Hybrid Corn in Oklahoma

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The development of hybrid corn is one of the most important achievements in plant breeding in recent years. It is an outstanding example of the influence of scientific research in revolutionizing the production practices of one of the nation's most important crops.

Corn hybrids are rapidly replacing the standard open-pollinated varieties in most of the states where corn is a major crop. In 1943 approximately 50 million acres, or nearly 52 percent of the total corn acreage in the United States, were planted with hybrid seed. The greatest use of hybrid corn is found in the Corn Belt. In much of this area, 95 to 98 percent of the corn acreage is planted with hybrid seed. Hybrid corn is used to a much less extent in Oklahoma, although the acreage is increasing. In 1943, only 104,800 acres, or 5 percent, of the total corn acreage in the state were planted with hybrid seed. The acreage of hybrid corn increased to 138,000 acres in 1944, or 7 percent of the total corn acreage.

POLLINATION IN CORN

In order to understand what hybrid corn is, it is necessary to know how the corn plant reproduces. The tassel, which produces large numbers of pollen grains, is the male flower and the shoot, or young ear, is the female flower. To form a kernel of corn, a male cell borne in the pollen grain unites with a female cell borne at the base of the silk on the ear. A pollen grain, falling on a silk, germinates and send out a tube which grows down through the silk. This tube carries the male reproductive cell which fertilizes the female cell and leads to the development of a kernel of corn.

Under natural conditions, corn is a cross-pollinated plant, the pollen being carried by wind and air currents. The pollen which falls upon any given silk may have come from the tassel of an adjacent plant, or from a plant growing at some distance. Each kernel on the ear may receive pollen from a different tassel. Certainly the kernels of each ear develop from the pollen coming from many different male parents. Since corn is naturally cross-pollinated, methods of selection are necessarily based upon the appearance of the female plant only, without any knowledge of the characteristics of the male or pollen parents. In spite of this condition, however, the better varieties of corn have been developed to a relatively high state of productiveness by careful selection over a long period of time.

WHAT IS HYBRID CORN

The term hybrid as used in the corn breeding program of today does not refer to a cross of different varieties of corn but rather to a cross between true breeding strains known as inbred lines or a combination of such lines. Many hybrids have been developed, and there is just as much variation in different hybrids as there is among the open-pollinated varieties.

KINDS OF HYBRIDS

A single-cross or first generation hybrid is a cross between two inbred lines. A double-cross hybrid is produced by crossing two single hybrids. A three-way hybrid is made by crossing a first generation single hybrid with an inbred line as the pollen parent. A top cross is a cross between an inbred line and an open-pollinated variety. A multiple hybrid is one involving five or more inbred lines.

Single-cross hybrids are not commonly used as seed for the commercial crop of field corn because the lines are less productive and the seed is usually smaller in size than normal corn. The cost of producing single-cross seed in field corn is also too high for commercial utilization. The plants and ears resulting from a cross between two inbred lines are very uniform in appearance and type. Consequently, single-cross hybrids are highly desirable in sweet corn for canning purposes, where uniformity of maturity, and ear characters are of major importance.

Breeders have found that hybrid vigor can be maintained for one generation by mating two single-cross hybrids. This is the four-way or double-cross hybrid. The seed is produced on a vigorous single-hybrid plant, yields are good, and commercial production of hybrid seed is entirely feasible and practical. Consequently, double-cross hybrids make up most of the commercial hybrid seed corn available at the present time.

Three-way hybrids are used to some extent, but have been largely replaced by double-cross hybrids. Top crossing is used mainly as a quick method of testing the performance of inbred lines. Multiple crosses are not used to any great extent.

HYBRID VIGOR

When two relatively pure inbred lines are crossed the resulting hybrid will usually be much more vigorous than the original open-pollinated varieties from which the inbreds were developed. Superior vigor is due primarily to the fact that by careful inbreeding and selection a large number of desirable

growth factors can be combined in the inbred lines. When the inbreds carry the factors which make for vigor, leafiness, extensive root systems, strong stalks, and resistance to disease, a desirable hybrid will usually result.

