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University of Minnesota
Center for International Food and Agricultural Policy

Universita degli Studi di Padova
Dipartimento Territorio e Sistemi Agro-forestali

Regione Veneto

Ente di Sviluppo Agricollo

SESSION II: LAND MARKETS IN THE U.S. AND E.U.

PAPER 1: SOME EVIDENCE OF INCREASING RISK IN CROP PRODUCTION IN MINNESOTA

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Spring Hill Conference Center, Wayzata, Minnesota
September 4-10, 1994

SOME EVIDENCE OF INCREASING RISK IN CROP PRODUCTION IN MINNESOTA*

PHILIP M. RAUP**

I. Introduction

This interim report of ongoing research grew out of dissatisfaction with the various attempts to explain the boom and bust in farm land values in the grain belts of the United States in the 1970s and 1980s. The focus is on Minnesota, but the argument applies generally to the corn, soybean, and wheat growing regions of the Midwest, Lake States, and Great Plains.

The magnitudes of the boom and bust were documented in an earlier paper presented to this joint University of Padova - University of Minnesota Seminar at Motta di Livenza, Italy on June 20, 1989. In summary, from 1972 to 1981 farmland values increased approximately five-fold in Minnesota and Iowa, and more than four-fold in other leading Midwest states. The smaller increases were in South Dakota, Missouri, Kansas, and Michigan.

In the bust phase, land values fell in the 1980s in approximately the reverse order in which they had increased in the 1970s. Iowa and Minnesota lost over 60 percent of their peak land values from 1981 to 1987, and losses in the remaining Corn Belt, Northern Plains and Lake States ranged from 54 to 34 percent, with the smallest declines

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in North Dakota and Michigan.

The earlier paper (Raup, 1989), stressed the influence in the boom phase of loose credit policies, negative real rates of interest, and the drive for economies of size through farm expansion by neighboring farmland owners, who comprised two-thirds to three-fourths of the buyers. The focus here shifts to the more interesting question of why credit agencies and knowledgeable farmland buyers misjudged so disastrously the prospects for future land income and land values in the 1970s.

The thesis being tested in this phase of the research is that the unprecedented increases in crop output made possible by plant genetic and plant nutrition advances in the 1950s and 1960s introduced new elements of risk, for which past experience provided no guides in risk assessment. Better seeds, higher seeding rates, heavier rates of fertilizer application, and greatly expanded use of farm chemicals changed fundamentally the exposure of farming to weather risk, under conditions of rainfed agriculture.

This thesis remains unproved. The words "interim report," and "ongoing research," were used in the introductory sentence to emphasize the tentative nature of the argument that is here presented. The evidence currently available suggests strongly that the thesis is worth exploring.

The data are presented graphically in a series of figures that use national data on corn and wheat production since 1900, to set the stage, followed by production and yield data on corn, wheat, and soybeans since 1950, for Minnesota. The initial analytical measurement device used is the coefficient of variation, calculated over 5-year intervals. Minnesota data have been compiled from annual reports of the Minnesota Crop and

Livestock Reporting Service. National data are from Agricultural Statistics, U.S. Department of Agriculture, various years. The laborious work of data assembly has been assisted by Steve Larson, Caroline Emerson-Price, and most recently by Molly Werner, to all of whom I am heavily indebted.

II. The Evidence of Increased Risk, Using Data on Production

Whether or not a speculative "bubble" characterized the U.S. farmland market in the 1970s depends on the estimates of risk that accompanied the bidding up of land prices. Output of major crops increased phenomenally from 1960 to 1980. With past concepts of relative risk in mind, it was rational to translate these output increases into anticipated future increases in net earnings from land.

What was not anticipated was the increase in risk of annual fluctuations in output associated with improved seeds, higher levels of fertilizer and chemical use, and greater exposure to variations in rainfall. From the 1960s to the 1990s the coefficient of variation in the output of corn in Minnesota roughly doubled, when averaged at five-year intervals. For wheat, the increase in risk was at least as great.

This increase in risk was not apparent in the 1970s, when the massive increase in farmland prices took place. Neither was it apparent when the majority of the studies of land value trends during the boom and bust were made in the mid- to late 1980s. The data used in these studies usually did not extend beyond 1987-88.

The data are arranged in a series of figures for corn, wheat, and soybeans, the major grain crops produced in Minnesota. The first series covers production, the second

series examines yields. For each of the three crops, the production and yield data are shown first as annually reported, followed by data calculated as five-year averages, for the half-decades beginning with 1950. (Data for 1994 were not yet available; the final data point is for a four-year average, 1990-93.)

A longer time perspective is provided by Figures 1 and 2, showing U.S. production of corn and wheat since 1900. For both crops, there was little change in trend from 1900 to 1945-50. Production increases began slowly in the 1950s and rose dramatically in the two decades from 1960 to 1980.

For the period since 1950, Figures 3, 5, and 7 for Minnesota production follow the general trend of the national data, but with wider deviations from trend in the period after 1975.

The magnitude of these variations is illustrated in Figures 4, 6, and 8, showing the coefficients of variation in production (the standard deviation divided by the mean and multiplied by 100) for each 5 year period.

Note that in the accompanying figures the left-hand scales showing production or yields are different for each crop, to accommodate the wide differences in magnitudes. The right-hand scales, showing the coefficients of variation in percentage terms, are the same for all crops. The slopes of the lines for production and yield cannot be compared among crops. The trends in coefficients of variation can be compared among crops, since the scale is in percentage terms, and is identical in all figures. Note that, if there was no change in relative risk over time, the trends in the coefficients of variation would be approximated by horizontal lines.

