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The Influence of Acreage and Yield Changes on Crop Production in Nebraska

Robert M. Finley

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The Influence of Acreage and Yield Changes on Crop Production in Nebraska

by

Robert M. Finley

University of Nebraska College of Agriculture And Home Economics
The Agricultural Experiment Station
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The Influence of Acreage and Yield Changes On Crop Production in Nebraska

By Robert M. Finley

INTRODUCTION

Even the most casual observer of agriculture has witnessed the increase in farm technology and efficiency over the past two decades. A primary impact of technology has been increased crop yields. However, total crop production has not increased in direct proportion to yields since weather conditions, government programs and farmers' expectations have caused fluctuations in crop acreages. Since total crop production is a function of both yield and acreage, a variation or change in total crop production is directly attributable to combination and interaction of both yield and acreage changes.

An important determinant of price and utilization of a commodity in any year is the total available supply. Persons interested in interpreting and formulating agricultural price and utilization policies and programs must be concerned with the relative contribution of yield and acreage changes on production changes. For example, if it is determined that year-to-year changes in production of a given crop are largely attributable to acreage changes, then a program designed to limit production by restricting acreage is likely to be successful. On the other hand, if yield changes account for a major portion of production variation, then efforts directed at reducing production through acreage controls will be frustrated.

Another need for assessment of the component makeup of crop production variations is in formulating crop insurance actuarial bases, which are based primarily upon yield levels and fluctuations. Because fluctuations of production of a given crop are related to yield and acreage changes, the extent of the total production variation due to yield alone should be determined before an actuarial base structure can be established that is equitable to both the insurer and insured.

The general purpose of the study is to assess the impact of acreage

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1 Appreciation is expressed to James B. Hassler for assistance at several stages of this study. His careful reading of a first draft aided in the clarification and interpretation of some of the statistical procedures used. A departmental committee composed of E. E. Peterson, Alfred Eckert, and T. S. Thorfinnson made many valuable suggestions, especially in organization of the manuscript.

2 Formerly Associate Professor of Agricultural Economics, University of Nebraska, Lincoln, Nebraska; Presently Professor of Agricultural Economics, University of Missouri, Columbia, Missouri.

and yield changes on total production of important Nebraska crops. A secondary purpose is to examine two different methods of imputing the influence of changes of yield and acreage on production changes. It is not presumed that all possible areas of usefulness of the analysis and information contained herein are anticipated. As previously indicated, most of the usefulness will probably lie in providing background information needed for interpreting and guiding governmental agricultural policies and programs. Furthermore, a general notion of the relative merits of the methods employed should be obtained and thereby aid in selecting the appropriate statistical method for similar analyses.

**PREVIOUS STUDIES**

Foote, Klein and Clough\(^4\) studied changes in corn production for the years 1919–48. They found that the average change in corn production from one year to the next was approximately 15 percent for the United States. However, for the West-North Central Region (which includes Nebraska) the average change was considerably higher—about 22 percent. Foote and associates stated that “about 80 percent of the year to year variation in corn production in the United States during the period 1919–48 resulted from changes in yield per acre.”\(^5\)

Relative effects of changes in yield and acreage on year to year changes in wheat production were investigated by Meinken.\(^6\) Meinken determined the “direct effect of yield” by multiplying the change in yield from one year to the next by the previous year’s acreage and the “direct effect of acreage” by multiplying the change in acreage from one year to the next by the yield of the previous year. The study indicated that for the period 1920 to 1938, the yield component was considerably more important than the acreage factor. However, from 1939 to 1954, the acreage influence was almost equal to the yield influence. The gain in influence of the acreage factor was attributed to the effects of the acreage allotment programs and attendant cuts in acreage.

Sackrin\(^7\) pointed out the limitations of the methods used by Foote et al. and Meinken. Foote et al. did not give the full details of their computations but Sackrin states that:

“the relative contribution of changes in corn yields apparently was ascertained as follows:

---


1. The average year to year change in yield (disregarding signs) was expressed as a percentage of the average yield for the period.

2. The average year to year change in acreage (disregarding signs) was expressed as a percentage of the average acreage for the period.

