Miscellaneous Publication 8--1981
Minnesota Agricultural Experiment Station
University of Minnesota

Evaluation of Agricultural Research

Proceedings of a Workshop Sponsored by NC-148
Minneapolis, Minnesota May 12-13, 1980

IMPORTANCE OF NEW VARIETIES IN KANSAS WHEAT PRODUCTION

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The preamble of NC-148 Regional Project stresses the need for more and better information as well as the analysis of the past and potential payoffs of publicly supported research programs, particularly those supported through agricultural experiment stations.

While no one questions the phenomenal productive capacity of American agriculture--much of which has been contributed by agricultural and related research--the public and its elected representatives are increasingly concerned about the "high public expenditures" and rightfully demand improved information on how well research expenditures pay off.

This study examines the effects of new varieties the last three decades (1948-78). Historically, Turkey Red was the dominant winter wheat variety in Kansas. At the turn of the century, virtually all Kansas wheat acres were seeded to Turkey Red--more than 82% in 1919 of the wheat acres used Turkey Red. The 82% had dropped to about 29% in 1939 and to 15% by 1945.

Since then, new varieties have replaced Turkey Red entirely. It disappeared from state reports before 1970. Newer wheat varieties have several advantages over the older varieties: smut and mildew resistance, hessian fly resistance, early maturity, stiff straw quality, etc. But the differences in yields are the most striking. Approximately the same acreage (13.5 million acres) produced 115 million bushels in 1939, 178 million in 1950, 345 million bushels in 1977, and more than 400 million in 1979.

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The average wheat yield in Kansas in the 1930s was about 12 bushels per acre; in the 1940s, 15; in the 1950s, 19; in the 1960s, 24; and in the 1970s, 32 bushels per acre. Factors contributing to the increased yields include improvements in quality of seed; better tillage operations; better control of diseases, weeds, and insects; increased use of fertilizer; and improved management. Better adapted varieties probably have played the most important role in increasing yields.

Wheat Variety Comparisons

Using test-plot data from experiment station farms, we compared the new varieties with Turkey Red yields from 1949 to 1978. In total, 356 test plots grew Turkey Red during the period. We compared the 24 most commonly grown varieties the past 20 years with Turkey Red. Each time one of the new varieties appeared in a test plot with Turkey Red, receiving the same treatment, that variety's yield in bushels per acre was divided by the yield of Turkey Red. This was done for over 2,600 observations. The results of our calculations are in Table 1. In addition to the number of observations, we also determined the average ratios (wheat variety divided by Turkey Red, $\bar{X}_i$), standard deviation (S_i) and t-statistics (Table 1). For example, Apache variety outproduced Turkey Red on average of 13%, Bison by 20%, Centurk by 41%, etc.

Impact of New Varieties on Wheat Production

The variety planting distributions of yearly data make it possible to calculate expected annual yield changes that result from improved varieties.1/ Thus, it is possible to estimate what wheat production in any year would have been if Turkey Red had been the only variety grown.

Table 2 shows wheat yields statewide, as well as the estimated state yield with only Turkey Red; the wheat acreage and the wheat acreage that would have been needed to match the given year's state wheat output with only Turkey Red. For example, in 1978 the state yield was 30 bushels, with Turkey Red it would have been 23

bushels or 7 bushels per acre less; wheat production that year was 309 million bushels from 10.3 million acres. On the same acreage with Turkey Red, the production would have been 237.6 million bushels or 71.4 million bushels less. To offset the 71.4 million-bushel loss, an additional 3.1 million acres planted to Turkey Red would have been needed. Similar comparisons are shown in Table 2 for 1959 through 1978.2/

The search for varieties that offer an improvement over the old established ones is an on-going process. It does not stop. It can be seen by examining year to year changes in leading wheat varieties.

Table 3 shows the leading wheat varieties with percentages of wheat acres planted in 1980. With the exception of two (Scout and Triumph), none of the other eight varieties planted in 1980 was available in 1970. Table 3, for example, also indicates the quick emergence of the 1980 leading variety, "Newton." In 1978 the Newton variety was planted on 0.1% of the 12.8 million acres sown in wheat in Kansas. In 1980, two years later, Newton has been planted on 2.25 million acres, 17.5% of the total. On the other hand, Scout, which in 1970 occupied nearly half of Kansas wheat acreage, by 1980 its percentage dropped to 12.5 sown acres.