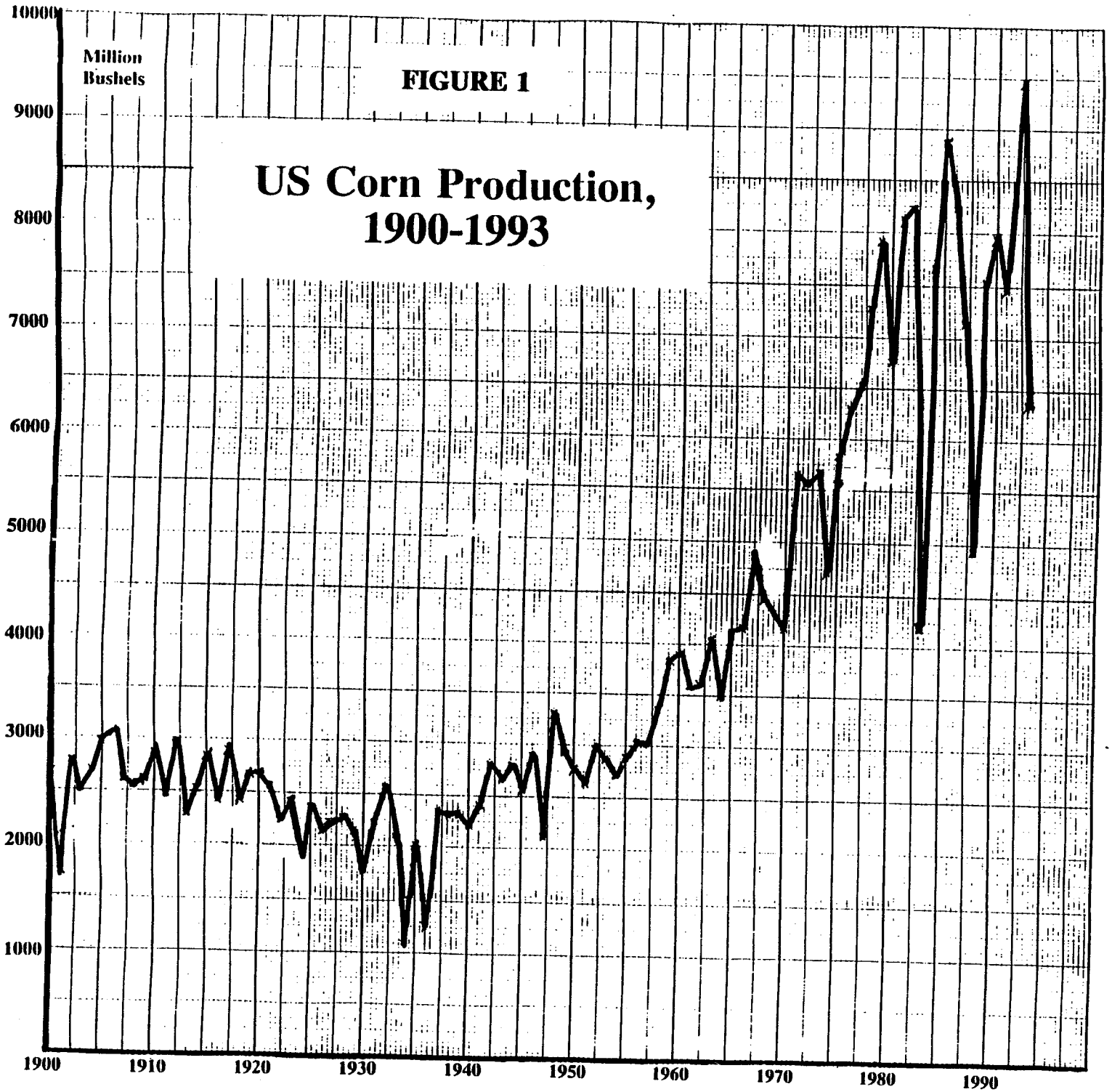
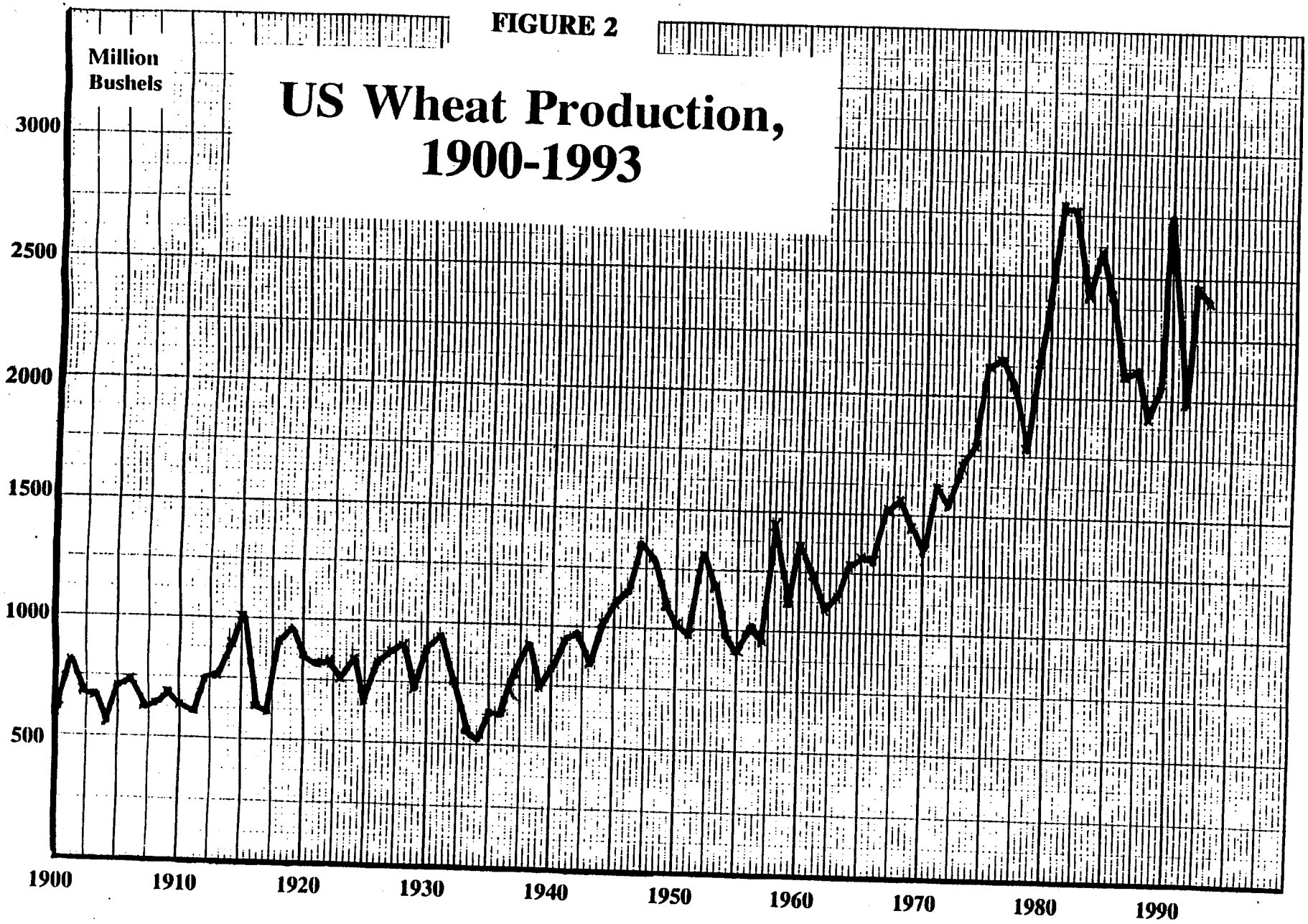


FIGURE 1
US Corn Production,
1900-1993
Million
Bushels
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990

FIGURE 2


Million
Bushels
US Wheat Production,
1900-1993
3000
2500
2000
1500
1000
500
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990