3. The two percentages were added. The result obtained in step 1 was then expressed as a percentage of this sum.

Sackrin indicated that although the Foote method may give a close approximation it does not “equate strictly changes that take place in acreage and yield with changes in production” because the elements of a multiplicative relationship were added and thus the final result is not “precisely equated.” Sackrin further pointed out that the Meinken method is limited by the fact that the direct effects of yield and acreage do not exactly equal actual changes in production. As an alternative he proposed that the year to year relative changes in production can be expressed as:

\[
\frac{\text{Production (present year)}}{\text{Production (immediate past year)}} = \frac{\text{Acre (present year)}}{\text{Acre (immediate past year)}} \times \frac{\text{Acre yield (present year)}}{\text{Acre yield (immediate past year)}}
\]

or

\[
\frac{P_t}{P_{t-1}} = \left( \frac{A_t}{A_{t-1}} \right) \left( \frac{\gamma_t}{\gamma_{t-1}} \right)
\]

and when expressed in first differences of logarithms the relationship is:

\[
\Delta \log \text{production} = \Delta \log \text{acreage} + \Delta \log \text{yield}.
\]

Thus a multicative relationship is converted to an additive relationship.

Swanson, using the method proposed by Sackrin, found that in

---

8 Sackrin, p. 136.

9 Rather than net regression coefficients of acreage and yield, only the simple regression coefficients \( b_{21} \) and \( b_{31} \) are required:

\[
b_{31} = \frac{\sum \chi_2^2}{\sum \chi_2 \chi_3}
\]

\[
b_{21} = \frac{\sum \chi_3^2}{\sum \chi_2 \chi_3}
\]

where \( b_{21} + b_{31} = 1 \)

general, the contribution of acreage changes was relatively small for major crops in Illinois. In the few cases when acreage changes were more important than yield changes, the crops affected were not major ones in the area.

PROCEDURE

The crops considered in the study were winter wheat, oats, corn, soybeans, and grain sorghum. These five crops are important ones in Nebraska, occupying about 70 percent of the cropland harvested.\(^\text{11}\)

Yields, acreage and production data sources were the annual reports of Nebraska Agricultural Statistics, published by the State-Federal Division of Agricultural Statistics, Lincoln, Nebraska.

For the analysis of the influential factors on production changes two methods are compared. "Method I" is the procedure attributed by Sackrin to Foote and associates. "Method II" is the one proposed by Sackrin.

Three time periods were considered—1940 through 1960; 1940 through 1952; and 1940 through 1960, excluding 1953 through 1957. Reasons for employing the various time periods are explained in later sections.

For the period 1940 through 1960, influence of yield and acreage changes on total production were examined for all crop-reporting districts as well as the state as a whole. For the other time periods, only state-wide data were used.

HARVESTED ACREAGE ADJUSTMENTS, 1940-60

Crop acreage adjustments indicate the necessity and/or willingness of farmers to make changes in farm organization and adjust for weather conditions. Responses summarize a composite of reaction to weather, government programs and regulations and many other variables. The percentage acreage adjustments presented in Table 1 were divided into those years in which harvested acres increased from the previous year and those years in which acreage decreased. For example, wheat acreage in the Northwest district increased from the previous year 11 times and decreased 9 times. The average percentage increase was 10.2 while the average decrease was 7.9 percent.

The use of average percentage data often obscures some important shifts of acreage in individual years. For example, state harvested acreage of winter wheat increased 29 percent from 1941 to 1942 and 36 percent from 1944 to 1945. The principle factor for the large increase in 1942 was a low abandonment rate resulting from a relatively good moisture status. While wartime incentive was an important factor,

Table 1. Harvested acreage adjustments expressed as average percentage increases or decreases from preceding year, 1940 to 1960.

<table>
<thead>
<tr>
<th>Region</th>
<th>Winter Wheat</th>
<th>Oats</th>
<th>Soybeans&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Corn</th>
<th>Grain Sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>10.2(11)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-7.9(9)</td>
<td>16.3(11)</td>
<td>-13.1(9)</td>
<td>........</td>
</tr>
<tr>
<td>North</td>
<td>26.6(12)</td>
<td>-12.8(8)</td>
<td>10.5(9)</td>
<td>-14.3(11)</td>
<td>........</td>
</tr>
<tr>
<td>Northeast</td>
<td>38.0(11)</td>
<td>-24.2(9)</td>
<td>16.4(10)</td>
<td>-8.8(10)</td>
<td>43.4(11)</td>
</tr>
<tr>
<td>Central</td>
<td>36.8(12)</td>
<td>-18.3(8)</td>
<td>33.9(8)</td>
<td>-18.5(12)</td>
<td>........</td>
</tr>
<tr>
<td>East</td>
<td>17.1(12)</td>
<td>-18.4(8)</td>
<td>17.7(9)</td>
<td>-13.9(11)</td>
<td>37.7(11)</td>
</tr>
<tr>
<td>Southwest</td>
<td>13.9(11)</td>
<td>-11.1(9)</td>
<td>12.9(9)</td>
<td>-21.3(11)</td>
<td>........</td>
</tr>
<tr>
<td>South</td>
<td>31.5(12)</td>
<td>-17.9(8)</td>
<td>22.5(7)</td>
<td>-23.4(13)</td>
<td>........</td>
</tr>
<tr>
<td>Southeast</td>
<td>12.9(11)</td>
<td>-14.6(9)</td>
<td>17.1(8)</td>
<td>-15.0(12)</td>
<td>50.4(8)</td>
</tr>
<tr>
<td>Nebraska</td>
<td>14.3(9)</td>
<td>-9.2(10)</td>
<td>15.6(9)</td>
<td>-12.2(11)</td>
<td>46.3(9)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Data for soybeans are from 1943 to 1960.

