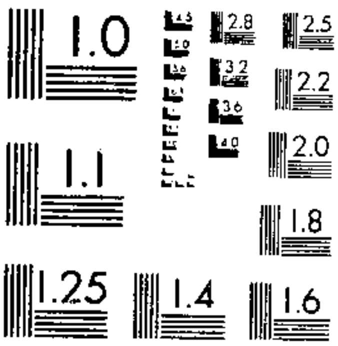
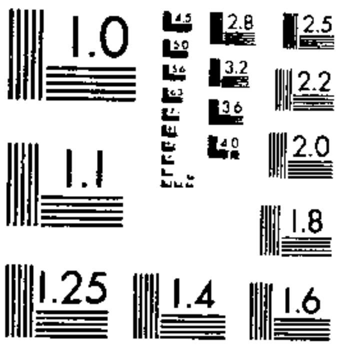
TB 826 (1942) USDA TECHNICAL BULLETINS UPDATA
CONTROLLING CORN AND HOG SUPPLIES AND PRICES
SHEPHERD, G 1 OF 1

START



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Technical Bulletin No. 826 • June 1942

UNITED STATES
DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

Controlling Corn and Hog Supplies and Prices [1]

BY GEOFFREY SHEPHERD, *principal agricultural economist, Bureau of Agricultural Economics*

CONTENTS

INTRODUCTION

Commodity price-stabilization programs in the United States have grown to large proportions during the last decade. These programs have profoundly affected prices, farming practices, trading practices and the volume of business in the various commodity trades, and the flow of commodities from producers to consumers. The programs are revolutionizing the character of the market for agricultural products, which market has traditionally provided one of the clearest examples of conditions of atomistic competition among the sellers. They are replacing that market by a governmentally controlled system in which prices are determined chiefly by the rates at which the Government makes nonrecourse loans to farmers on the commodities

[1] M. L. Klayman, junior agricultural economist, Bureau of Agricultural Economics, supervised the assembling and statistical handling of most of the basic data. The author wishes to acknowledge the helpful criticisms of F. V. Waugh, M. Clough and others of the Bureau of Agricultural Economics, C. F. Sarle and others in the Commodity Credit Corporation, and R. Roberts and others in the Agricultural Adjustment Administration.

concerned, and in which Government stocks, purchases, and sales are often the controlling element in the situation.

The price-stabilization programs can benefit both producers and consumers. Taking the fluctuations out of the prices of farm products would take a large part of the gambling element out of farming. The Ever-Normal Granary program for corn may reduce the wide fluctuations in livestock production, thus reducing costs to producers and providing stable supplies of meat for consumers. The programs for wheat and cotton may stabilize production, milling, and processing all the way through to the consumer. Yet dangers as well as benefits are in prospect.

Price-stabilization programs in earlier times and in other countries have sometimes gotten into difficulties, and this country can hardly expect to avoid having troubles of its own. It is not so long since the stabilization operations of the Federal Farm Board ended in an unfortunate way. Price-stabilization programs are complex things; perhaps not enough knowledge is available for their proper management. In any case, the more that is known about the problems involved, the better they will be handled; in a democracy there is urgent need for widespread public discussion of these problems in order to pave the way for their solution. This bulletin is intended to promote discussion.

The agricultural price-stabilization problem is broader than the specific price-stabilization programs that have been set up to deal with it. In a wider view, several questions arise. What are the objectives of price stabilization? Are stable prices an end in themselves, or are they a means to some further end; and, if so, what end? What are the benefits from price stabilization, from the social point of view? What are the social costs? If booms and depressions continue, should the objective be stable prices or stable quantities, or something else entirely? Is stabilization of prices an adequate goal? Perhaps what is needed is not merely price stabilization but price control—some means of putting prices where they "should be," at a level that does not remain constant but varies from one year to another with variations in demand. If so, what is meant by "should be?"

The questions indicated call not merely for an examination of the objectives, attainments, and problems of the price-stabilization programs themselves, but rather for an analysis of the whole problem of price control for farm products. Accordingly, the discussion in this bulletin is not limited to the Ever-Normal Granary and programs of the AAA as such. Instead it is concerned more with the price problems with which the programs were set up to deal and uses the programs only as concrete illustrations of specific attacks on those price problems.

No one could hope to answer in one bulletin all of these questions that have been raised. In attempting to answer as many of them as possible, and as realistically as possible, attention is focused on one specific commodity or group of related commodities, rather than on several commodities. Some commodity analyses have already appeared. One deals comprehensively with cotton (*11*). Other shorter studies have dealt with certain problems involved in the corn-loan program (*13, 17*). The problem of controlling prices of corn is particularly complicated, because of the repercussions of supplies and prices of corn on supplies and prices of livestock. A comprehensive treatment of corn and livestock price control is needed and this bulletin is an attempt in that direction.

CORN AND HOGS IN THE UNITED STATES[2]

Corn is the great grain feed of the United States. Total production of corn averages about 2.5 billion bushels a year. Corn is grown all over the eastern half of the country; the western border of the area where corn is produced closely parallels the 100th meridian (fig. 1). Production is most heavily concentrated in the north central part of the United States, in the Corn Belt, which includes all of Iowa, Illinois, Indiana, and Ohio, and parts of Minnesota, Missouri, Nebraska, Wisconsin, Kansas, Michigan, and South Dakota.

About 90 percent of the corn crop is fed to livestock, most of it close to the point where it is grown. In two areas of heavy production, a considerable percentage of the crop is sold from the farm as grain. One of these areas lies in Illinois. From this area nearly half the crop is sold as grain. The other area lies in Iowa. About 15 or 20 percent of Iowa's corn is sold as cash grain; the proportion in some counties has run as high as 69 percent (*1, p. 22; 2, p. 344*). These two areas are shown in figure 2.

Location of Heavy Corn-Producing Areas

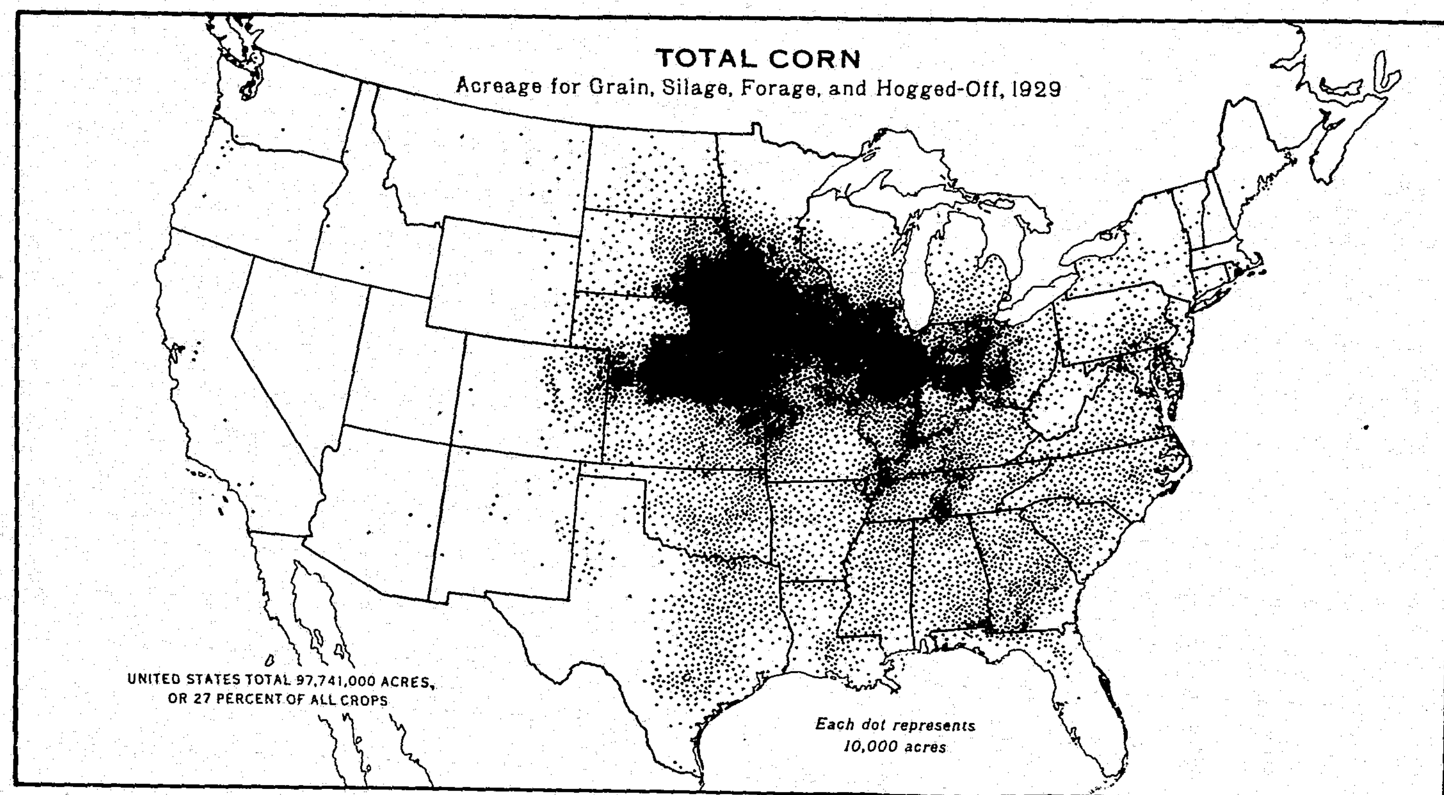
The Corn Belt States are ranked in the order of their average production of corn over the last 10 years in the following tabulation. The two top States, Iowa with its 400 million bushels and Illinois with its 330 million, are far ahead of the rest. Indiana, Minnesota, and Ohio, which come next, produce only about 150 million bushels each.

Nebraska and Missouri produce between 100 and 120 million bushels of corn each. Production of corn in both of these States suffered a marked reduction during the last few years (Nebraska's production was cut in half) chiefly because of a sharp decrease in acreage after the severe droughts of 1934 and 1936. The remaining Corn Belt States, in order of their importance as corn producers, are Wisconsin, Kansas, Michigan, and South Dakota. Each produces on the average substantially less than 100 million bushels.

The important corn-producing States, ranked in order of their average corn production, from 1931 to 1940 were:

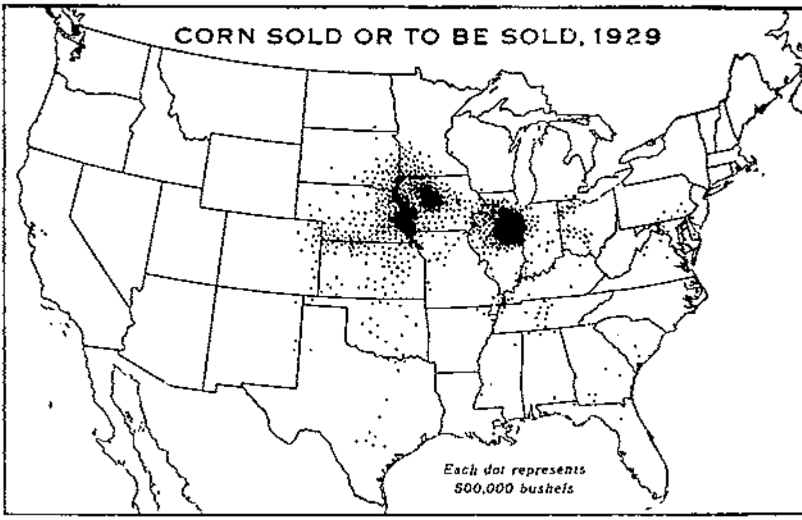
State:	Average corn production 1931–40, 1,000 bushels
Iowa	406, 703
Illinois	330, 856
Indiana	162, 658
Minnesota	146, 830
Ohio	142, 734
Nebraska	120, 604
Missouri	109, 551
Wisconsin	77, 202
Kansas	55, 522
Michigan	50, 036
South Dakota	39, 060

[2] This section consists mostly of basic factual material; it is essential for background and reference purposes, but those readers who are familiar with corn and hogs and the relations between them may prefer to read only the conclusions and summary on p. 77 to 78.



BAE 24994-C

FIGURE 1.—Corn is grown all over the eastern half of the United States. The production of corn is most heavily concentrated, however, in the North Central States.



BAE 31109

FIGURE 2.—Most of the corn produced is fed to livestock on or close to the farm where the corn is grown. Within the Corn Belt, however, lie two areas of heavy corn production where a considerable percentage of the crop is sold from the farm in the form of grain.

PRODUCTION OF HOGS

Pork is the leading meat produced in the United States. The production of pork usually ranges between 8 and 9 billion pounds, plus about 2 billion pounds of lard. Production of beef usually ranges between 6 and 7 billion pounds.[3]

By and large, hogs are produced where corn is produced; the Hog Belt is much the same as the Corn Belt. The most important States in hog production rank as they do in corn production, with one exception: Ohio ranks over Missouri and Nebraska in production of corn, but below them in production of hogs.

The utilization of corn in the United States is shown over different periods of time in table 1. The periods represented by the different

TABLE 1.—*Percentage utilization of corn in the United States, averages 1910–14, 1924–29, and 1925–34*

Distribution	Average 1910–14	Average 1924–29
	Percent	*Percent*
Hogs	30.8	41.6
All cattle and sheep	17.2	20.3
Horses and mules	17.4	13.9
Other farm uses	16.9	12.1
Industrial and city uses	17.7	12.1

Distribution	Average 1925–34
	Percent
Hogs	40.1
Cattle	22.2
Sheep	.7
Horses and mules	14.4
Poultry	10.3
Human food on farms	1.3
Fed to stock not on farms	2.1
Industrial and commercial utilization	7.9
Exports	.3
Seed	.7

[3] UNITED STATES AGRICULTURAL MARKETING SERVICE. LIVESTOCK, MEATS, AND WOOL MARKET STATISTICS AND RELATED DATA 1940. 107 pp. 1941. [Processed.] See p. 100.

columns are not all mutually exclusive, and the classification of the uses (distribution) of corn has not remained constant. But in general the table shows that hogs consume about 40 percent of the corn produced in the United States. This percentage has remained fairly constant over the last few decades. Consumption of corn by horses and mules is declining with the decline in their numbers. It is considerably lower today than in the period 1925–34, as numbers of horses and mules have continued to decline. Increasing consumption by cattle (probably mostly by milk cows) has taken up most of the slack.

FLUCTUATIONS IN THE PRODUCTION OF CORN AND HOGS

Production of corn fluctuates greatly from year to year (fig. 3). The chief reason lies in the pronounced fluctuations in yield per acre. The short-time changes in acreage from year to year are usually not large. The instability of the price of corn from year to year is shown in the lower part of figure 3. The data are given in table 2.

The fluctuations in production and prices of corn are not only disturbing to farmers in themselves but they also give rise to severe fluctuations in supplies and prices of hogs. Hog production fluctuates

TABLE 2. *Corn: Harvested acreage, production, yield per acre, and price, United States, 1870–1940*

Year	Acreage	Production	Yield per acre	Season average farm price per bushel [1]	Year	Acreage	Production	Yield per acre	Season average farm price per bushel [1]
	1,000 acres	*1,000 bushels*	*Bushels*	*Cents*		*1,000 acres*	*1,000 bushels*	*Bushels*	*Cents*
1870	38,388	1,124,775	29.3	52.1	1906	95,624	3,032,910	31.7	39.1
1871	42,062	1,141,715	27.2	46.4	1907	96,094	2,613,797	27.2	50.5
1872	43,584	1,279,360	29.4	38.3	1908	95,285	2,566,742	26.9	65.0
1873	44,084	1,008,326	22.9	48.3	1909	100,200	2,611,157	26.1	61.8
1874	47,040	1,058,778	22.2	64.1	1910	102,267	2,852,794	27.9	51.6
1875	52,446	1,450,276	27.7	41.9	1911	101,393	2,474,635	24.4	68.0
1876	55,277	1,478,173	26.7	36.1	1912	101,451	2,947,842	29.1	55.3
1877	58,709	1,515,862	25.8	35.7	1913	100,206	2,272,540	22.7	70.4
1878	59,659	1,564,737	26.2	31.3	1914	97,796	2,523,750	25.8	70.8
1879	62,229	1,751,984	28.2	36.4	1915	100,623	2,829,044	28.1	68.0
1880	62,545	1,706,673	27.3	39.0	1916	100,561	2,425,206	24.1	118.6
1881	63,026	1,244,803	19.8	62.8	1917	110,893	2,908,242	26.2	145.9
1882	66,157	1,755,272	26.5	48.1	1918	102,195	2,441,249	23.9	152.2
1883	68,106	1,652,148	24.2	41.8	1919	98,145	2,678,541	27.3	151.3
1884	68,834	1,947,838	28.3	34.9	1920	101,359	3,070,604	30.3	61.8
1885	71,854	2,057,807	28.6	32.2	1921	103,155	2,928,442	28.4	52.3
1886	73,911	1,782,767	24.1	35.7	1922	100,345	2,707,306	27.0	74.5
1887	73,290	1,604,549	21.9	43.4	1923	101,123	2,875,292	28.4	82.5
1888	77,474	2,250,632	29.1	33.1	1924	100,420	2,223,123	22.1	106.1
1889	77,650	2,294,289	29.5	27.5	1925	101,331	2,798,367	27.6	69.9
1890	74,785	1,650,446	22.1	49.6	1926	99,452	2,546,972	25.6	74.5
1891	78,855	2,335,804	29.6	39.8	1927	98,357	2,616,120	26.6	85.0
1892	70,914	1,897,412	24.7	39.3	1928	100,336	2,665,516	26.6	84.0
1893	79,832	1,900,401	23.8	36.1	1929	97,805	2,521,032	25.8	79.9
1894	80,069	1,615,016	20.2	45.1	1930	101,465	2,080,421	20.5	59.6
1895	90,479	2,534,762	28.0	25.3	1931	106,912	2,575,611	24.1	32.0
1896	89,074	2,671,048	30.0	21.4	1932	110,577	2,931,281	26.5	31.9
1897	89,965	2,287,628	25.4	26.0	1933	105,963	2,399,632	22.6	52.2
1898	87,784	2,351,323	26.8	28.5	1934	92,354	1,461,123	15.8	81.5
1899	94,591	2,645,796	28.0	29.8	1935	95,804	2,303,747	24.0	65.5
1900	94,852	2,661,978	28.1	35.9	1936	93,020	1,507,089	16.2	104.5
1901	94,422	1,715,752	18.2	60.0	1937	93,741	2,651,284	28.3	52.0
1902	97,177	2,773,954	28.5	40.1	1938	92,222	2,562,197	27.8	50.4
1903	93,555	2,515,093	26.9	41.9	1939	88,430	2,602,133	[2] 29.4	55.9
1904	95,228	2,686,624	28.2	43.6	1940 [2]	[3] 86,738	2,460,624	28.4	......
1905	95,748	2,954,148	30.9	40.6					

[1] Before 1908 prices are as of Dec. 1.
[2] Preliminary estimate.
[3] October 1 estimate.

markedly from year to year, over a range equal to about 50 percent of the average production. The fluctuation for hog production is about 2.5 times as great as the fluctuation in beef-cattle production. Furthermore, changes in hog production closely follow the changes in corn production, whereas changes in beef-cattle production follow a somewhat cyclic course of their own, largely independent of corn production. The difference was most strikingly shown by the results

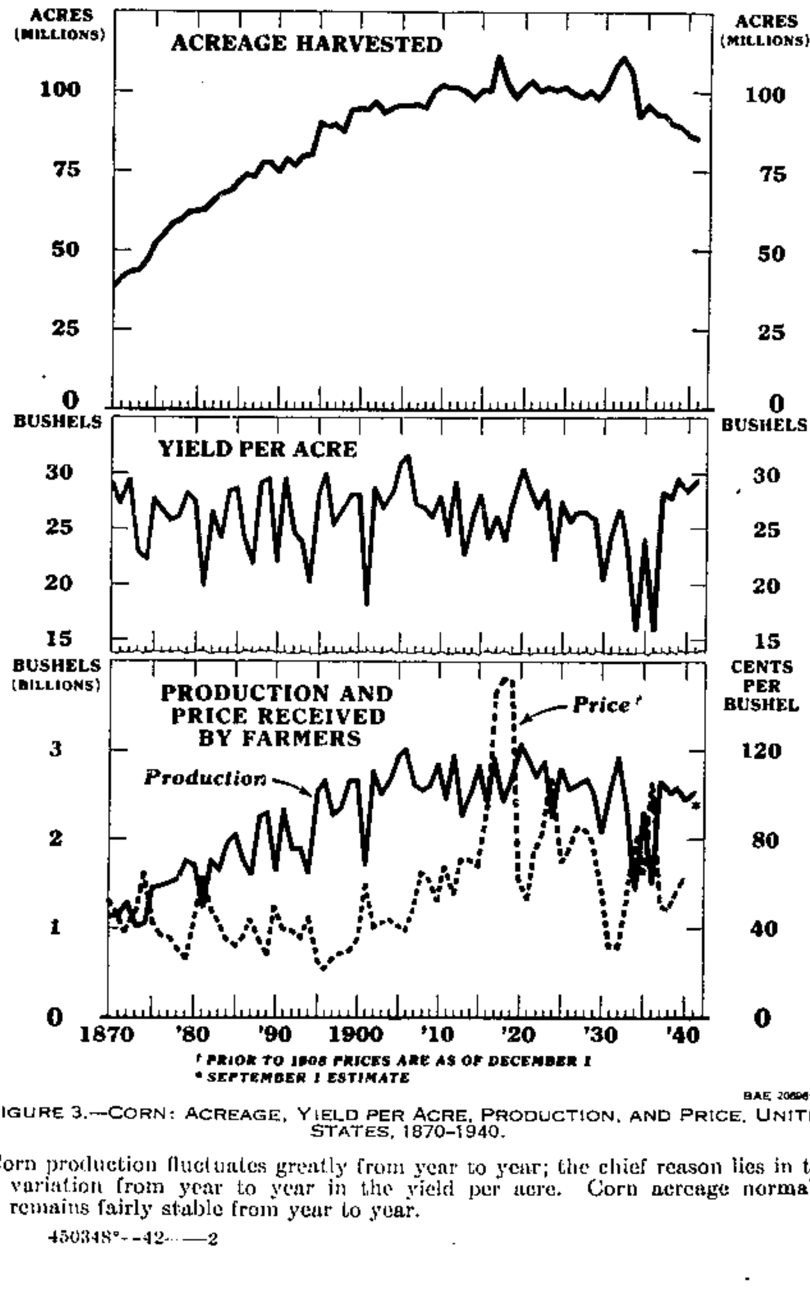


FIGURE 3.—CORN: ACREAGE, YIELD PER ACRE, PRODUCTION, AND PRICE, UNITED STATES, 1870–1940.

Corn production fluctuates greatly from year to year; the chief reason lies in the variation from year to year in the yield per acre. Corn acreage normally remains fairly stable from year to year.

of the two severe droughts of 1934 and 1936. Those droughts cut hog production about 40 percent, whereas they resulted in very little reduction in production of beef cattle.

The relation between fluctuations in the supplies and prices of corn and hogs is usually shown by plotting the ratio between the prices of corn and hogs along with hog marketings in a simple time chart. A chart of this sort, familiar to outlook workers, is shown in figure 4. It shows how changes in the hog-corn price ratio cause changes in the same direction in hog marketings about 2 years later.

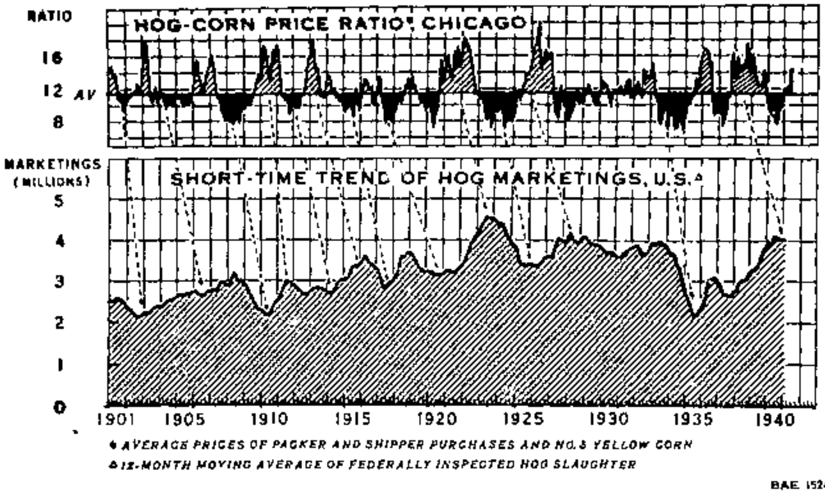


FIGURE 4.—HOG-CORN RATIOS AND HOG MARKETINGS, 1901–40.

The hog-corn price ratio (the price of hogs in dollars per hundred pounds divided by the price of corn in cents per bushel) fluctuates rapidly from month to month and year to year. Annual fluctuations in the hog-corn price ratio are followed about 2 years later by corresponding fluctuations in hog marketings.

Year-to-year changes in the hog-corn price ratio result from changes in prices of both hogs and corn. Hog prices rise and fall not only with the changes in consumer demand that accompany booms and depressions, but also with the changes in supply caused by the internal characteristics of the hog industry. The internal characteristics are such as to give a periodic quality to the fluctuations in hog production much in the same manner as the structure of a tuning fork gives a constant frequency to its vibrations. But the basic factor causing short-time (year-to-year) fluctuations in production of hogs is a physical one; it is the irregular year-to-year fluctuations in production of corn. The close relation between the two basic physical series, production of corn and production of hogs, is shown in figure 5. In this figure the corn crop (total United States production) each year is plotted against the total weight of hogs slaughtered under Federal inspection in the hog year beginning in October of the same year (Federal inspected slaughter covers only about two-thirds of the total hog slaughter, but it is the most accurate index of hog production on a hog-year basis).

The positive correlation between the two series is only moderately high when the data are plotted in their original form (fig. 5, *A*).

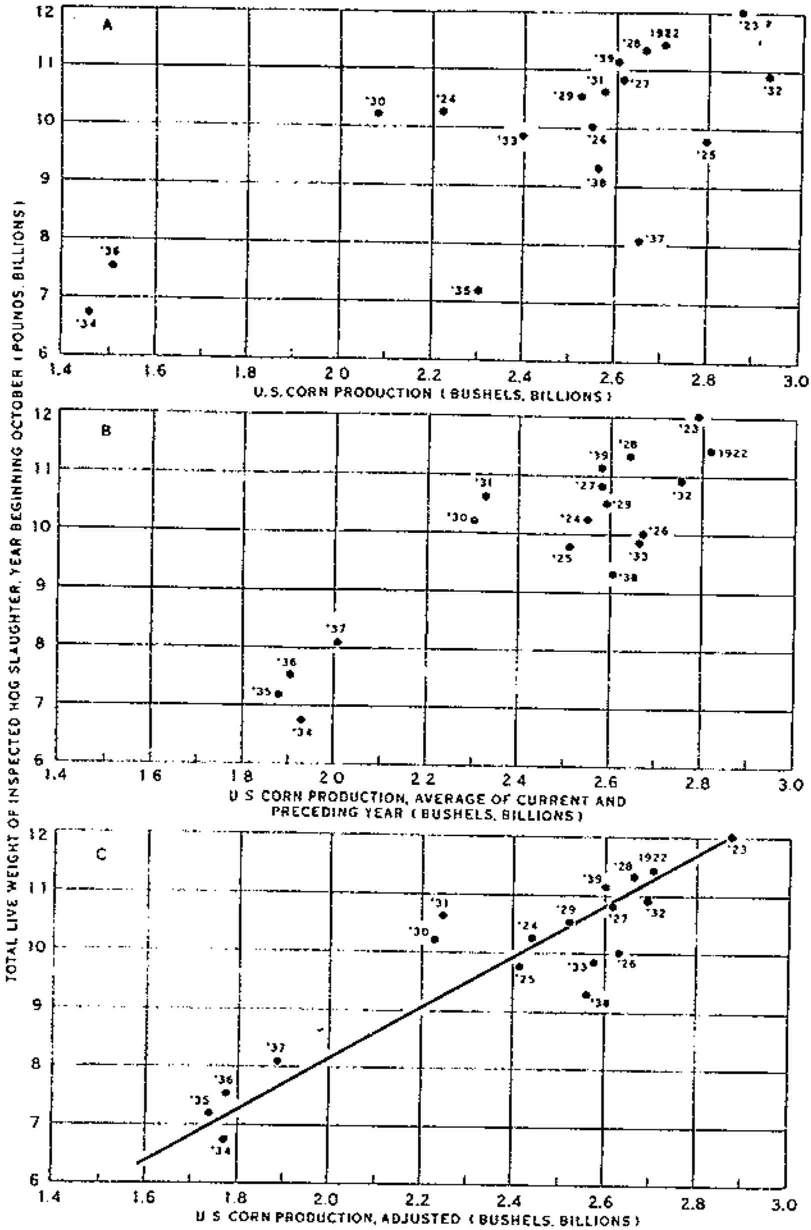


FIGURE 5.—UNITED STATES CORN PRODUCTION AND TOTAL WEIGHT OF HOGS SLAUGHTERED, OCTOBER-SEPTEMBER 1922 40: *A*, ORIGINAL DATA; *B*, PRODUCTION OF CORN EACH YEAR AVERAGED WITH PRODUCTION THE YEAR BEFORE; *C*, CORN PRODUCTION IN YEARS WHEN THE CHANGE FROM THE PREVIOUS YEAR WAS MORE THAN A THIRD OF A BILLION BUSHELS AVERAGED WITH PRODUCTION THE YEAR BEFORE.