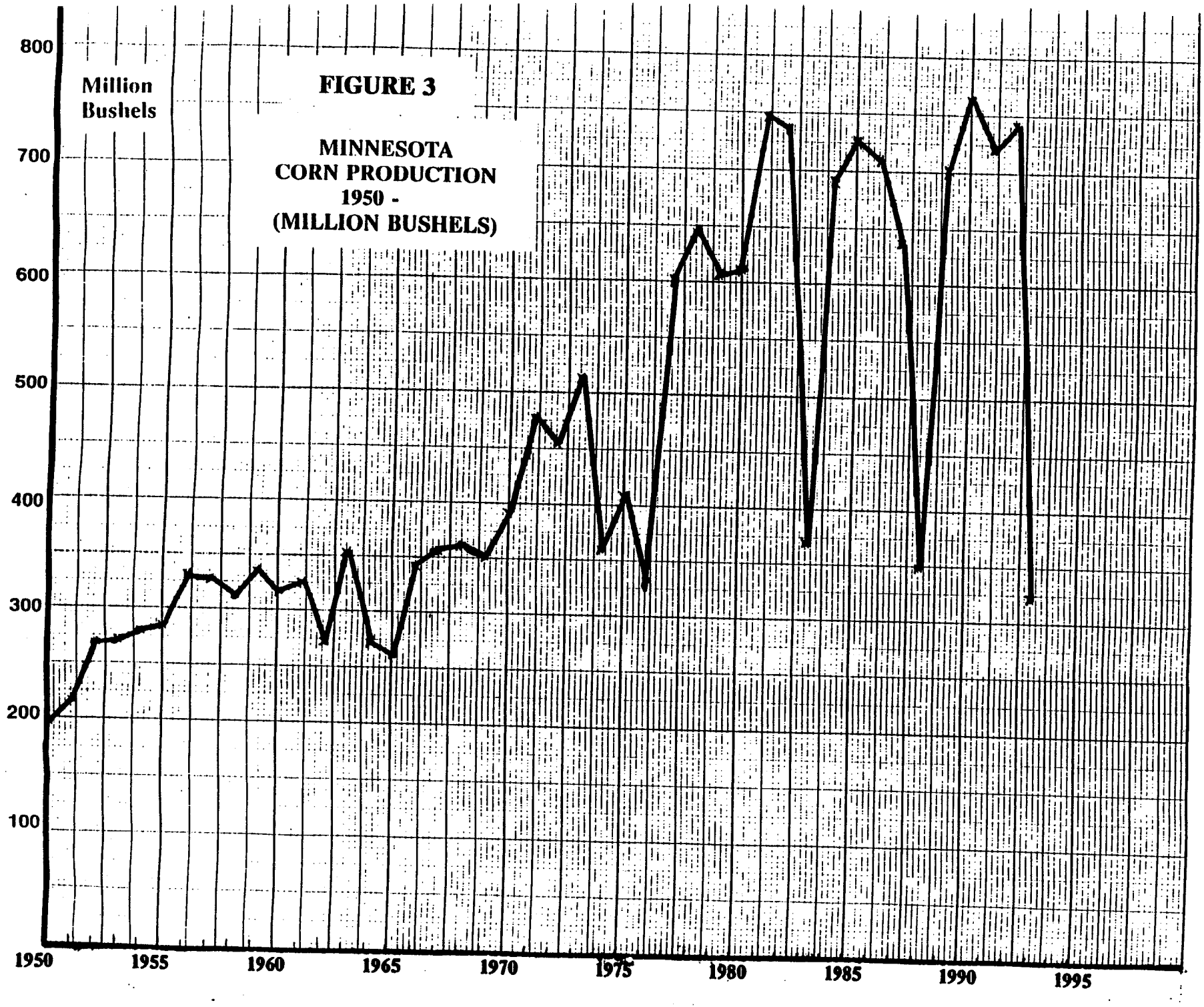
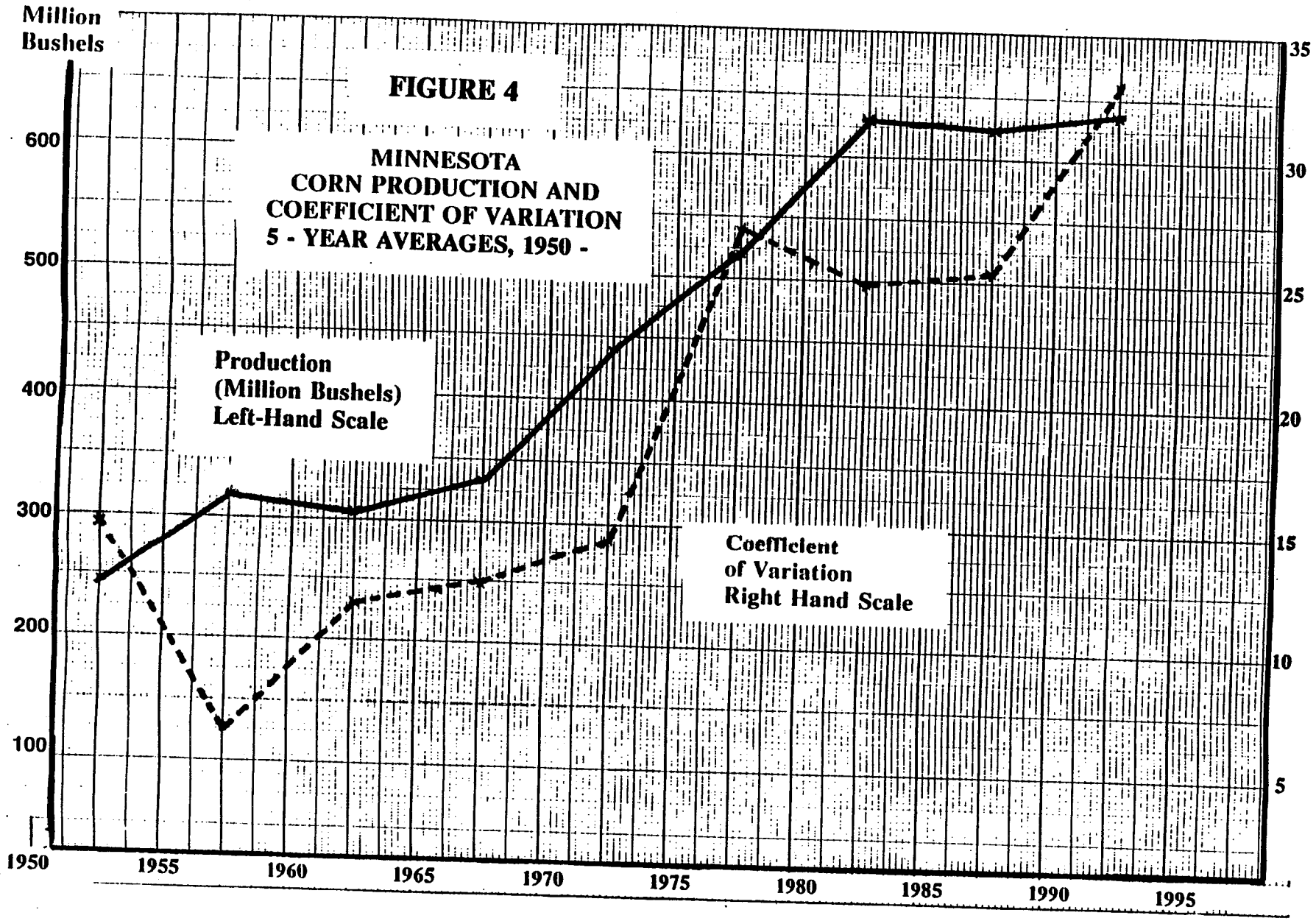
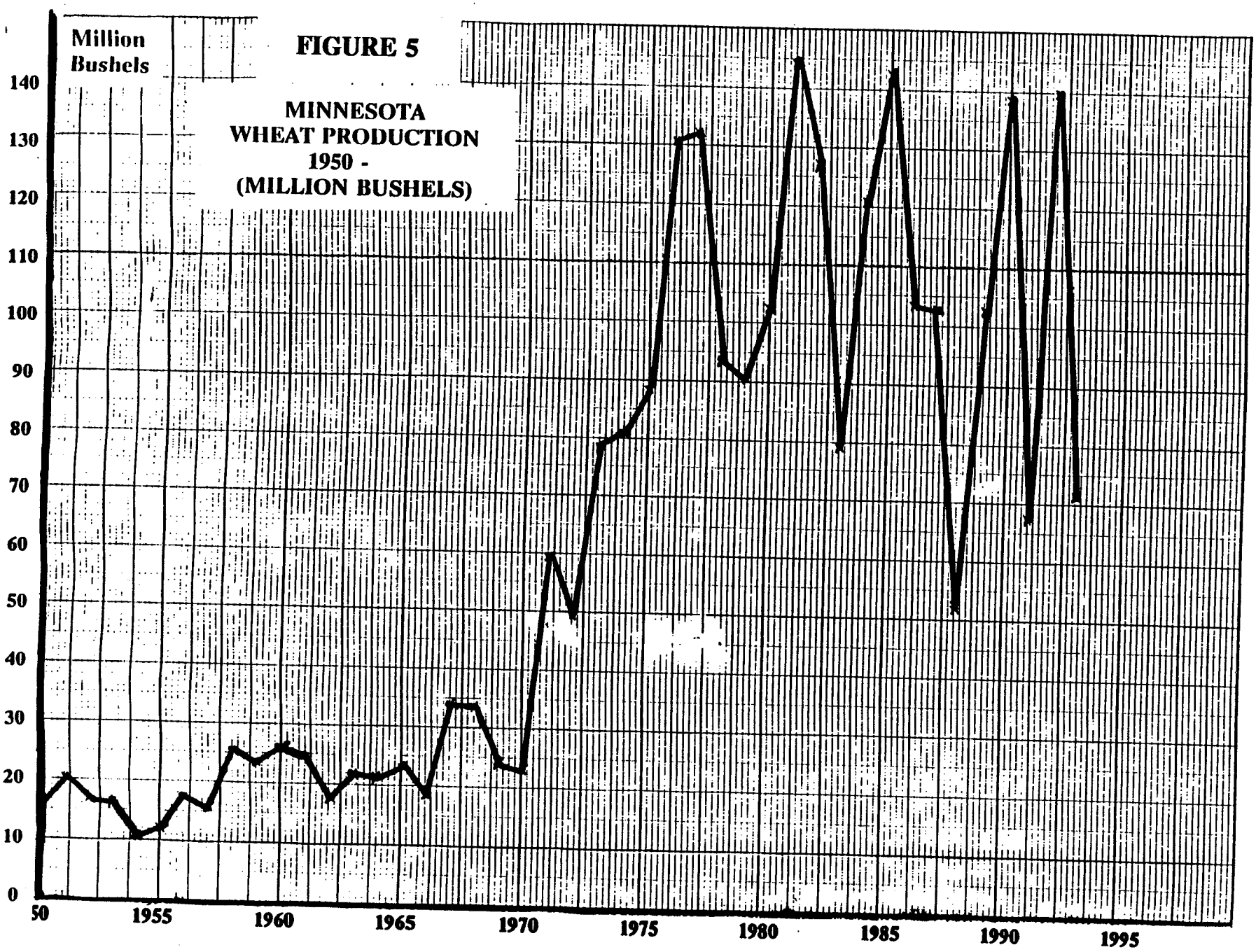