DEVELOPING INBRED LINES

Successful hybrid corn breeding consists in developing vigorous inbred lines or strains and finding those that can be crossed to form desirable hybrid combinations for commercial use. Inbred lines are developed in order to eliminate as nearly as possible the uncertainty of mixed inheritance found in open-pollinated corn. This is done by inbreeding, which is accomplished by placing the pollen from the tassel of a given plant on the silks of the same plant, and at the same time excluding all other pollen. A small paper bag is placed over the ear shoot just before the silks emerge to protect them from foreign pollen. A similar bag is placed over the tassel as the pollen grains start shedding (See Fig. 1.) As soon as the silks emerge, pollen from the tassel is applied on the silks to make the desired mating and the pollinated silks are again covered by the paper bag. In this way the parentage on both sides is definitely controlled.

In developing inbred strains, desirable plants of one or more varieties are self-pollinated and the best of the resulting ears are saved. These are planted an ear to a row, and good plants within the best rows are again self-pollinated. This is usually continued for a period of five to seven years. Each year, however, only the choice ears from the most desirable plants in the best rows are selected for continuing the various strains.

After several successive generations of inbreeding and rigid selection have been carried on, the inbred lines show greatly reduced size and vigor. They also become uniform in growth and appearance. This uniformity of inherited characteristics, which is the goal sought by the breeder, indicates purity of breeding.

MAKING HYBRID COMBINATIONS

After the hybrids have been developed, the next step is to find desirable combinations for commercial hybrids (See Fig. 2). Many trial crosses must be made and their progeny tested in actual field trials in order to find the combinations which will give best results. When a desirable combination is found, however, it can be expected to perform in the same way each time it is produced.

Fig. 1.

The inbred lines may be increased and maintained year after year by growing under conditions of complete isolation, in the same manner that purity in open-pollinated varieties is maintained.

COMMERCIAL PRODUCTION OF HYBRIDS

The production of commercial hybrid corn seed is a highly specialized business, requiring scientific knowledge, technical skill and careful supervision. A grower wishing to produce a double-cross hybrid either develops the single-cross parents or obtains these single-cross hybrids from another source. The common planting method is to plant four rows of the single-cross hybrid from which seed is to be harvested, to one row of the single-cross which is to be used as the male or pollinating parent. In the rows of female or seed-producing plants, the tassels are pulled out as they appear and before they shed pollen.

The detasseling work must be continued daily for a period of 10 days to 2 weeks, or as long as tassels show up, the object being to prevent the seed producing plant from shedding any pollen. Thus, all of the ears will be pollinated from the male rows on which the tassels are allowed to develop. The ears on the detasseled plants are harvested and used as the commercial double-cross hybrid seed. The ears from the male rows must be harvested separately, and they are usually used for feed.

HYBRID SEED

Hybrid seed corn maintains its uniformity and superior vigor for one generation only. When seed from a field of hybrid corn is saved and planted the following year, a reduction in yield will occur. To obtain the full benefits from corn hybrids it is, therefore, necessary to purchase new seed each year.

NOT ALL HYBRIDS ARE GOOD

Not all hybrids are equally productive. A grower buying hybrid seed just because it is hybrid has no assurance that he will get larger yields; he may get lower yields of corn of inferior quality. Hybrids vary widely in adaptation, maturity, resistance to disease, quality of corn, and yield. These differences depend upon the inbred lines used in the combination, isolation of the fields, proper detasseling of seed producing plants, and how the seed was processed.