The three sections of this figure show correlation between corn production and the total live weight of hogs slaughtered; *A* shows the relation between corn production and hog slaughter in the year immediately following; *B* shows the relation between the average of corn production in two successive years, and hog slaughter immediately following; *C* shows the relation when adjustments are made for the slowness with which hog slaughter can be increased after a severe reduction in corn production.

Inspection shows that the chief reason for this is the location of the dots for the years when there was a marked change in the size of the corn crop from the year before. Hog slaughter in those years changed to some extent, in the same direction as the change in the size of the corn crop, but the full effect of the change did not show up until a year later.

Perhaps, therefore, the hog-slaughter data should be lagged a year. But when this is done, the resulting correlation is still lower than when no lag is used. If, however, the hog data are plotted against the average production of corn for the current year and the preceding year, the correlation is fairly high (fig. 5, *B*).

The data are so handled because of purely statistical considerations—the scatter of the dots, the dates of certain dots, and so on—without any attention to the conditions under which hogs are produced. But the nature of the response of hog production to corn production is conditioned by the inherent characteristics of the hog industry. One is that hog slaughter cannot be increased as rapidly as it can be decreased. When a large crop follows a short crop, production of hogs cannot snap back to full capacity at once; it takes a year or more to build the herd up again. A small increase in production of corn can be taken care of by feeding hogs to heavier weights, but a large increase must be taken care of by breeding more sows, and the pigs from sows bred in December cannot reach the market until about 12 months later, in the next marketing year. When there is a marked *decrease* in corn production from the year before, however, slaughter of hogs decreases rapidly, because a herd can be reduced more quickly than it can be built up.

The situation described is handled statistically as follows: In the years when the corn crop was much larger (say a third of a billion bushels or more) than the year before, the large crop can be averaged up with the preceding small crop, giving the small crop a weight of 2. In the years when the corn crop was much smaller than the year before, the small corn crop can be averaged with the preceding crop, again giving the small crop a weight of 2.

The results of these weighting and averaging procedures are shown in figure 5, *C*. The correlation in this section is high, except for the years 1930 and 1931 early in the depression, and the year 1938 when production of hogs had still not completely recovered from the droughts of 1934 and 1936.

All three sections of figure 5 show that the relation between production of corn and production of hogs is about 1 to 1; a change of 10 percent in corn supplies causes a change of about 10 percent in hog supplies. Because of the close relation between prices and production of corn and hogs both of these commodities are considered in this bulletin. Whatever affects one affects the other, and a program for controlling the production and price of either must deal with the other as well.

Fluctuations in Demand for Corn and Hogs

Fluctuations in *supplies* of corn and hogs are not the only reasons for fluctuations in prices of corn and hogs. Changes in demand affect prices of corn and hogs perhaps even more than changes in supply. The same total slaughter of hogs that sold for an average United

States farm price of \$9 per 100 pounds in 1928–29 sold for a price of \$3.40 in 1932–33. The difference between those prices was entirely the result of differences in demand.

A study of the relation between the demand, supply, and prices of hogs (*14; 19, p. 269*) shows that a change of 1 billion pounds in federally inspected hog slaughter causes an opposite change of about \$1.33 in hog prices. The relation can also be expressed in percentages. A change of 10 percent in slaughter of hogs causes an opposite change of about 16 percent in prices of hogs.

The same hog-price analysis also shows how changes in demand affect prices of hogs. Demand here is measured or represented by total nonagricultural income in the United States. A change of 10 billions in total nonagricultural income causes a corresponding change of \$1.20 in hog prices. In percentage terms, the relation is 10 to 14. The curve showing this relation is concave from above, because changes in income have less effect on prices of hogs when incomes are low than when they are high.

Problem of Controlling Prices of Corn and Hogs is Two Problems

The foregoing analysis crystallizes into quantitative form the conclusion that the problem of controlling corn and hog prices is not one problem, but two. And the two problems are not (1) controlling prices of corn, and (2) controlling prices of hogs. Corn and hog prices fluctuate together (with an intervening time lag) but for two different reasons: (1) because the production of corn and hogs fluctuates, and (2) because the demand for corn and hogs fluctuates. The control of corn and hog prices therefore calls for two different programs, or at least a program with two different parts—not one for controlling prices of corn and another for controlling prices of hogs, but one for controlling supply and the other for controlling demand. And as fluctuations in supply arise at the producer end, and fluctuations in demand arise from the consumer end, the problem of controlling supply is largely a problem of controlling the supply of the raw material, corn, whereas the problem of controlling demand is largely a problem of controlling the demand for the finished product, hogs.

The first part of this bulletin, therefore, deals with the problem of controlling the supply of corn; the second deals with controlling the demand for hogs.

The first problem boils down to smoothing out fluctuations in the supply of corn that result from fluctuations in yields, in turn resulting from irregular and unpredictable changes in the weather. Fluctuations in the supply of corn can be met by storing the excess over average yield until yields fall below average again, and this will smooth out fluctuations in the production of hogs above and below the level desired. This sort of program is independent of what (if anything) is done about controlling demand.

The second problem boils down to meeting fluctuations in the demand for hogs, which have nothing to do with fluctuations in supply. Controlling these changes in demand, or dealing with them in some other way if they cannot be controlled, is a new and unexplored field; the theoretical and statistical analysis in the second part of this bulletin is chiefly exploratory in nature.

Review of the Situation Today

Production of corn fluctuates greatly from year to year, chiefly because of variations in yields caused by the weather. These fluctuations in the supply of corn cause great changes in production of hogs.

Prices of corn and hogs fluctuate because of fluctuations in demand as well as in supply. A program for controlling corn and hog prices, therefore, must consist of two parts—not one for controlling corn prices and another for controlling hog prices, but one for controlling the supply of corn and the other for controlling the demand for hogs.

CONTROLLING THE SUPPLY OF CORN

The problem of controlling the supply of corn and hogs reduces to the problem of controlling the supply of corn. Basically, short-time (year-to-year) fluctuations in the number of hogs produced are caused by short-time fluctuations in the quantity of corn available to feed them. The causal effect is exercised through the hog-corn price ratio, as shown earlier, but the basic controlling element is the supply of corn; the total weight of hogs produced (measured by the total live weight of the federally inspected slaughter) follows the quantity of corn produced as closely as the internal characteristics of hog production permit.

The basic problem, then, is to control the supply of corn, which fluctuates chiefly because of changes in yield per acre (fig. 3). The fluctuations in yields result chiefly from changes in the weather. No way has yet been found to stabilize the weather, so the next best course is to stabilize the quantities of corn available for consumption by withholding the excess over average yield, in big-crop years, and carrying this excess over to short-crop years. Storing the excess over average yield is a good way to smooth out that kind of fluctuation, because a high yield is usually followed by a low yield within a few years, and the storage stocks ordinarily would be used up before deterioration or storage costs would become excessive.

Storage Programs in Ancient Times

Many people in the United States think of the Ever-Normal Granary as a modern idea, original with us, except for Joseph's venture with the storage of grain from the 7 fat years to the 7 lean years in the time of the Pharoahs. Storage programs on a large social scale were in operation, however, many centuries before Joseph was born, and they have appeared in many different countries since.

Egypt was a granary for starving people for hundreds of years. "As far back as the fifth dynasty in Egypt, which historians place at 2830 B. C. at the latest, there was inscribed on the tomb of the Nomarch Henku 'I was lord and overseer of southern grain in this nome.' [Nomarch was the title for the chief magistrate of a nome, a Province of ancient Egypt.] In the book of Genesis 12 there are various references dating back to the time of Abraham, to the fact that Egypt was a granary where all people were sure of finding a plenteous store of corn."[4] About 1700 B. C. Joseph stored one-

[4] Lacy, Mary G. Food control during forty-six centuries. Reprint of an address before the Agricultural History Society, Washington, D. C., March 16, 1922. Bur. Agr. Econ., 20 pp. [Processed.] See pp. 1, 2.

fifth of the crop in years of abundance, thus carrying the people through years of famine. He used granaries similar to our elevators. "The outstanding result of the Egyptian control of the grain crop was a system of land tenure by which the land became the property of the monarch, and was rented from him by the agricultural class." [5]

The Chinese were also well versed in the practice of storing grain from good years to bad, a thousand years before Christ. When Li K'o became the minister of Wei he pointed out how high grain prices in years of short crops hurt consumers, and how low grain prices in years of large crops hurt farmers. He then went on to say:

"Those who want to equalize the price of grain must be careful to look at the crop . . ." In years of good crops, he said, the Government should buy up most of the surplus, and sell it back to the people in years of poor crops. ". . . the Government controls the excess of supply in a good year in order to meet the demand in a bad year." [6] The same policy was followed by Mencius, who lived from 372 to 289 B. C.

The name Ever-Normal Granary applied to the present-day storage programs was adapted from the records of that early Chinese era. "The principle of equalizing the price of grain advocated by Li K'o and Mencius was adopted into the system of 'constantly normal granary.' " (*5*) The Chinese found that this system not only benefited the people but that more than once it was administered in such a way as to make money for the Government. The difficulties of administering the programs were admittedly great.

In Athens and Rome, for several hundred years before Christ, attempts were made to control the quantities and prices of grain. In more recent times, the Government of India in 1770 and again in 1886 tried to regulate and stabilize the marketing of grain in Bengal. In England, the famous corn laws, from 1804 to the time of their repeal in 1846, constituted an attempt to stabilize grain prices.

In more modern times, the Brazilian coffee-valorization scheme, the tobacco monopoly in France, the Chadbourne sugar plan, and many others—to say nothing of the United States Federal Farm Board and its stabilization operations in the early 1930's—are examples perhaps more of price-raising than of supply-stabilizing plans (*8, p. 87*).[7] But they were all of similar nature.

Enough has been said in the preceding brief historical sketch to bring out a significant point: Modern stabilization programs are not newfangled schemes of a sort that were never heard of before. They are the current version of man's long struggle to control the supplies and prices of his food and fiber—a struggle that has continued from time immemorial to the present and will no doubt extend well into the future.

Development of the AAA Ever-Normal Granary Program for Corn

The Ever-Normal Granary program of the Agricultural Adjustment Administration for corn can best be understood in the light of its development.

[5] Lacy, Mary G. FOOD CONTROL DURING FORTY-SIX CENTURIES. (See footnote 4.) P. 3.

[6] Lacy, Mary G. FOOD CONTROL DURING FORTY-SIX CENTURIES. (See footnote 4.) Pp. 4-5.

[7] Edminster, Lynn Ramsey, Schaben, Leo J., and Lynsky, Myer. AGRICULTURAL PRICE-SUPPORTING MEASURES IN FOREIGN COUNTRIES. Bur. Agr. Econ. Foreign Agr. Serv. F. S. 56, 204 pp. 1932. [Processed.]

Lacy, Mary G., Hannay, Annie M., and Day, Emily L. PRICE FIXING BY GOVERNMENTS 424 B. C.—1926, A. D. Bur. Agr. Econ. Agr. Econ. Bibliog. 18, 140 pp. 1926. [Processed.]

The Supreme Court of the United States, on January 6, 1936, declared unconstitutional the AAA processing tax on hogs. That decision dried up the source of funds that had been used for making benefit payments to producers of hogs for reducing production. The AAA then changed its attack. It endeavored to adjust production of hogs indirectly, instead of directly, by adjusting production of corn and raising the price of corn. That would make the hog-corn price ratio unfavorable, and would thus cut down production of hogs.

The way to adjust corn production was to adjust corn acreage. That would not do the job by itself; yields per acre fluctuate so much that total production, and therefore prices, would still fluctuate from year to year. Accordingly, the AAA took over the Ever-Normal Granary idea of stabilizing prices of corn by offering nonrecourse loans on corn above the market price in big-crop years. The Ever-Normal Granary idea was that this loan would put a floor under prices in big-crop years and cause supplies to accumulate in the Ever-Normal Granary, and that these supplies could be thrown on the market in short-crop years and prevent prices rising to excessive heights in such years. The result would be more or less complete stabilization of supplies and prices.

Under the Ever-Normal Granary plan, prices of corn would be stabilized at about average levels (about equal to prices for an average crop.) The objective would be merely to smooth out the fluctuations about that average level. The AAA, however, proposed to use the loan for an additional purpose—to raise the level of prices, as well as to stabilize them, in order to cut down production of hogs. "A good high corn loan would do the job."

There was some question as to the efficacy of this proposal, but it coincided with corn farmers' natural desire for high corn prices, and appeared to be a workable approach to the problem. The loan rates that were finally written into the Agricultural Adjustment Act of 1938 were only moderately high, and it did not seem that there would be a great deal of difference in effect between the two approaches—(1) reducing acreage and then stabilizing prices about the higher level attained by acreage reduction, and (2) stabilizing and raising prices by high loans, and then reducing acreage enough to keep supplies from accumulating.

In actual practice, the difference between the two approaches turned out to be considerable; it has raised important questions of policy, which are considered later.

OBJECTIVES OF THE AAA

The objectives of the AAA with respect to marketing were put in very broad and general terms in the Agricultural Adjustment Act of 1938. As stated in the declaration of policy, they were:

> to assist in the marketing of agricultural commodities for domestic consumption and for export; and to regulate interstate and foreign commerce in cotton, wheat, corn, tobacco, and rice, to the extent necessary to provide an orderly, adequate, and balanced flow of such commodities in interstate and foreign commerce through storage of reserve supplies, loans, marketing quotas, assisting farmers to obtain, insofar as practicable, parity prices for such commodities and parity of income, and assisting consumers to obtain an adequate and steady supply of such commodities at fair prices. (*25*)

LOAN RATES FOR CORN

The basic rate for loans on corn laid down in this act was 75 percent of parity. That figure was, however, to be subject to reduction according to the size of the crop in that crop year. It was to be 70 percent of parity, if production exceeded normal consumption and exports by not more than 10 percent; it was to be 65 percent of parity if production exceeded consumption between 10 and 15 percent, and so on down to the lowest figure, 52 percent of parity, if production exceeded consumption by more than 25 percent.[8]

On May 26, 1941, Congress changed the basic rate of 75 percent by an amendment to the act. It set the loan rates for the 1941 crops of cotton, corn, wheat, rice, and tobacco at 85 percent of parity.[9] The amendment boosted the loan rate for corn from 61 cents a bushel to a hypothetical 71 cents.[10]

The loan rates that were set each year and the prices of corn at Chicago by months, for comparison, are shown in figure 6.

QUANTITIES OF CORN STORED

It is obvious that the loan rates offered little inducement to farmers during the drought years, 1934 and 1936, when corn prices were far higher than the loan rates. In the other years, substantial quantities of corn were put into the Ever-Normal Granary. Table 3 shows the number of bushels sealed each year under the program, also the number of bushels redeemed by farmers each year, and the quantities not redeemed—that is, the number of bushels delivered to the loaning agency, the Commodity Credit Corporation.

The quantities of corn under seal (owned by farmers) and the quantities owned by the Commodity Credit Corporation on October 1 each year are shown in table 3. The total United States stocks of corn October 1 are shown in the last column of that table. The totals include the commercial stocks as well as the stocks on farms, and the corn under seal and owned by the Commodity Credit Corporation. They are shown in graphic form in figure 7.

---

[8] The schedule in full detail follows:

"(d) The Corporation is directed to make available loans upon corn during any marketing year beginning in the calendar year in which the November crop estimate for corn is in excess of a normal year's domestic consumption and exports, or in any marketing year when on November 15 the farm price of corn is below 75 per centum of the parity price, at the following rates:

"75 per centum of such parity price if such estimate does not exceed a normal year's consumption and exports and the farm price of corn is below 75 per centum of the parity price on November 15;

"70 per centum of such parity price if such estimate exceeds a normal year's domestic consumption and exports by not more than 10 per centum;

"65 per centum of such parity price if such estimate exceeds a normal year's domestic consumption and exports by more than 10 per centum and not more than 15 per centum;

"60 per centum of such parity price if such estimate exceeds a normal year's domestic consumption and exports by more than 15 per centum and not more than 20 per centum;

"55 per centum of such parity price if such estimate exceeds a normal year's domestic consumption and exports by more than 20 per centum and not more than 25 per centum;

"52 per centum of such parity price if such estimate exceeds a normal year's domestic consumption and exports by more than 25 per centum." *(25, p. 43-44.)*

[9] "(10) The Commodity Credit Corporation is directed to make available upon the 1941 crop of the commodities cotton, corn, wheat, rice, or tobacco, for which producers have not disapproved marketing quotas for the marketing year beginning in 1941, loans as follows:

"(a) To cooperators (except cooperators outside the commercial corn-producing area, in the case of corn) at the rate of 85 per centum of the parity price for the commodity as of the beginning of the marketing year;

"(b) To cooperators outside the commercial corn-producing area, in the case of corn, at the rate of 75 per centum of the rate specified in (a) above;

"(c) To noncooperators (except noncooperators outside the commercial corn-producing area, in the case of corn) at the rate of 60 per centum of the rate specified in (a) above and only on so much of the commodity as would be subject to penalty if marketed." *(26).*

[10] The rate was hypothetical, because it was computed on the basis of the April prices of the goods farmers buy. The loans were to be made only on the 1941 crop, however, and the prices of the goods farmers buy were likely to have changed from their April levels by the time the corn crop was harvested in the fall—in the words of the amendment, "as of the beginning of the marketing year."

450348—42——3

The figures in table 3 show that care must be used in dealing with such questions as: How much corn is in the Ever-Normal Granary? and What should be the outside limits of size of Ever-Normal-Granary stocks? It must be made clear whether the question refers to (1) the quantity of corn owned by the Commodity Credit Corporation, (2) this quantity plus the corn that is under seal and still owned by farmers, or (3) the total number of bushels of corn in the country, regardless of who owns them.

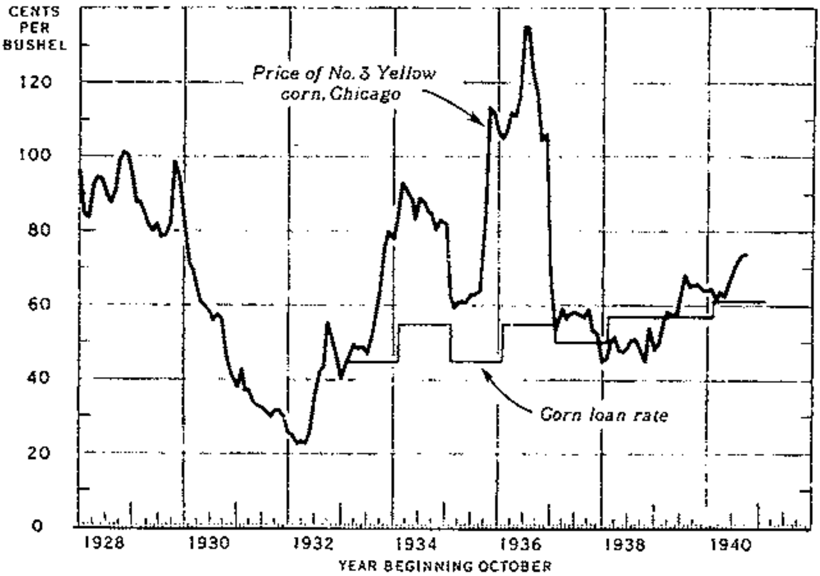


FIGURE 6.—LOAN RATES FOR CORN, 1934 40, AND CORN PRICES AT CHICAGO BY MONTHS, 1929 40.

The prices of corn at Chicago were much higher than the loan rates during the marketing seasons for the 1934 and 1936 crops, when the crops were very small. In recent years, the market prices have ranged closer to the loan rates.

TABLE 3.—*Corn loan data, by original loan programs, 1937–40. Quantities sealed, redeemed, and delivered under each program* [1]

Loan program	Sealed	Redeemed	Delivered to Commodity Credit Corporation	Quantity of corn Oct. 1: Under seal	Quantity of corn Oct. 1: Owned by Commodity Credit Corporation	Quantity of corn Oct. 1: Total United States stocks
1937	47,117,105	7,680,404	39,436,701			60,222,000
1938 [1]	228,838,574	18,281,985	135,908,736	45,208,317		363,093,000
1939 [1]	301,836,869	102,055,730	110,769,692	253,731,321	7,122,375	582,543,000
1940	103,173,197	33,983,281	1,749	372,115,000	107,228,758	691,804,000
1941				236,889,207	150,083,804	631,755,000

[1] 1938 and 1939 corn resealed in 1940 was commingled, and all redemptions and deliveries of such resealed corn are shown under the 1939 program.

Grain Division, Commodity Credit Corporation, as of October 25, 1941.

The total stocks of corn have risen to large figures in recent years. Stocks on October 1, 1940, reached an all-time high. Stocks in 1936 were about equal to the average of the previous 10 or 20 years. The "free supply" in the years since 1937 has been about equal to normal total stocks for the sizes of the corn crops in those years. The corn under seal and held by the Commodity Credit Corporation represents approximately the extra quantity of corn carried over as a result of the corn-loan program. On October 1, 1940, this amounted to nearly 500 million bushels; on October 1, 1941, it was about 400 million bushels.

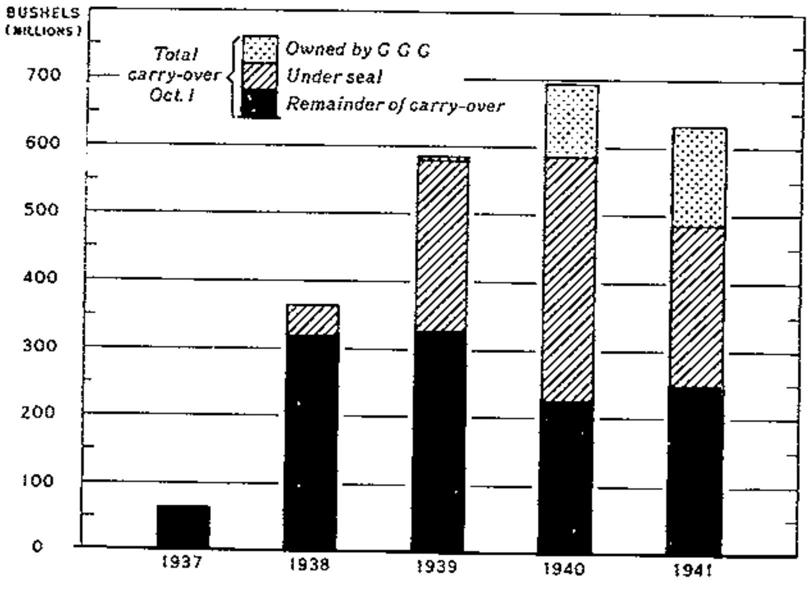


FIGURE 7. TOTAL STOCKS OF CORN OCTOBER 1, 1936 40, OWNED BY THE COMMODITY CREDIT CORPORATION, UNDER SEAL, AND "FREE."

An increasing proportion of the storage of corn on October 1 each year has been placed under loan or delivered to the Commodity Credit Corporation, since the short crops of 1934 and 1936. The quantity of "free corn" in October 1940 was slightly larger than the average carry-over before the droughts.

EFFECT OF LOANS ON PRICES

The average price of corn at Chicago was lower than the loan rate, from the middle of 1937 on. The question was frequently raised: Would the price of corn have been still lower if the loan had not been available? In other words, did the loans raise the price of corn after 1937?

The statistical corn-price analysis based on the years 1921 22 to 1937 38 (fig. 8) indicates that if no corn loans had been available, the average farm price of corn over the United States would have been about the same as it was in the corn year October 1937 to September 1938, that it would have been about 5 cents lower in 1938–39, and about 18 cents lower in 1939 40 and 1940 41. In other words, the corn loans raised the United States average farm price of corn each year by those amounts (table 4).[11]

[11] This conclusion agrees closely with the conclusion reached by other economists working on price analysis in the Department of Agriculture. They are also investigating the effects of the loan on the total incomes of corn producers. In some local areas, of course, the effects of the loan may have been greater than the figures given, and in other areas, less. The figures given are the averages for the United States as a whole and do not include allowance for unredeemed corn at the appropriate loan rates.

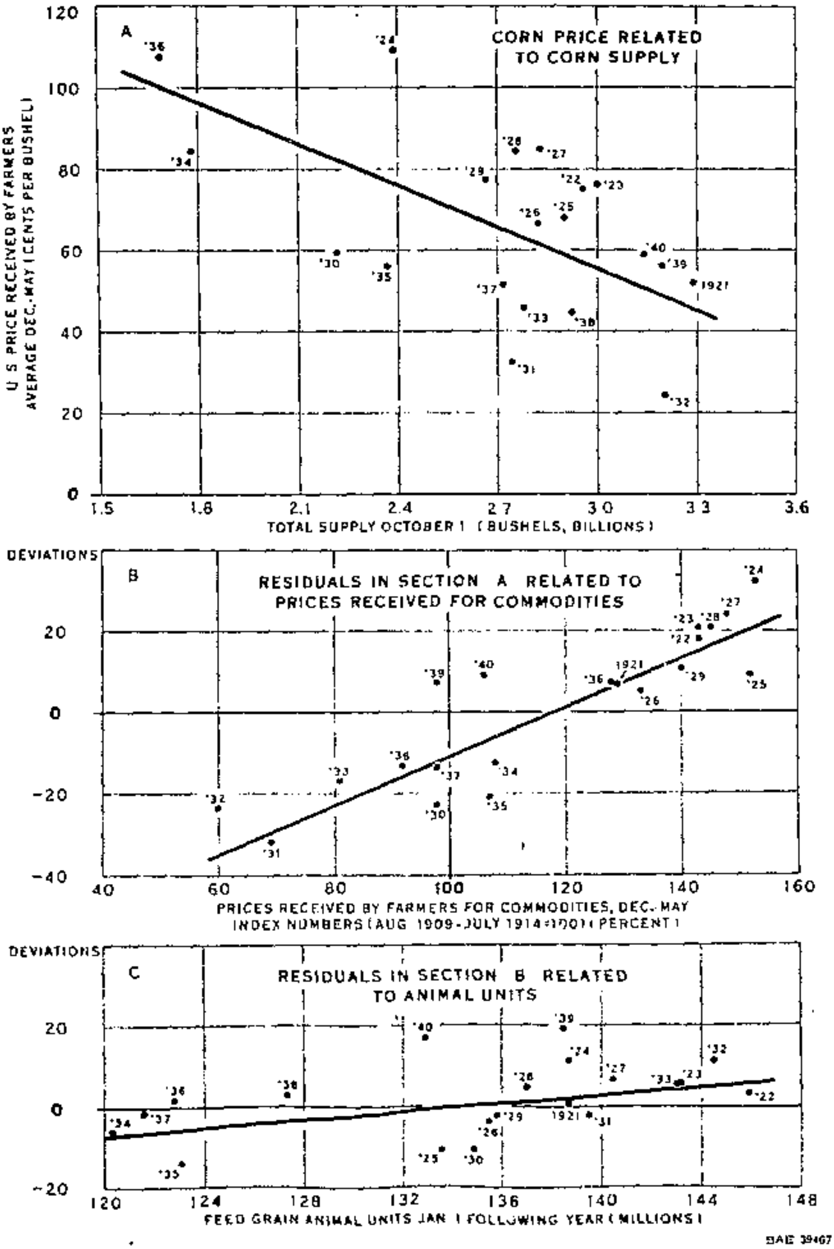


FIGURE 8.—RELATIONS BETWEEN THE UNITED STATES AVERAGE FARM PRICE OF CORN DECEMBER-MAY AND (A) TOTAL UNITED STATES CORN SUPPLY OCTOBER 1 (B), PRICES RECEIVED BY FARMERS DECEMBER-MAY, AND (C) NUMBER OF ANIMAL UNITS ON FARMS JANUARY 1, 1921-22 TO 1937-38. MULTIPLE R, 0.965.

The dots for 1939 and 1940 in *C* lie about 18 cents above the line, showing the average relationship of corn prices to the three factors mentioned. Presumably this shows the influence of the corn loans in those years.

TABLE 4.—*Factors determining the United States average farm price of corn, 1921–40*

Year beginning month specified	Average United States farm price of corn per bushel, December–May [1]	Total corn supply October 1 [2]	Index numbers of prices received by farmers December–May (August 1909–July 1914 =100) [3]	Feed grain animal units Jan. 1 of next year [4]
	Cents	*Million bushels*		*Million*
1921	52.0	3,290	129	138.7
1922	74.9	2,960	143	145.9
1923	76.0	3,000	143	143.2
1924	100.2	2,390	153	138.7
1925	68.0	2,900	152	133.6
1926	60.5	2,825	133	135.5
1927	85.0	2,833	148	140.5
1928	84.3	2,757	145	137.0
1929	77.2	2,809	140	135.8
1930	59.4	2,217	96	134.9
1931	32.4	2,743	69	130.5
1932	24.2	3,202	60	144.5
1933	45.7	2,786	81	143.1
1934	84.6	1,708	108	120.3
1935	55.9	2,369	107	123.1
1936	107.6	1,657	128	122.8
1937	51.5	2,718	98	121.6
1938	45.0	2,925	92	127.3
1939	56.0	3,192	98	138.4
1940	58.6	3,144	106	132.9

[1] UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS. *Agricultural Statistics 1940* (*24, p. 55*); and *Crops and Markets 1935* (*23, p. 590*).
[2] *Feed Statistics*, FdS-Sup. 2, 53 pp., March 1941. [Processed.] See p. 11.
[3] *Agricultural Situation* (*22*).
[4] UNITED STATES AGRICULTURAL MARKETING SERVICE. LIVESTOCK, MEATS, AND WOOL MARKET STATISTICS AND RELATED DATA 1940. 107 pp. 1941. [Processed.] See p. 7.

