

CHANGING PATTERNS OF CORN YIELDS PER ACRE: THE POSITION OF ILLINOIS IN THE UNITED STATES

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INTRODUCTION

The present paper is an attempt to show through comparative regional analysis the position which the state of Illinois has taken in the national trend toward increasing corn yields per acre.

The sharp rise in average corn yields per acre which occurred in the United States during the past two decades has brought about a significantly larger output of corn, and at the same time has made it possible to reduce the acreage on which corn is grown. Illinois has taken a prominent position in this development. For the country as a whole, average corn production during the decade 1943-1952 was 18% higher than the average production during the decade 1900-1909 (Table 1). At the same time, the acreage from which corn was harvested has been reduced 10%. With respect to Illinois, figures show an increase of 23% in corn production, and a decline in corn acreage of 16%. Figures for the increase in corn yields per acre, related to the base years given above, are 31% for the nation as a whole, and 39% for Illinois.

As a corn-producing state, Illinois ranks second only to Iowa. The latter state has the largest corn acreage and the largest production. The leading position of Iowa in corn

yields per acre, however, has been lost. During the 10-year period, 1943-1952, corn yields in Illinois were 45% above the national average, and higher than in any other state of the nation.

A map of average corn yields per acre in the United States exhibits great regional diversity (Fig. 1); since very little corn is grown in the New England, Rocky Mountain, and Pacific states, these areas have been excluded from the present discussion). In many of the Midwestern states, corn yields are twice as high as in most states of the South. Generally speaking, they rank above the national average in the Corn Belt, Lake, and Middle Atlantic states, and below the national average in the South and the Great Plains states.

On a national basis, corn yields per acre have shown an astonishing increase during the past two decades. From the early part of the century until the middle twenties, they averaged only 26 to 28 bushels per acre. A subsequent decline, partly due to poor farm management, but also a consequence of drought during the middle thirties, was followed by a steep rise. During the past 10 years, corn yields in the United States averaged nearly 36 bushels per acre.

In the race for higher corn yields per acre, several states have taken a

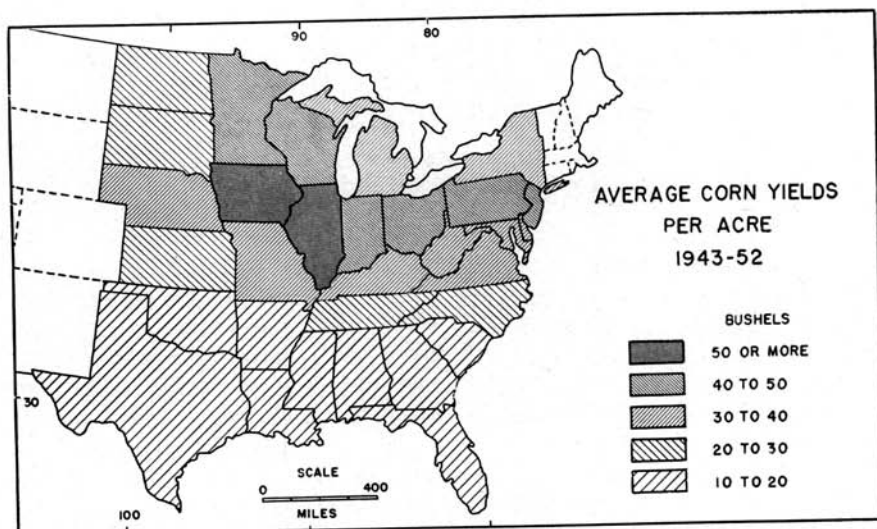


FIG. 1.—Average corn yields per acre in corn growing area, 1943-1952 (Fluctuations in Crops and Weather, 1866-1948, and Agric. Sta., 1951 to 1953).

more prominent position than others (Fig. 2). Of the 31 corn-producing states to the east of the Rocky Mountains, 9 have raised their yields more than 12 bushels per acre, while 5 states have failed to obtain any significant increase. In Oklahoma and Texas, average corn yields have actually declined.

The most important factors which have contributed to increases in corn yields per acre are: (1) use of hybrid seed; (2) more abundant and more effective fertilization; (3) the mechanization of farm operations; and (4) changes in the pattern of corn acreage and improvements in crop rotation.

HYBRID SEED

The introduction of hybrid corn in the United States was followed by a rapid development in the use of this type of seed. While corn hybrids were unknown to farmers until the middle thirties, they oc-

cupied nearly one-third of the nation's corn acreage in 1940, over one-half in 1943, and more than four-fifths in recent years.