<sup>b</sup> Numbers in parentheses are the number of year-to-year increases or decreases. For the state as a whole, no change in harvested acres occurred of wheat 1942 to 1943, and of corn 1951 to 1952. For the North district, no change in harvested acres of grain sorghum occurred 1952 to 1953.
the primary reason for the large increase in harvested acres from 1944 to 1945 was that rust, unfavorable planting and early growing conditions resulted in a relatively small 1944 crop, while the excellent 1945 wheat crop broke all previous records for total production by a large margin.

Two substantial reductions in corn acres harvested in 1955 (15 percent) and 1956 (11 percent) were results of drought, lower planted acres and heavy abandonment. The percentage of harvested acres rose sharply over the previous year in 1943 and 1959 (15 percent and 22 percent respectively). In 1943, few acres were abandoned, corn prices were up 25 cents or more per bushel and production was nearly double the ten-year average. The largest percentage increase occurred, however, from 1958 to 1959 when corn allotments were removed.

Several other items deserve mention. Because of low bases, the percentage of acreage variability of both soybeans and grain sorghum is high.

For soybeans, three abrupt acreage changes from the previous year are indicated—two substantially above average increases and one above average decrease. From 1949 to 1950, soybean acreage increased 127 percent statewide. In 1953 to 1954 the increase was 81 percent. The increase of soybean acreage in 1950 was primarily a response to the introduction of acreage allotments for corn for the first time in nine years. The 1954 increase is also explained, at least partially, by a substitution of soybeans for corn when acreage allotments were resumed after a lapse during the Korean War. A sizeable decrease (67 percent) of harvested acres of soybeans occurred from 1943 to 1944 primarily because of the large increase in corn acreage.

In three periods, 1949 to 1950, 1953 to 1954, and 1956 to 1957, grain sorghum acreage increased over 100 percent from the previous year. The explanation is: In 1950, corn allotments were in force for the first time since 1941; in 1954, many farmers adopted grain sorghum as part or all of their feed grain base because of its drought resistance; in 1957, many farmers were anticipating another dry year and substituted grain sorghum for corn, and the Soil Bank program discouraged corn production.

The main periods of above average yearly declines in harvested acres of grain sorghum occurred immediately before and during World War II; 1940 to 1941, 1941 to 1942, 1942 to 1943 and 1944 to 1945. In each of these periods, the decline from the previous year was over 40 percent. The primary reasons were competition with corn (these were periods of increasing corn acreage with but one exception 1944 to 1945) and the fact that the number of acres was small to begin with compared to other crops such as corn.
Table 2. Yield per acre expressed as average percentage increases or decreases from preceding year, 1940 to 1960.