A question of interpretation arises. If the corn loans had not raised corn prices in the year 1938–39, more corn would have been consumed in 1938–39 and more livestock would have been produced and sold at lower prices that year and the next. However, less corn would have been carried over to add to the supply and depress corn prices the next year, 1939–40. Similarly, if the high loan rate in 1939–40 had not raised prices and reduced the consumption of corn, more livestock would have been produced to add to the excessive supplies and reduce livestock prices further below the extremely low prices which did prevail. At the same time, less corn would have been carried over to add to supplies and depress corn prices the next year, 1940–41. If there had been no loan raising prices in the earlier years, livestock farmers' incomes would have been smaller, but there would have been less need for a loan to support corn prices in the later years. Prices in the later years were depressed partly because the loans made in the earlier years had raised prices, reduced consumption of corn, and increased the carry-over of corn to those later years.

Specific figures may clarify the point. The total carry-over of corn on October 1, 1940, was nearly 700 million bushels. A normal carry-over, in view of the size of the 1939 crop, would have been a little under 200 million bushels. The corn loan that raised prices 18 cents in 1939–40 withheld from market nearly 500 million bushels in 1939–40. Otherwise, most of it would have been consumed in further expansion of livestock production and this would have depressed livestock prices further. Thus the loan added about that quantity to the total supplies for the next crop-year. Figure 8 shows that the addition of 500 million bushels to the total supply of corn depresses prices about

17 cents. The loan in 1940–41 that raised prices of corn 18 cents raised corn prices only to the point where they would have been anyway if there had been no loans in previous years affording protection to corn producers from low corn prices and to livestock farmers from low incomes which would have resulted from further overexpansion of livestock production.

Speaking of corn supplies and corn prices alone, the situation may be compared to that of a man who steps on the platform of a weighing scale, and then takes hold of a bar over his head and lifts all his weight off the scales, thus "supporting the pointer" until it registers zero again. The pointer would have registered zero if he had not stepped on the scale in the first place. The explanation given does not detract

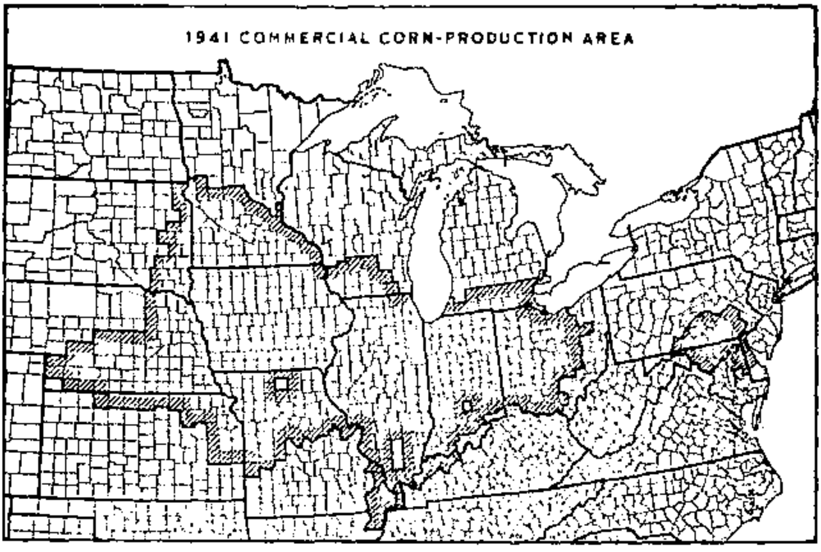


FIGURE 9.—The commercial corn-producing area shown within the shaded outline in the map includes all counties in which the average production of corn is 450 bushels or more per farm and 4 bushels or more for each acre of farm land in the county.

from the value and the necessity of withholding supplies by loans or other means. That must be done, or supplies could not be stabilized, and stocks could not be accumulated to fill in when short crops come. The man needs to be standing on the scales, and lifting his weight off it, in order to be on the spot ready to let go and bear his weight on the scales whenever the pointer begins to register minus quantities. Only if stocks become larger than necessary for stabilization purposes does the explanation raise any question concerning the program.

THE LOAN-RATE STRUCTURE

To simplify the administration of the AAA program, the administrators outlined what is called the "commercial corn area" (fig. 9). It includes those counties in which production of corn per farm is large enough to warrant including the county in the administrative machinery.[12]

The Agricultural Adjustment Act of 1938 specified lower corn-loan rates for farmers in the commercial corn area who did not cooperate in the acreage-control program, and for farmers outside the commercial corn area. The rate to noncooperators in the area is only 60 percent of the rate to cooperators, and the rate to cooperators outside the area is only 75 percent. Differentials in loan rates, "as the Secretary of Agriculture prescribes," are also provided for in the act, for differences in grade, type, staple, and quality.

Nothing is said in the act, however, about *geographical* differentials in loan rates for any commodity (aside from the differential against producers outside the commercial corn area mentioned). The AAA administrators were left free to establish a flat rate, or to use differentials according to location, as they chose. In the case of wheat, the AAA administrators established geographical differentials in loan rates, based upon costs of transportation. In the case of cotton, flat loan rates were used at first; but, beginning with the 1939 crop, geographically differentiated loan rates were introduced. In the case of corn, a flat loan rate was adopted over all the commercial corn area.

There were some reasons for adopting this flat loan rate for corn. About 90 percent of the corn crop is fed to livestock, and the geographical corn price structure over the commercial corn area is not a simple one based only on transportation costs of corn. It is more nearly flat than that. In addition, corn moves in different quantities and in somewhat different directions from year to year, so that one fixed set of differentials might not do for different years. Under these conditions, the simplicity of the flat loan rate has a strong appeal.

The flat loan rate, however, along with some other features of the AAA program, caused some disturbances in production of corn and hogs and in the operation of the Ever-Normal Granary. The average corn-price surface over the Corn Belt slopes generally upward from west to east and from north to south, and the flat loan rate proved more attractive to producers in the northwestern part of the Corn Belt than in the south and east. Corn piled up in storage most heavily in Iowa, and production of hogs in Iowa declined for a time relative to production of hogs in Indiana and Ohio. These effects, and some others, are discussed in detail later, in the pages dealing with differential loan rates for corn.

REVIEW OF THE SITUATION TODAY

The stocks of corn impounded under the Ever-Normal Granary program rose to 500 million bushels by October 1, 1940. The "free corn" added to this quantity made a total of practically 700 million bushels, the largest carry-over on record. The loans apparently raised the United States average farm price of corn about 18 cents a bushel in 1939–40 and in 1940–41.

The flat loan rate caused some disturbances in marketing of corn and perhaps in production of hogs. Corn piled up in storage most heavily in Iowa, and production of hogs may have declined there for a time relative to production of hogs in Indiana and Ohio.

[12] *Agricultural Adjustment Act of 1938.* "Sec. 301 (4) (A) 'Commercial corn-producing area' shall include all counties in which the average production of corn (excluding corn used as silage) during the ten calendar years immediately preceding the calendar year for which such area is determined, after adjustment for abnormal weather conditions, is four hundred and fifty bushels or more per farm and four bushels or more for each acre of farm land in the county." *(26, p. 40.)*

SIZE OF STABILIZATION STOCKS

Several over-all problems are involved in setting up and operating an Ever-Normal Granary program for corn. One of the most significant is the quantity of corn that should be carried in the granary. What are the outer limits for the size of the stabilization stocks?

Before the proper size of the stabilization stocks of corn can be ascertained, a preliminary question must be answered: What is it that is being stabilized? Is it the price of corn, or is it merely the physical supply of corn?

If demand remained stable, stabilization of the supply would effect stabilization of the price. There would be no difference between the two. But when demand changes, no matter how completely the supply might be stabilized, prices would still fluctuate. Changes in demand are usually so unpredictable, and cover such long periods of time, that it is doubtful whether they could be offset by changes in supplies resulting from the accumulation and subsequent liquidation of storage stocks. Long-time changes in demand obviously cannot be offset by storage; the stocks would deteriorate, or the costs of keeping them in good condition would be excessive, over a long period of years. It would be difficult to offset short-time cyclic changes in demand, as from prosperity to depression, by a storage program; cyclic changes in demand are so violent, and so difficult to predict, that an Ever-Normal Granary would probably do well to confine itself, at least for the first few years, to the clear-cut job of stabilizing physical supplies. That would stabilize one side of the price equation (the supply side), without directly affecting the other side, demand. That sort of an Ever-Normal Granary program would be essentially a physical grain-storage program. It might be part of a wider program for stabilizing prices, but in itself it would be purely a program for stabilizing physical supplies. The discussion in the next few sections of this bulletin is based on the assumption of this sort of a stabilization program; the broader problem of dealing with changes in demand is considered in the last few sections of the bulletin.

STABILIZATION STOCKS REQUIRED FOR COMPLETE STABILIZATION OF CORN SUPPLIES

The proper size of the stabilization stocks of corn (the quantity carried over from year to year) depends on the degree of stabilization of supply that is desired. The more completely supplies are to be stabilized, the larger must be the stocks.

Before governmental stabilization operations were ever thought of, farmers acting as individuals operated virtual Ever-Normal Granaries of their own, though only on a small scale. They carried over some surplus corn in good crop years, either with the intention of using it as a backlog of feed supplies or in the hope of selling it at higher prices in later years when supplies were scarce. On the average, an increase in size of a corn crop of 500 million bushels was followed by an increase in the carry-over to the next crop year of 100 million bushels. Thus the stocks of corn carried over in good crop years were large enough to offset about one-fifth of the fluctuation in total production. That is, the fluctuations in consumption were only four-fifths as great as the fluctuations in production; the other one-fifth of the excess supplies went into storage, and supplies and prices were stabilized to that extent (*18, p. 308*).

More complete stabilization would require the carrying over of larger surplus stocks. Complete stabilization of supplies would require that in big-crop years all of the corn produced in excess of an average-size crop would be held off the market then and dumped back on the market in small-crop years. If, for example, corn crops fluctuated regularly from 3 billion to 2 billion bushels, averaging 2.5 billion bushels, complete stabilization of supply would be achieved by withholding half a billion bushels from the big crop and adding it to the small crop.

Actually, the situation is more complicated than indicated. Corn crops come in all kinds of sizes, and the order of their coming is highly irregular. Furthermore, the distribution of these different sized crops is not normal. There are twice as many large crops (crops above average size, 2.5 billion bushels) as there are small crops. The reason is that large crops run only as high as 3 billion bushels (20 percent over average size) while the small crops run as low as 1.5 billion bushels (40 percent below average size). Fluctuation in the size of the United States corn crop, and the abnormal nature of the distribution of the different sizes of crop, is shown in the appendix.

That is to say: Large corn crops are many, but they are only moderately large; small corn crops are comparatively few, but when they do come they are very small. On the average then it is necessary to build up stabilization stocks from more than 1 year's excess supplies, as the large crops are more numerous than the small crops, and do not exceed the average as much as the small crops fall below average.

But averages are not safe guides for action in individual years or small series of years. One short crop goes with two large crops, on the average, but a wide dispersion of the items about this average is found. Occasionally, several large or small crops come in a bunch. Obviously, the order in which large, medium, and small crops come has a significant bearing on the way a stabilization program would work out.

HYPOTHETICAL STORAGE OPERATIONS, 1870–1940

The order in which crops of different sizes come is shown by the original United States corn acreage, yield, and production statistics, by years, given earlier in table 2 and figure 3. The way a complete stabilization program would have worked out over the years covered by these data is shown in figure 10.

In 1870, for instance, the yield was 29.3 bushels to the acre. The excess over the average yield, 3.3 bushels, multiplied by the acreage of that year, is the quantity that would have been put into storage that year. It is represented by the vertical bar for 1870 in the upper part of the chart. In the year following, the yield was 27.2 bushels, again above average. The excess (1.2 bushels) multiplied by the acreage in 1871, would have been added to the storage stocks from the previous year. In 1872 the yield was 29.4, again above average, and stocks would have risen farther, as shown by the vertical bar for that year in the upper part of the chart. In 1873, however, the yield was 3.1 bushels below average; the storage stocks would have been

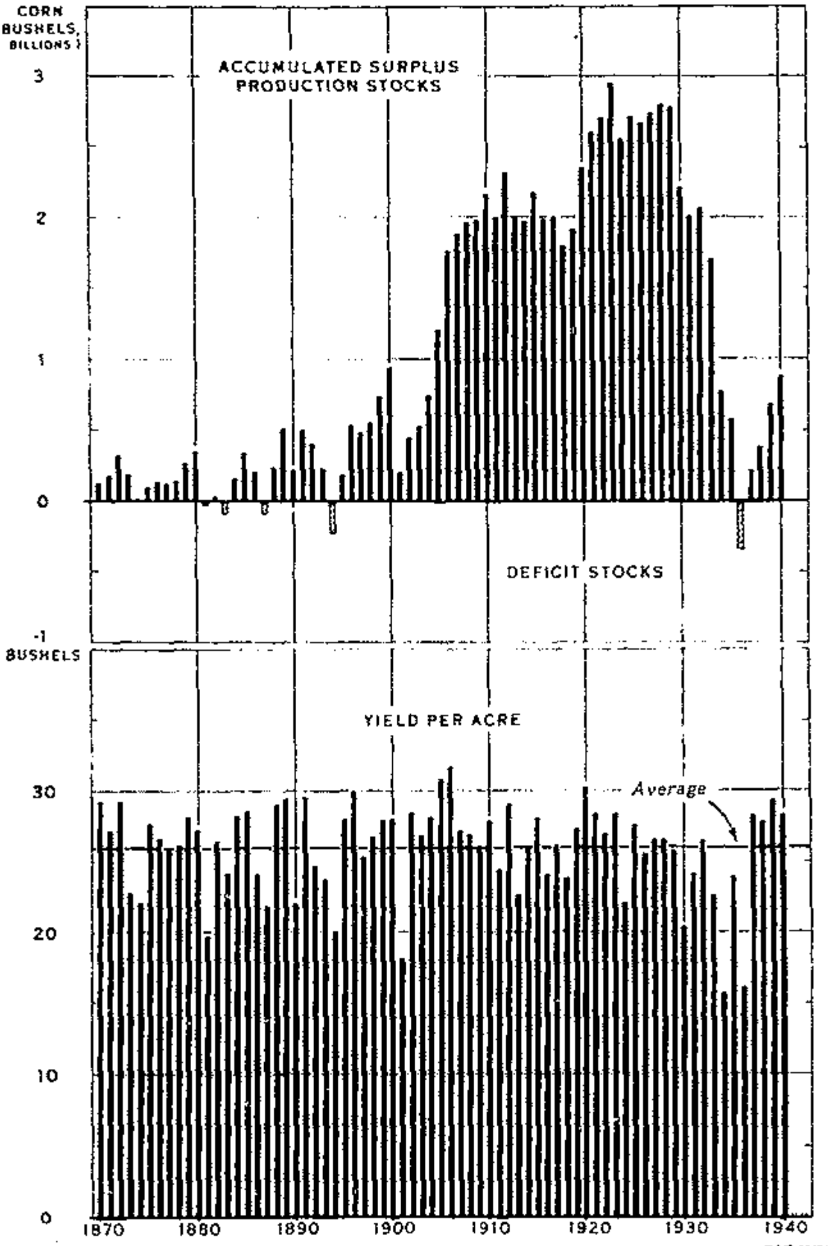


FIGURE 10.—UNITED STATES CORN YIELDS AND STORAGE STOCKS REQUIRED FOR COMPLETE STABILIZATION, 1870–1940.

The vertical bars in the lower part represent the United States average yields of corn per acre since 1870. The horizontal line running through the tops of the bars represents the average yield over the 71 years—26 bushels to the acre. The vertical bars in the upper part represent the stocks that would have accumulated if the excess above average yields had been put into storage in good-crop years and taken out in poor-crop years.

reduced by 3.1 times the acreage for that year. Further reductions would have taken place in 1874, when the yield was below average again.

This shows the general procedure. If in a short-crop year stocks would not have been sufficient to fill out the short crop, the extent to which the short crop plus the entire carry-over would still be short of average is represented by a hollow bar extending below the zero line in the upper part of the chart. The year following one of these "hollow-bar" years starts off from zero again and not from the bottom of the hollow bar, for a minus quantity of corn cannot be carried over.

Study of figure 10 discloses that the storage program would have worked out better during the first half of the period than during the second half. The average yield in this part of the period was 26 bushels, the same as for the period as a whole, but the fluctuations in yield were less severe and followed each other more rapidly and alternately than in the second half of the period. The situation over the first 32 years, from 1870 to 1901, can be summarized in one statement: Storage stocks on one occasion (1900) would have risen to nearly a billion bushels, but in most cases they did not rise above half a billion bushels. Stocks would occasionally have had to be carried for as much as 5 years, and on a few occasions they would not have been large enough to fill out the short-crop years completely. On the whole, however, the stabilization program would have worked out fairly well.

The situation after 1901 was quite different. A program of complete stabilization started then, based on the records of the previous 32 years, would have been unfortunate. Immediately after 1901 came 9 years in a row when yields were above average. Figure 10 shows that by 1910, storage stocks would have risen above 2 billion bushels and that they would have remained at about that level for the next 9 years. Then came another succession of large crops, lasting from 1919 to 1923. In this period more than half a billion bushels would have been added to the existing storage stocks, bringing them over 2.5 billions—more than an average crop. Large granary stocks would have had to have been carried along, furthermore, for 10 years before they would have been appreciably reduced.

Short crops after 1923 would have begun to whittle the granary stocks down, but not until the severe droughts of 1934 and 1936 would they have been used up. And, as large as the stocks were, they would have fallen about one-third of a billion bushels short of filling out the short crop of 1936. After that year, stocks would have begun to accumulate again.

What it adds up to is this: A program of complete stabilization in the past would have involved carrying as much as 2.5 billion bushels of corn at a time, part of it for 10 or 20 years, and even that would not have been enough to fill out the short crops completely.

HOW WOULD A COMPLETE STABILIZATION PROGRAM WORK OUT IN THE FUTURE?

A program which would involve the carrying for 10 or 20 years of stocks equivalent to an entire corn crop, which still would not completely fill out all the short crops, appears on the face of it to be impracticable. Can a less ambitious but more workable program be figured out for the future?

There are some reasons why this may be possible. Under the AAA program, acreage of corn is being controlled to some extent. There is some question as to how much the total production of feeds has been controlled, but better techniques of control may be worked out in the future.

If storage stocks of corn in the 1940's were to grow as large as they did in the 1920's (fig. 10), acreage of corn would be reduced in an attempt to reduce the storage stocks of corn, and the attempt might well be successful. Had production of corn been reduced in the 1920's, the stocks would not have grown so large; this would not have been all to the good, however, for the stocks would then have been much too small to meet the short crops from 1933 to 1936. But this could have been offset in considerable part by increasing the acreage of corn in 1935 and 1936. If production of corn can be controlled in the future, it will mean that smaller storage stocks of corn will be required than in the past.

Even without production control, figure 10 shows that if the four drought years 1933–36 are excluded, complete stabilization of supplies could have been accomplished in the past by storage stocks of only about a billion bushels of corn. This is a substantial reduction—60 percent—from the 2.5 billion bushel stocks needed for complete stabilization if the years 1933–36 are included. Stocks of a billion bushels would have been enough for all emergencies except that of the years 1933–36 in 71 years.

The odds against another group of short crops like those of 1933–36 occurring in the future are less than 1 in 71. One of the great technological advances in agriculture during the last decade has been the development of hybrid seed corn. Corn yields from hybrid seed have been above those of the best open-pollinated varieties planted in similar representative farm fields, by quantities ranging from 7 to 31 percent and averaging 14.5 percent over the last 10 years in Iowa.[13] Similar results are reported from other Corn Belt States. The increase is the greatest in years of severe drought; that is, the hybrids are more drought-resistant than open-pollinated corn. Hybrid 939, much used in Nebraska, is very drought-resistant, as are Iowa 13 and Iowa 8, which are popular in Missouri. In dry years the yields from those hybrids have run as much as 50 or 60 percent higher than open-pollinated corn, according to a statement by H. D. Hughes of the Iowa State College. With continued genetic research greater increases may be attained in the future. It seems probable that when droughts come in the future, corn yields will not be cut down so much as they were in the past. The size of the stocks needed for stabilization would thereby be reduced below a billion bushels how much below cannot be said until more is known about the drought resistance of the newer corn hybrids. Perhaps storage stocks of 700 or 800 million bushels would be enough.

[13] The percentages fluctuate from year to year. For the last 10 years the yields of the hybrids, expressed each year as a percentage of the yield of open-pollinated corn that year, were:

1930	111	1934	115	1938	117
1931	108	1935	111	1939	114
1932	107	1936	131		
1933	115	1937	116		

Data from *1939 Corn Yield Test* (*15*).

SIZE OF STOCKS SUMMARIZED

How much corn should be carried in the stabilization stocks? The answer depends upon the degree of stabilization desired. If complete stabilization of supplies (the withholding of any excess over average production in good-crop years and its release in short-crop years) had been sought in the past, it would have required carrying as much as 2.5 billion bushels of corn, the equivalent of an average crop, for 10 or 20 years. Even that would not have given complete protection in 1936. Probably a program of that size would have been unworkable.

A less ambitious program for the future, designed to cover all emergencies but those like the group of extremely short crops in 1933–36 (and this has occurred only once in the last 71 years) could get along on storage stocks of about 1 billion bushels. This is all the truer if production control is effective. If hybrid seed corn is as drought-resistant as it appears to be, less than 1 billion bushels would be required—perhaps only 700 or 800 million.

Location of Stabilization Stocks

The second major problem is that of the most economic location of the stabilization stocks. This depends upon several things: (1) The relative size of the fluctuations in production of corn in different parts of the Corn Belt, (2) the costs of storage, including deterioration, in different areas, and (3) the costs of transportation to and from the place of storage.

It could be only an accident if these three factors all led to identical conclusions. For example, fluctuations in production of corn might be much greater in the western part of the Corn Belt than in the eastern part; that would point to the conclusion that the storage stocks should be larger in the western than in the eastern. Yet the danger of insect damage might be less in the northern parts of the Corn Belt, and that would lead to the conclusion that the bulk of the corn should be stored in the North. Yet again, the costs of transportation might be lower if the storage stocks were distributed evenly over the entire area.

The first problem is to investigate each factor separately, and in that investigation each factor will be treated independently of the influence of the other factors.

FLUCTUATIONS IN PRODUCTION OF CORN IN DIFFERENT PARTS OF THE CORN BELT

Under the simplest conditions, if all the corn produced were consumed in the same county where grown and if production of corn fluctuated about as much in one part of the Corn Belt as in another, these would be reasons for storing supplies evenly over the area. But if production of corn in one part of the Corn Belt fluctuated frequently from 30 percent above average to 30 percent below, for example, whereas in another part it fluctuated only from 10 percent above average to 10 percent below, that would be a reason for carrying stocks as large as 30 percent of a crop in the one place and only 10 percent in the other. In that case the major part of the storage stocks for the Corn Belt as a whole would need to be carried in the area with the greatest fluctuations in production.

How do the actual fluctuations in production compare in the important Corn Belt States? This can be shown in two ways: (1) Graphically, by means of separate charts for each State, all on logarithmic scales to permit direct visual comparison of the fluctuations, and (2) mathematically, by the computation of some numerical index or coefficient of fluctuation.

The graphic method is superior to the mathematical method in one respect; it shows what happened each year—whether there were large fluctuations in a few years and comparative stability in the others, or whether the fluctuations were about the same size in different periods—and whether there were trends up or down, and the nature of any curvature in the trends. In this case, however, 11 separate States are involved, and the chart showing the fluctuations in production for each State from 1900 to 1940 on separate logarithmic scales is too large to reproduce here.[14] It can be described and appraised verbally as follows:

The fluctuations in production of corn from year to year in the five principal corn-producing States—Iowa, Illinois, Indiana, Ohio, and Minnesota—appear to be all of about the same order of magnitude. The size of the fluctuations in the next group, consisting of the four States along the western border of the commercial corn area (South Dakota, Nebraska, Kansas, and Missouri), cannot be so easily summarized in one sentence, because of the pronounced trends upward or downward in production that took place over the period. The trend of corn production in South Dakota rose steeply from 1900 to 1923, but after 1927 it fell precipitately to below any previous levels during the early 1900's. In Missouri, the trend of acreage has declined irregularly since 1917, and yields were cut drastically by the severe droughts in 1901, 1934, and 1936. Much the same can be said of Nebraska and Kansas, except that the reduction occurred almost all in one sharp drop after 1934. In these four States rainfall is the chief limiting factor, and the fluctuations in production are considerably greater than in the five principal Corn Belt States. At the other extreme, the fluctuations in Wisconsin and Michigan are the smallest of all.

Further inspection of the charts for the five most important Corn Belt States shows that they can all be broken into two periods, each about 20 years long. One period runs from 1900 to 1920, and the other from 1921 to 1940. The fluctuations during the second period are greater than those during the first. Yet the same general conclusion can be drawn concerning both periods: The fluctuations in the five principal corn-producing States are all about the same size; the droughts in 1901, 1934, and 1936 reduced yields most severely in the four States along the western border of the commercial corn area, and partly for that reason the fluctuations in those States are greater than in the five principal corn-producing States.

The fluctuations in the different States are represented mathematically in table 5. The measure of fluctuation is the standard deviation of the differences between successive corn crops, divided by the mean of the corn crops for the period concerned, expressed

[14] A multilithed copy of this chart may be obtained by writing to the Bureau of Agricultural Economics, United States Department of Agriculture, asking for a print from negative 39700.

as a percentage.[15] With the exception of Kansas and Missouri, production of corn in the second 20-year period, 1921–40, fluctuated about 50 percent more than in the first period. In all three of the periods shown, the fluctuations in the five principal States—Minnesota, Iowa, Illinois, Indiana, and Ohio—were of about the same order of magnitude. The fluctuations in the four western States—South Dakota, Nebraska, Kansas, and Missouri—were about 50 percent greater than in the other States.

The data in table 5 indicate that, insofar as the factor of relative fluctuations in production is concerned, the storage stocks of corn should be spread evenly (in even percentages of average production) over the five principal Corn Belt States where the fluctuations in production are about equally large; but in the four western States of South Dakota, Nebraska, Kansas, and Missouri, the stocks should be about 50 percent larger (in percentage terms) than in the principal Corn Belt States. The preliminary conclusion relates only to the one factor, the relative fluctuations in production, under the simplest conditions where all of the corn is consumed in the county where it is grown. The influences of other factors and other conditions, which may lead to different conclusions, must also be considered.

TABLE 5.—*Measures of fluctuation in corn production, by States, 1901–40*

Period	Coefficient of variation in corn production in—[1]										
	Iowa	Ill.	Ind.	Ohio	Minn.	S. Dak.	Nebr.	Kans.	Mo.	Wis.	Mich.
1901–20	18.0	21.4	20.9	16.5	17.0	20.1	31.6	54.7	43.6	20.3	14.1
1921–40	29.7	29.8	29.0	28.1	28.3	44.8	49.4	45.4	31.3	24.5	26.6
1901–40	25.5	25.4	24.2	22.6	27.6	37.5	40.5	52.9	40.7	23.3	20.7

[1] The coefficient of variation in each State was obtained by the formula $\frac{\sigma \times 100}{M}$

σ = Standard deviation of the first differences;
M = Mean of the original series.

MINIMIZING TRANSPORTATION COSTS

Here the discussion begins with the assumption that corn moves in large quantities year after year from the surplus-producing areas in the western and central Corn Belt through to the East.

Under those conditions, the corn-price surface would slope fairly smoothly upward from west to east. The prices at eastern points would be higher than the prices at western points by the amount of the transportation and handling charges between them. In that case the better place to locate the storage stocks of corn would be in the western part of the Corn Belt. A given amount of loan money would accomplish more there, where prices would be lower, and the storage costs that vary with the value of the corn would also be lower. When eastern livestock farmers needed to get corn out of the storage stocks, it would cost them no more to get it out of these stocks than if the stocks had been located in the East.

AVERAGE PRICE DIFFERENTIALS.—The situation in actuality is not so simple as indicated. It lies somewhere between the two extremes. The price surface over the Corn Belt does not slope smoothly upward

[15] The reasons for using this measure, and a comparison of the results of using this measure and another measure, are given in the appendix.

in any direction (fig. 11). Figure 11 shows the average farm prices of corn over the last 16 years (the data go back only to 1924) by crop-reporting districts over the commercial corn area. "Iso-price" lines, connecting approximately equal prices, like contour lines on a topographical map, help to bring out the character of the "price surface" over the area.