FIGURE 3
MINNESOTA
CORN PRODUCTION
1950 -
(MILLION BUSHELS)
Million
Bushels
800
700
600
500
400
300
200
100
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995


Million Bushels
FIGURE 4
MINNESOTA
CORN PRODUCTION AND
COEFFICIENT OF VARIATION
5 - YEAR AVERAGES, 1950 -
Production
(Million Bushels)
Left-Hand Scale
Coefficient
of Variation
Right Hand Scale
600
500
400
300
200
100
35
30
25
20
15
10
5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995


Million
Bushels
FIGURE 5
MINNESOTA
WHEAT PRODUCTION
1950 -
(MILLION BUSHELS)
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
50
1955
1960
1965
1970
1975
1980
1985
1990
1995

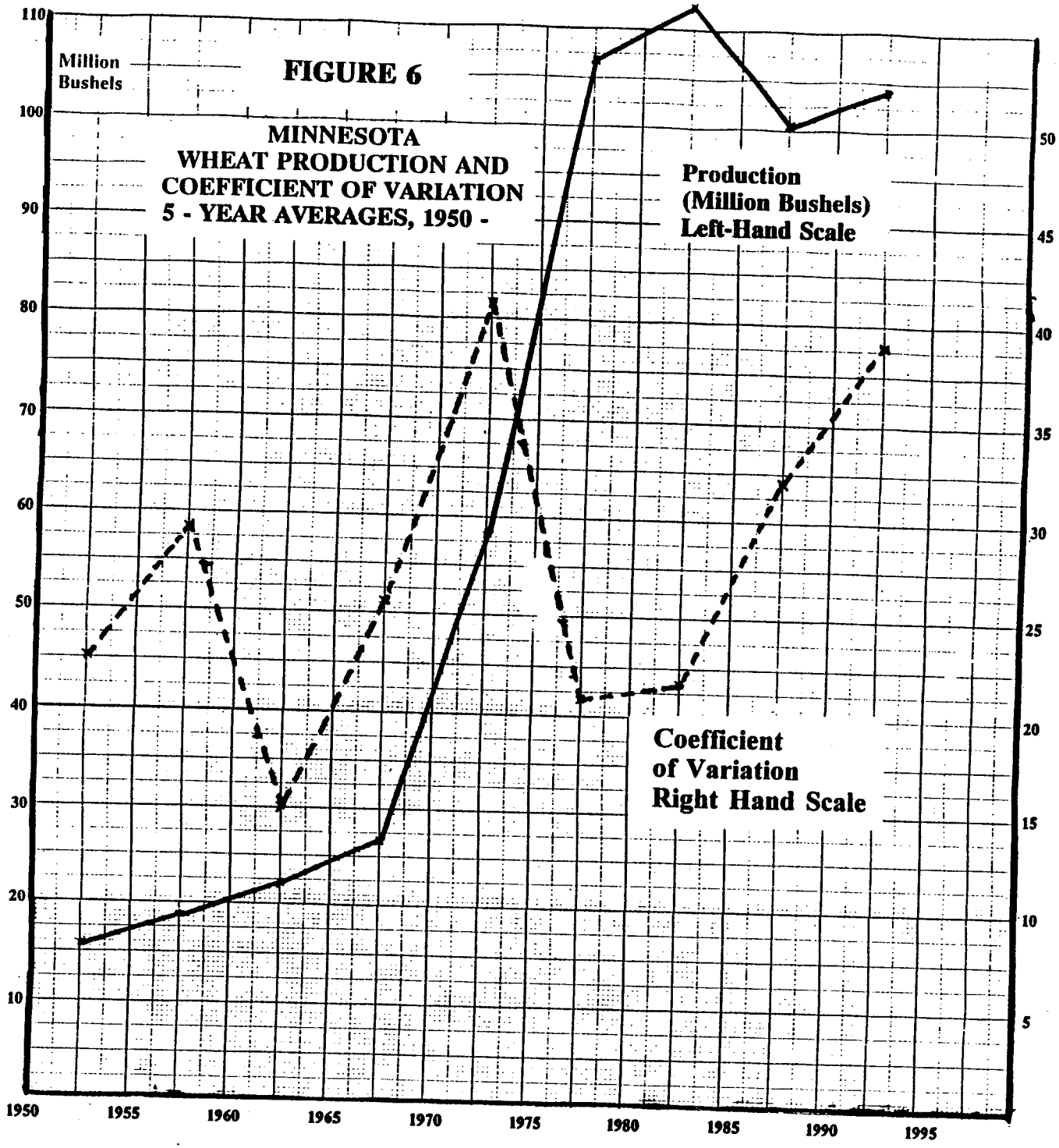


FIGURE 6
MINNESOTA
WHEAT PRODUCTION AND
COEFFICIENT OF VARIATION
5 - YEAR AVERAGES, 1950 -
Million Bushels
Production
(Million Bushels)
Left-Hand Scale
Coefficient
of Variation
Right Hand Scale
110
100
90
80
70
60
50
40
30
20
10
50
45
40
35
30
25
20
15
10
5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995

For corn, the disastrous production years of 1983, 1988, and 1993 more than doubled the coefficient of variation in output, from an average of approximately 12 prior to 1970-74 to a level of 25 or higher for each half-decade since 1975 (Figure 4).

For wheat, the pattern of output variation is similar to corn, but with an even greater proportionate increase in production after the mid-1960s. In no year prior to 1971 did Minnesota produce over 34 million bushels of wheat. This escalated to an average annual output of over 100 million bushels for each of the five-year periods after 1970-74 (Figure 6).

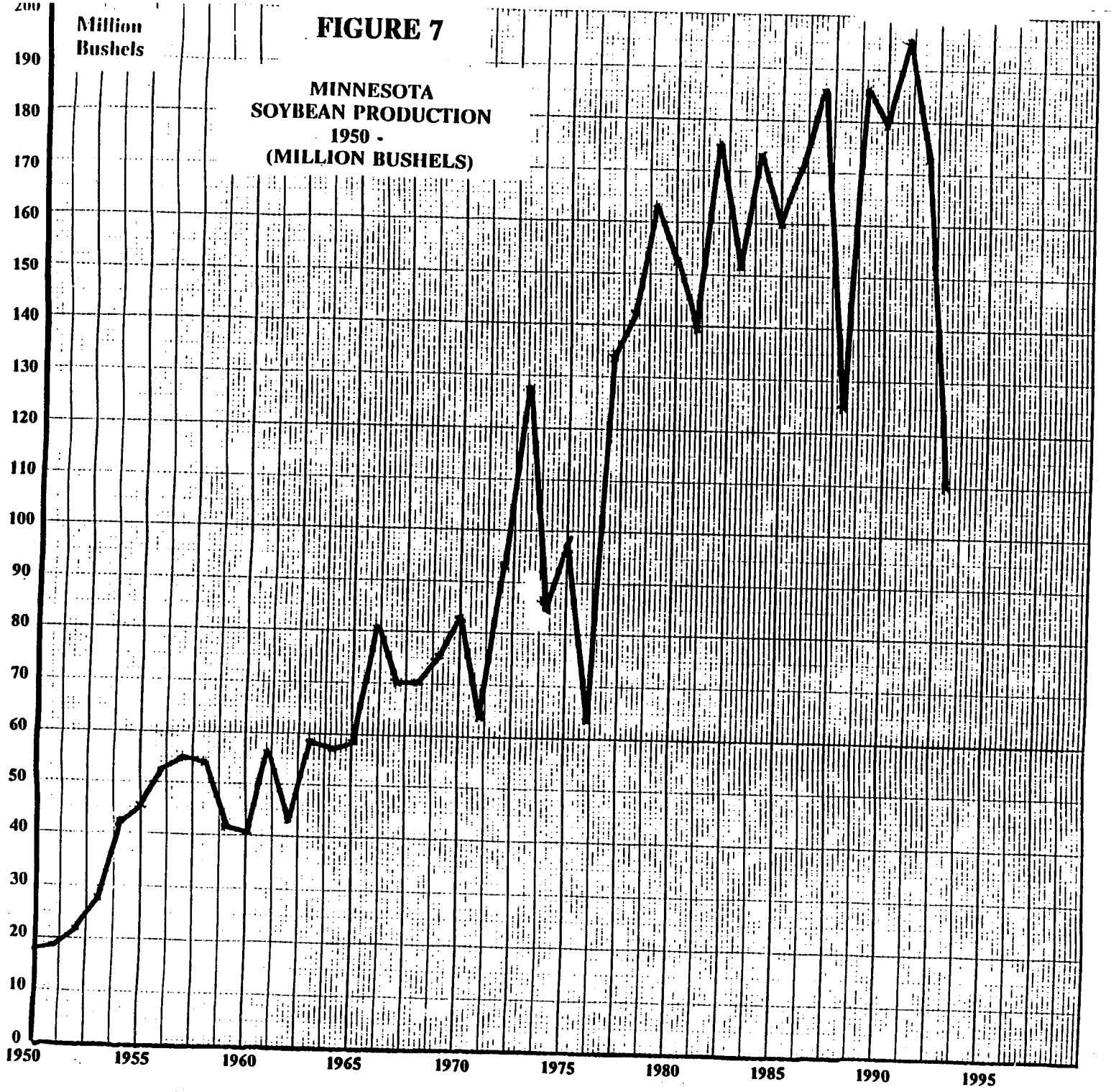
The associated trend in the coefficient of variation in production of wheat is more erratic than for corn, but the upward shift is less pronounced. In approximate terms, the slope of a trend line fitted to the coefficient of variation for corn is twice that of the trend line for wheat (compare Figures 4 and 6). Measured in five-year averages, corn has been a riskier crop than wheat in Minnesota, since 1950.