In all instances, hybrid corn strains are bred in order to obtain optimum yields per acre. The specific qualities which are desired of the hybrid plant, however, vary widely with local conditions. As a result, literally hundreds of different hybrid strains have been developed and tested during the past 20 years. To fit local conditions, they may be bred to be drought resistant, early maturing, or resistant to specific insects or fungus. Often the aim is to achieve a combination of these qualities.

Up to the present time, the result of the use of hybrid corn in terms of increased corn yields per acre has varied considerably in different regions. The following examples are evidence for the great regional diversity in the response to hybrid seed.

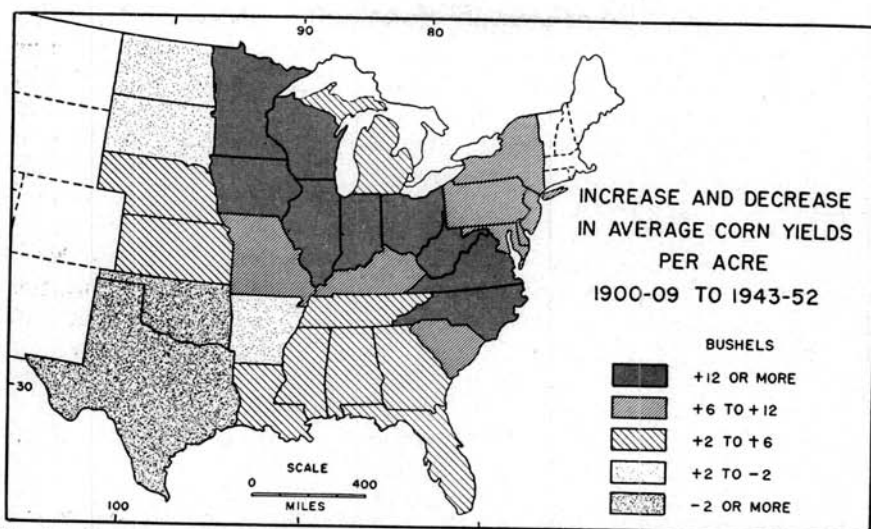


FIG. 2.—Increase and decrease in average corn yields per acre, 1900-1909 to 1943-1952 (Fluctuations in Crops and Weather, 1866-1948, and Agric. Sta., 1951 to 1953).

In Illinois, the increase in corn yields per acre was greatest during the forties; it was closely associated with the introduction of hybrid seed (Fig. 3).

Sizable increases in corn yields

per acre in Wisconsin and Minnesota (Fig. 2) and the large percentage of corn acreage planted to hybrid seed during the past 17 years in these two states (Fig. 3) illustrate the great success in the devel-

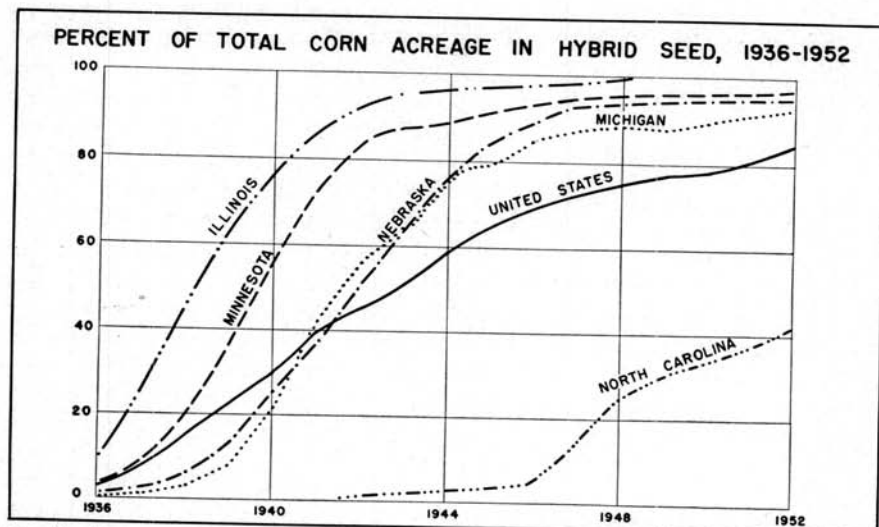


FIG. 3.—Percent of total corn acreage in hybrid seed for selected states, 1936 to 1952 (Agric. Sta., 1945 to 1953).

opment of early maturing hybrid strains. In Michigan, the increase in corn yields from 1900-1909 to 1943-1952 was considerably less (Fig. 2). This may partly be attributed to a later start in the development and application of suitable hybrid strains (Fig. 3). During the last few years, however, the percentage of corn acreage planted to hybrid corn in Michigan was nearly equal to that of Wisconsin and Minnesota. If yield changes from 1900-1909 to 1950-1952 are compared, the increase in corn yields per acre in Michigan is nearly as great as in Wisconsin and Minnesota.