Figure 11 shows that the corn-price surface is not flat like the ocean, nor is it uniformly sloped in any single direction. The rough general tendency is for the price surface to slope downward from the east to the west, and from the south to the north; but the slope is not uniform. Valleys and ridges, plateaus, and even basins, occur in the price surface. In central and eastern Illinois and western and central Indiana there is a basin of 63-cent prices surrounded by a ring of higher prices on all sides. Going west from that area, prices at first do not decline; they rise. It is necessary to surmount a ridge of 64- and 65-cent prices in western Illinois and southeastern Iowa before reaching the low-price valley that runs northwest from central Iowa, deepening as it goes.

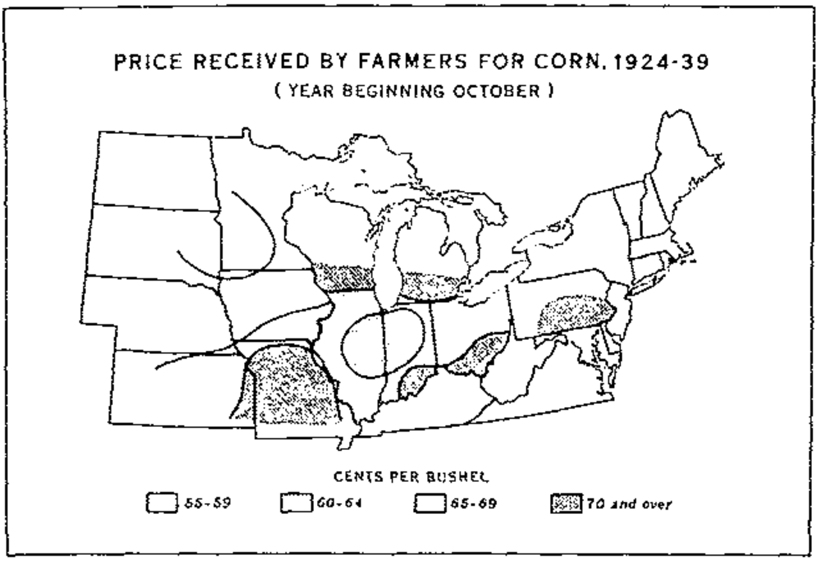


FIGURE 11.—The price surface for corn has a general slope upward from west to east, except for a depression in eastern Illinois and western Indiana, where large quantities of corn in excess of local needs are produced. The lowest prices are found in the northwest corner of the Corn Belt. (Average farm price, by crop-reporting districts in the commercial corn area.)

The actual differences in prices shown in figure 11 are in most cases less than the transportation costs between the different points. It is evident from these price relations, as well as from data regarding corn shipments and destinations, that the corn produced in the surplus-producing areas does not move from the western and central part of the Corn Belt clear over to the Eastern States, unless it be in a few exceptional years, and in comparatively small quantities. Corn from western and central Iowa ordinarily goes to eastern Iowa and as far east as Chicago (*8, pp. 11–19, 48*), but very little of it seems to go east of Illinois. Less is known about shipments from eastern central Illinois, but it appears from the price charts that corn does not move regularly, year after year, from Illinois to Indiana and Ohio, for prices in Indiana average about the same as in Illinois, and in Ohio they average only 4 or 5 cents higher.

What may happen is this: The price surface may change greatly from year to year, and in any one year the differentials from certain areas to certain others may be great enough to cover transportation costs between these areas. In another year these price differentials change, perhaps even reverse, and corn flows differently. The average figures show very small average-price differentials, but in any one year the price differentials may be large. Investigation of the years separately is required.

It is difficult to carry several price maps for individual years in the mind's eye at the same time, for comparison; the variability of the price surface from 1 year to another can be shown more clearly by sacrificing some detail and showing only cross sections rather than entire price surfaces. A cross-section comparison can be made by use of data from a row of crop-reporting districts running from east to west along the middle of the Corn Belt, with the district centers approximately equal distances (about 100 miles) apart. The prices in these districts may be represented by vertical bars, the chart then looking something like a picture of a picket fence with the stakes driven unevenly into the ground.

The Corn Belt widens out toward the west, so that it is advisable not only to show a section along the Corn Belt from east to west, but also a cross section cutting across the western end of the belt from north to south. The districts selected for this north-south section should lie successively adjacent to one another, their centers being closer together than those in the east-west line, because the gradation of prices is steeper and the distances involved are shorter. Each such chart, therefore, consists of two parts, one showing the east-west section and the other showing the north-south section.

Charts of the kind described, one of which has been prepared for each year, are too complicated and numerous to be reproduced here, but they show a story that can be told in a few sentences. They show that the character of the price surface changes greatly from year to year. In most years, it differs widely from the 16-year average surface shown in figure 11. In 1927, 1928, 1929, and 1932, the surface sloped steeply upward from west to east; in 1936, it sloped almost as steeply downward from west to east; in 1925, 1926, 1931, 1934, 1935, and 1937, the general contour was horizontal, but the surface was uneven, in different places in the different years. In the other 5 years, the surface had a general sloping character similar to that of the 16-year average, but it had a different sort of unevenness each year. The price surface of the cross section from north to south is more nearly stable from year to year than that of the cross section from west to east, but in 1931 the normal steep upward slope from north to south was reversed, and in 1932 it was almost flat; and no 2 years are alike.

Variations in Corn Price Differentials Between Iowa, Indiana, and Ohio.—The price surface varies greatly from month to month, as well as from year to year. The data to show this for all the crop-reporting districts, or even for the cross section districts, are too numerous to provide any clear mental impression. But the data for a few representative States and districts tell the story more clearly than the mass of data for all of the districts together.

The top-heavy line in figure 12 shows the difference between the price of corn in Indiana and the price of corn in Iowa, by years, from 1921 to 1940. The Iowa price is used as the base; it is represented by the horizontal zero line across the chart. The Indiana price is plotted as so much above or below the Iowa price as represented by this horizontal zero line. The chart shows that the Indiana price ranged from 8 cents above to 4 cents below the Iowa price—a total range of 12 cents.

The second heavy line from the top shows the same sort of comparison of Ohio and Iowa prices, by years. The price differentials in this case cover a range of 22 cents.

The third heavy line, representing the difference between Ohio and Iowa prices, by months, shows that the monthly differentials fluctuate rapidly over a wide range, within the season as well as between seasons. The range of the monthly differentials is 42 cents.

Figure 13 shows the price differentials between crop-reporting districts No. 1 in the northwest corner of Iowa and No. 6 in the east central section of Iowa, by years. The fluctuations are much smaller within the State than between States, but they are still considerable. Most of the fluctuation in the corn price differentials between States results from fluctuation in relative production (fig. 14).

An interesting byproduct of these charts in figures 12, 13, and 14 is the light they shed on the effect of the flat corn-loan rate on the corn-price surface. Statements were made in an earlier study that the flat corn-loan rate had a flattening effect on the corn-price surface.[16] But the preceding charts show (1) that great changes occurred in annual price differentials before corn loans were ever thought of, extending over a range of 22 cents, (2) that the chief reasons for changes in relative prices are changes in relative production, and (3) the effects of the loan on price differentials after these relative changes in production are taken into account, are either nil or too small to detect.

Preliminary conclusions with respect to minimizing shipping costs to and from the place of storage may now be drawn. Most of the average corn price differentials between districts are smaller than the costs of transportation between the districts, but the differentials in individual years, and they are what count, are comparatively wide and are variable in amount and even in sign. The corn-price surface changes so much from year to year that there is no telling where corn that is put into storage 1 year will be shipped the next. The place to store the corn in order to keep shipping costs at a minimum is on the farm where it is grown; then it can move in any direction, or not move at all, without incurring unnecessary shipping charges.

[16] Fact No. 5: Corn Price Changes. The flat rate also tends to level out the regional differences in market prices for corn. Corn prices between east and west within the Corn Belt have come closer together. The average spread in corn prices, for example, between Ohio and Iowa has narrowed from 12 cents to 8 cents a bushel, as shown here:

	1928–30 average	*1938–40 average*
Between Iowa and Ohio	12	8
Between Iowa and Indiana	7	5
Between Iowa and Illinois	4	4

This footnote is a quotation from OUR U. S. IOWA CORN GRANARY (*17, p. 10*).

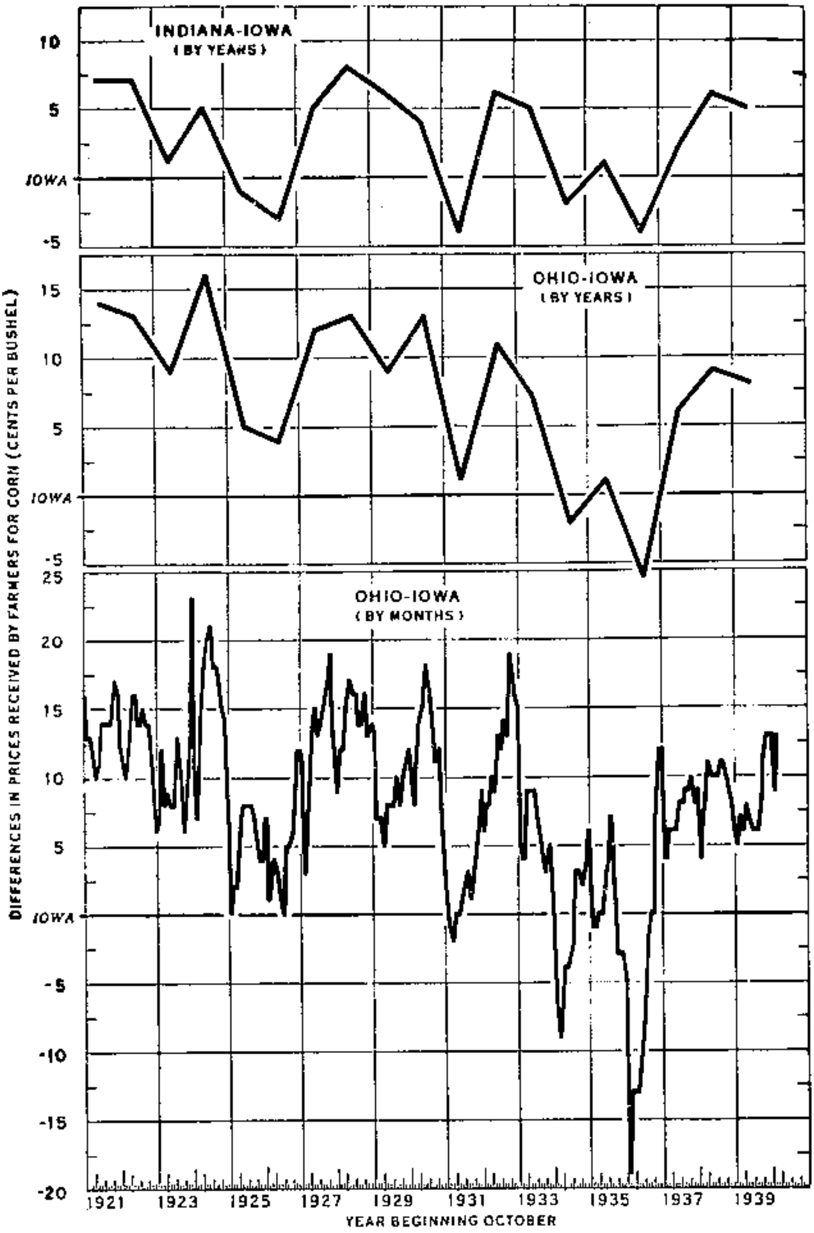


FIGURE 12.—ANNUAL AND MONTHLY CORN PRICE DIFFERENTIALS BETWEEN IOWA AND INDIANA, AND IOWA AND OHIO, 1921–40

The differentials between the farm prices of corn in Iowa and two eastern States (Indiana and Ohio) vary greatly from year to year. The variations from month to month are considerably greater than the variations from year to year.

Fluctuations in production in different areas are not perfectly correlated; the procedure each year would be to store any excess over average production in the State (or other unit of area) where it occurred. Thus corn might be going into storage in one State with a large crop at the same time that it might be coming out of storage in another State that had a short crop that year. But over a period of years, relatively short crops would average out with relatively large crops in the different States, and stocks would grow to approximately even (that is, uniform or identical) proportions over the area.

If no corn moved from county to county, the term "even proportions" would mean "even percentages of production in each area"

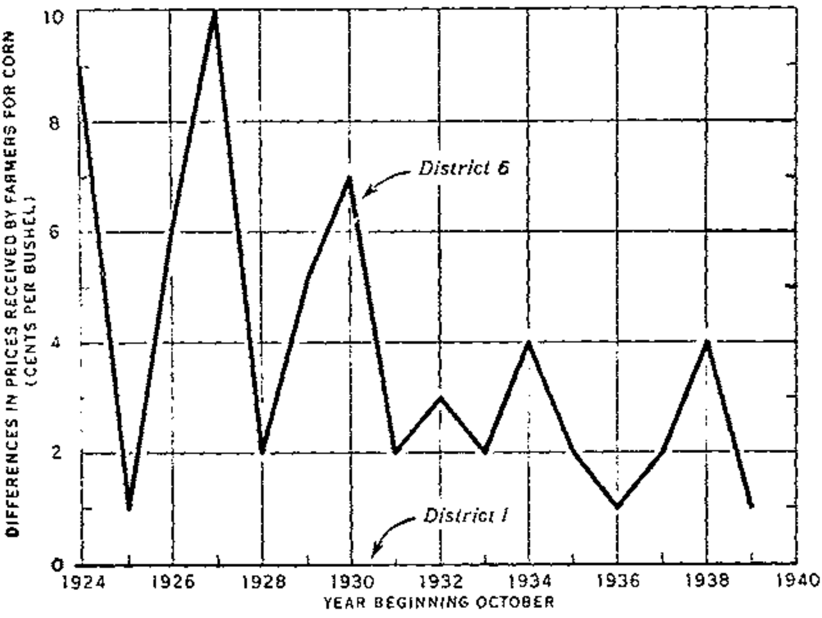
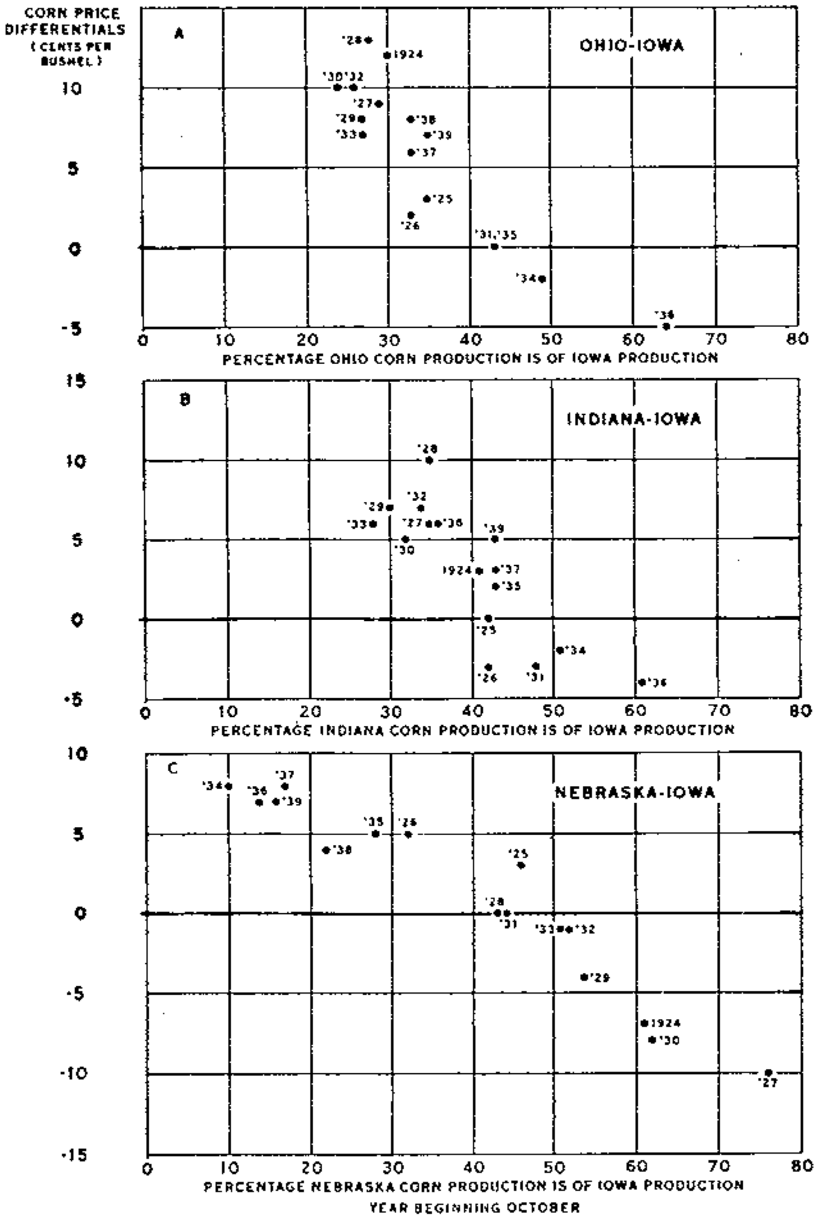


FIGURE 13.—ANNUAL CORN PRICE DIFFERENTIALS BETWEEN CROP-REPORTING DISTRICTS 1 AND 6 IN IOWA.

The differentials between the farm prices of corn in crop reporting district No. 1 in the northwest corner of Iowa and crop-reporting district No. 6 in the central eastern part of Iowa fluctuate greatly from year to year, but the prices in district No. 6 have remained higher than those in district No. 1 throughout.

(corrected for the relative fluctuation in production in each area as indicated). But considerable quantities of corn are shipped out of some districts. In central Illinois, nearly half the corn produced is shipped out. Production never has fallen 50 percent below average there. In that case, should any stocks of corn be held in that district? If corn production there were cut in half by drought or deluge, could not the corn growers maintain their consumption of corn unchanged simply by shipping out no corn at all?

Clearly, the answer is yes. But that answer is not sufficient. It is adequate for that particular district, but not for the corn-growing and corn-consuming area as a whole. Suppose that the United States corn crop was 20 percent larger than average in a certain year.



BAE 39409

FIGURE 14.—RELATION BETWEEN CORN PRICE DIFFERENTIALS AND RELATIVE CORN PRODUCTION FOR VARIOUS STATES: A, CORN PRICE DIFFERENTIALS BETWEEN INDIANA AND IOWA (PLOTTED UP THE SIDE) AND THE PERCENTAGE THAT INDIANA PRODUCTION IS OF IOWA PRODUCTION (PLOTTED ALONG THE BOTTOM); B, SAME SORT OF RELATIONSHIP FOR OHIO AND IOWA; C, FOR NEBRASKA AND IOWA.

The inverse relationship between relative corn production and relative corn prices in the different States is clearly revealed.

and that all of the 20 percent excess were to be carried over. The corn from most surplus areas moves to different deficit areas in different years. If in the year when 20 percent of the United States crop was being stored, no storage stocks were accumulated in central Illinois, more than 20 percent of the local production would have to be stored in other areas, presumably the deficit areas. But most deficit areas vary in their "import" requirements from year to year; some even change to surplus areas, in years when the local corn crop is large. If one of the deficit areas the year after the large United States crop had a large crop itself, and did not need to import much if any corn, it would have to carry over the large stocks from the previous year, for 2 years, thus accumulating 2 years' storage charges. But if the surplus stocks in the large United States crop year had been carried over in the surplus area (as in other areas) in proportion to production there, it would all move the next year to the deficit area that needed it most and only 1 year's storage charges would be incurred.

In fact, the quantity of corn that should be stored in surplus areas is likely to be more, rather than less, than proportional to production, for the conclusion was reached earlier that in cases where corn moves consistently from a surplus area to a deficit area, the best place to carry the storage stocks is in the surplus area, where loan rates and some of the storage costs would be the lowest.

Corn does not move consistently, however, from one area to another, year after year; in most cases the average price differentials are less than the transportation charges, and in those cases corn should be stored in even percentages of production in the different areas. The storage stocks should be allowed to accumulate unevenly from year to year, to be sure, as relative production of corn fluctuates in the different areas, but this accumulation should be over a period of years, in quantities proportional to the production in each area. This general conclusion is modified in two ways: The storage stocks should be large in the areas where production of corn fluctuates most and small where it fluctuates least. The stocks should be proportional to corn production multiplied by some index of average fluctuation in production in each area. Finally, the stocks should be large in those surplus areas from which corn moves consistently year after year to other deficit areas, the price differentials consistently running high enough to cover transportation; but it is difficult to put this in precise numerical form.

COSTS OF STORAGE

Costs of storage must also be considered in the location of storage stocks.

The cheapest way to store corn is to put it in a crib on the farm where it is grown, or to shell it after it has dried out sufficiently and put it in a bin on the farm or in a town nearby. Estimates of the cost of farm storage range from 3 cents a bushel per year (*18, pp. 309–315*) up to the 7 cents that the AAA paid farmers for storing corn up to 1940. The 7 cents was regarded by the AAA as more than enough to cover the costs of storage—enough in fact to stimulate increased building of cribs, which it did. The storage payment on corn resealed on farms in the fall of 1940 was 5 cents a bushel, which will be used here to represent the cost of storing corn in a crib or bin.

At country elevators and terminal markets, under the uniform grain-storage agreement (CCC Form H) used by the Commodity Credit Corporation, the charge is "one-thirtieth cent per day for the first 210 days of the period for computing charges and no charge for the remainder of the period." That amounts to 7 cents a bushel for any period between 7 months and a year. No doubt most of the corn for stabilization purposes will continue to be stored in the country, as it has been so far under the AAA program. The storage costs for that part of the total stocks that is owned by the Commodity Credit Corporation will be either the cost of keeping it in steel bins in the country, or in country or terminal elevators. The costs in elevators, as given, are roughly 1 cent per bushel a month up to 7 months, with no charge for additional months up to 12. The costs in steel bins are not given in any specific figure like the elevator costs but must be computed on the basis of costs of materials, construction, maintenance, etc., for the steel bins.

INSECT DAMAGE IN DIFFERENT REGIONS

The probable extent of insect damage to corn in storage has an influential bearing on the location of the storage stocks.

Broadly speaking, insect damage is a function of latitude; it decreases with distance north, being greatest in the Southern States. It is also affected by humidity; the lower the humidity, the less the damage. Figure 15 shows that the United States may be divided into 4 regions according to the severity of insect damage (*20, p. 7; 21, p. 19*). In region 1, stored grain is comparatively free from insect

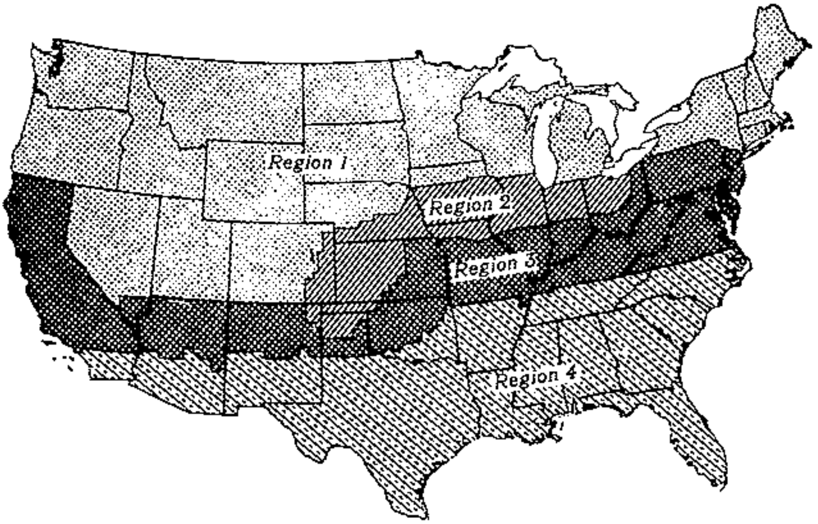


FIGURE 15.—THE UNITED STATES DIVIDED INTO FOUR AREAS ACCORDING TO THE SEVERITY OF THE INSECT HAZARD TO STORED GRAIN

The severity of insect damage to stored grain in different regions of the United States is indicated by the shadings. The most heavily shaded areas are the ones where the insect damage is the greatest. The regions run in broad belts from east to west.

damage; in region 2, farm storage of grain is hazardous in some years, and frequent inspection and occasional fumigation is required; in region 3, farm storage is hazardous every year, and frequent fumigation is necessary; and in region 4, grain storage is not recommended at all.

Region 2 runs along the middle of the commercial corn area from east to west. The danger from insect damage to corn is greatest in Kansas, Missouri, and the southern halves of Illinois, Indiana, and Ohio, which lie in region 3.

Very little is known about insect damage, in quantitative terms. The extent of damage varies with changes in temperature from year to year; the higher the temperature, the greater the damage.

During the summer, the insects in stored grain—"bran bugs," flour beetles, saw-toothed beetles, foreign grain beetles, and in southern areas, weevils—move about freely in the grain. In the cool weather of the fall, they move toward the center of the bin to get away from the cold. The living processes of the mass of insects produce heat and moisture. The warm damp air arises, and condenses when it reaches the surface of the grain if the weather is cold. Molds develop and a crust forms in the surface layer of corn.

Control measures include fumigation with such heavier-than-air gases as ethylene dichloride and carbon tetrachloride (a relatively easy and inexpensive process) and cleaning the grain to remove the insects and the broken bits of kernels. In regions 1 and 2 insect damage can be kept to a small percentage by the use of these methods. Estimates are that in region 2 the cost of control measures would average about 1 cent a bushel per year. In areas south of region 2 the cost would be considerably higher.

PROBLEM AREAS.—Most of the commercial corn area lies in regions 1 and 2, but the southern part lies in region 3. Missouri and the small part of Kansas that lies in this area constitute a special storage problem. The fluctuations of corn production in those States are considerable, and this calls for the carrying of large stocks there. Yet they are located in region 3 where insect damage is high, and that means that storage stocks should be kept as small as possible.

The way to a partial solution to this difficulty is indicated by the fact that corn prices are ordinarily from 5 to 10 cents higher in Kansas and Missouri than in Iowa and Nebraska. In most cases prices run 10 cents higher in parts of Missouri that are about 100 to 150 miles south of surplus-corn sections in central, western, and southern Iowa; prices in Kansas are about 5 cents above those in Nebraska. Ten cents a bushel is enough to cover transportation costs for a 200 to 300-mile haul. Perhaps the thing to do is to store the supplies from Kansas and Missouri in Iowa and Nebraska and draw on them only as needed. This would increase the quantity of corn stored in Iowa about 20 percent. Missouri produces about 110 million bushels of corn on the average (one-fourth of the Iowa production) and the southern part of Missouri lies outside the commercial corn area. Much the same thing is true of Nebraska in relation to Kansas.

COMPROMISE CONCLUSION

The compromise between the somewhat different conclusions reached in the discussions of transportation costs, storage cost, and insect damage can be put in the form of a major conclusion modified by two or three minor ones. The major conclusion is that corn stocks should be located in fairly even (that is, uniform or identical) percentages of production over the commercial corn area. The storage stocks should be allowed to accumulate unevenly from year to year, as relative production of corn fluctuates in the different areas, but over a period of years, in quantities proportional to the production in each area.

The general conclusion is modified in two or three respects: The fluctuations in production of corn in the four States along the western edge of the area (South Dakota, Nebraska, Kansas, and Missouri) are about 50 percent greater than in the rest of the area, so the storage stocks in these States should be about 50 percent larger than stocks in the rest of the area. But this modification itself needs a further modification. Damage from insects is high in Missouri and eastern Kansas, so stocks should be kept small there, in spite of the fact that fluctuations are high. A partial solution to this difficulty would be to keep most of the stocks from Missouri in Iowa, and stocks from Kansas in Nebraska, because the price differentials between those States are usually high enough to cover costs of transportation.

COMPARISON OF STORAGE STOCKS ON OCTOBER 1, 1940, WITH RECOMMENDED STOCKS, BY STATES

The compromise conclusion is only a rough-and-ready first approximation. More research will be required before the recommendations for each State or area can be put in more precise quantitative terms. But rough as the compromise conclusion is, it will serve as a sort of standard by which the existing location of the actual storage stocks can be appraised in a preliminary way. This appraisal is made as of two recent dates October 1, 1940, and October 1, 1941.

On October 1, 1940, the total stocks of corn on farms in the 11 Corn Belt States amounted to 517,528,000 bushels.[17] They were distributed among the 11 States as shown in the first column of table 6. These stocks were in total about 32 percent of the 1931–40 average production of corn in the 11 States. They were about the right size, in total, for stabilization purposes. (The total stocks in the United States stood at about 700 million bushels, about the size recommended at the end of the section on the size of stabilization stocks.) If they had been located in the States according to the major recommendation reached earlier in this section—in even percentages of production—the number of bushels in each State would have been as shown in the second column of table 6.

The broad conclusion was reached that storage stocks of corn should be held in even percentages of production in the different States. The chief modification of this conclusion was that the percentages should be larger in the States with the larger fluctuations in production, and smaller in the States with the smaller fluctuations. The percentages should vary proportionally with the fluctuations.