<table>
<thead>
<tr>
<th></th>
<th>Winter Wheat</th>
<th>Oats</th>
<th>Soybeans&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Corn</th>
<th>Grain Sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northwest</td>
<td>29.0(11) b</td>
<td>-15.8(9)</td>
<td>41.9(11)</td>
<td>-22.2(9)</td>
<td></td>
</tr>
<tr>
<td>North</td>
<td>38.9(9)</td>
<td>-16.2(11)</td>
<td>56.2(9)</td>
<td>-21.9(11)</td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>73.1(9)</td>
<td>-27.5(11)</td>
<td>63.3(7)</td>
<td>-17.3(13)</td>
<td>35.5(10)</td>
</tr>
<tr>
<td>Central</td>
<td>49.0(10)</td>
<td>-18.2(10)</td>
<td>61.9(10)</td>
<td>-25.2(10)</td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>66.4(10)</td>
<td>-31.0(10)</td>
<td>41.2(12)</td>
<td>-31.2(8)</td>
<td>43.1(10)</td>
</tr>
<tr>
<td>Southwest</td>
<td>39.9(11)</td>
<td>-24.7(9)</td>
<td>62.5(9)</td>
<td>-25.1(10)</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>57.7(11)</td>
<td>-23.2(9)</td>
<td>83.0(8)</td>
<td>-24.0(11)</td>
<td></td>
</tr>
<tr>
<td>Southeast</td>
<td>49.6(12)</td>
<td>-37.3(8)</td>
<td>54.8(10)</td>
<td>-33.2(8)</td>
<td>32.5(11)</td>
</tr>
<tr>
<td>Nebraska</td>
<td>41.4(9)</td>
<td>-21.4(9)</td>
<td>42.0(10)</td>
<td>-23.0(9)</td>
<td>31.4(11)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Data for soybeans are from 1943 to 1960.

<sup>b</sup> Numbers in parentheses are the number of year-to-year increases or decreases. For the state as a whole, no change in yield/acre of wheat occurred 1945 to 1946 and 1952 to 1953; oats, 1942 to 1943; corn, 1953 to 1954; and grain sorghum, 1945 to 1946. No yield change occurred for corn in the Northwest District, 1953 to 1954; for oats in the Southwest, 1942 to 1943, South, 1942 to 1943, and Southeast, 1950 to 1951; for grain sorghum in the Central, 1942 to 1943, and Southwest, 1953 to 1956.
YIELD CHANGES, 1940-60

While harvested acre changes indicate adjustments to factors such as government programs and weather conditions, yield changes primarily are caused by weather conditions and technology (e.g. irrigation, fertilizer, etc.) The average year-to-year yield changes expressed as percentages are presented in Table 2. A division was made between those years in which yields increased and those in which yields decreased. For example, winter wheat yields in Nebraska increased from the previous year 9 times, decreased 9 times, and did not change 2 times. The average decrease was 21.4 percent and the average increase 41.4 percent.

As in the case of acreage adjustment percentages, use of averages may obscure important yield changes in individual years. Hence, some of the more important departures for the crops considered will be discussed.

For wheat, the largest change in yield occurred from 1944 to 1945—more than 81 percent. The wheat year 1945 was extremely favorable and the second highest total wheat volume on record (at that time) occurred. Because of a very dry planting season and rust damage in the spring, the previous wheat yield (1944) had been disappointingly low—almost 40 percent below 1943.

Corn yields in 1947, 1948, 1955, and 1957 varied widely from the mean percentages. The 1947 corn crop was only about 60 percent of normal, with yields about 33 percent below 1946. A cold wet spring which delayed planting was followed by a marked moisture deficit and unusually high temperatures in July, August, and September. In 1948, relatively high and well distributed amounts of summer rainfall as well as favorable weather conditions during harvest caused almost an 85 percent increase over 1947 corn yields. In 1955, corn yields declined 36 percent from the previous year. The year 1955 was a third consecutive drought year and very dry conditions delayed planting; however June was a month of normal rainfall and by the first of July crop prospects were highly favorable. Extremely hot and dry weather in July and August, however, ruined previously bright prospects. In 1957, average precipitation was about 9 inches more than the previous year and several inches above normal. As a result corn yields increased greatly—109 percent over 1956.

Yield patterns of the other crops, oats, soybeans, and grain sorghum, follow those of corn quite closely. However, without exception, the 1957 yield increase for these crops exceeded that of corn—oats, 179 percent; soybeans, 135 percent; grain sorghum, 179 percent. This was because oats, soybeans, and grain sorghum were primarily dryland crops and responded relatively more than corn to the high rainfall of 1957. 12

12 For example, in 1956, approximately 11 percent of the acres of grain sorghum harvested were irrigated, as compared to 22 percent of corn acreage.
INFLUENCE OF YIELD AND ACREAGE CHANGES ON PRODUCTION CHANGES, 1940 TO 1960 INCLUSIVE

METHOD 1

The relative influences of change in acreage and yield on total production of Nebraska crops are presented in Table 3. The year-to-year influence of yield on total production of wheat in all crop reporting districts accounts for more variation than acreage changes. Only in the North, Northeast, and Central crop reporting districts do acreage changes account for more than 40 percent of production changes. However, these three districts are not important wheat producing areas, accounting for less than 8 percent of the average acreage of wheat and less than 7 percent of the average total production for the period 1940–60.