The relatively insignificant increase in corn yields per acre in Nebraska, in spite of a fairly high percentage of all corn acreage in hybrid seed, witnesses a much smaller success in the development of drought resistant hybrid strains.

In the South, the percentage of corn acreage planted to hybrid seed has until recently been rather low. In 1950, Virginia and Kentucky were the only southern states that had more than 70% of their total corn acreage in hybrids.

FERTILIZATION

Some states, such as North Carolina, have shown actual increases in corn yields per acre comparable to what has been obtained in Illinois, Wisconsin, or Minnesota. Hybrid corn, however, has been quite unimportant (Fig. 3). In the case of North Carolina, the answer to the great increase in average corn yields seems to be increased fertilization of the soil.

While the consumption of commercial fertilizers in the United

States during the early thirties was little greater than at the beginning of the century, it has rather steadily increased in recent years. On a national basis, the quantity of fertilizers consumed has more than doubled during the past two decades. At the same time, the fertilizers were improved in quality (Harris, 1954).

Through increased fertilization, farmers are able to grow more plants on a given area, provided that the water supply is sufficient. In the more humid parts of the corn-growing area, the larger number of plants per acre in recent years, as compared to the beginning of the century, has helped considerably to increase the output per acre.

Unfortunately, data indicating the amount of fertilizers consumed for various crops are not readily obtainable on a state basis. Therefore, it is presently impossible to trace on a statistical basis the effect of increased fertilization on the changing patterns of corn yields per acre. Using the available figures of total fertilizer consumption and of acreages in different crops, one can only compute some index for the over-all intensity of fertilization. This index may later serve as the basis for a rough estimate of the intensity of fertilization in corn cultivation.

In order to obtain an index for the over-all intensity of fertilization in different states, the writer has computed the fertilizer consumption per acre in primary fertilized crops (Fig. 4). The "primary fertilized crops" include corn, cotton, wheat, oats, vegetables, tobacco, and rice. Some of these crops, however, are more heavily fertilized than others. The writer would estimate that

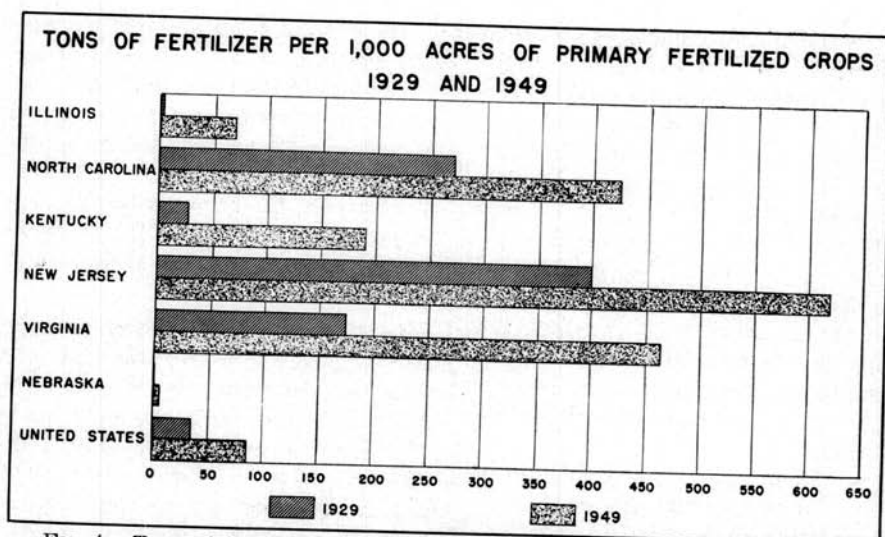


FIG. 4.—Tons of fertilizer per 1,000 acres of primary fertilized crops, 1929 and 1949 (Agric. Sta. 1938, 1951 to 1952; U.S. Census Agric., 1950; data for fertilizer application computed by dividing average consumption of commercial fertilizers during 1928-1930 and during 1948-1950 by total number of acres in seven primary fertilized crops in 1929 and 1949, respectively).

vegetables and tobacco are most heavily fertilized; second in order are cotton and rice; third is corn; and fourth are wheat and oats. In instances where total fertilizer consumption is rather low, nearly all fertilizer may be applied to only one or two intensively fertilized crops. Therefore, if increases in corn yields per acre are to be related to the increasing intensity of over-all fertilization, one must take into consideration not only the increase in over-all fertilization, but also the present intensity of fertilization.