Fluctuations in production in each of the 11 Corn Belt States were represented numerically in table 5. By the use of these measures of fluctuation, the storage stocks equal to 32 percent for the 11 States

[17] Farm stocks are used here rather than total stocks, because the data for the nonfarm stocks are not complete by States.

as a total can be apportioned among the different States in such a way that the stocks in each State are proportional (in percentage of the average production in the State) to the measure of fluctuation in production of corn in that State.

TABLE 6.—*Stocks of corn in 11 Corn Belt States, Oct. 1, 1940, and Oct. 1, 1941*

State	(1) Actual stocks of corn on farms Oct. 1, 1940 [1]	(2) Stocks of corn proportional to average production [2]	(3) Stocks of corn proportional to average production multiplied by average fluctuation in production [3]	(4) Column (1) as a percentage of column (3). Data as of Oct. 1, 1940	(5) Data similar to that in column (4) but for Oct. 1, 1941
	1,000 bushels	*1,000 bushels*	*1,000 bushels*	*Percent*	*Percent*
Iowa	235,970	128,204	115,253	204.7	210.5
Illinois	97,057	104,205	93,392	103.9	73.6
Indiana	18,438	51,274	43,745	42.1	33.8
Minnesota	68,524	46,285	45,036	152.2	129.6
Ohio	13,753	44,004	35,849	38.4	24.0
Nebraska	37,323	38,018	54,282	68.8	97.5
Missouri	16,594	31,534	49,550	33.5	40.3
Wisconsin	3,605	24,336	19,991	18.0	35.6
Kansas	4,053	17,502	32,641	12.4	13.3
Michigan	6,363	15,773	11,511	55.3	46.2
South Dakota	15,848	12,313	15,278	97.4	132.0
Total	517,528	517,528	517,528		

[1] Crops and Markets [illegible], 1940, p. 210. Total stocks of corn in the 11 States shown in this table were 31.528 percent of the 1931–40 average production of corn in those States on Oct. 1, 1940, and 21.8136 percent on Oct. 1, 1941.

[2] The figures shown for each State equal 31.528 percent of each State's 1931–40 production of corn.

[3] The figures in column 3 are computed by applying to the figures in column 2 a correction factor for each State given by the formula

$$C = \frac{V}{\frac{\Sigma PV}{\Sigma P}}$$

Where:

V = The coefficient of fluctuation in the period 1900–40 for the State (see appendix).

P = The 1931–40 average production of corn in the State.

This formula was worked out by Richard O. Been of the Bureau of Agricultural Economics.

The formula used to make this apportionment is given at the foot of table 6. The results of the computations, expressed in bushels, are shown for each State in the third column of table 6.

The other more minor modifications, with respect to insect damage and surplus and deficit areas, are either open to some question as a matter of practical administration or are difficult to express in quantitative form. They may be ignored for the time being, or may be kept in mind in a general way.

The comparison can now be made between the actual stocks of corn on farms in each State on October 1, 1940, and the recommended stocks in column 3. That comparison is shown numerically in column 4, where the actual stocks on hand are shown as percentages of the recommended stocks. It shows that the two eastern Corn Belt States, Indiana and Ohio, had less than half as much corn as they needed. Illinois had about the right quantity. Iowa had twice as much as it needed, although if insect damage and surplus needs were taken into account, the excess would be more nearly 50 percent than 100 percent. Minnesota had about 50 percent too much corn. The western-fringe States, where production fluctuates greatly, did not have enough.

The percentage figures in column 5 give the same sort of information as the figures in column 4, but for October 1, 1941. They show that the stocks of corn on October 1, 1941, were smaller than on October 1, 1940, in the central and eastern Corn Belt States, but that they were larger in the western States, Iowa, Nebraska, South Dakota, Kansas, Missouri, and Wisconsin. That is, the maldistribution of stocks in 1941 was greater than in 1940.

It should be emphasized here that table 6 and the conclusions based upon it are preliminary and suggestive rather than in any sense conclusive. They constitute explorations in an uncharted field rather than a complete survey.

LOCATION OF STOCKS SUMMARIZED

The bulk of the storage stocks of corn should be held on farms or in nearby towns all over the Corn Belt, and should not be heavily concentrated in any one area. The number of bushels held in each State should be proportional to the average production of corn, multiplied by the average fluctuation in production in that State. In addition, some allowance should be made for the percentage of production consumed in an area and for storage difficulties like insect damage.

Appraisal of the actual stocks of corn on farms by this standard shows that the stocks on October 1, 1940, were (1) about twice as large as necessary in Iowa, (2) 50 percent too large in Minnesota, (3) about right in Illinois and South Dakota, and (4) too small in Indiana and Ohio in the eastern part of the Corn Belt and in Nebraska and Kansas on the western edge. On October 1, 1941, the maldistribution of stocks was greater than on October 1, 1940. These findings are preliminary and not in any sense final.

PRICES, COSTS, AND INCOMES

The discussion so far has dealt with physical problems—the number of bushels of corn required to smooth out fluctuations in production, the location of the physical supplies, and so forth. It is now necessary to consider the economic problems of prices, costs, and incomes.

STABILIZING SUPPLIES OF CORN REDUCES THE COST OF PRODUCING LIVESTOCK

Stabilizing supplies of corn has a stabilizing effect on prices of corn; it also reduces the cost of producing livestock. During the last 20 years, the total live weight of hogs slaughtered under Federal inspection has varied from 12 billion pounds in 1923–24 to 6.7 billion pounds in 1934–35. Such variations in production of hogs increase the costs involved in producing, shipping, and slaughtering hogs and in processing and distributing the pork. Equipment adequate to handle 12 billion pounds of hogs is almost half idle when only 7 billion pounds are produced, and idle equipment increases costs per unit.

Moreover, the figures for total slaughter in the United States tell only part of the story. The weather does not change evenly over the whole Corn Belt; drought always strikes harder in some parts than in others. In a year when the total corn crop in the United States is

10 percent smaller than average, in some areas it may be 20, 30, or 60 percent smaller than average, whereas in other areas it may be larger than average. These local fluctuations in supplies affect production costs of hogs. These costs are only partly alleviated by the automatic flow of corn from surplus to deficit areas as a result of the differences in prices between the two, because the costs of shipping corn are high compared with most area-price differences. The flow of corn from good-crop areas to short-crop areas is far from adequate to even out supplies. This is shown by the differences in average hog weights (reflecting differences in corn supplies) at different markets in the same year. The average weight at Omaha has fluctuated from 30 pounds over the average weight at Chicago in December 1927 to 25 pounds under it in December 1936 (*23, 1927, 1936*).

Hog production costs are divided on a percentage basis about as follows: Feed 75 to 85 percent, other costs (such as veterinary which vary directly with the number of hogs produced) 5 to 10 percent, fixed costs, such as interest on buildings and equipment, 10 to 15 percent (*10*). If the hog-producing plant is equipped to produce 10 billion pounds but is utilized to produce only 8 billion pounds, the cost per pound will be raised by about 3 percent, because the total overhead costs run on as large as ever, but are spread over fewer hogs. Costs per pound go up proportionately more as the hog crop decreases, until the excessive overhead costs on a crop half as large as normal in any area result in 10 to 15 percent higher costs per pound than hog crops that fully utilized the fixed investment in the hog-producing plant * * *.

Fluctuations in the corn-hog price ratio have another indirect effect on hog-production costs. A given quantity of feed will make more pounds of pork if fed to hogs which are slaughtered at from 200 to 230 pounds than if fed to hogs which are marketed at either lighter or heavier weights. But when the corn prices are low relative to hog prices because of a large crop (or for any other reason), as in the fall and winter of 1937–38, hog producers find it profitable to feed their hogs to heavier weights. Although it takes 10 to 15 percent more feed to put a pound of gain on hogs weighing 250 to 350 pounds than on pigs weighing 175 to 225 pounds, farmers believe they can still increase their profits by using cheap corn to obtain these relatively expensive gains [*9, 16*]. They believe it better to take a 10 to 15 percent loss in feeding efficiency than a 20 or 40 percent reduction in corn price (*18, pp. 330–331, appendixes A, B*).

Much the same thing is true of cattle and other classes of livestock. Fluctuations in supplies of corn make for high costs of livestock production, and stabilization of supplies of corn would reduce those costs.

STABILIZING PRODUCTION OF CORN INCREASES INCOMES

Stabilizing supplies of corn not only decreases the costs of producing livestock; it also increases gross incomes to corn and hog producers. The lower part of figure 16, *A* shows the demand curve or average-revenue curve for corn, taken from the price analysis given earlier in this bulletin. This is the average-revenue curve when the level of demand is average. The upper part of figure 16, *A* shows the total-value curve for corn; this shows the total value of different-sized crops. Most of the corn crop is sold not as cash corn, but in the form of livestock. The value of the major livestock crop, hogs, follows closely the value of the corn crop, the demand for hogs having about the same elasticity as the demand for corn (*18, pp. 323–326; appendixes A, B*). The total-value curve for corn, therefore, approximates the total-revenue curve for the value of the products into which most of the corn is converted. It will be referred to henceforth as the total-revenue curve for corn, in conformity with analytical economic terminology.

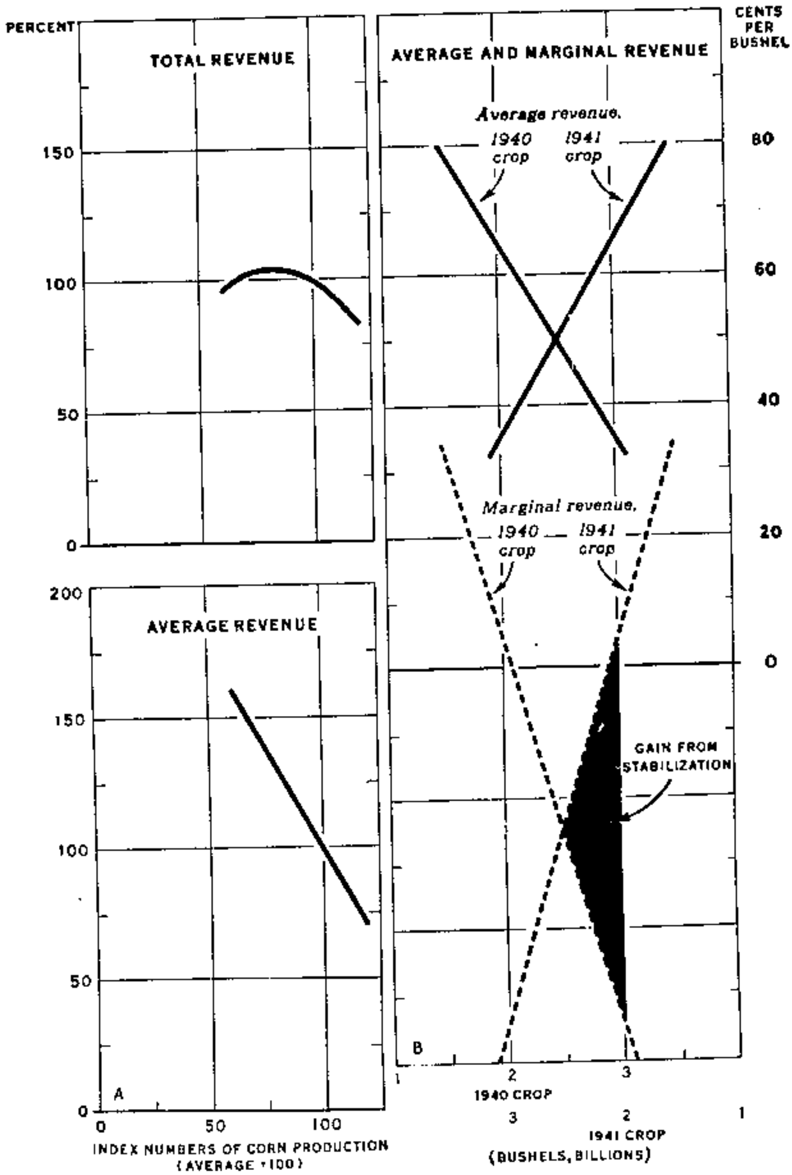


FIGURE 16.—AVERAGE, MARGINAL, AND TOTAL REVENUE FOR DIFFERENT SIZE CORN CROPS. *A*, AVERAGE AND TOTAL REVENUES; DATA EXPRESSED IN TERMS OF PERCENT OF AVERAGE. *B*, AVERAGE AND MARGINAL REVENUE AND GAIN FROM STABILIZATION.

A shows that large crops and small crops are both worth less than crops between 80 and 85 percent of average size. *B* shows that the gain from stabilization is greater when fluctuations in crop production are large than when they are small.

Study of this total-revenue curve for corn shows that two crops, one large and the other small, are worth less than two crops of average size. A crop that is 20 percent larger than average is worth 84 percent of average; a crop that is 20 percent smaller than average is worth 104 percent of average; the sum of these two total values, divided by 2, is 94. But the sum of the total values of two average crops, divided by 2, is 100; that is 6 percent more than 94. Stabilization of supplies would convert a series of various-sized crops into a series of average-sized crops, and this would increase the value of the crops.

The illustration used is rather an extreme case. Crops as much as 20 percent oversize represent about the limit that has been reached in the past; few corn crops exceed 3 billion bushels. The situation for all sizes of crops up to 20-percent oversize can be represented in one diagram, shown in figure 16 *B*.[18] The left-hand part of this figure shows the demand curve for the corn crop as of one year, for example 1940. The right-hand part (which is similar to the left-hand part but reversed) shows the demand curve for the corn crop as of the next year, in this case 1941 (the scale along the right-hand half of the bottom of the chart runs from right to left, not from left to right). For simplicity, the average price of corn is represented as 50 cents, and the average corn crop, as 2.5 billion bushels.

The dotted lines in the lower part of 16 *B* are the marginal-revenue (addition-to-total-revenue) curves. They cross (have equal values) at 2.5 billion bushels. That means that if the crop were large in 1940 and small in 1941, so that the two crops totaled 5 billion bushels, the way to maximize returns would be to sell 2.5 billion bushels each year. The amount of the gain over selling crops of unequal sizes is shown by the black triangular area in the lower part of the chart. The area in this case shows the gross gain from converting a crop of 3 billion bushels, followed by a crop of 2 billion bushels, into two average-sized crops of 2.5 billion bushels each. The gross gain in this case amounts to 150 million dollars, which, divided by 2, is 75 million dollars a year.

EFFECT OF STABILIZING SUPPLIES ON STABILITY OF INCOME

Before the Ever-Normal Granary programs were put into effect, a large crop of corn depressed prices so much that it was worth less than a small crop. If all the crop were sold as grain, as practically all of the wheat crop is, this would mean that total revenues from corn would fluctuate inversely with the size of the crop (inversely, because the demand for corn is inelastic through most of its range). The fact that most of the corn crop is fed to livestock appears on the face of it to add complications to this simple conclusion; but as the total value of the hog crop closely follows the total value of the corn crop on which it was raised, the simple conclusion holds that the total revenue from corn fluctuates inversely with the size of the crop.

---

[18] This type of chart was first worked out by F. V. Waugh to show the effect of price discrimination between two income groups. R. O. Been added the idea of representing the gain by the use of the marginal curves in the way shown.

The two demand curves are shown as if they were independent. This is not strictly true. An increase in the demand for hogs in a given year would increase the demand for corn, not only that year owing to the rise in the price of hogs (a vertical shift in the position of the demand curve) but also for the next year, when hog production had had time to expand (resulting in a horizontal shift). Also, a large crop of corn 1 year resulting in an increase in hog production by the next year would increase the demand for corn that year, unless the excess were held over as part of an Ever-Normal Granary program. But these complications do not affect the main principles, and could not in any case be handled here without overloading the exposition.

Under a stabilization program that situation is reversed, especially when stabilization is effected by means of loans. What happens is this:

Suppose the crop is 20 percent oversize. If the loan is set at the average-crop level, the excess 20 percent of the crop is sealed, loans are taken out, and the money is spent about the same as though the 20 percent excess had been sold at the same price as the loan rate. The total revenue from the "sale" of the large crop therefore is 20 percent greater than average. If the crop the next year is 20 percent smaller than average, the total revenue is also smaller than average. Stabilization of supplies at the average-crop level, therefore, would cause total revenues from the "sale" of corn to fluctuate *directly and proportionally* with the size of the crop.

Under the particular schedules of loan rates written into the Agricultural Adjustment Act of 1938, the situation is a little more complicated than has been indicated. The loan rates vary inversely, but not proportionally, with size of the corn crop. An arithmetically simple way to show the effect of the varying loan rates is to assume that the basic loan rate of 75 percent specified in the act happens to work out to a price of 75 cents a bushel, and furthermore that a normal year's domestic consumption and exports of corn as defined in the act is 2.5 billion bushels (the Secretary's latest determination was 2,585 million bushels). Based on that assumption table 7 and figure 17 show total revenues from corn crops of different sizes.

TABLE 7.—*Total revenues from corn crops of different sizes under the schedule of loan rates specified in the Agricultural Adjustment Act of 1938*

Size of crop: Percentage	Size of crop: Quantity	Loan rate per bushel	Total income
	Million bushels	*Cents*	*Million dollars*
100 or less	2,500 or less	75	1,875 or less.
101 to 110	2,501 to 2,750	70	1,750 to 1,925.
111 to 115	2,751 to 2,875	65	1,788 to 1,869.
116 to 120	2,876 to 3,000	60	1,725 to 1,800.
121 to 125	3,001 to 3,125	55	1,650 to 1,719.
126 or more	3,126 or more	52	1,625 or more.

Figure 17 also shows the total revenues from corn crops of different sizes under *B*, a loan rate fixed at a single figure, in this case 75 cents, regardless of the size of the crop; and *C*, no program at all, with prices of corn fluctuating as they used to do, inversely with the size of the crop. Total incomes under the loan rates in the Agricultural Adjustment Act of 1938, represented by the series of steps, figure 17, *A*, would lie between the two other lines.

SHOULD TOTAL REVENUES BE STABILIZED, RATHER THAN PRICES?—A case could be made for setting loan rates in relation to the size of the crop in such a way that the total revenue would remain at a constant level year in and year out no matter what the size of the crop. Perhaps that would be a more desirable action than stabilizing prices.

But corn is primarily a raw material for producing livestock, and if prices of corn and quantities of corn consumed were permitted to fluctuate, livestock production and prices would fluctuate also. It would seem preferable to stabilize supplies of corn completely, in

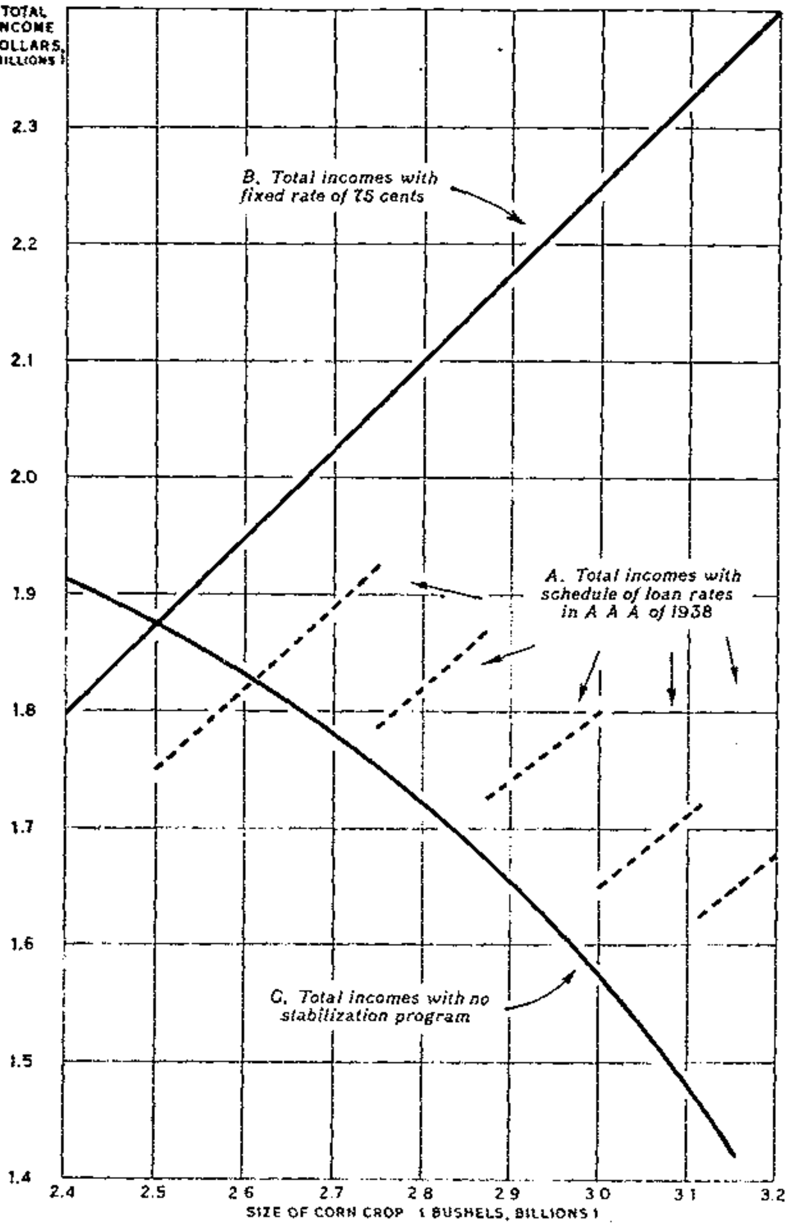


FIGURE 17.—TOTAL REVENUES FROM THE SALE OF DIFFERENT SIZED CORN CROPS WITH *A*, THE SCHEDULE OF LOAN RATES IN THE AGRICULTURAL ADJUSTMENT ACT OF 1938; *B*, THE LOAN RATE FIXED AT 75 CENTS; AND *C*, NO STABILIZATION PROGRAM AT ALL.

The corn-loan rates written in the Agricultural Adjustment Act of 1938 are such that the total revenues from a large corn crop are somewhat larger than the total revenues from an average crop. If there were no stabilization program, the total revenues from a large crop would be considerably lower than the total revenues from an average crop. If loan rates were fixed at a constant figure, the total revenues from a large crop would greatly exceed the total revenues from an average crop; they would vary directly with the size of the crop.

order to stabilize supplies of livestock, thereby stabilizing prices of livestock and total revenues. The only penalty for doing so would be the fluctuation that would exist in the total revenues from corn. The fluctuation would be small, however, as so small a percentage of the crop is sold as cash grain. It could be controlled completely by making the loans on the corn in some form that could not be turned into cash until a short crop came along—a sort of warehouse certificate for the corn, rather than a cash loan on it. Perhaps that is an impracticable suggestion, at least until the stabilization programs have become thoroughly established on the cash-loan basis and until the change could be made with a minimum disturbing effect on the program as a whole.

A SELF-FINANCING STABILIZATION PROGRAM

From a banker's point of view, any program of complete stabilization of supplies would be uneconomic; it could not finance itself. If demand remained constant, a program that stabilized supplies completely would stabilize prices, so that the corn would be taken out of storage at the same price at which it was put in. The farmer who carried the corn, or the loaning agency that took it over, would be "out" the costs of storage.

A stabilization program would finance itself directly, if the loan rate were set a few cents below the price that would move an average crop of corn into consumption. This would withhold, not all of the excess supplies above average, but only the major part of them. It would only partly stabilize supplies, and therefore it would only partly stabilize prices. The rise in prices from large-crop years to short-crop years would be sufficient to cover the costs of storage. Such a program would come close to complete stabilization, and would pay for itself.

The basic problem is not how large should the stocks be, nor how much would they cost, but rather, How can that cost be covered? Complete stabilization of supplies would place all the costs on the loaning agency, and if complete stabilization is worth that much to society, that may be where the costs should be placed. On the other hand if there is any prospect that something approaching complete stabilization could be attained in such a way that the program would finance itself, that prospect is worth investigating.

Accordingly, the next section is devoted to whether a stabilization program could be set up in such a way as to cover its own costs, and if so, how that kind of program would work out. The discussion begins on a somewhat oversimplified plane, for purposes of clarity, and then moves closer to the complications of reality.

A "COSTLESS" STABILIZATION PROGRAM

The controlling factor here is the *net* cost which is determined by the three items of gross cost: (1) The costs of storage per bushel per year, (2) the number of bushels to be carried in the storage stocks, and (3) the number of years the stocks would be carried. Against these items of cost one item of income is to be considered here—the amount of the rise in price from large-crop years to short-crop years, which would enable the owners of the stored corn to more or less completely recover their gross costs. Other items of income are considered later.

The objective would be to carry over such quantities of corn as would reduce the net costs to zero. The principle will be illustrated under the simplest conditions. In the preceding chapter the figure 5 cents a year was used to represent the cost of carrying corn in storage. If large and small crops alternated regularly, the net costs of storage would be reduced to zero by setting loan values in the large-crop years 5 cents lower than prices of corn would be in small-crop years. The rise in prices would just cover the gross storage costs, and net costs would be zero. This would come within 2.5 cents of complete stabilization of prices. It would require the storing of all but 70 million bushels of the excess over average production in the large-crop years, as the corn price analysis given earlier in this report shows that a change in price of 2.5 cents is associated with a change in quantity of 70 million bushels.

Actually, as shown earlier, large crops are twice as numerous as small crops. On the average, storage stocks would have to be carried over from two large-crop years to fill out one short-crop year. The costs of storage for the average storage operation (filling and emptying) would therefore be 10 cents (5 cents each year) for the half of the corn that would be carried 2 years, and 5 cents for the other half that would be carried only 1 year, equalling 7.5 cents a year for the total quantity of corn stored.[19] Reducing the net costs to zero in this situation would require setting loan values 7.5 cents lower in large-crop years than in small-crop years. This would come within about 4 cents (accurately, 3.75 cents) of complete price stabilization, and would require the storing of all but 100 million bushels of the excess over average production in the large-crop years.

The preceding discussion is based upon the average order in which large and small crops come—two large crops and one small crop. In reality this average is not closely followed. There have been as many as seven or nine large crops in a row, and as many as four short crops together. There is no way of telling, after one large crop has come, how many others are going to follow it.

The plan that would fit the facts best would seem to be something along the following lines. When a big crop comes, no matter how big it is, the loan value should be set 2.5 cents below the price at which an average crop would have sold. This would withhold all but about 60 million bushels of the excess over average production. Then if the crop the next year fell as short of average size as the large crop had exceeded it, prices would rise 5 cents, and the stored corn could be sold at a price that would cover the costs of storage. The maximum of stabilization at zero net cost would have been accomplished.

But if the crop the next year (after the original big crop) were not short but large, making two big crops in a row, the corn stored from the

[19] Accurate computation of this figure would involve more complicated calculations. The cost of storing that half of the corn that was carried for 2 years would be less than 5 cents a year, as the overhead on the crib would be spread over 2 years out of 3 (not over 1 year out of 2, as it would if large and small crops alternated regularly). For the same reason, the cost of storing that half of the corn that was carried only 1 year would be more than 5 cents a year. But there are some reasons for using only the simple calculation given in the text. In many cases the same crib or bin would be used for the 2 years (not two separate ones) and in many others, such as at terminal markets, a straight storage rate per bushel per year would be paid. The straight 5 cents is used here partly for these reasons, and partly to avoid complicated computations of dubious accuracy.

original large crop would have to be carried for 2 years. The storage costs for that corn would be 10 cents a bushel. The corn stored from the second large crop would have to be carried only 1 year, and the storage costs for that corn would be only 5 cents a bushel.

If the two large crops were equally large, the loan rate should be set at 3.75 cents below the price at which an average crop would sell. If the first large crop were larger than the second, the loan rate should be closer to 5 cents below the average-crop price; if it were smaller, the loan rate should be closer than 2.5 cents. That is, the loan rate should be below the average-crop price by one-half the weighted average storage costs that would be accumulated before the next crop came.

The question of how large the storage stocks should be, therefore, reduces to a question of how nearly complete the stabilization of prices and supplies should be, and this boils down to the question of what the loan rate should be to enable a rise in the price of the corn stocks to cover the storage costs. The answer apparently is this: The loan rate should be equal to the price at which an average crop would sell, minus one-half of the weighted average storage costs that would be accumulated before the next year's crop comes into being. Thus, if a number of large crops come in succession, storage charges would gradually mount, loan rates would be gradually reduced, and less and less of the excess over average production each year would be added to the existing quantities in store. Eventually a short crop or succession of short crops would come along, and the stored corn could be sold at a price that would cover the storage costs.

A "COSTLESS" STABILIZATION PROGRAM. TAKING INCREASES IN TOTAL INCOME INTO ACCOUNT

The question may now be raised: Is that a too narrow "banker" type of conclusion?

It was shown early in this bulletin that a series of different sized crops sell for less than a series of average sized crops, and therefore that stabilization of supplies would increase the total value of a series of crops. The increase in total value is in most cases more than sufficient to pay storage costs estimated at 5 cents a bushel. This is true partly because the increase in total value applies to the total crop, whereas the costs of storage apply only to the part of the crop that is stored. In the case of a 20-percent oversized crop followed by a 20-percent undersized crop, the cost of storage at 5 cents a bushel on 20 percent of the crop would be equivalent to 1 cent a bushel on the entire crop. Of 50-cent corn this would be 2 percent of the total value of the crop. But stabilization would increase the total value of both crops 6 percent, which would much more than cover the storage costs.