Oats are of little importance outside the three eastern districts. In general, about one-third of total production variability can be assessed to year-to-year acreage changes and two-thirds to yield changes.

Soybeans are an important field crop in only the Northeast and East districts. These two districts accounted for approximately 84 percent of the average harvested acres and average total production, 1943–1960. The influences of acreage and yield approach equal importance for the state as a whole. Acreage changes appeared to be slightly more important in the Northeast district while the reverse was true for the East district.

Nebraska’s most important crop is corn. In 1960 each district except the North and Northwest produced an average of over 10 million bushels. In the three leading districts, Northeast, East, and Southeast, acreage changes accounted for less than 25 percent while year-to-year yield changes accounted for more than three-fourths of the production changes.

Grain sorghum production in Nebraska has increased greatly in the past decade. Furthermore, hybrid grain sorghum is a very recent innovation. As might be expected, acreage changes were generally more important than yield changes as an influence on production. Two exceptions are noted: in the South and Southeast districts yield changes were slightly more influential than acreage changes.

METHOD II

A summary of the relative influences of changes in acreage and yield on total production computed by Method II is presented in Table 4. This method is quite sensitive to extreme changes in either of the components, since the average relative contribution is measured.

\[13 A map indicating crop reporting districts in Nebraska is presented in Appendix Figure 6.\]
Table 3. Relative effects of changes in acreage and yield on year-to-year changes in total production of various crops, Nebraska, 1940-1960, as computed by Method I.

<table>
<thead>
<tr>
<th>Crop-Reporting District</th>
<th>Wheat</th>
<th>Oats</th>
<th>Soybeans</th>
<th>Corn</th>
<th>Grain Sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acreage</td>
<td>Yield</td>
<td>Acreage</td>
<td>Yield</td>
<td>Acreage</td>
</tr>
<tr>
<td>Northwest</td>
<td>(percent)</td>
<td>31 69</td>
<td>35 65</td>
<td>43 57</td>
<td>68 32</td>
</tr>
<tr>
<td>North</td>
<td>42 58</td>
<td>29 71</td>
<td>24 76</td>
<td>62 38</td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>43 57</td>
<td>32 68</td>
<td>19 81</td>
<td>78 22</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>41 59</td>
<td>38 62</td>
<td>32 68</td>
<td>64 36</td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>28 72</td>
<td>34 66</td>
<td>24 76</td>
<td>66 34</td>
<td></td>
</tr>
<tr>
<td>Southwest</td>
<td>29 71</td>
<td>33 67</td>
<td>32 68</td>
<td>55 45</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>36 64</td>
<td>41 59</td>
<td>33 67</td>
<td>46 53</td>
<td></td>
</tr>
<tr>
<td>Southeast</td>
<td>26 74</td>
<td>34 66</td>
<td>22 78</td>
<td>47 53</td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>29 71</td>
<td>35 67</td>
<td>23 77</td>
<td>55 45</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Relative effects of changes in acreage and yield on year-to-year changes in total production of various crops, Nebraska, 1940-1960, as computed by Method II.

<table>
<thead>
<tr>
<th>Crop-Reporting District</th>
<th>Wheat</th>
<th>Oats</th>
<th>Soybeans</th>
<th>Corn</th>
<th>Grain Sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acreage</td>
<td>Yield</td>
<td>Acreage</td>
<td>Yield</td>
<td>Acreage</td>
</tr>
<tr>
<td>Northwest</td>
<td>(percent)</td>
<td>22 78</td>
<td>30 70</td>
<td>32 68</td>
<td>94 6</td>
</tr>
<tr>
<td>North</td>
<td>44 56</td>
<td>20 80</td>
<td>15 85</td>
<td>77 23</td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>37 63</td>
<td>24 76</td>
<td>8 2</td>
<td>85 15</td>
<td></td>
</tr>
<tr>
<td>Central</td>
<td>49 51</td>
<td>36 64</td>
<td>19 81</td>
<td>81 19</td>
<td></td>
</tr>
<tr>
<td>East</td>
<td>29 71</td>
<td>24 76</td>
<td>5 95</td>
<td>83 17</td>
<td></td>
</tr>
<tr>
<td>Southwest</td>
<td>25 75</td>
<td>23 77</td>
<td>24 76</td>
<td>75 25</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>47 53</td>
<td>23 77</td>
<td>15 85</td>
<td>51 49</td>
<td></td>
</tr>
<tr>
<td>Southeast</td>
<td>22 78</td>
<td>22 78</td>
<td>7 93</td>
<td>63 37</td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>25 75</td>
<td>25 75</td>
<td>7 93</td>
<td>62 38</td>
<td></td>
</tr>
</tbody>
</table>
In general, for the major crops, corn, oats, and wheat, the yield contribution was somewhat greater than that calculated by Method I. This was particularly true for corn. Using Method I, about 77 percent of year-to-year production variability was attributed to yield changes, while Method II attributed almost 93 percent of production variation to yield. This method may give a reasonable approximation of influences of the components, especially when one considers that some "extreme" years of drought occurred from 1953 through 1956. Yields varied more than harvested acres and hence the influences of the yield component may be exaggerated.\(^{14}\) In the Northeast district the yield factor's influence is misleading and must be rejected.