Technological changes not only bring shifts in the use of varieties, but at times affect and alter the relative significance of crops produced in certain areas. Changing comparative advantages or disadvantages induce some crops to move into a new area while others may move out or decrease in importance.

An example of how technological development changes areas' competitive positions and thus have an important bearing on farm enterprises and

Table 1. Wheat varieties, variety/Turkey Red - average ratio, standard deviation, t-statistic, and number of observations

Wheat variety	Variety/Turkey Red average ratio X_i	Standard deviation S_i	t-statistic t_i*	Number of observations n
Apache	1.1295	0.2954	1.6983	15
Bison	1.2015	0.2283	13.1485	222
Buckskin	1.3761	0.3107	8.4727	49
Centurk	1.4073	0.3055	12.7867	92
Chanute	1.2069	0.3253	4.8014	57
Comanche	1.1828	0.2337	11.2960	203
Eagle	1.3478	0.3542	9.4164	92
Gage	1.3009	0.3251	11.2960	149
Kaw	1.1785	0.3022	7.4731	160
Kiowa	1.1895	0.1985	9.3513	96
Lancer	1.2302	0.1428	9.8054	37
Larned	1.3910	0.3656	5.4536	26
Ottawa	1.2569	0.3442	8.0391	116
Parker	1.2857	0.3041	10.3335	121
Ponca	1.1605	0.2848	7.8689	195
Rodeo	1.2779	0.2824	10.0849	105
Sage	1.4347	0.3573	9.8103	65
Satanta	1.2084	0.2550	6.8390	70
Scout	1.2891	0.2780	14.4089	192
Tam-W-101	1.4236	0.5638	3.0978	17
Trison	1.3171	0.4166	5.7959	58
Triumph	1.1854	0.3552	9.0417	300
Wichita	1.1985	0.2862	10.4718	228

*The average yields of all varieties except Apache differ significantly from Turkey Red's yield. Apache (PL0.001) differs at between 0.05 and 0.10.

incomes is that of hybrid corn and hybrid sorghums. In the early 1930s Kansas produced about 3 million hogs and 3.5 million cattle a year. Then hybrid corn became available to feed hogs and cattle. Compared with Corn Belt states, Kansas at that time had relatively little corn acreage, so hybrid corn gave the Corn Belt states a competitive edge until the late 1950s, when hybrid sorghum became available. By then, Kansas was producing less than one-third as many hogs and about the same number of cattle as she had in the early 1930s. Many more people were eating much more meat per person and meat exports had risen. But Kansas was not getting even her depression share of the market. Hybrid corn had given the Corn Belt states a competitive advantage in finishing cattle and in feeding hogs.

Table 2. Index of wheat production, wheat acres and bushels and estimated bushels had Turkey Red wheat variety been seeded on all wheat acreage in Kansas, 1959-1978.

	Years									
	1978	1977	1976	1975	1974	1973	1972	1971	1970	1969
Index	1.3	1.3	1.288	1.275	1.249	1.241	1.236	1.240	1.236	1.229
Actual Yield-T	30	28.5	30	29	27.5	37	33.5	34.5	33	31
Yield-H	23.07	21.91	23.29	22.74	22.02	29.81	27.09	27.83	26.69	25.23
Diff(Yield)	6.93	6.59	6.71	6.26	5.48	7.19	6.41	6.67	6.31	5.77
Actual Bu-T(000)	309,000	344,850	339,000	350,900	319,000	384,800	314,900	312,605	299,013	305,319
Bu-H(000)	237,640	265,225	263,224	275,201	255,465	310,064	254,671	252,199	241,846	248,491
Diff(bushel) (000)	71,360	79,625	75,776	75,699	63,535	74,736	60,229	60,406	57,167	56,828
Actual Acres-T(000)	10,300	12,100	11,300	12,100	11,600	10,400	9,400	9,061	9,061	9,849
Acres-H(000)	13,392	15,732	14,552	15,428	14,484	12,906	11,623	11,231	11,202	12,101
Diff(Acres) (000)	3092	3632	3252	3328	2884	2506	2223	2170	2141	2252
	1968	1967	1966	1965	1964	1963	1962	1961	1960	1959
Index	1.217	1.206	1.193	1.189	1.169	1.184	1.164	1.165	1.161	1.176
Actual Yield-T	24.998	20	19.5	23.965	22.519	21.5	23.5	26.5	28	20
Yield-H	20.53	16.57	16.35	20.15	19.25	18.16	20.18	22.75	24.11	17
Diff(Yield)	4.468	3.43	3.15	3.815	3.269	3.34	3.32	3.75	3.89	3
Actual Bu-T(000)	243,755	221,620	200,070	243,264	215,640	185,480	211,171	273,718	290,640	209,700
Bu-H(000)	200,274	183,713	167,762	204,622	184,401	156,694	181,353	234,993	250,276	178,246
Diff(Bushel) (000)	43,481	37,907	32,308	38,642	31,239	28,786	29,818	38,725	40,364	31,454
Actual Acres-T(000)	9,751	11,081	10,260	10,151	9,576	8,627	8,986	10,329	10,380	10,485
Acres-H(000)	11,867	13,367	12,235	12,067	11,198	10,211	12,463	12,031	12,054	12,335
Diff(Acres) (000)	2116	2286	1975	1916	1622	1584	1477	1702	1674	1850