North Carolina ranks sixth place among all states in tonnage increases in fertilizer consumption per acre in primary fertilized crops (Fig. 4). Increases were greater only in Florida and New Jersey (both states having relatively large acreages in such very intensively fertilized crops as vegetables), in Virginia and West

Virginia (where corn yields have increased about as much as in North Carolina), and by a very small margin in Kentucky. In terms of the present intensity of fertilization, North Carolina occupies fourth place, being surpassed only by Florida, New Jersey, and Virginia. Average fertilizer consumption per acre in primary fertilized crops in North Carolina is five times as great as for the nation as a whole, and two and a half times as much as in Kentucky. At the present time, the intensity of fertilization in Kentucky is only little more than what it was in North Carolina some 20 years ago. One may assume, therefore, that the amount of fertilizer applied to corn in Kentucky at this time is not large enough to raise the state's average corn yield per acre to the same extent as it has been raised in North Carolina.

In the western parts of the corn-growing area, where soil fertility ranks rather high and where the land has been under cultivation for a comparatively short time, fertilization is still quite insignificant (see Nebraska, Fig. 4). Also in Illinois, present fertilizer consumption per acre in primary fertilized crops ranks below the national average. However, in view of the fact that only 20 years ago fertilization was hardly practiced at all, the increase in fertilizer consumption is considerable.

In recent years, a trend toward more intensive fertilization has become common to all Corn Belt and Lake states. This may partly be attributed to the large acreages planted to hybrid corn. Hybrid plants, by growing larger and developing a more extensive and stronger root system, deplete soils at a faster rate than open-pollinated varieties.

MECHANIZATION OF FARM OPERATIONS

An additional factor in increasing corn yields per acre in the United States has been the introduction of new farm machinery. The use of tractors, mechanical corn pickers, and other improved machinery has not only facilitated farm operations but has also helped to make farm management more efficient. Methods of plowing, seedbed preparation, planting, crop cultivation, and harvesting have often been improved. At the same time, the number of man-hours required to take care of the corn crop in the United States has been reduced some 65% since the beginning of the century (Agric. Stat., 1952: 709).

The introduction of farm machinery has been a most significant development in the Corn Belt and Lake states; but this movement developed at a much slower pace in the southern parts of the country. The reason for this difference in trends may be explained by yet another comparison of Illinois, North Carolina, and Nebraska.

In 1949, the average corn acreage per farm in North Carolina was only 9 acres, compared to 83 acres in Nebraska, and 56 acres in Illinois (U. S. Census of Agric. 1950: 532-534). In North Carolina, 75% of the farms reporting corn have acreages of less than 10 acres; in Nebraska, this figure is only 4% and in Illinois 23%. In North Carolina, most farms have acreages so small that the purchase of expensive farm machinery could not be considered a sound investment. In Illinois, Nebraska, and other midwestern states, the mechanization of farm operations has become an economic necessity. In 1951, an estimated 15% of the corn acreage for grain was harvested by mechanical pickers in North Carolina, compared to 90% in Nebraska, and 93% in Illinois (Harv. Corn for Grain, 1953: 8).

The effects of mechanized crop cultivation on average corn yields per acre have varied not only with the degree of mechanization, but also with the relative need which exists for the improvements which mechanization can help to accomplish. In the northern parts of the corn-growing area, for example, the greater speed in the seedbed preparation and planting of corn has become most significant to corn cultivation. The use of tractors has made

it possible for farmers to plant their corn within such a short time that unfavorable weather conditions in spring need not result in an unusually short growing season and in a diminished harvest (Harris, 1954). In areas which have the advantage of a relatively long-growing season, planting dates are less critical. In the corn-growing areas of North Carolina, for example, where the frost-free period extends over a considerably longer period than in the northern parts of the Corn Belt (Climate and Man, 1941: 746), farm machinery would do much less to raise average corn yields per acre.

CHANGES IN THE PATTERN OF CORN ACREAGE

Corn acreage has declined at a considerably faster rate in Illinois than in the nation as a whole (Table 1).

A decline in corn acreage may reflect two essentially different trends: (1) It may indicate improvements in crop rotation, as has been the case in the claypan areas of northeastern Missouri, of large areas of southern Illinois, and of southwestern Indi-

ana; or (2) it may indicate that land has been taken out of corn and converted to other uses. This has been the case in large areas of central and western Kansas, central Oklahoma, parts of northeastern and north central Texas, and in sections of the southern Piedmont region. In nearly all instances, decreases in corn acreage have contributed toward higher corn yields per acre, because most commonly the less productive land was taken out of corn.