The rapid rise in grain sorghum acreage was reflected in coefficients computed by Method II. In every district the acreage changes were more influential than those computed by Method I. For soybeans, a situation similar to that of grain sorghum was found when Method II was used. Both in districts and the state as a whole, the coefficients indicating the influence of acreage changes increased as compared to those calculated by Method I.

**INFLUENCE OF YIELD AND ACREAGE CHANGES ON PRODUCTION CHANGES, 1940-52 INCLUSIVE**

Influences of yield and acreage changes on production changes were computed for 1940–1952 in the same manner as for 1940–1960. The major reason for the consideration of a shorter time period was that 1952 was the last year before drought conditions prevailed throughout the state.\(^{16}\) Relative effects of acreage and yield changes presented in Table 5 were calculated by the methods previously described and again referred to as Methods I and II.

For wheat, only slight changes in relative influence of the yield and acreage components were apparent. The use of either method indicated a slight increase in the importance of yield changes as a factor influencing production changes. While acreage changes were quite apparent from 1940–1952, more stringent acreage controls and drought conditions after 1952 changed the influence of acreage changes on total production.

\(^{14}\) See Table 6: The influence of yield changes on production change decreased when a time period excluding drought years was used.

\(^{15}\) Soybeans and grain sorghum are not considered in this time period because of relatively low acreages.

\(^{16}\) The beginning of the recent drought varied in different sections of the state. For example, in 1953 average precipitation in the eastern section of Nebraska was only about 79 percent of the average 1940–52 precipitation, while the state as a whole received about 88 percent of average 1940–52 precipitation. Also, for the years 1953–56, the state average precipitation was approximately 79 percent of average precipitation, 1940–52, while the eastern section averaged only 71 percent.
Table 5. A comparison of the influence of yield and acreage changes on total production changes of selected Nebraska crops for 1940 to 1952 inclusive.

<table>
<thead>
<tr>
<th>Method</th>
<th>Time Period</th>
<th>Wheat</th>
<th>Oats</th>
<th>Corn</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Acreage</td>
<td>Yield</td>
<td>Acreage</td>
</tr>
<tr>
<td>(percent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>1940–1952</td>
<td>27 % 73</td>
<td>42 % 58</td>
<td>19 % 81</td>
</tr>
<tr>
<td>II</td>
<td>1940–1952</td>
<td>24 % 76</td>
<td>28 % 72</td>
<td>5 % 95</td>
</tr>
</tbody>
</table>

Table 6. A comparison of the influence of yield and acreage changes on total production changes of selected Nebraska crops for 1940 through 1960, excluding 1953 through 1956.

<table>
<thead>
<tr>
<th>Method</th>
<th>Time Period</th>
<th>Wheat</th>
<th>Oats</th>
<th>Soybeans</th>
<th>Corn</th>
<th>Grain Sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Acreage</td>
<td>Yield</td>
<td>Acreage</td>
<td>Yield</td>
<td>Acreage</td>
</tr>
<tr>
<td>(percent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>1940–1960 excluding 1953–57</td>
<td>26 % 74</td>
<td>39 % 61</td>
<td>65 % 35</td>
<td>24 % 76</td>
<td>59 % 41</td>
</tr>
<tr>
<td>II</td>
<td>1940–1960 excluding 1953–57</td>
<td>25 % 75</td>
<td>26 % 74</td>
<td>94 % 6</td>
<td>8 % 92</td>
<td>72 % 28</td>
</tr>
</tbody>
</table>
Acreage changes for oats influenced production more than was the case when the longer series of years were considered. After 1952, acreage was declining and somewhat variable but yield changes were very pronounced, more than offsetting the acreage change.

In using the shorter period (1940–1952) for corn, the analysis indicated an increase in the influence of yield changes as a cause of production changes. Toward the end of the shorter series, acreage was relatively stable but yields varied widely.