In tests conducted by the Oklahoma Experiment Station on bottomland in 1942 and 1944, the highest yielding hybrid

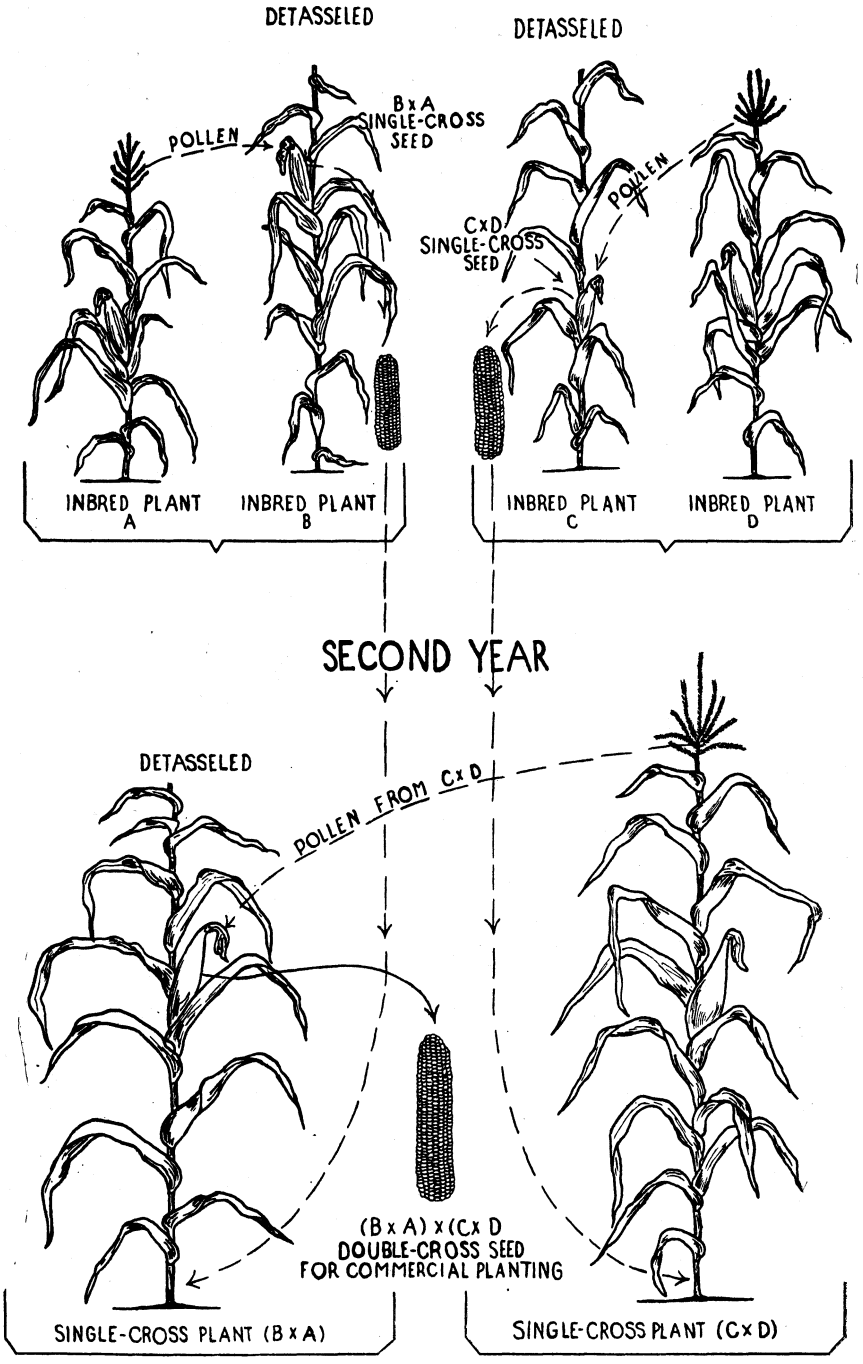
FIRST YEAR
DETASSELED
DETASSELED
POLLEN
B x A
SINGLE-CROSS
SEED
POLLEN
C x D
SINGLE-CROSS
SEED
INBRED PLANT
A
INBRED PLANT
B
INBRED PLANT
C
INBRED PLANT
D
SECOND YEAR
DETASSELED
POLLEN FROM C x D
(B x A) x (C x D
DOUBLE-CROSS SEED
FOR COMMERCIAL PLANTING
SINGLE-CROSS PLANT (B x A)
SINGLE-CROSS PLANT (C x D)

Fig. 2.

has averaged 65.2 bushels per acre as compared to only 32.7 bushels for the lowest yielding hybrid strain. In another test conducted on upland in 1943-1944, yields of hybrids have varied from 34.2 bushels to only 20.3 bushels per acre.