The picture changes when we shift to soybeans (Figures 7 and 8). The production increase is no less dramatic than for corn or wheat, but the trend in the coefficients of variation at five-year intervals is only slightly upward since 1955-59. There have been sharp annual variations in production, but production risks faced by soybean growers are significantly lower than those faced by corn and wheat growers.

III. Risk as Measured by Variability in Yields

We now shift to the data on yields per acre. For corn, the yield data trends in Figure 9 are clearly similar to those in Figure 3 for production, but with important

FIGURE 7


Million Bushels
MINNESOTA
SOYBEAN PRODUCTION
1950 -
(MILLION BUSHELS)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995

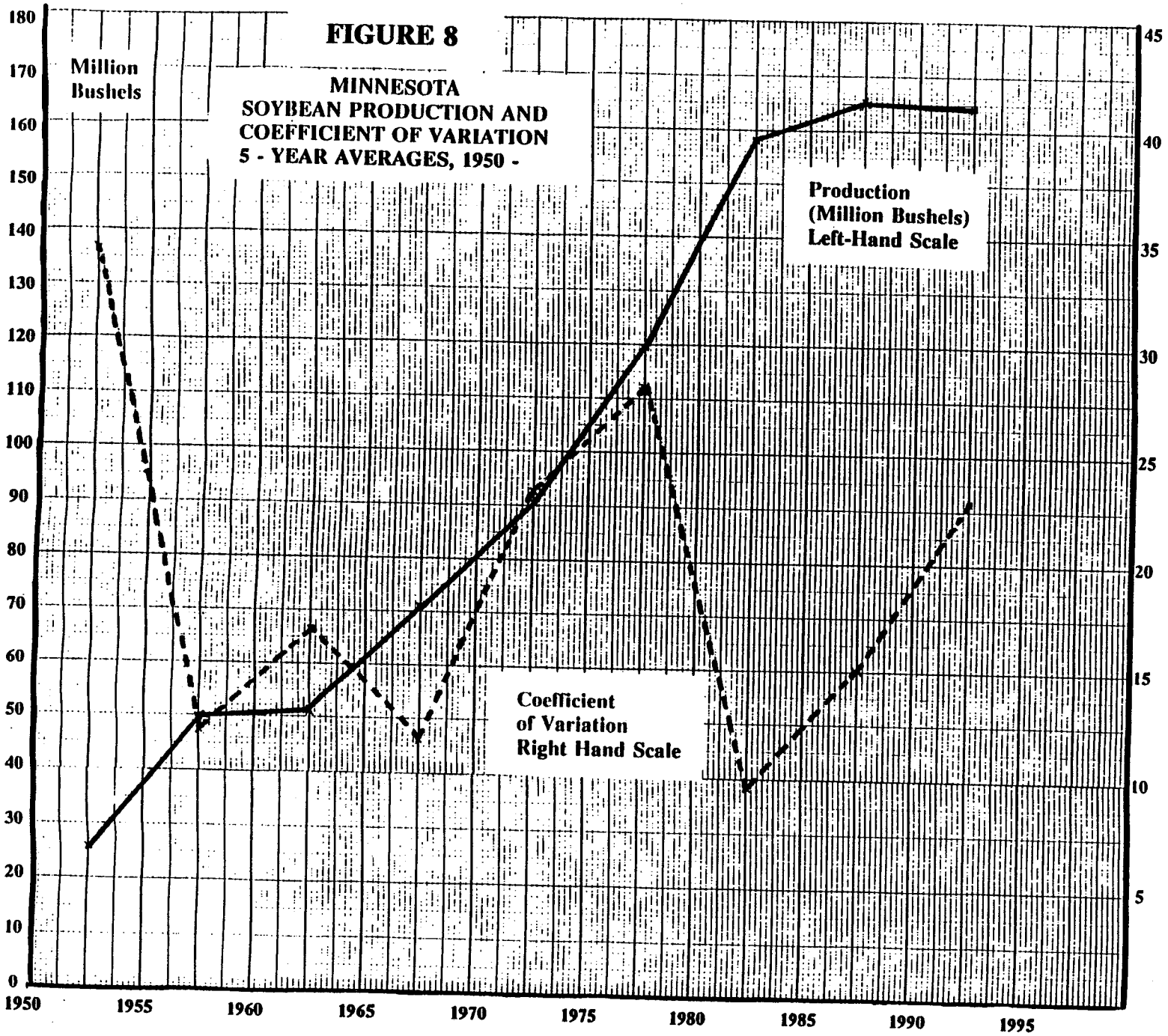


FIGURE 8
MINNESOTA
SOYBEAN PRODUCTION AND
COEFFICIENT OF VARIATION
5 - YEAR AVERAGES, 1950 -
Million
Bushels
Production
(Million Bushels)
Left-Hand Scale
Coefficient
of Variation
Right Hand Scale
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
45
40
35
30
25
20
15
10
5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995