Most of the reasons for changes in the relative importance of influential factors can be found by examining the data presented in Appendix Figures 1 through 5. It must be remembered that the relative importance of changes was measured and therefore the influence of large absolute changes in one component could be offset by still larger absolute changes in the other.

**INFLUENCE OF YIELD AND ACREAGE CHANGES ON PRODUCTION CHANGES, 1940-60 EXCLUDING 1953-57**

Estimates of relative influences of yield and acreage changes were made for the period 1940 through 1960, excluding the years 1953–1957 (Table 6). Year-to-year changes in acreage, yield, and production were calculated in the previous manner for the years 1940 through 1952 and 1958 through 1960, thus eliminating the drought years while still taking cognizance of the post-drought period. An alternate method of computation was considered which would also tend to reduce the impact of drought. This method would involve taking deviations in yields, acreage, and production for the year 1957 (the first post-drought year) from the year 1952 (the last pre-drought year). This approach, however, was deemed inappropriate since the change from 1952 to 1957 would be considered as a one year change. Even though the years 1952 and 1957 were similar in being non-drought years, other conditions undoubtedly were dissimilar (e.g. cropping and fertilizer practices, irrigation, attitudes of farm operators, governmental programs, etc.) and results could be misleading. For example, the decline in Nebraska wheat acreage from 1952 to 1957 was almost 1,500,000 acres. Hence, acreage influence would be unduly magnified.

The influence of acreage and yield changes on wheat production was approximately the same when the series was from 1940 to 1960 or 1940 to 1952. Use of Method I, however, does indicate slightly more yield influence than was the case of the 1940 to 1960 series. This is logical since a large part of the wheat acreage decline occurred in the early and mid-1950's.

For oats, the acreage and yield influences were about the same as those indicated for the two previous time periods considered.

Acreage influence on soybean production, which was already domi-
nant in the 1943 to 1960 series, increased when either method was employed. Omission of the years 1953 to 1957 eliminated years of erratic yield changes while acreage of the crop continued to increase.

Compared to the 1940–60 data, yield changes of corn had only slightly less influence on production change (1 percent less when either method is used). Results from the series of years 1940 to 1960, excluding 1953 to 1957, depart from those obtained using the 1940 through 1952 series for approximately the same reasons discussed above.

For grain sorghum, elimination of the drought years erased a sharp decline in yields while acreage continued to rise. As a consequence, acreage changes contributed even more to changes in production than was the case of the 1940 through 1960 series.

SUMMARY

This analysis indicated the magnitude of two primary factors affecting production of major Nebraska crops. Recognition and quantification of these factors are necessary for prediction of the consequences of various programs of agricultural policy. For example, the acreage control program is commonly used for controlling crop production. While this program cannot be dismissed as entirely ineffective, its effectiveness as a sole program can be seriously doubted, especially for wheat and corn where the influence of yield on production change is several times more important than that of acreage.

The crop acreage adjustment analysis also provides a useful index of the response to changes for various kinds of economic expectations. Economists employing prediction models will find the quantification of yield and acreage influences on production changes helpful for testing the reasonableness of predicted responses in normative analyses.

Two methods for imputing the influence of changes of acreage and yield respectively on production changes were compared. Method I amounts to an averaging of percentage changes of yields and acreages, adding the percentages, and expressing the respective averages as a percentage of the total. Mathematically, Method I had a serious limitation because multiplicative processes are added; hence the final result is not precisely equated.

Method II expresses the functional relationship of acreage and yield to production as first differences of logarithms and is mathematically consistent in that equality of each side of the equation is maintained.

As shown in Table 7, a comparison of results of the two methods indicates that Method II generally attributes a greater relative influence to yields for wheat, oats, and corn than does Method I. For the crops with greatly increased production in the periods considered, soybeans and grain sorghum, Method II attributes more influence to acreage changes. But the general conclusions reached by
Table 7. Summary of the influence of yield and acreage changes on total production changes of selected Nebraska crops for 1940 to 1960, 1940 to 1952 inclusive, and 1940 to 1960 excluding 1953 to 1956.