ADAPTATION

Corn hybrids respond differently under varying soil and climatic conditions. Adaptation is just as important in hybrids as in open-pollinated varieties. Hybrids will perform satisfactorily only when grown under conditions to which they are suited. Tests conducted by the Oklahoma Experiment Station indicate that when soil and climatic conditions are favorable, adapted hybrids may be expected to give higher yields than open-pollinated varieties. On bottom land, the better hybrids have averaged 18 percent higher yields than adapted open-pollinated varieties. On upland soils, yields of the better hybrids have averaged 25 percent higher than the best open-pollinated varieties. Where soil fertility, the supply of available moisture, or other conditions are limiting factors in plant development, however, increased yields of hybrid corn may not be large enough to make its use economically feasible.

HOW TO SELECT A HYBRID

Early maturing hybrids have given highest yields on upland soils. Earliness does not seem to be so important on the more productive soils, and later maturing hybrids have given highest yields on fertile bottom lands when moisture is not the first limiting factor in plant development. In determining which hybrid to plant, it is well to select one that has produced satisfactory yields both in the immediate community and over a wide area.

Corn performance tests were conducted by the Oklahoma Experiment Station at 14 locations in 11 counties in the corn producing sections of the state in 1944. The land on which these tests were located was classed as (1) upland, (2) bottomland of medium fertility, and (3) bottom-land of high fertility. In order to provide a better basis on which to compare the performance of the different hybrids, summaries of the yields were made for the more productive of the hybrids which were grown in four different locations on each of the three classes of land.

(1) Upland Soils

The highest yielding hybrids included in the tests planted on upland soils in 1944 in Bryan, Craig, Grady, and Payne counties are shown in Table 1.*

Table 1.—Average Yields of Hybrids in Bryan, Craig, Grady, and Payne counties, 1944.

UPLAND SOILS

	Hybrid	Yield		Hybrid	Yield
1	National 125 (Experim'tal)	34.44	16	Funk G-114	30.3
2	Ohio C38	34.2	17	Pioneer 336	30.2
3	Ferris F44-1	33.8	18	Indiana 608C	29.9
4	Indiana 818	33.6	19	Pioneer 339	29.9
5	Keystone 39	32.1	20	Kansas 2234 (wh)	29.5
6	Funk G-94	31.5	21	Pioneer 333	29.5
7	Indiana 844D	31.4	22	Keystone 38	29.4
8	Dekalb 816	31.4	23	Indiana 610B	28.7
9	Illinois 751	31.4	24	Ferris F31	28.4
10	Missouri 313	31.3	25	Ohio W10	28.3
11	Indiana 826D	31.1	26	U. S. 13	27.6
12	Missouri 148	30.9	27	Indiana 620	27.5
13	Indiana 425B	30.5	28	Pioneer 334	26.2
14	Shannon 1300	30.4	29	Kansas 1583	24.8
15	Pioneer 332	30.3	30	Mandelartz 287A	24.6

(2) Bottom-land Soils of Medium Fertility

Hybrids were planted on bottom-land soils of medium fertility in Grady, Payne, Pittsburg, and Tulsa counties in 1944. The average yields of the hybrids for the four different locations are shown in Table 2.*

Table 2.—Average Yields of Highest Yielding Hybrids in Grady, Payne, Pittsburg and Tulsa counties, 1944.