Table 3. The 1980 leading wheat varieties in Kansas, with percentages of acres planted to these varieties in 1980, 1979, 1978, and 1970.

Wheat variety	Years			
	1980	1979	1978	1970
Newton	17.5	2.8	0.1	0
Eagle	15.7	21.1	23.0	0
Scout	12.5	15.6	19.6	48.1
Larned	11.1	8.4	2.8	0
Sage	8.8	12.7	14.0	0
Centurk	5.9	8.7	10.0	0
Triumph	5.1	6.5	5.8	11.7
Tam 101	4.8	4.9	4.1	0
Voma	2.9	0.8	0	0
Trison	1.8	1.8	2.0	0

That changed when hybrid sorghums became available. The first hybrid sorghum seed in Kansas was distributed commerically in 1957. By 1966, five counties produced more sorghum than all 105 Kansas counties produced in 1956, the year before hybrid seed became available. Within a few years, the sorghum producing areas of the Great Plains, called the "Milo Belt" by some, became a feed-surplus rather than a feed-deficit area.

In addition, since 1970, Kansas has had every January 1 nearly six times more cattle on feed than January 1, 1957. The increase in cattle feeding in Texas has been even more dramatic. Thus, the "Milo Belt" became a bona-fide competitor with the Corn Belt. In 1956, the Corn Belt fed nearly 50% of U.S. cattle and the Milo Belt, about 20%; now, 1980, the percentages are almost even. The number of cattle fed in the Corn Belt has not decreased. But nearly all the tremendous gains in beef feeding in recent years has been in the Great Plains area--Texas, Oklahoma, Kansas, Colorado, New Mexico and Nebraska.

None of the changes came overnight, but they came with such rapidity that the packing industry, the grain trade, transportation, and other allied industries have had difficulty adjusting to them.

APPENDIX

(1). Calculation of the average ratio of Wheat Variety/Turkey Red, $\bar{X}_i$

$$\bar{X}_i = \frac{\sum_{j=1}^{n} \frac{Xij}{TRj}}{n}$$

where i denotes a wheat variety, j denotes test plot observation; thus, Xij is the yield of wheat variety i in test plot j, TRj is the respective Turkey Red yield in test plot j, and n denotes the number of observations.

(2). The standard deviation (S_i) is obtained by:

$$S_i = \frac{\sum_{j=1}^{n} \frac{Xij}{TRj} - \bar{X}_i^2}{n-1}$$

(3). The t-statistic is calculated by:

$$t_i = \frac{\bar{X}i - 1}{S_i / \sqrt{n}}$$

(4). Wheat production index (Table 2) is obtained by:

$$\sum_{i=1}^{n} \bar{X}_i D_{it} = \text{Index}$$

Where $\bar{X}_i$ is defined as above in (1), t denotes the year, D_{it} denotes the percentage of total wheat acres in Kansas planted to variety i, n is the number of varieties planted to more than 1% of the acres in year t. The relatively small acreage planted to insignificant varieties was

assumed to yield the same as Turkey Red. Thus, the index accounts for all wheat acres.

Footnotes

1/Derivation of Wheat Production Index is explained in the Appendix.

2/Statistical analysis (regression) using state yields of wheat as dependent variable and wheat production index as independent variable was highly significant. The coefficient of determination (R^2) of about 0.9 suggests that the derived crop index is a good indicator of the wheat yields of varieties grown in the years considered.