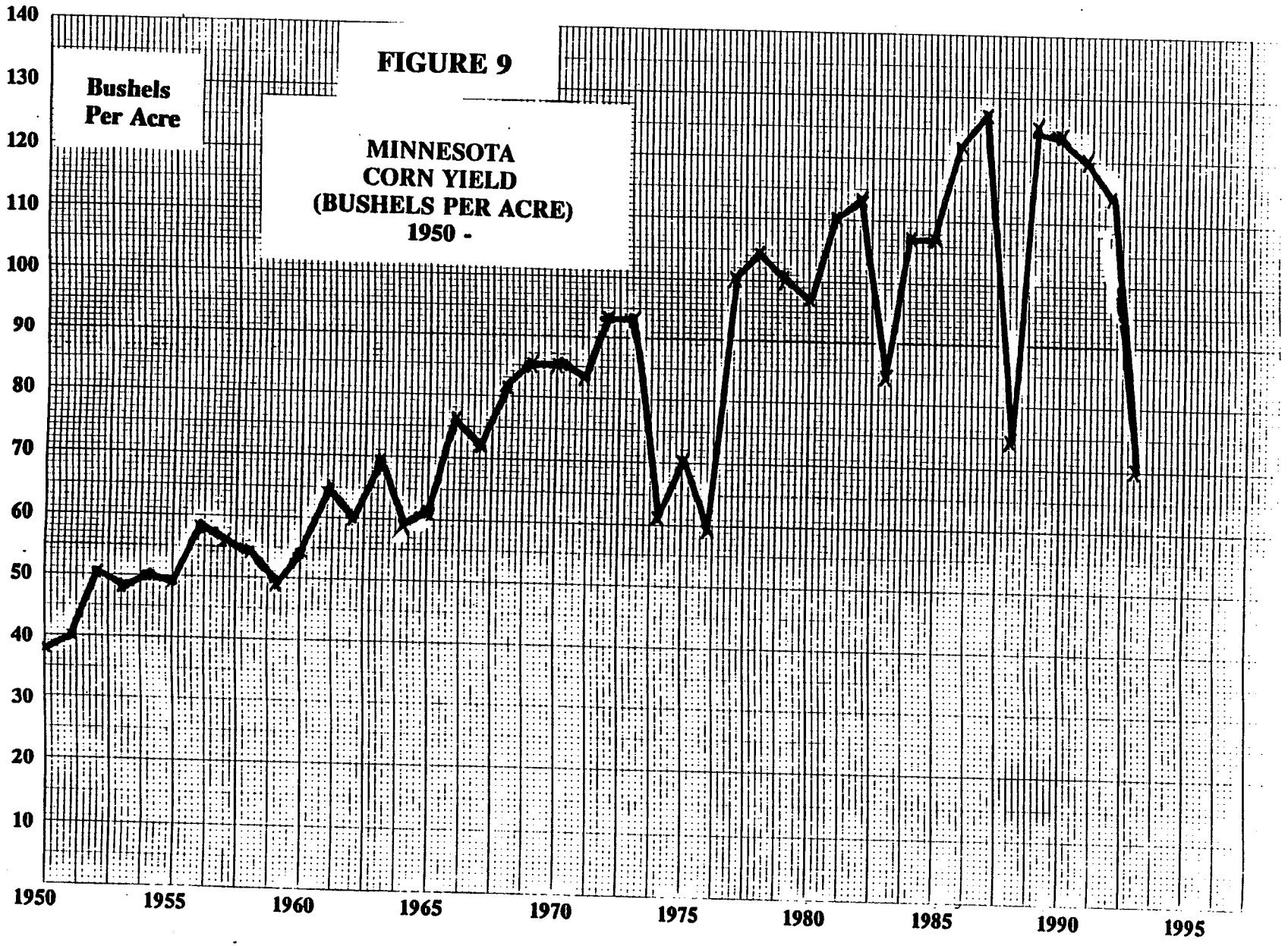


FIGURE 9
Bushels
Per Acre
MINNESOTA
CORN YIELD
(BUSHELS PER ACRE)
1950 -
140
130
120
110
100
90
80
70
60
50
40
30
20
10
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995

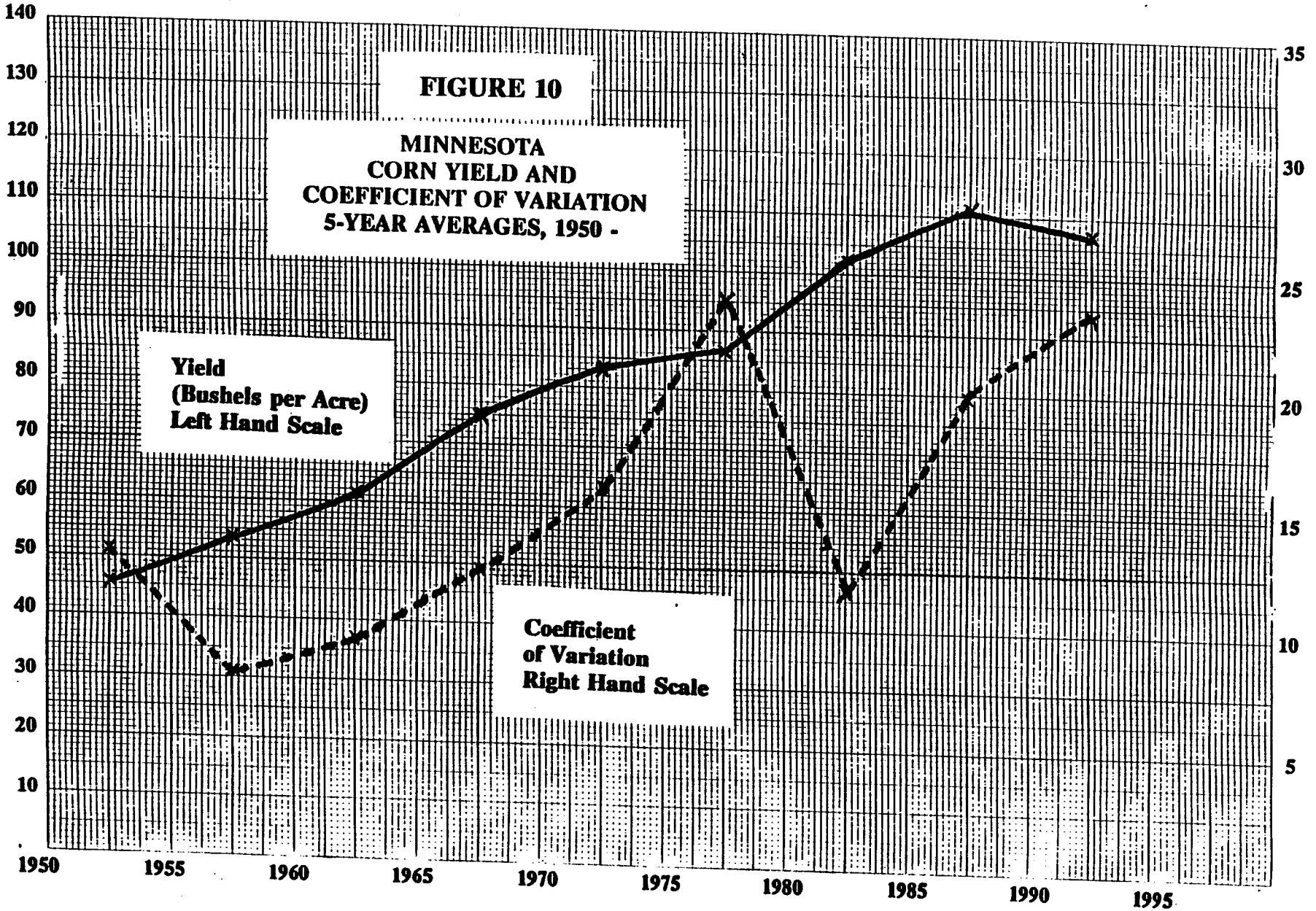


FIGURE 10
MINNESOTA
CORN YIELD AND
COEFFICIENT OF VARIATION
5-YEAR AVERAGES, 1950 -
Yield
(Bushels per Acre)
Left Hand Scale
Coefficient
of Variation
Right Hand Scale
140
130
120
110
100
90
80
70
60
50
40
30
20
10
35
30
25
20
15
10
5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995

differences. The coefficients of variation in corn yields in Figure 10 have increased over time, but the slope of their trend line is not as steeply upward as is the case with corn production (compare Figure 10 with Figure 4).

Since production is the product of yield times area harvested, it is clear that changes in acres harvested have had more influence on the coefficient of variation in corn output than have changes in yields per acre. This is understandable in Minnesota, where corn growing has been pushed ever closer to the limits set by temperature and length of growing season. Shifting from corn harvested for grain to corn harvested for silage or fodder is an ever-present option for most Minnesota corn growers. The data show that this is a major contributor to variability in Minnesota production of corn for grain.

For wheat, the increase in yields and in the coefficient of variation in yield in Figures 11 and 12 show an upward slope that is similar to that for corn. Unlike corn, the slope of the trend in coefficient of variation in wheat is greater for yields per acre than for production, for the entire period since 1950. Output variability in Minnesota wheat production has increased over this period, with yields rather than area harvested playing the major role.

For soybeans, the increase in yields is less dramatic than for corn or wheat, since 1950 (compare Figures 9, 11, and 13). Yield variability has also increased, but at a much lower rate than for corn or wheat (Figure 14). Measured by risk in variation in both output and yield, corn emerges as the crop in which the relative change in risk over the years since 1950 has been most pronounced.