In many cases the storage stocks would have to be carried for more than a year. In the present illustration, the stocks could be carried for 6 years before the costs of storage would be as great as the increase in cash income resulting from stabilization.

As a stabilization program increases the total value of a series of corn crops, in a manner that can be definitely measured in dollars and cents, perhaps this rise in total value should be taken into account, in the same way that the rise in prices from large- and small-crop years was taken into account, as covering the costs of storage.

The point to which this would permit stabilization to be carried can be shown by adding one more complication to figure 16. The costs of storage at 5 cents a bushel can be represented by a line running 5 cents below the marginal-revenue curve for the 1941 crop. This line constitutes the upper boundary of the triangle that shows the net gains from stabilization above storage costs. Such net gains from stabilization would exceed the costs of storing corn for 1 year, for all crops larger than 42 million bushels above average. Further computations show that the gains would exceed the costs of storing corn for 2 years, for all crops larger than 63 million bushels; for 3 years, 83 million, and so on up.

The minimum amounts indicated are only a little more than half as great as the minimum amounts given earlier for a program designed to cover the costs of storage from the rise in corn prices alone (not from the increase in total corn-crop values). That is, a program taking into account the rise in crop values as offsetting storage costs would approach nearly twice as close to complete stablization as a program taking into account only the rise in prices to cover costs of storage.

The more complete stabilization program would permit prices to rise only enough to cover about half the storage costs. Under those conditions, most of the corn put under seal would not be redeemed by the farmers who put it there. They would turn it over to the loaning agency, and this agency would sell it later in short-crop years when the price would have risen only about half enough to cover the storage costs. The loaning agency would be "out" the other half. Where would it get the money to cover that part of its costs?

The question stated is a practical one, and in dealing with it an equally practical point should be recognized: In all probability, a program that would come within 42 million bushels of completely stabilizing corn supplies would be carried the rest of the way to complete stabilization, as being simpler to grasp and administer, for all the difference a few cents a bushel would make. If this were done, the loaning agency would be "out" all the storage costs. There are only two possible places where it could get the money to recoup its losses. One is from the producers of corn and livestock. The other is from the consumers. Which should it be?

It was shown earlier that stabilization of corn supplies increases the value of a series of corn crops, whether the corn is sold for cash or converted into livestock, and this clearly benefits corn and livestock producers. Could the producers not legitimately be called upon for a share of their benefits, to cover the losses (equal to the storage costs) incurred by the loaning agency? Before that question can be answered, one more complication needs to be explored. That is, Do consumers get any benefits from stabilization programs?

DOES STABILIZATION BENEFIT CONSUMERS?

It could be argued that consumers are harmed by stabilization to the same extent that farmers are benefited by the increased total value of their crops, for the increased total value of crops to farmers emerges as an increase in the cost of food to consumers. If stabilization increases the total value of a series of crops 6 percent, as in the illustration just used, it must increase the cost of consumers' purchases by the same amount.

The harm or benefit to consumers cannot be measured, however, merely by the increase or decrease in the amount of money they pay for corn. If a monopolist restricted the production of his product, and the demand for that product were inelastic, consumers would pay more for the small quantity than they did before. They would clearly be harmed, but the harm would not be measured by the extra amount of money they had to pay. For if the demand were elastic instead of inelastic, consumers would pay less for the small quantity than before. No one could claim that they would be benefited because their total outlay for the product had been reduced; least of all could anyone claim that they would be benefited by the amount of the reduction in their total outlay for the product.

The question can be approached from a different direction. Any one consumer gets more satisfaction from a fairly even consumption of a particular food than he does from a scarcity at one time and a glut at another. In technical terms, the total-utility curve is convex from above. A stable supply is therefore worth more to him than a fluctuating supply. The extra worth of the stable supply may be greater or less than the extra money he has to pay for it—there is no way of telling which—so the consumer may benefit by more or less than the extra money he pays. The important point is merely that he does benefit to some extent; the extra money he pays is not all loss, and may even be less than the benefit he receives.

But fluctuations in the production of different foods have a differential effect on different classes of consumers. When supplies and prices fluctuate, consumers with low incomes can make those incomes go farther by buying most heavily of those foods that are cheapest at the time, and buying least heavily—or perhaps not at all—of those foods that are temporarily scarce and high priced. At first thought, therefore, it would appear that stabilizing supplies would work some hardship on the low-income groups; they would be obliged to pay more for their food. But the effect on prices is likely to be more or less offset by another effect, that of stabilizing supplies. In the long run, consumers as a group are likely to get most of the benefits that in the short run go to producers, processors, and distributors. The lowering of costs of producing and handling farm products all along the line would increase producers' and distributors' profits. To the extent that competition exists, the increased profits lead before long to increased production, and this results in lower prices to consumers. If production is permitted to expand, consumers ultimately get most of the benefits of stabilization programs, and they are the ones who should pay for them. If production is not permitted to expand, the benefits will be retained by the producers and processors, and the costs should then be charged to them.

If consumers ultimately get most of the benefits from stabilization programs, the method of collecting the costs of a program (the storage costs) is mechanically simple. Any impairment of the Commodity Credit Corporation's capital is restored each year from the Federal Treasury, which gets its funds from taxation of consumers. If farmers get most of the benefits, however, the collection problem is more difficult. Most of the corn produced is fed to livestock on the farm where it is grown, and there is no convenient point at which the amounts per farmer could be accurately and impartially ascertained and taxes could be levied. A processing tax on hogs and other livestock might be used because a large part of it would be borne by the farmers. Another way to collect from the producers would be to deduct storage charges from the loans when made; thus a farmer would get only 56 cents a bushel, for example, instead of 61 cents. That, of course, would decrease the effectiveness of the stabilization operations.

PROTECTION AGAINST INVENTORY LOSSES

A different kind of cost that should be taken into account is the inventory loss that would be incurred if loan rates were set so high that the corn accumulated under the loan had to be disposed of by the loaning agency at a lower cost than that at which it was acquired.

Perhaps the best way to guard against such loss would be to add a "life-saver" clause to the AAA bill specifying that if stocks accumulate to a quantity in excess of, let us say, 500 or 600 million bushels, the loan rate should automatically be reduced. This clause would replace the present schedule of loan rates in the AAA of 1938, which automatically reduces the loan rate according to the size of the crop exclusive of carry-over. The AAA schedule is a step in the right direction, but it embodies the wrong kind of flexibility in the loan rates because it makes them responsive to the size of the crop, regardless of the size of storage stocks, whereas what is needed is to make them responsive to the size of the storage stocks, regardless of the size of the crop. Another approach would be to make the rates responsive to total supplies (crops plus carry-over).

It would seem to be wise to make reductions in the loan rates only after the quantities of corn owned by the loaning agency plus the quantities sealed (which are still owned by farmers but may become the property of the loaning agency) equal some such figure as 500 million bushels. The reductions in the loan rate after that point should be sharp, of the order, perhaps, of 5 percent for every 100 million bushels over 500 million.

The system outlined would help to keep the storage program out of extreme difficulties, but it would still be far from satisfactory. If a loan were in effect at 70 cents a bushel, and low consumption and high production caused large stocks to accumulate so that the loan rate had to be reduced to 65 cents, the price of corn would fall correspondingly. Corn acquired by the loaning agency at 70 cents would have to be disposed of at 65 cents. The losses would be considerable. A self-financing program, on the other hand, would call for buying corn at 65 cents and selling it at 70.

PERCENTAGES OF PARITY AS THE BASIS FOR LOAN RATES

The loan rates in the present Ever-Normal Granary programs are set at certain percentages of parity, in an attempt to raise the level of prices. This attempt would be ineffective if it were not backed up by production controls. The conclusion was reached earlier that a stabilization program by itself could only set rates at a level that would even out large and small crops over a period of years, and that is the level at which an average crop would sell. If that level is lower than parity prices, then parity prices can be attained over a period of years only by production control; parity cannot be attained over a period of years by a stabilization program alone.

The concept of parity has some good points and some weak points as a goal for agricultural price levels to be reached by production control. It is a distinct improvement over any price goal that leaves out the effects of changes in the price level. But it is not very accurate. It ignores changes in the relative costs of producing different crops that have taken place since 1910–14. It looks backward through two World Wars instead of forward at the current and prospective situations that must be met. In times when demand is expanding, parity prices may not be high enough to call forth enough increase in production to meet the demand. In times of depression, parity prices may require a greater cut in production than farmers would be willing to make. Figure 18 shows some of the economic difficulties involved. It shows that in the past the actual relation between the prices farmers received and the prices they paid has been, not 1 to 1, as called for by parity price, but 2 to 1.

Even if parity prices were completely valid as goals, as guides to what farm price levels should be, it is clear that those goals cannot be reached by a stabilization program alone. The *price-stabilizing* program can only smooth out fluctuations about the general level of corn prices. The way to do that job is to set the price at the level at which an average crop can be sold, in view of the acreage in production and the strength of the demand. If the general level of corn prices is to be raised, that *price-raising* job has to be effected by controlling production at the source.

It is essential that the loans, a very effective means for stabilizing prices, should not be used, unsupported by production control, for raising prices. There is danger that the means designed for stabilizing prices, used alone for raising prices as well, may get the whole Ever-Normal Granary program into difficulties. The warning that Henry Wallace issued several years ago is still good:

> One difficult point in working out a sound Ever-Normal Granary program has to do with the size of the loan. If the loan is too high and there is favorable weather in the following year, or perhaps the 2 following years, the result may bring losses so large as to discredit the program. This program is so important that it must not be discredited. I am urging Corn Belt farmers to cherish it as something which is not primarily the Goverment's program, but their very own. If they do not cherish it in this spirit, but organize in the spirit of looting the Government, the final result will be a greater loss to the farmers than if there had been no program at all.[29]

PRICES, COSTS, AND INCOMES SUMMARIZED

A program for completely stabilizing corn supplies and prices could not finance itself directly, for corn prices when supplies came out of storage would be the same as when the supplies were put in; the farmer who carried the corn, or the loaning agency that took it over, would be "out" the costs of storage.

If the loan rate were set a few cents below the price that would move an average crop into consumption, supplies and prices would be only partly stabilized and prices would rise from large-crop years to short-crop years. The rise would be enough to cover the storage costs if the loan rate were set half as far below the price for an average corn crop as the accumulated storage costs per bushel.

---

[29] WALLACE, HENRY A. THE EVER-NORMAL GRANARY: WHAT CAN IT DO FOR THE CORN BELT AND THE NATION? Address before a conference of corn and livestock producers and business and labor leaders at Indianapolis, Ind., Nov. 8, 1937. Bur. Agr. Econ., 25 pp. 1937. [Processed.]

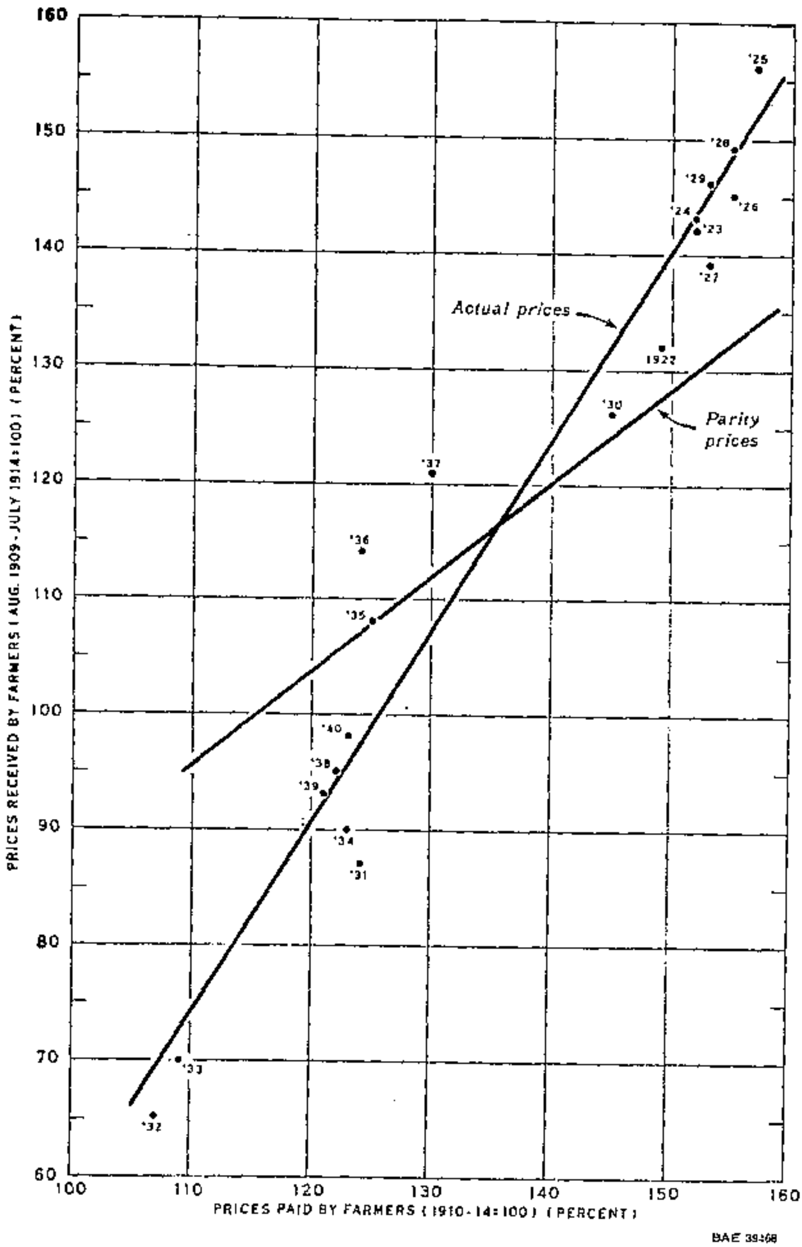


FIGURE 18.—PRICES RECEIVED AND PRICES PAID BY FARMERS, 1922–40.

Parity prices for farm products would fluctuate in a 1-to-1 relationship with the prices paid by farmers. The actual relationship that has existed over the past has been more nearly 2 to 1; the prices farmers received have fluctuated twice as much as the prices they have paid.

Perhaps that concept of a self-financing program is too narrow. Stabilization both increases the total value of a series of corn crops of varying sizes and lowers the cost of producing and distributing livestock. Complete stabilization, involving losses to the loaning agency equal to the costs of storage, could be equitably financed by a levy on the increased total value of the corn crops stabilized, and the reduced cost of livestock production.

But it would be difficult to collect a levy of the sort suggested because most of the corn crop never leaves the farm where it is produced. If the benefits which go at first to farmers soon showed up in the form of increased production and lower prices to consumers, then consumers could well be asked to finance a complete stabilization program. If not, it should be financed by farmers, who retain the benefits of the program. The costs might be collected from producers by deducting the storage charges from the loans at the time they are made.

It is clear that percentages of parity are not good bases for loan rates. They may be too high or too low for stabilization purposes. The loan rates for a stabilization program should be equal to stabilization prices—prices at which all of an average crop of corn would move into consumption. If that level of prices is not high enough, it should be raised by acreage control; otherwise excessive accumulations of corn in storage are likely to wreck the program. If percentages of parity are retained as the basis for loan rates, perhaps the flexible provisions in the AAA of 1938 could be changed to apply to the total storage stocks or total supplies, not to the crop exclusive of storage stocks as at present, so that as storage stocks increased over the quantities needed for stabilization purposes, the loan rate would be reduced. The Ever-Normal Granary program is a program for stabilizing supplies, not a program for raising prices; the production-control programs are the only programs that can raise prices over a period of years and make those prices stick.

The Geographical Corn Loan-Rate Structure

The fourth major problem is the geographical structure of the loan rates for corn.

Up to the present time, the loan rate for corn each year has been a flat rate over the commercial corn area. In 1940–41, for example, the loan rate was 61 cents a bushel to any cooperator in the AAA program, no matter where he was located in the commercial corn area.

The flat loan rate each year has been accompanied by some changes in relative production of corn and hogs over the commercial corn area. Those changes have resulted from several things; the flat loan rate was only one of them. Other significant factors were the severe droughts in 1934 and 1936 in the western Corn Belt States, the continued shortage of moisture in Kansas and Nebraska from 1936 to 1940, occasional short crops in certain areas, and the differences in the percentage sign-up in the AAA program in the different States. It is almost impossible to give each of these factors their proper weight, but the attempt will be made.

CHANGES IN CORN ACREAGE

The acreage of corn in the different Corn Belt States was sharply reduced during the droughts of 1934 and 1936. But by 1937, acreage had recovered to predrought levels (except in Nebraska and Missouri). The year 1937 makes a good bench mark from which to measure changes in acreage of corn due to things other than drought.

The changes in corn acreage after 1937 show the same pattern in all the Corn Belt States. Acreage declined steadily from 1937 to 1940. The original acreage data and the percentage changes in acreage from 1937 to 1940 are shown in table 8. The percentages range between 79.6 and 84.8, with the exception of Minnesota where the percentage is 91.2.

TABLE 8.—*Corn acreage in the seven most important Corn Belt States, 1937 and 1940, and 1940 acreage, yield, and production in percentage of 1937*

State	Acreage		1940 as percentage of 1937		
	1937	1940	Acreage	Yield	Production
	Acres	*Acres*	*Percent*	*Percent*	*Percent*
Iowa	11,082	9,031	81.5	113.3	92.4
Illinois	9,367	7,551	80.6	91.7	73.9
Indiana	4,752	3,937	82.8	82.2	68.1
Minnesota	4,788	4,366	91.2	109.7	100.0
Ohio	3,796	3,220	84.8	87.2	74.0
Nebraska	7,904	6,289	79.6	161.9	128.8
Missouri	4,360	3,698	84.8	113.0	101.3

The percentage sign-up in the AAA program in 1940 as shown in a release of May 15, 1940, from the North Central Division of the AAA was lowest in the eastern Corn Belt States (lowest of all, 68 percent, in Ohio) and highest in the western Corn Belt States (highest of all, 88 percent, in Nebraska).

The differences in percentage sign-ups in the different States were even greater in the earlier years. There seems to be no consistent relation between sign-up and acreage reduction. The greatest reduction in acreage was made in Nebraska, where the sign-up has been the highest of any State shown in table 8 in most of the years since 1936; but the smallest reduction in acreage was made in Minnesota, where the sign-up was next highest to, or exceeding that in, Nebraska in every year since 1936. Acreage of corn was reduced between 15 and 20 percent in all seven States under the AAA program, but neither the percentage sign-up in the AAA program nor the flat loan rate for corn seems to have had much differential effect on corn acreage.

CHANGES IN PRODUCTION OF CORN

As acreage has changed so nearly to the same extent in the chief Corn Belt States since 1937, changes in production of corn must have resulted chiefly from changes in yield. The changes in yield result chiefly from changes in the weather, and only to a small extent from changes in farming practices, loan rates, or other factors. They are given in percentage form in the next-to-the-last column of table 8. The percentage data for production are given in the last column; they show that production of corn increased in some States and decreased in others mainly because of differences in yields.

CHANGES IN UTILIZATION OF CORN

Many differences are found among the States in the uses made of the corn after it is produced. The figures in the top row of table 9 show the average stocks of corn on farms October 1 (representing the carry-over from one crop year to another) in each one of the important Corn Belt States over the 8-year period, 1926–33, before the 1934 and 1936 droughts. They show the situation before corn loans were begun. The figures in the next three rows of table 9 show how stocks of corn accumulated in the different States after corn loans became a significant factor in the market.

The table shows that by October 1, 1940, the stocks of corn on farms in Iowa had grown to more than six times their 1926–33 average size, and four times the size reached in the previous record year, 1934. Stocks piled up in Minnesota, and to a lesser extent in Illinois. The corn crops in those States were large in the years 1937–39, but that could not have been the reason for the large stocks, because the corn crops in Indiana and Ohio were similarly large, but stocks there were only slightly higher than normal. The stocks of corn on October 1, 1941, were somewhat reduced from the peak reached in 1940, but the general relations remained as in 1940.

The chief reason why corn piled up in Iowa, Minnesota, and Illinois is indicated by figures in the lower part of table 9. Most of the stocks of corn in 1940 and 1941 consisted of sealed corn under loan. If the loan corn is subtracted from the total stocks in each State, the "free" corn is reduced to about an average quantity or less. Apparently, then, the flat loan rate for corn appealed most to the farmers in the area where prices of corn are normally the lowest.

TABLE 9.—*Stocks of corn on farms Oct. 1, average 1926–33, annual 1938–41*

Item and year	Iowa	Illinois	Indiana	Minnesota	Ohio	Nebraska	Missouri
	1,000 bushels	*1,000 bushels*	*1,000 bushels*	*1,000 bushels*	*1,000 bushels*	*1,000 bushels*	*1,000 bushels*
Corn on farms Oct. 1, average 1926–33	36,827	36,548	12,356	5,854	10,744	21,348	10,494
Corn on farms Oct. 1, 1938	105,984	85,066	26,085	20,970	14,424	13,471	10,364
Corn on farms Oct. 1, 1939	217,336	121,725	21,187	38,199	16,214	40,560	24,293
Corn on farms Oct. 1, 1940	231,078	95,821	18,438	68,524	13,753	37,323	16,251
Corn on farms Oct. 1, 1941	203,742	53,538	11,753	45,946	6,865	43,925	19,361
Corn under seal Oct. 1, 1940	203,312	67,517	2,372	44,954	743	23,082	5,543
Corn under seal Oct. 1, 1941 [1]	140,210	21,138	1,213	32,253	357	24,950	4,432
"Free corn" Oct. 1, 1940	27,766	28,304	16,066	23,575	13,010	14,241	10,708
"Free corn" Oct. 1, 1941	58,872	32,972	10,427	13,693	6,418	16,668	13,014

[1] Grain Division, Commodity Credit Corporation.

The average farm prices of corn during the first 3 months when the 1940–41 corn loan was in effect (December 1940 to February 1941) were: Iowa 48 cents, Illinois 53 cents, Indiana 57 cents, Minnesota 45 cents, Ohio 61 cents, Nebraska 53 cents, and Missouri 54 cents. The flat loan rate for corn during 1940–41 was 61 cents a bushel. The loan rate was 13 cents per bushel higher for the Iowa farmer than the open-market price, and the inducement for him to seal his corn was considerable. But in Ohio the inducement was nil; the loan rate was the same as the open-market price.

CHANGES IN PRODUCTION OF HOGS

It might be expected that, if farmers in Iowa, Minnesota, and Illinois have been putting a great deal more corn than usual into the Ever-Normal Granary, they must have been putting a great deal less corn into hogs. That expectation may be readily checked against the facts. The production of hogs in the different Corn Belt States each year can be shown by adding the spring and fall pig crops for each calendar year. The series runs back to 1924. In figure 19, the data tell a story in two parts (1) what happened before the droughts of 1934 and 1936, and (2) what has happened since:

(1) Before the droughts, the trend of hog production was horizontal in Minnesota and Nebraska, horizontal or slightly upward in Iowa, Illinois, and Missouri, and definitely upward in Indiana and Ohio. The trends were obviously not affected by the flat loan rate, which did not become an appreciable market factor until after 1936.

(2) Since the droughts the level of corn production in Nebraska has remained low—only about 50 percent as high as before the droughts. The level of hog production has done the same thing. This has happened also in Missouri, although to a lesser extent. The droughts were more severe in these two States than in the others, and their effects were more devastating.

In the other five States the trends that were evident before the droughts have reestablished themselves since the droughts. By 1940 production of hogs had recovered until it was slightly higher than the highest peak attained before the droughts, except in Iowa and Minnesota where it was not quite so high.

Production of hogs in Iowa and Minnesota may have failed to return to predrought levels because in those two States the trends of corn production before the droughts were horizontal. Production of hogs in the other three States may have exceeded their predrought levels because the trends of corn production there were upward. That is, the behavior of hog production in the different States could be merely a reflection of underlying trend-determining forces persisting through the droughts. On the other hand, it is possible that production of hogs failed to return to predrought levels in Iowa and Minnesota because in those States corn was being put into the Ever-Normal Granary instead of into hogs. That explanation is open to some question, however, as it is contradicted by the situation in Illinois. That State ranks next after Iowa and Minnesota in percentage of the crop put into the Ever-Normal Granary, but hog production in Illinois did not remain below predrought levels; it exceeded the highest peak attained before the drought.

What over-all conclusion can be drawn as to the effect of the flat loan rate on production of hogs?

The flat loan rate may have been responsible for a slight reduction in production of hogs in Iowa and Minnesota, compared with Illinois, Indiana, and Ohio, although this reduction may represent simply an extension of trends established before the droughts. In either case the effect is small. Perhaps this happened because farmers made up for most of the corn they put into the Ever-Normal Granary by producing more soybeans, alfalfa, and other substitute crops. Perhaps the effects have not yet had time enough to show up very clearly, and the call for increased production of hogs in 1941 and 1942 may defer their appearance for 2 more years.

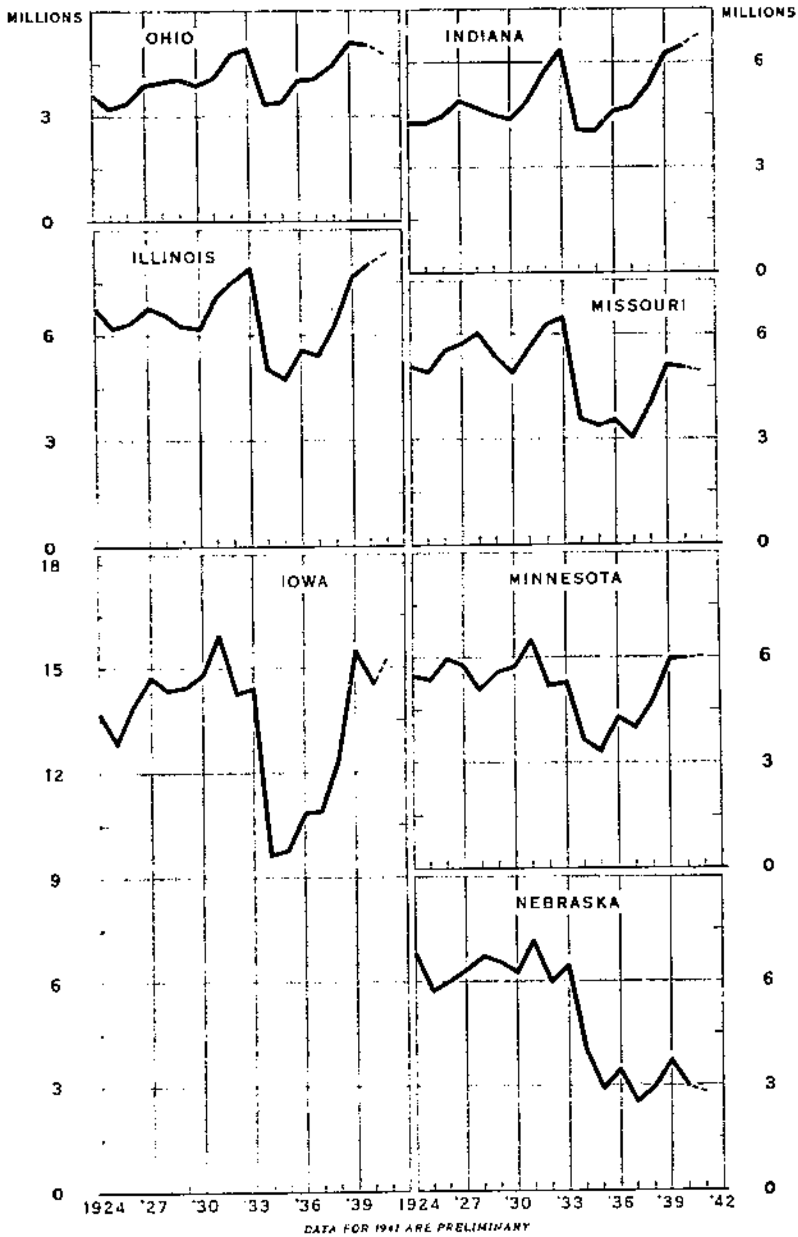


FIGURE 19.—PRODUCTION OF HOGS IN SEVEN CORN BELT STATES, 1924–40.

The effects of a flat loan rate for corn on hog production in the different Corn Belt States are difficult to trace because of the violent effects of the droughts in 1934 and 1936. The effects of the measures designed to support hog prices, announced in 1941, further complicate the problem. Hog production in the important Corn Belt States (with the exception of Missouri and Nebraska) has now returned to figures which approximate extension of the trends established before the droughts.

CRITERIA FOR GEOGRAPHICAL LOAN-RATE DIFFERENTIALS FOR CORN

Corn is important chiefly as a raw material for feeding to livestock. Under the free interregional competition that exists in the production of corn and livestock, those two commodities are produced in such areas and proportions as to minimize costs of production. Any shifts from the normal proportions would increase costs of production in the long run as well as in the short run (except for shifts that result from technological changes in production or marketing practices, such as hybrid seed corn, improved trucks and roads, etc.).