BOTTOM-LAND SOILS OF MEDIUM FERTILITY

	Hybrid	Yield		Hybrid	Yield
1	Ohio L86	50.9	18	Indiana 818	42.5
2	Missouri 148	49.0	19	Missouri 8	42.3
3	Ferris F44-1	47.6	20	Ferris F31	42.2
4	Pioneer 332	47.1	21	Illinois 246	42.1
5	Kansas 1583	46.0	22	Funk G-114	42.0
6	Illinois 21	45.0	23	Pioneer 339	41.9
7	Kansas 2234 (wh)	44.6	24	U. S. 14	41.4
8	Funk G-150	44.0	25	Illinois 751	41.3
9	Indiana 844D	43.6	26	U. S. 13	41.3
10	Iowealth T+1	43.4	27	Ohio C38	41.2
11	Texas 7W (wh)	43.2	28	Tennessee 14 (wh)	39.8
12	Illinois 200	43.1	29	Tennessee 15 (wh)	39.6
13	National 134D	43.1	30	Ohio M20	39.4
14	Kansas 1585	43.1	31	Indiana 210B	39.1
15	Tennessee 10	42.8	32	Ohio K24	38.8
16	Texas 12	42.7	33	U. S. 35	38.2
17	Pioneer 334	42.5	34	U. S. 63	37.7

* Calculated from yields reported in Oklahoma Experiment Station Bulletin No. B-283, "Performance Tests of Corn Varieties and Hybrids," 1944.

(3) Bottom-land Soils of High Fertility

Hybrid corn tests were planted in 1944 on bottom-land soils of high fertility in Bryan, Garvin, Seminole, and Wagoner counties. Table 3* shows the average yield for each hybrid in the four different locations.

Table 3.—Average Yields of Highest Yielding Hybrids in Bryan, Garvin, Seminole, and Wagoner counties, 1944.

BOTTOM-LAND SOILS OF HIGH FERTILITY

	Hybrid	Yield		Hybrid	Yield
1	Funk G-711	86.1	10	Texas 8	74.7
2	National 134th	83.9	11	Tennessee 15	74.2
3	National 134t	81.9	12	Texas 7W (wh)	73.2
4	Tennessee 14 (wh)	81.1	13	Kansas 1585	72.1
5	Hendrix E	81.0	14	Tennesse 10	71.7
6	Texas 12	79.2	15	Kansas 1583	71.3
7	Kansas 2234 (wh)	77.7	16	Iowealth T+1	70.8
8	Funk G-150	77.1	17	Texas 16	70.7
9	Funk G-707	74.8	18	Pioneer 334	69.6

* Calculated from yields reported in Oklahoma Experiment Station Bulletin No. B-283, "Performance Tests of Corn Varieties and Hybrids," 1944.

Hybrid corn tests are conducted each year on the Experiment Station farm at Stillwater. Tests are conducted on both bottom-land soils and upland soils in order to compare the performance of commercial hybrids which are being produced in other states at the present time. Open-pollinated varieties are also included in these tests.

The average yields of the hybrids and open-pollinated varieties on upland soils are shown in Table 4. The average yields on bottom-land soils are shown in Table 5.

Table 4.—Summary—Payne County (Upland) Oklahoma Agricultural Experiment Station Farm, Perkins.

