from one egg mass may do serious damage to as much as 6 feet of row before the end of the season.

Under conditions of light infestation one application of spray or dust gives a practical control. This application should be made as soon as injury by the larvae becomes apparent. It is important to apply the insecticides in such a manner as to cover the undersides of the leaves thoroughly. Do not delay until the foliage is seriously skeletonized. If the adults appear in the field in such numbers that their injury is apparent during June or the forepart of July, an application should be made to stop their feeding and egg laying, with a second application when larval injury appears. Non-irrigated beans rarely warrant more than two treatments, although three are often found practical under irrigation. Arsenite of zinc, 2 pounds to 100 gallons of water, has been the most generally used material in Colorado. Tests conducted with cryolite, 6 pounds to 100 gallons of water, during the past season, showed somewhat superior results. If water for spraying is not readily available, dusts can be effectively used. The best dust mixtures are:

(1) Calcium arsenate, 12 pounds
Talc or other inert carrier, 88 pounds

(2) Cryolite, 33 pounds
Talc or other inert carrier, 67 pounds

The calcium arsenate dust is the cheaper of the two. If the bean rust, as described under plant diseases, is a problem, 20 pounds of dusting sulfur can be substituted in either of the dust mixtures for an equal weight of the talc as a control for this disease.

Dusts may be applied by either a hand or a mechanical duster. Apply them only when the wind is not blowing and at the rate of about 20 pounds to the acre.

Summary

Dry field beans are an important non-irrigated farm crop in Colorado.

Of all the designated wartime necessary crops, field beans are by far the best-adapted to dryland conditions in Colorado.

Present production is largely located on the higher elevated portions of the Eastern Slope and the mesa lands of southwestern Colorado. There is some scattered production all over Colorado. Beans are well-adapted to all parts of the State where the season will permit maturity.

Beans are not fitted for production in large individual areas such as are often employed for winter wheat. They should be produced in strips, in alternation with some crop that will leave a good winter ground cover. The strips should run at right angles to the prevailing wind direction.

Beans leave the soil the most susceptible to blowing of any of the adapted and commonly grown Colorado non-irrigated crops. Bean-land soil must be fall cultivated with implements that will raise clods to the surface and leave preferably a "pock-marked" condition. There is also need for the occasional wind-breaking strips of well-anchored stubble cover provided by the alternating crop.

Successful seedbed preparation for beans is almost identically like that for corn, sorghum, and proso. In preparing for any of these crops, it is well to remember that heavy run-off rains are likely to fall in late April and all through May. Good soil husbandry will always seek to trap rain on the surface until it can percolate into the soil mass for storage.

Beans are planted with a lister or a corn planter. Furrow openers are very useful additional equipment for the corn planter.

The best planting period for beans in the Akron section, at an altitude of about 4,500 feet, is between June 10 and 20. June 1 is a little better planting date than July 1. Planting at a slightly later date at lower altitudes and at more southerly points may be possible and even advisable. They should not be planted anywhere until safely after the normal last spring frost date.

The Pinto is the best-adapted variety of dry field bean for the region. The better strains of Great Northern will apparently produce about 85 percent as large yields per acre as the Pinto.

Pinto strains are apparently quite uniform for yield. However, they may be selected for uniform color and marking, the factors that contribute to quality up to the harvest time. Growers should carefully grade their seed supply, or secure a strain that has been purified for such characteristics.

Beans require a comparatively small amount of soil moisture. They will nearly always produce enough top growth for yield on the moisture that can be stored in the soil and that which falls during the growth of the crop.

Quality in beans is almost wholly determined by the state of maturity at harvest, and on the weather that prevails after harvest.

Field curing until dry enough, then stacking in narrow, low, long ricks topped with a rainfall shedding material until threshing time is probably the best way of annually achieving a regular high-quality product.

Threshing should seek to shell and clean the beans without cracking.

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