The corn loan-rate structure, therefore, should be such as to cause the least possible change in the existing distribution of corn and livestock production (although it should facilitate any changes that are in progress resulting from technological developments). It follows, then, that the corn loan-rate structure should be patterned after the geographical differentials that have existed in prices of corn in the recent past, modified to take recent technological developments into account.

An additional reason for making the corn loan-rate structure follow the price structure of corn is that this would treat corn producers in different parts of the Corn Belt more fairly than the flat loan rate. Corn prices usually run higher in the eastern part of the Corn Belt than in the western part; the farm price of corn in Ohio over the last 20 years has averaged 7 cents a bushel higher than the farm price of corn in Iowa. A flat loan rate for corn, therefore, that happened to be equal to the average Iowa price of corn, would be 7 cents lower than the average Ohio price of corn; if the flat loan rate were fair to Iowa farmers, it would be 7 cents less than fair to Ohio farmers. A geographical corn loan-rate structure based on geographical corn-price differentials would treat all producers of corn equitably, and would cause the least disturbance in storage and production practices.

Finally, it was shown in an earlier section that the storage stocks for stabilization purposes should be located evenly over the Corn Belt (except for somewhat larger stocks along the western edge and in heavy surplus areas) not concentrated heavily in any one part of it. A corn loan rate structure that fitted the average corn-price structure would offer more nearly the same incentive to storage in one part of the Corn Belt as another, and would help to bring about even distribution of storage stocks.

It is evident from the charts in the preceding section, showing the corn-price surfaces for individual years, that no single corn loan rate structure, neither flat nor sloping, smooth or uneven, would conform at all closely with the different corn-price structures for different individual years. Still less would it conform by quarters or months. The question then arises: Should the loan-rate structure be made to conform to the price structure each year, or should it be more stable and conform only to a price structure based on long-time averages of corn prices in each district over a period of years?

EFFECTS OF A VARIABLE LOAN-RATE STRUCTURE

A little consideration shows that making the loan-rate structure conform to the price structure each year would lead to some undesirable results. One result would be to encourage the storing of roughly the same percentages of the crop in each State, regardless of the size of crop in each State. If Missouri had a small crop in a year when total production of corn in the United States was 10 percent above average, a loan-rate structure that conformed to the price structure that year would encourage the storing of about 10 percent of the short crop in Missouri, and the shortage would be accentuated there. That would be contrary to the purposes of stabilization operations.

A second undesirable result that would come from making the loan structure conform to the price structure each year would lie in the fact that in all probability the price structure itself would be affected before the year was out. The storing of corn in the short-crop areas would drive prices higher than they would have been if the high loan had not been in effect, so that the loan and the price would not conform anyway, unless they chased each other up to abnormal heights.

EFFECTS OF A STABLE LOAN-RATE STRUCTURE

A loan structure based on average prices of corn over a period of years would work out much better than a variable structure. In the Missouri situation already discussed, the scarcity of corn in Missouri would drive prices up to a point where the loan rate based on Missouri price averages would not be attractive and very little, if any, Missouri corn would be stored. Any State with a particularly large crop that year would have a low price; a loan rate based on price averages for that State would be attractive; and this would result in a large quantity of that large crop being stored. In effect, this would provide some geographical stabilization along with chronological stabilization.

If the loan-rate structure should be based on average prices of corn over a period of years, the question arises: What sort of average should be used, and how many years should it include?

Several different averages, covering several different periods of years, were tried before the selection was finally made. The price data by crop-reporting districts go back only as far as 1924, although by States they go back much further. Among the periods selected as the bases for the different averages were: (1) The 16-year period from 1924–25 to 1939–40; (2) the 16-year period from 1924–25 to 1939–40, excluding the two drought years 1934 and 1936; (3) the 10-year period from 1930–31 to 1939–40; (4) the arithmetic mean of (a) the 10-year period from 1930–31 to 1939–40 and (b) the 3-year period 1937–38 to 1939–40; and (5) the 16-year period from 1924–25 to 1939–40, adjusted to the State averages over the 20-year period from 1920–21 to 1939–40. After much discussion, the latter average was finally selected as the basis for the district price averages.

In some cases, a difference of several cents occurred between the average corn prices in adjacent crop-reporting districts. The difference resulted from the fact that the crop-reporting districts were large, and the averages represented steps rather than the smooth slope in the price surface that actually underlaid them. The prices in the districts were finally broken down by counties. In nearly all cases this could be done in such a way that the differences in loan rates between adjacent counties were no more than 1 cent per bushel.[23]

[23] The prices by counties used as the basis for the loan rates for the 1941 corn crop are given in CCC Corn Form 1, Supplement 1 (mimeographed). Copies can be obtained by writing to the Commodity Credit Corporation, Washington, D. C.

AVERAGE FARM PRICE OF HOGS AS A BASIS FOR CORN-LOAN RATES

The average farm price of corn by districts over a recent period of years is not the only possible basis for differential corn-loan rates. Other bases may be considered. One of these is the average farm price of hogs by districts. Nearly 90 percent of the corn crop is fed to livestock, and hogs take more corn than any other class of livestock. Perhaps the prices of the most important final product, hogs, should be used as the basis for corn-loan rates rather than the prices of the raw material, corn.

The 16-year (1924-39) average prices of hogs by districts are shown in figure 20. The average-price surface shown for hogs is more evenly

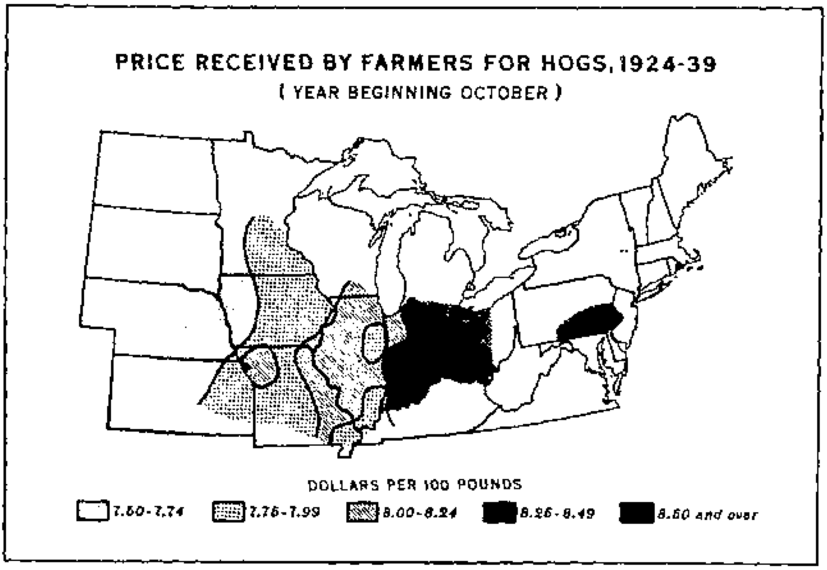


FIGURE 20.—The average price surface for hogs slopes upward from west to east more evenly but less steeply than does the average price surface for corn (fig. 11).

sloped than the price surface for corn. It is also more nearly flat; that is, it is less steeply sloped than the price surface for corn. Prices of hogs range from about $7.60 in the low-price area in North Dakota to about $8.40 in the high-price area in Ohio, a difference of 10 percent of the average of the two values. The 14-year average corn prices range from 52 cents to 64 cents (fig. 11), a difference of 20 percent of the average of the two figures. The average corn-price surface, therefore, is twice as steeply sloped as the average hog-price surface.

The slope of the hog-price surface is also different in character from that of the corn-price surface. The corn-price surface is like two shallow basins lying side by side, the one basin (east of Illinois) being a step higher than the other; but the hog-price surface is like a ramp, a straight slope, leading up to a flat-topped area in the two eastern States, Indiana and Ohio.

Finally, the hog-price surface shows less variation from year to year than the corn-price surface. In several different years the normal upward slope of the price of corn from west to east was reversed; but the hog-price surfaces slope the same way every year (upward from west to east). This is true even of the severe drought years 1934 and 1936, so there is no need to omit them from the 16-year average, as was done in the case of corn.

The fact that the price surface for hogs is more nearly flat than the price surface for corn means that the hog-corn price ratio is not uniform over the Corn Belt. Corn loan rates based on average hog prices, however, would make hog-corn price ratios uniform over the whole Corn Belt. That would change the previously existing relationships between the prices of corn and hogs, and change the previous pattern of corn and hog production, and that would increase production costs.

In any case, using hog prices would ignore the prices of other finished products—beef, butter and eggs, lamb, etc. If finished material prices should be used, these other products should be included, which would involve problems of differential weighting, and introduce complexities and controversies that would be difficult to handle. If the results were somewhat similar to the average hog prices previously computed, the same objections would apply to them as to the hog prices. No sort of finished-product prices would be as good as the original corn prices.

DIFFERENTIALS BASED ON FREIGHT RATES

A third choice would be to base geographical differentials in corn-loan rates on freight rates outward from the terminal markets. This alternative was chosen for wheat and cotton. It has the advantage of facilitating the easy movement of storage stocks when shortages occur; it keeps the stocks geographically mobile.

This basis is well suited to products like wheat and cotton that are practically all sold and shipped off the farm in their original form. But it does not appear to be well suited to corn. About 80 to 85 percent of the corn crop is fed to livestock on the farm where it is grown,[22] and only the remaining 15 to 20 percent is sold as cash corn. The sort of mobility that corn needs is not mobility from place to place, but mobility into livestock. The sort of prices that have kept corn moving into livestock in the past would take care of 80 to 85 percent of the corn without involving any shipments.

As for the other 15 or 20 percent of the corn, a question arises as to whether differentials based on freight rates outward from the terminal markets would keep it geographically mobile: (1) Only half, or less than half, of the commercial corn moves through a terminal market.[23] Half, or more than half, of the corn does not move through a terminal market at all. (2) A fundamental assumption inherent in the freight-rate set-up is that corn prices in the different counties would become equal to the loan rates; thus corn moving from a county where the loan rate is 70 cents a bushel could be moved to another county where the rate is 75 cents and be sold at 75 cents there. That assumption is all right insofar as the acquisition of the corn is concerned,

[22] The receipts of shelled corn graded by licensed inspectors at all inspection points run about 15 percent of the total crop. In addition, some corn moves without inspection, but how much is not known.

[23] The total receipts of corn at prominent western grain centers are only about two-thirds as large as total inspections in the United States. In addition, a lot of corn moves by truck without passing through either an inspector's hands or a terminal market.

the corn would be acquired at 70 cents. But there is no reason to believe that the price in the county where the corn is sold would be equal to the loan rate of 75 cents. The flat loan rate has not made prices conform to the loan rates over the area; the differences between Iowa and Ohio farm prices have been greater since the flat loan rates have been in effect than they were before. Setting corn loan-rate differentials equal to freight-rate differentials would not insure that corn could move without loss, because setting corn loan-rate differentials does not set corn price differentials.

Whatever basis is adopted for the loan rates—historical price averages, freight rates, etc.—it provides only a first approximation to a final system of loan rates. The basic loan-rate differentials set up under any system would need to be modified in order to effect the proper location of the storage stocks in the quantities desired. In areas where the storage stocks need to be large, that result can be brought about by a high loan rate; conversely where stocks need to be small. Thus the loan rates in the three States along the western edge of the Corn Belt—South Dakota, Nebraska, and Kansas—where large stocks are required, probably should be higher than indicated by historical average prices, and the loan rates in Missouri, where small stocks are desired because of high insect damage, probably should be lower. Such adjustments of the basic loan rates should be made in close cooperation with the local AAA committees to make it possible for these committees to express their views, and to make generally known the reasons for making the adjustments.

THE LOAN-RATE STRUCTURE SUMMARIZED

The existing flat loan rate for corn over the commercial corn area is piling up large quantities of corn in storage in low-price areas such as Iowa. It is having the opposite effect in high corn-price areas such as Indiana and Ohio. The large stocks of corn in Iowa can move out of storage to Indiana and Ohio only with difficulty, if at all, as prices in those States normally exceed prices in Iowa by only a few cents a bushel—not as much as the shipping charges between them. The only way that producers in the high corn-price areas can get corn out of storage in the low corn-price areas is to pay what seems to them exorbitant prices for it. This not only disrupts normal livestock producing plans and increases the cost of producing livestock, but makes it hard for corn to move out of storage once it gets in storage.

The corn loan-rate structure that would change corn storage and livestock production practices the least, and would be most fair to producers in the different parts of the commercial corn area, would be based upon average geographical differentials, by crop-reporting districts, over a recent period of years. Another possible basis for loan rates would be freight rates, the object in that case being to keep the stocks geographically mobile. The rates established on either of of these bases would be only first approximations, in any case. It would be necessary to raise or lower them in certain areas in which large or small stocks are desired.

MEETING FLUCTUATIONS IN THE DEMAND FOR HOGS

Up to this point, this report has dealt with the problem of keeping supplies of corn reasonably stable from year to year, so as to stabilize supplies of livestock. If demand remained constant, this would stabilize corn and livestock prices. Actually, demand does not remain constant; it fluctuates widely from 1 year or period of years to another. In this situation, stabilization of supplies is only one step in a broader program for controlling corn and livestock prices in the interests of producers and consumers, when supply and demand both change. It may even appear to conflict with a program for dealing with changes in demand, for when demand decreases, as during an industrial depression, a question arises as to whether it is desirable to keep supplies of corn and livestock stable. If supplies are kept stable, then clearly prices must fall; but if the object is to keep prices stable, then clearly supplies must be reduced. When demand changes, supplies and prices cannot both be stabilized.

In this section, therefore, the discussion will not deal with the problem of stabilizing supplies and the question of how existing stabilization programs may be made more effective. Instead, it will push ahead of existing programs into the broader field of controlling the prices of corn and livestock when supply and demand both fluctuate. This broader field may call for unstabilization, rather than stabilization, of supplies. The work in this section is exploratory in character. It attempts to open up the field and to locate and define the problems rather than to offer solutions to them.

This sounds as though the present-day Ever-Normal Granary program, designed to stabilize corn and livestock supplies, must be inherently in conflict with a broader program for meeting changes in demand as well, which might call for unstabilizing supplies or prices or both. Actually, however, the two programs are or should be separate programs, dealing with separate problems. There is no reason for conflict between the two. All that an Ever-Normal Granary supply-stabilization program is designed to do is to smooth out erratic and unpredictable fluctuations in supplies (due chiefly to fluctuations in yields, in turn due to fluctuations in the weather) about a level set by the level of acreage. All that a demand-stabilization program is designed to do is to smooth out fluctuations in demand, or if that cannot be done, to meet them with corresponding, consciously evoked changes in supplies or prices. There is no correlation between fluctuations in supply due to the weather and fluctuations in demand due to booms and depressions, wars, and a hundred other causes. Neither is there any similarity between the erratic fluctuations in supply due to the weather, which a supply-stabilization program is designed to smooth out, and the consciously evoked changes in supply which a demand-stabilization program would bring about to meet changes in demand.

Can Demand Be Controlled?

There are several different kinds of changes in demand. The most spectacular and violent kind is that which comes with booms and depressions. As shown earlier, the same number of hogs may sell during a depression at less than half the price at which they sold during a boom. Changes of this kind result from changes in the purchasing power of consumers.

Smoothing out such major changes in demand, in any basic sense, requires stabilizing the entire economy, which is an exceedingly difficult problem, and is clearly outside the scope of this bulletin. Until the whole economy has been stabilized, however, the effect of the extreme fluctuations can only be mitigated, on the demand side, by such measures as Government purchases for distribution to low-income groups. In the past at least, these measures have not been large enough to have much effect on prices. In 1940, the quantity of pork bought with blue stamps under the Food Stamp Plan, 64,199,000 pounds,[26] was less than 1 percent of the total production of pork in 1939.[27] The quantity of lard, 30,230,000 pounds, was only 1.5 percent of the total production of lard.

It would be necessary to expand such purchases many times over before the total demand for hogs would be substantially affected. The total purchases of all foods under the Food Stamp Plan in 1940 amounted to $44 million, and expanding that many times over would run into a lot of money. It has been estimated that if the Food Stamp Plan were extended to all people in the United States who received public assistance in 1940 (nearly 20 million people) and 75 percent of them participated, the cost of the program to the Federal Treasury would be from $375 to $450 million dollars a year *(6, p. 86)*. That is considerable but it would fall far short of completely stabilizing the demand for pork.

It seems probable that demand will continue to change in the predictable future because of continued changes in consumer purchasing power. These future changes in demand may be less violent than those of the past if efforts to stabilize the whole economy meet with some success, and if Federal food programs are increased in scope; but there appears to be small chance that they will be completely smoothed out.

If fluctuations in demand continue, what can be done to meet them? Should the production of hogs and other foods be held constant, prices therefore fluctuating with demand? Or should prices be held constant, supplies fluctuating with demand? Or should some flexibility be given to both production and prices?

Some grounds exist for maintaining that supplies should be kept stable through changes in demand, with prices fluctuating. Physical goods are the fundamental things, not prices. If consumers need certain quantities of food and fiber in prosperity, they need them in depression too.

But the needs of producers must be taken into account as well as the needs of consumers. If the demand for hogs and other foods cannot be stabilized, yet consumers are to continue to get a full ration of pork in depression as in prosperity, then the same quantity of pork must be produced in depression as in prosperity; and this means that prices are bound to fall then, as they did during the last depression. Unless the prices of the goods and services that farmers buy also fall, a difficult situation for producers will arise. Industrial manufacturers respond to such a situation by severely reducing their production. Farmers recognize as clearly as anybody else that cutting down production all round can only harm society as a whole, and that everybody would be better off if production of all kinds of goods proceeded at full capacity; but so long as manufacturers cut production 50 or

[26] UNITED STATES SURPLUS MARKETING ADMINISTRATION. PURCHASES OF SURPLUS COMMODITIES BY THE SURPLUS MARKETING ADMINISTRATION DURING DECEMBER 1940. 23 pp. 1941. [Processed.] See p. 1.
[27] UNITED STATES AGRICULTURAL MARKETING SERVICE. LIVESTOCK, MEATS, AND WOOL MARKET STATISTICS AND RELATED DATA, 1940. 107 pp. 1941. [Processed.] See p. 100.

75 percent in times of severe depression, farmers can hardly be blamed for wanting to do the same thing on a smaller scale.

Furthermore, when demand increases, the inducement to expand production is very great. Prices rise, and at those higher prices greater profits can be made if production is expanded than if it is kept constant. Without any over-all program for control of production, farmers found it difficult to reduce production in the face of reduced demand; but they were always willing to increase production when demand increased, and they will want to do so again whenever demand increases in the future. As increased production is always desired by consumers, the demand for increasing production in time of prosperity would be pretty well unanimous.

Apparently, then, changes in the demand for hogs in the future will be met by corresponding changes in prices and production of hogs a year or two later. It would probably be impossible to keep prices stable through ups and downs in demand, even if it were desirable to do so. For in time of depression, farmers would not reduce hog production if hog prices were maintained as high as before, and perhaps not anyway, unless corn prices were made higher. This would be unwise, as it would stimulate production of corn at the same time that it reduced production of hogs and would pile up trouble for the future. Moreover, in times of prosperity prices of hogs could not be kept stable, as consumers would be offering to take more pork at the same prices as before, and the only way to satisfy them would be to produce more hogs. The only way to make that happen would be to let prices of hogs rise, or to make prices of corn fall; but if the latter course were chosen, production of corn would decrease and soon there would not be enough corn to go around. It seems clear that prices and production of hogs will have to change from time to time with changes in demand.

Effect of the Hog-Corn Price Ratio on Hog Production

How can production and prices of hogs be controlled?

It was shown earlier that the chief immediate determinant of hog production is the hog-corn price ratio. Changes in this ratio are followed about 2 years later by corresponding changes in production of hogs. It was also shown that the basic cause of the changes in the hog-corn price ratio is fluctuations in corn production from year to year.

The immediate instrument of control over the production of hogs, therefore, is the hog-corn price ratio; but it must be backed up by control over corn supplies, not merely stabilization of supplies at a fixed figure, but control of supplies at whatever figure is desired.

The effects upon hog production of these two things (the hog-corn price ratio and the supply of corn available) were shown in a preliminary way in figures 4 and 5 early in this bulletin. They are to be investigated more fully now, and if possible brought together in one combined system of relations.

The relation between the hog-corn price ratio and the slaughter of hogs about 2 years later showed up fairly clearly in figure 4. The relation can be shown more analytically if the data are made up into annual figures, on the hog-year basis (October to September) and plotted in scatter diagram form. Consideration of the nature of the hog industry, and the empirical evidence given in figure 4, indicates that a 2-year lag should be used between the two series. That is, the hog slaughter for 1 hog year should be plotted against the hog-corn price ratio 2 years earlier. (Trials with the ratio 1 year before, and with the ratio 1 year before and 2 years before as separate variables, confirm this belief.)

The relationship between hog slaughter and the hog-corn price ratio 2 years before is shown in figure 21*A*. From a statistical point of view, the correlation shown appears practically nil. Closer inspection shows that the correlation is rather high for the 10-year period from 1923-24 to 1932-33, with the exception of the year 1927-28 when hog slaughter was about 1.5 billion pounds less than would have been expected. The average relation for the dots for the 10-year period is represented by the line drawn in through them, free-hand. The line does not mean much, as it is based upon so few years, but it does indicate that what may be called the hog-corn price-ratio elasticity of the supply of hogs in those years was about 0.36. That is, a change in the ratio of 10 percent caused a change in hog slaughter 2 years later of about 3.6 percent.

Figure 21, *A* shows that during the years since 1923-32, other things besides the hog-corn price ratio have had a great effect on production of hogs. The dots for the years from 1933-34 on are displaced downward by two or three different things—chiefly by the severe droughts of 1934 and 1936, which caused heavy liquidation of breeding stock, and by the AAA corn loans above market prices after 1937.

EFFECT OF RATIO ON SPRING FARROWINGS

The effects of the hog-corn price ratio and of these other factors may be isolated with greater precision if the time units for the basic hog slaughter and hog-corn price-ratio data are chosen more carefully, with reference to the internal characteristics of the hog industry. The time unit for the hog-corn price ratio can be narrowed down to the few months when farmers are deciding whether to breed more sows, or less, or the same as the year before. Similarly, the number of sows farrowing can be used in place of the total number or weight of the hogs slaughtered. The total pounds of meat produced is the main thing so far as the consumer is concerned, but the chain of causation can be revealed more clearly by using the shortest possible lags and cutting out as many links (such as unpredictable changes in the average size of the litter, due to good or bad weather at farrowing time) as possible. The shortest chain of causation is that which runs direct from the hog-corn price ratio at breeding time to the number of sows farrowing 4 months later.

The spring pig crop in the United States is two or three times as large as the fall pig crop. The peak month for farrowing in the eastern Corn Belt is March; in the western Corn Belt the peak comes in April. The gestation period of the hog is about 120 days, so most of the sows are bred in November and December. One would expect to find a close relationship, then, between the hog-corn price ratio in the last 3 months of the calendar year and the number of sows farrowing the next spring.

The number of sows to farrow in the spring is not entirely settled by the end of December. If the ratio turns adverse (falls) during January and February, some of the piggy sows may be sent to market

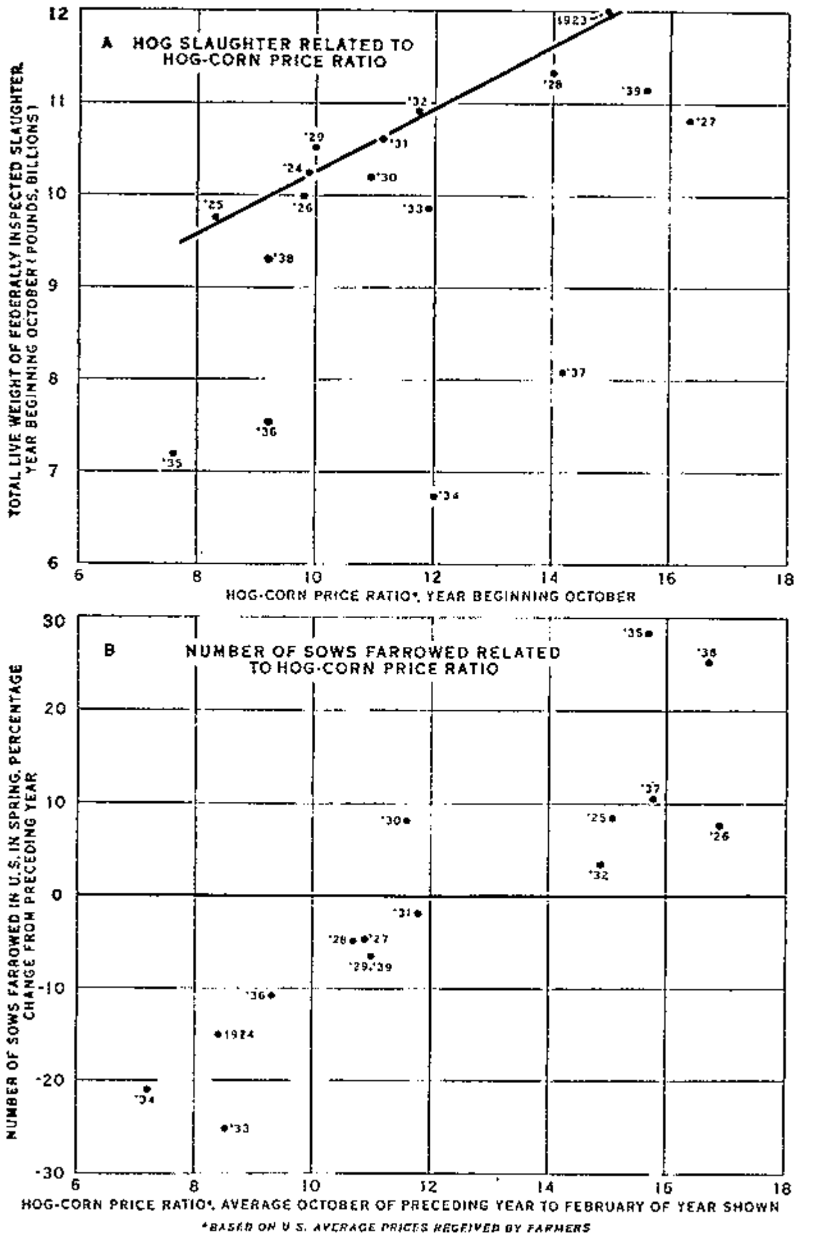


FIGURE 21.—RELATION BETWEEN UNITED STATES HOG-CORN RATIO AND UNITED STATES HOG PRODUCTION: *A*, AVERAGE RATIO OCTOBER-SEPTEMBER AGAINST SLAUGHTER OCTOBER-SEPTEMBER 2 YEARS LATER; *B*, RATIO OCTOBER-FEBRUARY AGAINST SOWS FARROWED THE NEXT SPRING.

The relation between the hog-corn price ratio and subsequent changes in the number of sows farrowed appears to be closer than the relation between the hog-corn price ratio and the subsequent hog slaughter.

during those months to be slaughtered as part of the regular run of hogs before spring arrives. Accordingly, the period during which the hog-corn price ratio affects the number of sows farrowing in the spring extends not merely from October to December but on through to February.[28]

The average hog-corn price ratio from October to February, therefore, is plotted against the number of sows farrowing the next spring, in figure 21, *B*. The data used are for the entire United States. (Similar data for the North Central States (roughly, the Corn Belt) yield similar results.) The number of sows farrowing in the spring is expressed as a percentage of the number in the preceding spring. The chart, therefore, shows the effect of the hog-corn ratio upon the change in the spring farrowings from the year before. The data are so handled for several reasons. (1) Because the procedure used follows the precedent set by earlier studies,[29] (*27*). (2) Because of its logic; a high hog-corn price ratio, for example, may cause farrowings to continue rising, rather than simply to be high. There is some question about this, and this question is investigated a little later. (3) Because it reveals a fairly high correlation, directly, over the entire period from 1924 to 1940.

The relation shown in figure 21, *B* shows an elasticity of about 0.6. A 10-percent change in the hog-corn price ratio in the fall and winter causes a change of 6 percent in the same direction in the number of sows farrowing the following spring.

The question concerning the logic of using *changes* in the number of sows farrowed, rather than the original numbers, can now be raised. It can be argued that a hog-corn ratio of 14, for example, would cause farmers to keep on expanding production of hogs year after year. Is this true? Obviously it could not continue for very many years, because a farmer would shortly be raising so many hogs on his farm that his costs would rise to the point where a ratio of 14 would induce no further expansion. Perhaps such a contingency does not actually arise because the initial expansion in hog numbers soon brings down prices of hogs and makes the ratio unfavorable.

The question can be submitted to empirical test by plotting the same data that are shown in figure 21, *B*, not as changes from 1 year to another, but in their original form as is done in figure 22, *A*. From a strictly statistical point of view, practically no relation between the hog-corn price ratio at the time of breeding and the number of sows farrowing 4 months later is thus indicated, a fact worth emphasizing, for many people seem to believe that hog supplies are determined almost completely by the hog-corn price ratio alone. Figure 22, *A*, shows that belief, at least in its simplest form, to be incorrect. To go to the other extreme and conclude, from the evidence of the chart, that the hog-corn price ratio from December to February has very little effect on the number of sows farrowing the next spring would be equally erroneous. What the chart does show is that other factors besides the hog-corn price ratio have much to do with the number of sows farrowed. The chart can be of some help in determining what those other factors may be.