Rank	Strain	Yield	Rank	Strain	Yield
	Four-year Average, 1941, 1942, 1943, 1944				
1	Hoosier Crost F-140	33.9	9	Missouri 8	26.6
2	Pioneer 334	33.8	10	*Hays Golden	26.2
3	Hoosier Crost F-150	33.5	11	*Golden Republic	26.0
4	Pioneer 332	32.2	12	National 134D	25.3
5	Hoosier Crost F-138	32.1	13	*Wood's Corn (wh)	24.0
6	Hoosier Crost F-139	30.7	14	*Ferguson Yellow Dent	23.3
7	U. S. 13	30.3	15	*Reid Yellow Dent	20.3
8	Iowealth T+1	26.7			
	Two-year Average, 1943 and 1944				
1	Illinois 751	34.2	29	Funk G-702	27.0
2	Pioneer 334	34.0	30	Hendrix L	26.8
3	Hoosier Crost F-150	33.7	31	Hendrix L_2	26.4
4	Pioneer 332	33.6	32	Funk G-150	26.2
5	Hoosier Crost F-140	33.3	33	Missouri 8	26.2
6	Hoosier Crost F-138	32.3	34	Kansas 1585	25.9
7	Hoosier Crost 746	31.8	35	Tennessee 10	25.6
8	U. S. 14	30.9			
			36	Texas 8	24.7
9	National 134	30.8	37	Hoosier Crost 1005A	24.7
10	Illinois 784	30.7	38	National 129	24.6
11	National 125	30.6	39	Iowealth T+1	24.2
12	Funk G-94	30.5	40	Tennessee 14 (wh)	24.0
13	Hoosier Crost F-139	30.4	41	*Hays Golden	23.8
14	National 127	30.3	42	Keystone 42	23.8
15	Keystone 39	30.3	43	Kansas 1583	23.6
16	Keystone 40	29.6			
17	Illinois 200	29.6	44	*Reid Yellow Dent 176A	23.5
18	Kansas 2234 (wh)	29.4	45	*Golden Republic	23.2
19	U. S. 13	29.4	46	National 134th	22.4
			47	Tennessee 15 (wh)	22.2
20	Hoosier Crost 616	29.3	48	National 134D	20.6
21	Keystone 38	29.2	49	*Woods Corn (wh)	20.5
22	Mandelartz 287	28.8			
23	Hoosier Crost F-181	28.7	50	Texas 12	20.4
24	Hoosier Crost 840	28.4	51	Funk G-707	20.3
25	Hendrix E	28.3	52	*Reid Yellow Dent	20.2
26	Iowealth 25A	27.6	53	*Ferguson Yellow Dent	17.3
27	Funk G-711	27.5	54	*White Surcropper (wh)	14.8
28	U. S. 35	27.1	55	*Yellow Surcropper	14.1

* Indicates open-pollinated variety. All others are hybrids. (wh)—white grain.

* Oklahoma Experiment Station Bulletin No. B-283, Performance Tests of Corn Varieties and Hybrids, 1944.

Table 5.—Summary—Payne County (Bottom land)
Oklahoma Agricultural Experiment Station Farm, Stillwater

Rank	Strain	Yield	Rank	Strain	Yield
	Four-year Average, 1940, 1941, 1942 and 1944				
1	U. S. 13	52.7	8	*Reid Yellow Dent 176A	41.2
2	Pioneer 332	49.6	9	*Wood's Corn (wh)	38.7
3	National 134D	48.3	10	*Golden Republic	38.5
4	Iowealth T+1	46.8	11	*Ferguson Yellow Dent	38.2
5	Iowealth 28N	45.5	12	*White Surcropper (wh)	35.9
6	Missouri 8	42.2	13	*Reid Yellow Dent	35.6
7	*Hays Golden	41.8	14	*Yellow Surcropper	28.4
	Two-year Average, 1942 and 1944				
1	Funk G-150	65.2	19	Hoosier Crost F-150	45.4
2	U. S. 13	60.0	20	Funk G-66	44.7
3	National 134D	59.2	21	National 126-1	44.3
4	National 129	59.2	22	Pioneer 334	44.1
5	Pioneer 332	56.9	23	Missouri 8	44.0
6	Tennessee 14 (wh)	55.8	24	Hoosier Crost F-139	44.0
7	Texas 12	54.7	25	U. S. 35	43.9
8	Iowealth 28N	52.3	26	Mandelartz 287A	43.8
9	Texas 8	51.4	27	Ohio C38	43.5
10	Reid Yellow Dent 176A	51.2	28	*Hays Golden	43.5
11	Tennessee 10 (wh)	50.7	29	Hoosier Crost F-138	43.3
12	Iowealth 26N	50.7	30	Hoosier Crost F-140	43.2
13	Iowealth T+1	50.5	31	*Woods Corn (wh)	42.2
14	Funk G-702	50.4	32	*White Surcropper	40.8
15	Tennessee 15 (wh)	49.7	33	*Golden Republic	36.7
16	*Ferguson Yellow Dent	47.5	34	*Reid Yellow Dent	36.3
17	Illinois 751	46.4	35	Mandelartz 287	32.7
18	U. S. 14	45.7	36	*Yellow Surcropper	31.1

* Indicates open-pollinated variety. All others are hybrids. (wh)—white grain.

* Oklahoma Experiment Station Bulletin No. B-283, Performance Tests of Corn Varieties and Hybrids, 1944.

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