<table>
<thead>
<tr>
<th>Method</th>
<th>Time Period</th>
<th>Wheat</th>
<th>Oats</th>
<th>Soybeans</th>
<th>Corn</th>
<th>Grain Sorghum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Acreage</td>
<td>Yield</td>
<td>Acreage</td>
<td>Yield</td>
<td>Acreage</td>
</tr>
<tr>
<td>I</td>
<td>1940–1960</td>
<td>29</td>
<td>71</td>
<td>35</td>
<td>65</td>
<td>53</td>
</tr>
<tr>
<td>II</td>
<td>1940–1960</td>
<td>25</td>
<td>75</td>
<td>25</td>
<td>75</td>
<td>64</td>
</tr>
<tr>
<td>I</td>
<td>1940–1952</td>
<td>27</td>
<td>73</td>
<td>42</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>1940–1952</td>
<td>24</td>
<td>76</td>
<td>28</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>1940–1960 excluding 1953–57</td>
<td>26</td>
<td>74</td>
<td>39</td>
<td>61</td>
<td>65</td>
</tr>
<tr>
<td>II</td>
<td>1940–1960 excluding 1953–57</td>
<td>25</td>
<td>75</td>
<td>26</td>
<td>74</td>
<td>94</td>
</tr>
</tbody>
</table>
either method are similar. An elimination of some drought years in
the series slightly altered the influence of yield and acreage compo-
nents regardless of the method employed; changes, however, generally
were in the same direction. An elimination of such years possibly could
be misleading, especially if interest is in the long run average contri-
bution to the production variation by the yield and acreage compo-
nents and when one considers the fact that "runs" of dry years in
the Plains may be a normal sequential event.\textsuperscript{17}

A comparison of the results obtained for Nebraska crops is fairly
consistent with findings in similar studies of other areas. For example,
Swanson,\textsuperscript{18} using Method II, found that the relative contribution of
acreage changes to production changes in corn for Illinois was 18
percent. Foote\textsuperscript{19} attributed approximately 20 percent of variation in
U.S. corn production (1919–48) to acreage changes.

For wheat, the Nebraska findings are in line with those of Illinois\textsuperscript{20}
but more weight was given yield variations than in studies for the U.S.
as a whole.\textsuperscript{21} A partial reason for this divergence was that the Nebraska
data series was 4 to 6 years longer and acreage which declined sharply
from 1952 to 1954, has leveled off considerably while yield changes
are still great.

Comparing the results of relative influence with the only other
study which considered oats,\textsuperscript{22} the Nebraska data appear to give
slightly more weight to acreage changes but, in general, the findings
are similar.

For soybeans, substantial agreement is found with data for the
U.S.\textsuperscript{23} (1939–56), where approximately 60 percent of the variations in
soybean production were associated with acreage changes. Data from
Illinois,\textsuperscript{24} however, credit only about 15 percent of the production
variation to acreage changes. An examination of the Illinois data
indicates that a wide variation in importance of the two components,
yield and acreage, occurred among districts in Illinois (e.g. the fluc-
tuations in acreage varied from a high of 65 percent of production
variation in one district to a low of 5 percent in another district).

No comparative data were available for grain sorghum, but
undoubtedly as more yearly data become available the relative contri-
butions of acreage and yield changes may approach those for corn.

\textsuperscript{17} R. J. Hildreth, “Bunchiness in Precipitation Data and Certain Analytical
Implications,” paper presented at Methodology Workshop, GP-2 technical com-

\textsuperscript{18} Swanson, p. 25.

\textsuperscript{19} Foote, \textit{et. al.}, p. 14.

\textsuperscript{20} Swanson, p. 25.

\textsuperscript{21} Sackrin, p. 138; Meinken, p. 33.

\textsuperscript{22} Swanson, p. 25.

\textsuperscript{23} Sackrin, p. 138.

\textsuperscript{24} Swanson, p. 25.
APPENDIX

Appendix Fig. 1. Harvested acres and yield per acre of wheat, Nebraska, 1940 to 1960. Source: Nebraska Agricultural Statistics, 1940 to 1960.
Appendix Fig. 2. Harvested acres and yield per acre of oats, Nebraska, 1940 to 1960. Source: Nebraska Agricultural Statistics, 1940 to 1960.
Appendix Fig. 3. Harvested acres and yield per acre of soybeans, 1943 to 1960. Source: Nebraska Agricultural Statistics, 1943 to 1960.
Appendix Fig. 4. Harvested acres and yield per acre of corn, Nebraska, 1940 to 1960. 
Source: Nebraska Agricultural Statistics, 1940 to 1960.
Appendix Fig. 5. Harvested acres and yield per acre of grain sorghum, Nebraska, 1940 to 1960. Source: Nebraska Agricultural Statistics, 1940 to 1960.
Appendix Fig. 6. Nebraska Crop Reporting Districts.