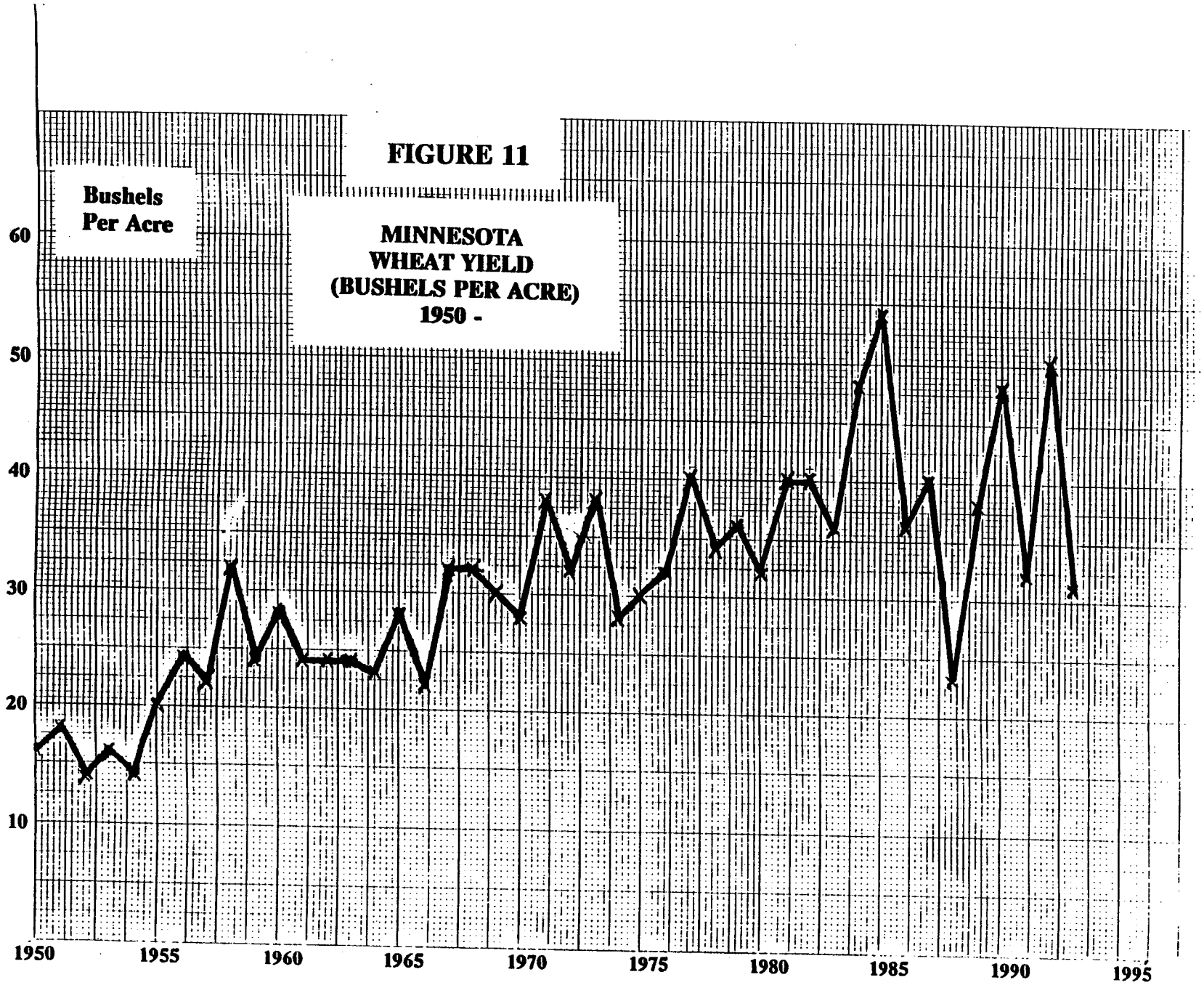


FIGURE 11
Bushels
Per Acre
MINNESOTA
WHEAT YIELD
(BUSHELS PER ACRE)
1950 -
60
50
40
30
20
10
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995

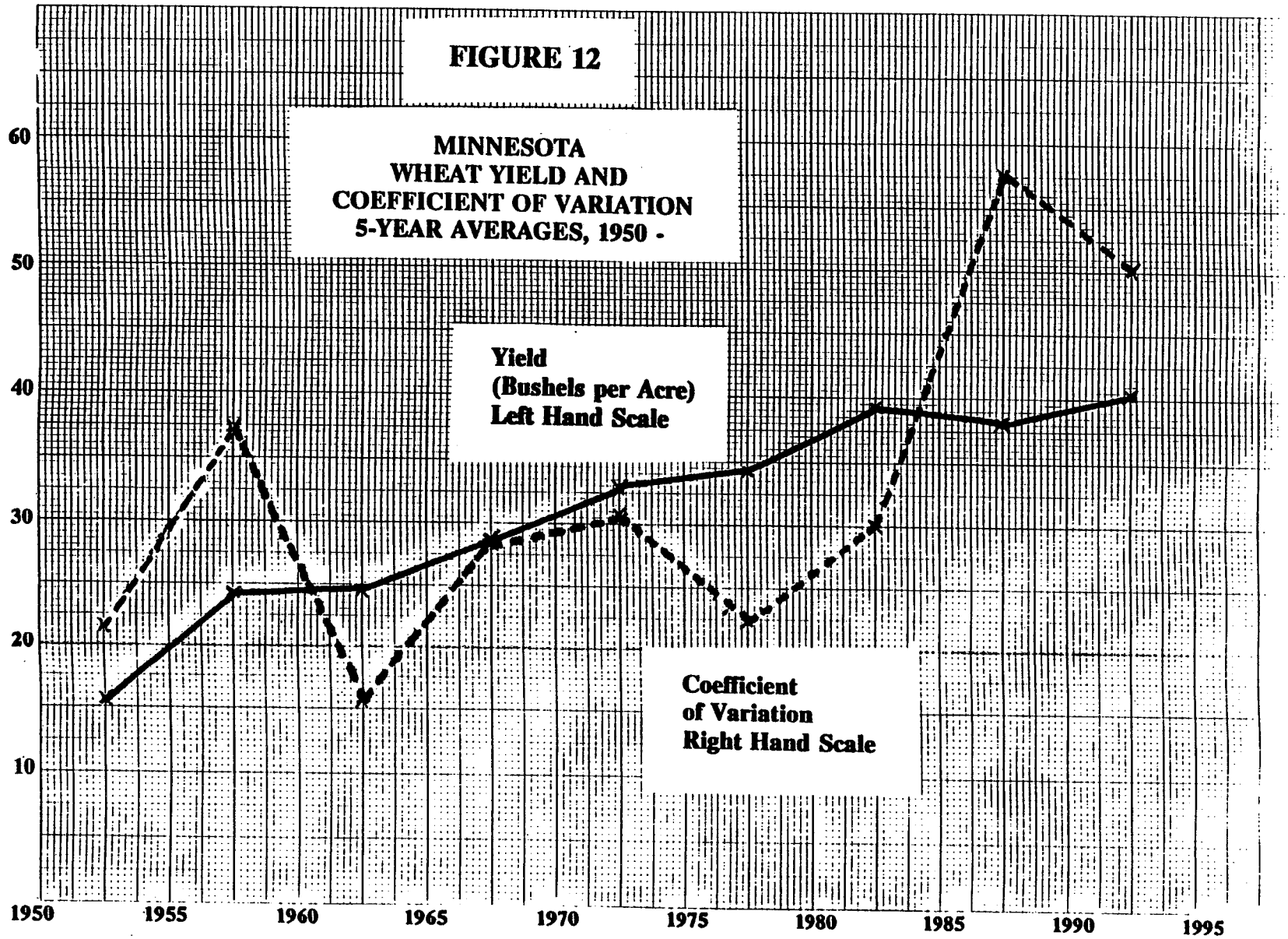


FIGURE 12
MINNESOTA
WHEAT YIELD AND
COEFFICIENT OF VARIATION
5-YEAR AVERAGES, 1950 -
Yield
(Bushels per Acre)
Left Hand Scale
Coefficient
of Variation
Right Hand Scale
60
50
40
30
20
10
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995