The claypan area of southern Illinois is an excellent example of a situation where improvements in crop rotation with a consequent decrease in corn acreage have resulted in a substantial increase in corn yields per acre. On most of the land in southern Illinois, which by reason of its heavy and compact soils was not well suited to corn cultivation, corn acreage has declined significantly during the past 12 or 15 years. At the same time, soybeans were introduced, and as a pioneer crop have done much to improve drainage and aeration in the soil (Weaver, 1954: 44-47). Soybeans have offered the additional advantage of adding to the nitrogen com-

TABLE 1.—Changes in Corn Production, Acreage, and Yields Per Acre, 1900-1909 to 1943-1952.

Years	Production (1,000 bushels)		Harvested acreage (1,000 acres)		Yield per acre (bushels)	
	U. S.	Ill.	U. S.	Ill.	U. S.	Ill.
1900-1909.....	2,613,215	369,789	95,818	10,437	27.3	37.3
1943-1952.....	3,085,755	456,421	86,332	8,763	35.8	51.9
Absolute change..	+472,540	+86,632	-9,486	-1,674	+8.8	+14.6
Percentage change	+18.1	+23.4	-9.9	-16.0	+31.1	+39.1

ponent in the soil, and thereby fertilizing the crop which follows in rotation. On some of this land, soybeans are now rotated regularly with corn.

Several acreage changes which occurred in other parts of the country have been effective in raising average corn yields for the entire United States. For example, the abandonment of corn cultivation in the low-yielding areas of central and western Kansas, central Oklahoma, and in the northern parts of Texas has raised the national yield average. The expansion of corn acreage in Minnesota and Wisconsin during the past two decades has been equally beneficial to the national yield average, because corn yields rank high in these two states.

SUMMARY

The preceding discussion has presented evidence that none of the factors which have contributed toward increased corn yields per acre in the United States has been of equal importance in all parts of the country. The following paragraphs summarize the above findings by focusing attention on the position of Illinois in the national trend toward increased corn yields.

In the development of hybrid seed, Illinois has occupied a leading position and still holds it. For the past six years, all of the state's corn acreage has been planted to hybrids. The increase in corn yields through the use of improved seed, however, has not yet run its course. At the present time, a large variety of new hybrid strains with larger yielding potentials under specific local con-

ditions is being developed and tested with many excellent results.

The intensity of fertilization in Illinois is less than the average for the United States. However, the percentage increase in fertilizer consumption in Illinois surpasses the national average by a considerable margin. One may expect that, with the continued use of hybrid corn, fertilization will become increasingly necessary, and that fertilizer consumption will continue to increase rather rapidly in Illinois.

Illinois holds a leading position in the use of farm machinery in corn cultivation. In the northern parts of the state, farm tractors have helped to overcome the disadvantages of a relatively short growing season. In the southern claypan areas, the power of the tractor has enabled farmers to plow deeper and to work the heavy clay soils more effectively (Weaver, 1954: 44-47). At the present time, corn cultivation in Illinois is nearly completely mechanized. Further advantages by means of mechanization, however, may eventually be obtained by improvements of the existing machinery or by the development and application of new machines.

The decrease in corn acreage which occurred in the southern sections of Illinois has definitely contributed to higher corn yields within this area, and has thereby raised the yield average for the entire state. If in the future further reductions in corn acreage should be desirable, one may expect that once more decreases in corn acreage will be greatest where corn yields per acre are lowest.

The relatively steep decline in corn acreage in Illinois as compared to the total in the United States (Table 1) has not impaired the relative position of Illinois as a corn-producing state. The percentage increase in corn production in Illinois

has been considerably greater than for the United States as a whole. As a result, Illinois has contributed a larger share to the total corn production of the United States in recent years than at the beginning of the century.

LITERATURE CITED

- AGRICULTURAL STATISTICS. 1938-1953. Wash., Gov't. Print. Office.
- CLIMATE AND MAN. 1941. Yearbook of Agriculture. Wash., Gov't. Print. Office.
- FLUCTUATIONS IN CROPS AND WEATHER, 1866-1948. 1951. U. S. Dept. Agric. Stat. Bull. No. 101.
- HARRIS, CHAUNCY D. 1954. The last fifty years and the next in American agriculture. Read at 50th Anniv. Meet. Assoc. Amer. Geog., Phila., Penn., 1954.
- HARVESTING CORN FOR GRAIN. 1953. U. S. Dept. Agric., Stat. Bull. No. 129.
- UNITED STATES CENSUS OF AGRICULTURE. 1950. General Report, Vol. 2. Wash., Gov't. Print. Office.
- WEAVER, JOHN C. 1954. Changing patterns of cropland use in the Middle West. *Econ. Geog.*, 30:1-47.