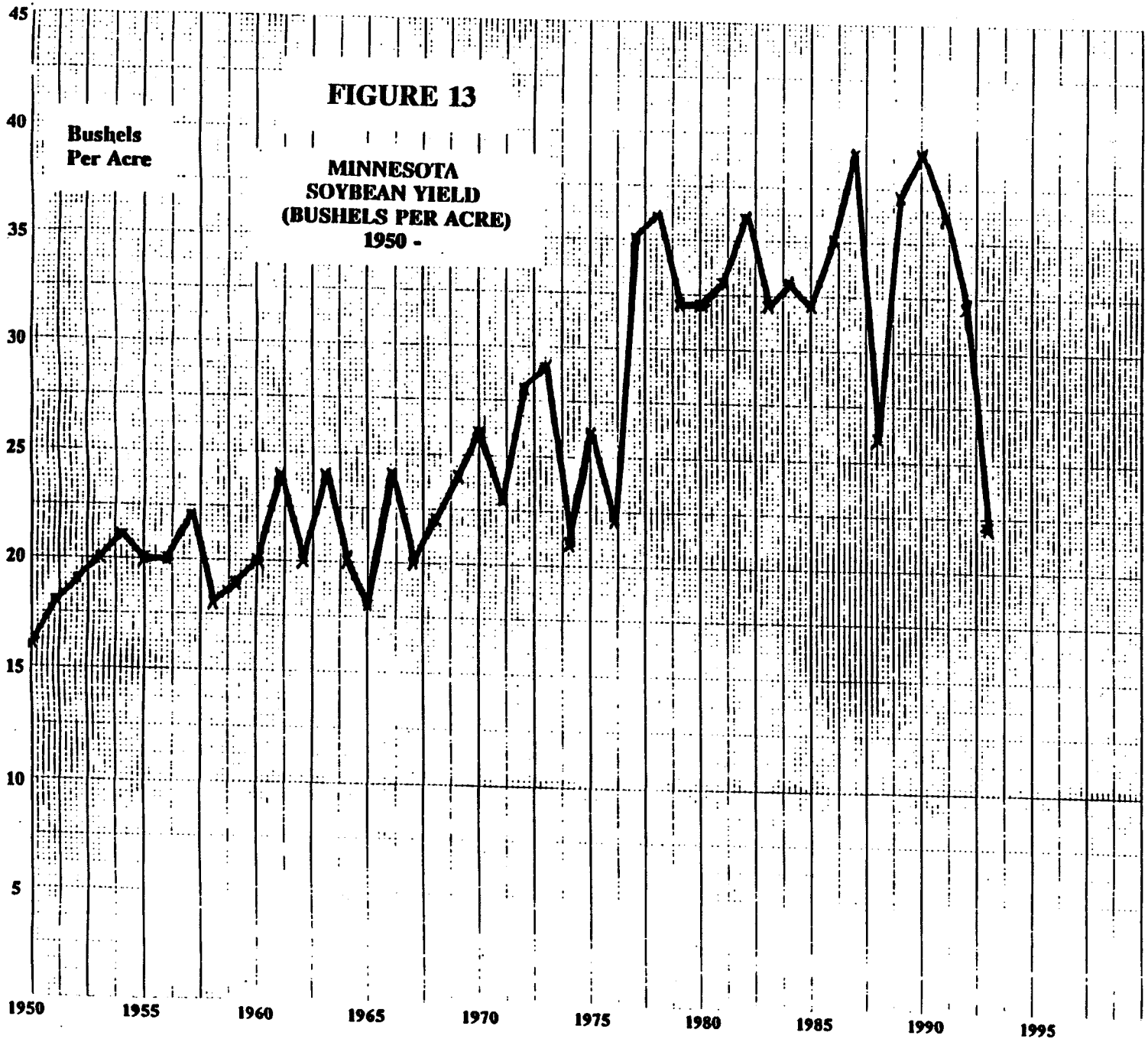
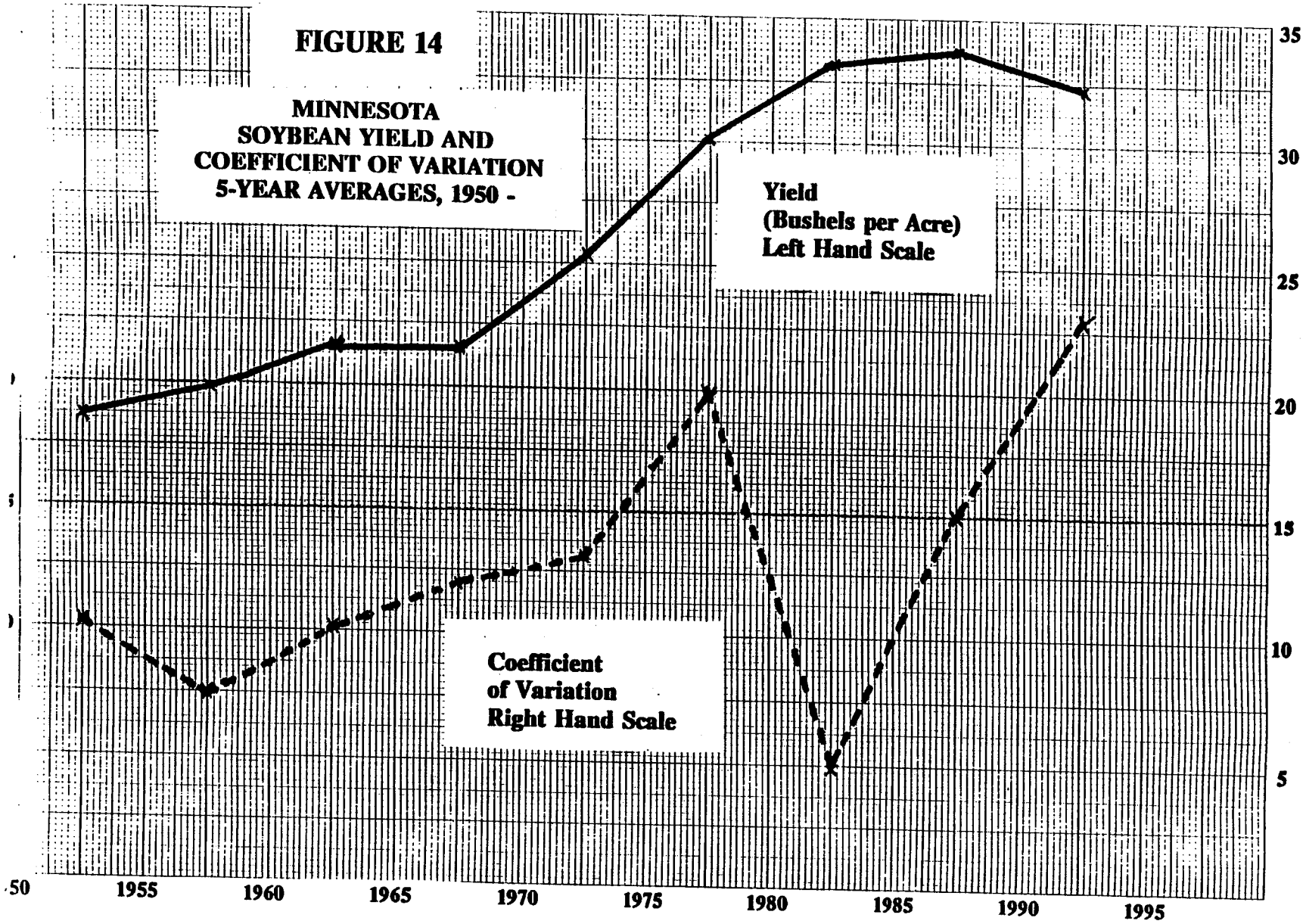


FIGURE 13
MINNESOTA
SOYBEAN YIELD
(BUSHELS PER ACRE)
1950 -
Bushels
Per Acre
45
40
35
30
25
20
15
10
5
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995

FIGURE 14


MINNESOTA
SOYBEAN YIELD AND
COEFFICIENT OF VARIATION
5-YEAR AVERAGES, 1950 -
Yield
(Bushels per Acre)
Left Hand Scale
Coefficient
of Variation
Right Hand Scale
35
30
25
20
15
10
5
1955
1960
1965
1970
1975
1980
1985
1990
1995

Wheat has been a high-risk crop in recent decades, but this is largely a function of where it is grown in Minnesota, in the colder northern counties. Corn has occupied the warmer southern counties in the state, with the longer growing season. It became a major beneficiary of hybridization, and the genetic revolution that shortened the growing season. The surge in output that followed became the engine that pulled rising land values in train.

IV. Some Lessons for Risk Assessment

In the light of the data shown here, it is not surprising that the biggest upsurge in land values after 1972 was centered in the principal corn-growing counties. The data also suggest that there should be no surprise in the fact that these counties also suffered the biggest losses when land values collapsed. The shift in relative risk was greatest in the most productive corn-growing regions of the state.

The tentative theses emerging from these data is that the risk associated with field crop production under rain-fed conditions in Minnesota has increased measurably in the past three decades. A corollary is that evidence is lacking that this increased risk has been incorporated into forecasts of long-run land value trends. For land owners, prospective land buyers, and their creditors, the key word is caution. We have apparently entered an era of higher risk in field-crop production.