[28] BURMEISTER, C. A. THE HOG-CORN RATIO AND HOG PRODUCTION. U. S. Bur. Agr. Econ. Livestock Situation No. 19, pp. 161-19. 1941. [Processed.]

[29] See Footnote 28.

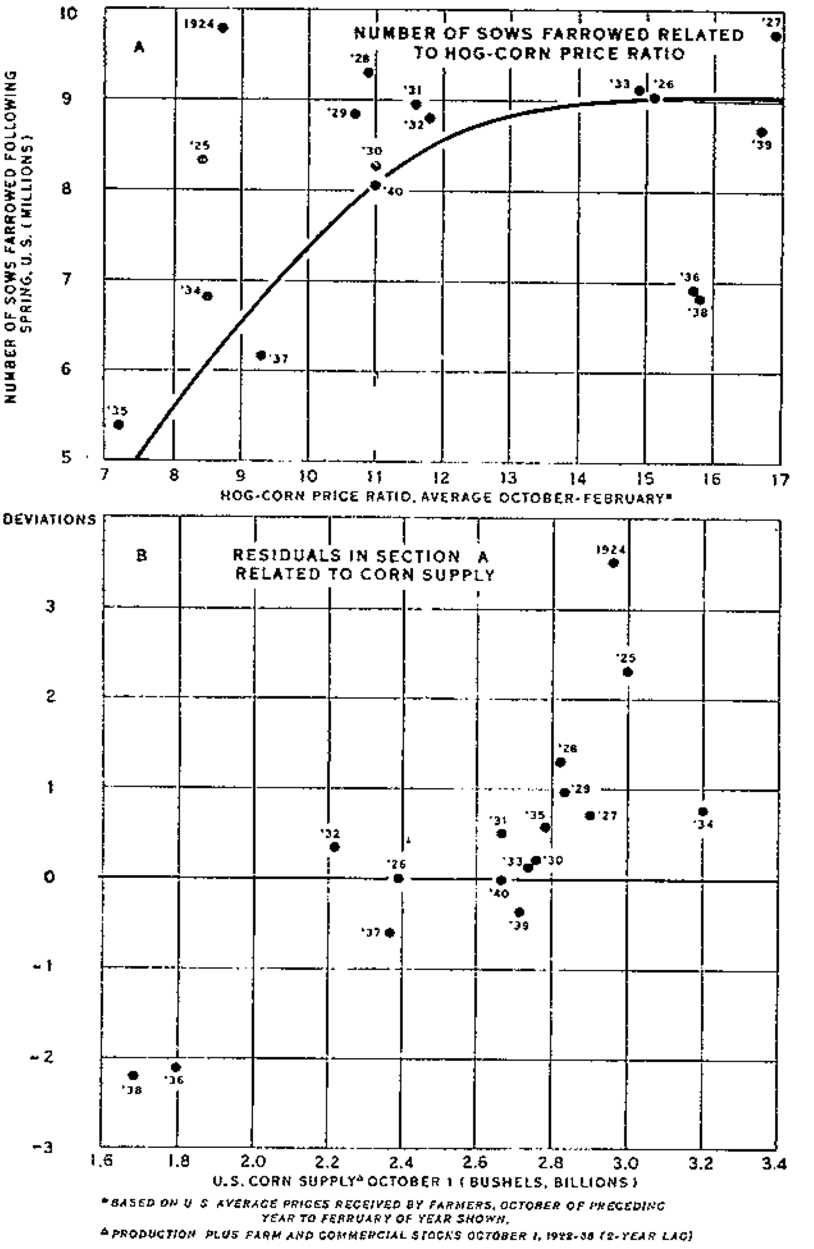


FIGURE 22.—RELATIONS BETWEEN THE UNITED STATES HOG-CORN RATIO, CORN PRODUCTION, AND SOWS FARROWED: *A*, AVERAGE HOG-CORN PRICE RATIO OCTOBER-FEBRUARY AGAINST UNITED STATES SOWS FARROWED THE NEXT SPRING; *B*, RESIDUALS FROM *A* AGAINST CORN PRODUCTION THE YEAR BEFORE.

The effect of corn production in the current year is already reflected in the hog-corn price ratio.

Spring farrowings in 1935–36 and 1937–38, for example, were lower than in other years of high hog-corn ratios, for an obvious reason. The severe drought years of 1934 and 1936 forced such a liquidation of breeding stock as well as butcher stock that despite the comparatively large corn crops and low corn prices of 1935 and 1937 spring farrowings were not yet back to normal. Farrowings did not recover fully, in fact, until 1939; the dot for 1938 is still low.

Three years in which farrowings were high although the hog-corn price ratio was low, were 1923–24, 1924–25, and 1927–28. The corn supplies October 1 in the year preceding each of these 3 years were among the largest on record, and apparently that induced an expansion in hog breeding that persisted through the following year.

The small spring farrowings in 1935–36 and 1937–38, therefore, and the large spring farrowings of 1923–24, 1924–25, and 1927–28, can all be explained by the size of the corn supplies October 1 of the year before. (Corn supplies in the current year are already taken into account in the current hog-corn price ratio.[30]) If the residuals from the curved line drawn in freehand in figure 21, *A* are all plotted against corn supplies the year before in each case, as in figure 21, *B*, they show some positive relationship.

The previous discussion does not by any means provide a complete explanation of the number of sows farrowed in the spring. Additional factors need to be taken into account. The dot for the year 1933–34, for instance, is low, partly as a result of the AAA hog-reduction campaign at that time, which called for a 25-percent reduction in hogs. The reduction actually effected was 25.2. Obviously, that decrease in hog farrowings was not the result of the reduction campaign alone; the hog-corn ratio was low (8.5) and a marked reduction was in the cards anyway. But the AAA campaign apparently caused the reduction to be greater than it otherwise would have been.

Other factors explain the situation in other years. The number of sows farrowed in the spring of 1922 was high, apparently because it followed several years of large hog crops (in turn caused by several years of large corn crops); the hog industry was still in an overdistended condition. The numbers of sows farrowed in the spring of 1938 and 1939 were low, perhaps because of the effects of the high loan rates for corn.

Further research is required to determine more accurately the causes of changes in spring farrowings. The chief value of the preliminary explorations is that they provide tentative measures of the effect of the hog-corn ratio on spring farrowings. Even these measures are not entirely consistent. The response of farrowings to the hog-corn price ratio shown in figure 21*B* can be represented by a straight line with an elasticity of about 0.6. There is some indication that the line should be curved, but not much. The response in figure 22*A* can be represented by a similar straight line of about the same overall elasticity, but it is much more accurately represented by the markedly curved line shown in the chart, whose elasticity differs at different points along the line. The curved line indicates that hog-corn price ratios ranging between 8 and 12 have, on the average, about a 1 to 1 effect on spring farrowings. That is, a change of

[30] Corn supplies on October 1 of the *current* year show practically no relation with the residuals from figure 22, *A*. The hog-corn price ratios from October to February of the preceding year show some relation, but not much; neither do the hog-corn price ratios from October to September of the preceding year.

10 percent in the price ratio causes about a 10-percent change in the same direction in the number of sows farrowing the next spring. The lower the price ratio, the greater the effect. The higher price ratios have less and less effect on farrowings as they get higher and higher. Changes in the price ratio from 14 to 17 have almost no effect on farrowings.

The same sort of analysis, applied to the hog-corn ratio appropriate to the fall farrowings, yields inconclusive results. The relation between the hog-corn ratio for March–August and the fall farrowings is poorly defined. Further work, using other factors, is needed. More detailed examination by States of both the spring and fall data is also required.

Procedure for Meeting Changes in the Demand for Hogs

Insofar as any broad simple conclusion can be drawn from the preceding analysis, it is this: The way to deal with expansions and contractions in the demand for pork is to meet them with corresponding expansions and contractions in the production of hogs. The way to do this, in turn, is to change the hog-corn price ratio—to raise it when expansion is desired, and lower it when contraction is desired. Changes in the hog-corn ratio must be made at least a year in advance of the time when the change in pork production is needed, because the gestation period of the hog is 120 days, and it takes 8 or 9 months to raise an average pig from farrowing time to a market weight of 225 to 250 pounds. That action should be backed up by providing the right quantity of corn to feed the number of hogs desired.

Abstractly, there are two ways of changing the hog-corn price ratio. One is to change the price of hogs, and the other is to change the price of corn (or, both prices can be changed, in opposite directions).

But in actual practice the most effective way to change the hog-corn price ratio is to change the price of hogs, unless the change in production of hogs is to be followed quickly, within a year or two, by another change in the opposite direction. A specific illustration will clarify this. Suppose that an increase in the demand for pork is foreseen, and the decision is made to raise the hog-corn price ratio in order to bring about the desired increase in production of hogs. If the rise in the hog-corn price ratio is brought about by an increase in hog prices (corn prices remaining unchanged) that provides a direct stimulus to hog producers to expand their production of hogs. Along with this should go a relaxation of restrictions on acreage of corn (unless corn supplies are already excessive) so that adequate supplies of corn will be on hand to feed the increased supplies of hogs. In addition, it may be wise to draw upon the existing stocks of corn in the Ever-Normal Granary, during the interval of time before the new supplies of corn are produced.

If, however, the hog-corn price ratio is raised by a reduction in the price of corn (hog prices remaining unchanged) increased production of hogs will be stimulated, but several undesirable effects will follow:

(1) Only a sort of back-handed stimulus to increased hog production would be provided; hog producers would be pushed into an expansion of production because of low corn prices, instead of being

drawn into it because of high prices of hogs. (2) Even though restrictions on corn acreage were relaxed, the fact that the price of corn was lowered would act as a discouragement to corn producers, and production of corn might not increase; it might even decrease. Then when the increased production of hogs materialized, there would not be corn enough to feed them. (3) Lowering the price of corn would be likely to conflict with the policy followed by the administrators of the corn supply-stabilization program.

It seems clear that the desired changes in the hog-corn price ratio should be brought about by changes in the price of hogs, not by changes in the price of corn. And along with the changes in the price of hogs should go corresponding changes in the utilization of corn in the Ever-Normal Granary and in the production of corn, to provide the right quantity of feed for the number of hogs produced.

How Can the Price of Hogs Be Changed?

The phrases "change the price of corn," "change the price of hogs," and "change the production of corn" are used rather glibly in the preceding explanation, as though it were easy to do those things. In the case of corn prices there is some excuse for this, as the price of corn is pretty well controlled by the loan rate set for corn; changing the loan rate (within limits) changes the price of corn. There is also some warrant for speaking of changing the production of corn, for corn is controlled to some extent by the acreage-control programs of the Agricultural Adjustment Administration. The price of hogs is a different matter, as there is no loan program for hogs. How would the administrators go about changing the price of hogs?

The experience in 1941 provides a partial answer. The United States Department of Agriculture, foreseeing an increased demand for pork and dairy and poultry products for export to Britain as well as for meeting the increasing domestic demand, announced early in April that it would

> make purchases of hog products in the open market to support a long-term level of prices of $9.00 per 100 pounds, based on the average price of all hogs at Chicago. In making purchases to support this level, consideration will be given to seasonal price variations and possible changes from existing price relationships. The program, therefore, does not provide for a fixed price of hogs.
>
> The Government's purchases of pork and lard and other products in the open market will be used to accumulate reserve supplies of food. These supplies can be used for transfer to Great Britain and other countries under the provisions of the Lease-Lend Act; for release upon the market in case of unwarranted speculative price increases; to meet requests from the Red Cross for shipment to war refugee areas; and for direct distribution in the United States through school lunch programs or through State welfare departments to public aid families. Arrangements also are being made for coordination of these purchases with those being made for our armed forces.[45]

The Department knew that farmers were more influenced by actual prices than by predictions of prices. The United States average farm price of hogs in March 1941 was only $7.08 per 100 pounds. The corresponding price of corn was 57 cents. The hog-corn price ratio, therefore, was only 12.4. The average ratio for March, over the 17-year period 1924–40, was 12.4. The ratio in March 1941, therefore, was only average, and production of hogs would not increase in response

[45] United States Bureau of Agricultural Economics. The livestock situation. No. 22, [20] pp., illus. 1941. [Processed.] See p. 9.

to an average hog-corn price ratio unless some drastic incentive of some other kind were offered.

The incentive in this case was an outright guarantee of $9 per 100 pounds for hogs for the next 2 years. The Department was able to make this guarantee because it could be implemented by purchases of pork and lard for any of the purposes specified, if the market did not rise to $9 unaided.

The main way the Government can raise the price of hogs is to make purchases of pork and pork products. What could the Government do with these purchased products if extensive outlets for disposing of them were not available? It could sell them currently, but only at a loss. Perhaps the loss could be avoided by some form of storage, carrying the products over for a year. Conceivably, purchase and carry-over of these products could serve two purposes—it could support the price during the current year because of the removal of part of the supply, and could also add to the supply during the next year when large supplies might be desired.

Can pork products be stored as suggested? That is largely a technical, physical, and chemical question. About 55 percent of the hog carcass is sold as fresh pork, and the rest as cured products—ham, bacon, etc. It might be possible to extend the curing period for the cured products; or perhaps they, as well as the fresh products, could be kept better by freezing. Perhaps they could be canned. Such problems lie outside the writer's field; they are mentioned as possibilities needing exploration by men who know something about pork curing and storage.

If storage of pork products were found to be impossible, either for physical or chemical reasons, or because of high costs, something still could be done. The Government could estimate requirements a year ahead, and guarantee a price, not for the next 2 years, but for the second year only, thus giving farmers a definite goal to shoot at, and enough time to breed their sows, raise the pigs, and send them to market at the desired weights. During the first year this would create no problem for the Government.

The risk assumed by the Government during the second year, with its guaranteed price in effect, would be high. A lot can happen in 12 months, and more yet in 24 months. Unpredictable events can increase or decrease drastically the demand for meat. The supply is subject to unpredictable forces also; the size of the average litter, alone, may change as much as 3 percent from one year to the next, as it has several times during the last 15 years, largely because of unpredictable changes in the weather. Three percent does not sound like very much, but the demand for hogs is inelastic, and a change of 3 percent in supply would cause an opposite change of 5 percent in price. That would amount to 50 cents per 100 pounds on $10 hogs, which, in turn, would amount to 70 million dollars on 14 billion pounds of hogs (a representative annual slaughter). The relation between total national income (or any of the major indexes used to measure demand) and hog prices is also inelastic, and changes from that side are larger than those on the supply side (if fluctuations in the supply of corn are removed). Losses could easily run up to several hundred million dollars.

Losses could be minimized by the Government setting its guaranteed price 50 cents or $1 per hundred pounds under its estimate, so as to be on the safe side. Most farmers would produce more hogs in response to a guarantee of $9 than to a forecast of $10. A guarantee of 90 percent of the estimated future value of the hogs would be a substantial step toward price assurance; yet stopping short of 100 percent would greatly reduce the risk to the Government. In addition, the distribution of pork and lard to low-income families could be increased, pork and lard could be put on the surplus list, and so on. Perhaps a major part of the risks could be eliminated.

IS A CONTROLLED SYSTEM ANY BETTER THAN THE OPEN-MARKET SYSTEM?

In conclusion, the broad question may well be asked: How would a system for controlling production and prices of corn and hogs, with all its difficulties and dangers, work out any better than the automatic, open competitive-market system of the past?

The way in which controlled production and prices would increase farmers' incomes and decrease their costs, and assure consumers a flow of livestock products more nearly in line with changes in their demand, has been shown. What is needed here is to survey the marketing mechanism in somewhat broader perspective.

One of the basic shortcomings of the competitive-market system for corn and hogs was that it did not look far enough ahead. It satisfied classical economists well enough. When supplies were scanty relative to demand, prices rose, and that encouraged production to expand until it was great enough to satisfy the demand. But this appraisal was too lordly in its sweep. It does not satisfy us today. It overlooked the lag of a year between a scarcity of a product like corn and an expansion in production to overcome that scarcity. The same thing was true of a surplus. It also overlooked the fact that fluctuations in yields from year to year were reduced only to a small extent by storage of only one-fifth of the surplus in large-crop years to be added to supplies in short-crop years. A large crop of corn resulting from high yields depressed prices of corn and increased production of hogs even though it was clearly recognized that the weather would change and the corn crop would be small again in the near future (in terms of a few years). The speculative-market price forecasts were based almost entirely on events that had already happened or were in process of happening, not on longer range statistical probabilities. The market was reasonably perfect, chronologically, within periods of about a year, but it was very imperfect over longer periods of time. It was too short-sighted.

The same sort of shortcoming was even more marked in the market for hogs. Hogs and pork are perishable, and when supplies are large they sell at low prices even though short supplies and high prices may be imminent a few months later, a fact which was clearly illustrated in 1940 and 1941. During the last 3 months of 1940, the price of hogs at Chicago ranged only a few cents above $6 until the middle of December, although the factors that were to carry hog prices almost twice that high within 6 months were pretty well known at the time. The monthly average price of hogs remained below $8 until April, 1941 when the Department of Agriculture announced that it would support hog prices at $9. Yet by the end of June, 1941 hog prices had risen above $11.

Stabilizing corn supplies by means of Government loans takes care of fluctuations in the supply of corn and hogs, but it still leaves the problem of fluctuations in the demand for hogs unsolved. The best way to bring about the corresponding changes in hog production is to change the price of hogs, and the problem reduces to the problem of changing the price of hogs, or at least guaranteeing that the change will take place, a year in advance of the time when the change in production of hogs is needed. That problem reduces to chemical and physical problems of processing and storing, to the economic problems of the costs of storing if it is physically feasible, to the problem of forecasting changes in demand a year and more in advance, and to the problem of keeping the risk of financial losses by the Government as low as possible. If those problems can be solved, the present program for stabilizing corn and hog supplies will become only a part of a broader program that will keep supplies of pork and lard more closely adjusted to demand than the uncontrolled-market system has been able to do in the past.

SUMMARY AND CONCLUSIONS

The job of controlling supplies and prices of corn and hogs consists essentially in (1) *taking out* the erratic fluctuations from year to year in supplies of corn and hogs that result from unpredictable changes in the weather, and (2) *putting in* the changes in production of corn and hogs from year to year that are required to meet changes in demand.

(1) The first of those jobs boils down to stabilizing supplies of corn. It involves four problems:

(a) *How large should the storage stocks (carry-over) of corn be in order to stabilize corn supplies?* Practically complete stabilization for all emergencies over the last 75 years, except for the one period from 1933-36, could have been attained with storage stocks not exceeding a billion bushels at any time. A program for the future could get along very well with storage stocks of 700 or 800 million bushels, if hybrid corn reduces the effects of drought and if control of production is effective.

(b) *Where should the storage stocks be located?* If the storage stocks for the country as a whole equalled, for example, 25 percent of the average production of corn, then the stocks in each State should equal 25 percent of the average production of corn in that State, multiplied in each case by a figure representing the severity of fluctuations in corn production in the State. In addition, the corn should be stored as far north as possible, in order to keep down damage by insects. Appraisal by this standard shows that farm stocks in October, 1941, ranged from twice as large as necessary in Iowa to one-eighth as large as necessary in Kansas.

(c) *Should corn loans continue to be made at the same flat rate all over the commercial corn area?* They should not. The corn-storage program would disturb corn-storage practices and relative livestock production in different parts of the Corn Belt less if the existing flat loan rate were replaced by a system of geographical differentials corresponding to average corn-price differentials over the last 15 or 20 years. An alternative system could be based on average prices at terminal markets and freight rates to those markets.

(d) *Should the corn supply-stabilization program be made to finance itself? If so, how? If not, who should pay for it?* It would be possible to make the stabilization program finance itself, from a banker point of view, by stopping short of complete stabilization and setting the loan rate each year a few cents below the price at which an average crop would sell. The price would then rise enough from large-crop years to short-crop years to cover the costs of storage. But as stabilizing supplies of corn increases gross incomes to farmers from the sale (or feeding) of corn, and also reduces the costs of producing, processing, and distributing livestock, perhaps it would be better to go all the way to complete stabilization. If farmers retained the benefits from this stabilization of supplies, it would seem that they should bear the costs. If, however, production expanded and the benefits were passed on to consumers in the form of more goods at lower prices, it would seem that the costs should be charged to them.

It would be well in any case to include a "life-saver" clause in the formula for determining the loan rate, so that the rate would be reduced automatically if the storage stocks exceeded half a billion bushels or some similar figure.

(2) Controlling the demand for corn and hogs:

Demand cannot be controlled (except to a very limited extent, perhaps 1 or 2 percent, by surplus-disposal programs) without stabilizing the whole economy. Until that is accomplished, the only feasible way to deal with fluctuations in demand for hogs is to meet them with corresponding fluctuations in production of hogs. That will require a more farsighted control of hog production than the open market has afforded in the past, for (a) pork is perishable, and large supplies sell at low prices even though short supplies and high prices may be imminent a few months later, (b) producers respond much more to present prices than to prospective prices, and (c) the decision to increase or reduce the number of hogs going to market must be made at least a year in advance of the time when the market supplies of finished hogs are needed.

The hog market can be made more farsighted by Government forecasts of the requirements for pork and lard a year or more in the future, implemented by a guaranteed price for hogs that will call forth the production needed. Risks of financial losses are involved, but they could be minimized if the Government guaranteed only 90 percent of the estimated price, and disposed of any unforeseen surpluses to low-income groups of consumers.

The system described, with all its difficulties and dangers, would keep corn and hog supplies more closely adjusted to demand than the uncontrolled market system ever did.

LITERATURE CITED

(1) Baker, O. E., and Genung, A. B.
1938. A GRAPHIC SUMMARY OF FARM CROPS. U. S. Dept. Agr. Misc. Pub. 267, 129 pp., illus. *See* p. 22.

(2) Bentley, Ronald C.
1928. THE MOVEMENT OF IOWA'S COMMERCIAL CORN AND OATS. Iowa Agr. Expt. Sta. Bul. 252, pp. 333–383, illus.

(3) ———
1934. THE DESTINATION OF IOWA'S COMMERCIAL CORN. Iowa Agr. Expt. Sta. Bul. 318, 64 pp., illus.

(4) Brownlee, O. H., and Schultz, T. W.
1941. NO PRODUCTION CONTROL. Iowa Farm Econ. 7 (5): 12–13, 16, illus.

(5) CHEN, HUAN-CHANG.
1911. THE ECONOMIC PRINCIPLES OF CONFUCIUS AND HIS SCHOOL. 2 v. Columbia Univ. Studies Hist., Econ., and Pub. Law, v. 44–45. New York.

(6) GOLD, NORMAN LEON, HOFFMAN, A. C., and WAUGH, FREDERICK V.
1940. ECONOMIC ANALYSIS OF THE FOOD STAMP PLAN; A SPECIAL REPORT. 98 pp., illus. Washington, [D. C.].

(7) GUNDERSON, H., and DECKER, G. C.
1941. ARE BUGS IN YOUR CORN? Iowa Agr. Col. Farm Sci. Rptr. 2 (1): 3–5, 16, illus.

(8) GUTHRIE, CHESTER L.
1941. A SEVENTEENTH CENTURY "EVER-NORMAL GRANARY": THE ALHÓNDIGA OF COLONIAL MEXICO CITY. Agr. Hist. 15 (1): 37–43.

(9) HOGAN, A. G., WEAVER, L. A., EDINGER, A. T., and TROWBRIDGE, E. A.
1925. THE RELATION OF FEED CONSUMED TO PROTEIN AND ENERGY RETENTION. Mo. Agr. Expt. Sta. Res. Bul. 73, 42 pp., illus.

(10) HOPKINS, JOHN A., JR.
1929. WHY HOG PROFITS VARY. Iowa Agr. Expt. Sta. Bul. 255, 12 pp. (Abridged.)

(11) HOWELL, L. D.
1941. COTTON-PRICE RELATIONSHIPS AND OUTLETS FOR AMERICAN COTTON. U. S. Dept. Agr. Tech. Bul. 755, 40 pp., illus.

(12) MALENBAUM, WILFRED.
1941. INDEXES ON A TYPE-FARM BASIS. Jour. Farm Econ. 23: 584–606, illus.

(13) NORTON, L. J.
1940. EFFECTS OF THE UNIFORMITY OF CORN LOANS, REGARDLESS OF LOCATION. Ill. Farm Econ., No. 67, pp. 437–439.

(14) RICHARDS, PRESTON.
1939. LIVESTOCK MARKETING METHODS AND LIVESTOCK PRICES. Jour. Farm Econ. 21: 219–227, illus.

(15) ROBINSON, JOE L., and ZUBER, MARCUS S.
1940. 1939 IOWA CORN YIELD TEST. Iowa Agr. Expt. Sta. Bul. P2, pp. 35–112, illus.

(16) ROBISON, W. L.
1919. EFFECT OF AGE OF PIGS ON THE RATE AND ECONOMY OF GAINS. Ohio Agr. Expt. Sta. Bul. 335, pp. 543–575, illus.

(17) SCHULTZ, T. W., and BROWNLEE, O. H.
1941. OUR U. S. IOWA CORN GRANARY AND HOW IT HAS AFFECTED HOGS IN THE CORN BELT. Iowa Farm Econ. 7 (1): 8–10, 16, illus.

(18) SHEPHERD, GEOFFREY, and WILCOX, WALTER W.
1937. STABILIZING CORN SUPPLIES BY STORAGE. Iowa Agr. Expt. Sta. Bul. 368, pp. [293]–344, illus.

(19) ———
1941. AGRICULTURAL PRICE ANALYSIS. 402 pp. Ames, Iowa.

(20) UNITED STATES AGRICULTURAL ADJUSTMENT ADMINISTRATION.
1938. CORN STORAGE IN THE EVER-NORMAL GRANARY. Commodity Inform. Ser. 38–Corn–2, 28 pp., illus.

(21) ———
1938. WHEAT STORAGE IN THE EVER-NORMAL GRANARY. Commodity Inform. Ser. 38–Wheat–1, 24 pp., illus.

(22) UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS.
1921–41. THE AGRICULTURAL SITUATION. v. 1–25. Washington, [D. C.].

(23) UNITED STATES DEPARTMENT OF AGRICULTURE.
1927–40. CROPS AND MARKETS. v. 4–18. Washington, [D. C.]

(24) ———
1940. AGRICULTURAL STATISTICS. 1940. Washington, [D. C.]

(25) UNITED STATES LAWS, STATUTES, etc.
1938. THE AGRICULTURAL ADJUSTMENT ACT OF 1938. 75th Cong., 3d sess. U. S. Statutes at Large. 52: 31–77.

(26) ———
1941. JOINT RESOLUTION RELATING TO CORN AND WHEAT MARKETING QUOTAS UNDER THE AGRICULTURAL ADJUSTMENT ACT OF 1938 AS AMENDED. 77th Cong., 1st sess., Pub. Law 74 [S. J. Res., 60], 3 pp.

(27) WELLS, ORIS V.
1933. FARMERS' RESPONSE TO PRICE IN HOG PRODUCTION AND MARKETING. U. S. Dept. Agr. Tech. Bul. 359, 56 pp., illus.

APPENDIX

Distribution of United States Corn Crops of Various Sizes

The distribution of United States corn crops of various sizes can be shown by classifying the crops according to size and noting the number of crops in each size group. But production of corn from 1870 to about 1910 showed an upward trend, and after 1910 a horizontal or downward trend. What is needed is to show fluctuations about the trend; and this would involve fitting some complicated function or other to the data, which in turn would raise questions as to the nature of the function—questions that different investigators would be likely to answer differently. But the trend of yields has remained horizontal throughout. A good trend line fitted to production, therefore, would look like the acreage line. The simplest and most logical thing to do, then, is to use the acreage line as the trend; this comes down to using the yield of corn per acre as the basic data to represent fluctuations in corn production about the trend.

The average United States yield of corn per acre over the 71-year period, from 1870 to 1940, is 26 bushels. The central class interval in the accompanying tabulation, therefore, is set to cover the range from 25 to 26.9 bushels. The other intervals extend in 2-bushel ranges above and below that central class interval.

The tabulation shows that the distribution of the size of the corn crops is skewed to the left. The average yield over the 71-year period is 26 bushels. The modal yields (the yields that occur most frequently) do not fall in the average range from 25 to 26.9 bushels, but in the next range above that, from 27 to 28.9 bushels. There were 27 years when the yield was below average, but 44 years when the yield was above average. Thus, there were 63 percent more large crops than small.

Frequency distribution of different sized United States corn crops, 1870–1940[1]

Number of crops	Class interval of yield per acre	Number of crops	Class interval of yield per acre
Frequency	*Bushels*	*Frequency*	*Bushels*
2	15–16.9	16	[2] 25–26.9
1	17–18.9	22	27–28.9
3	19–20.9	10	29–30.9
7	21–22.9	1	31–32.9
9	23–24.9		

[1] Size of crop represented by United States average yield per acre.
[2] Average.

How could this be? The answer is that the large crops did not exceed the average size as much as the small crops fell below it. The 44 high yields averaged 2.1 bushels above the average yield for the entire 71 years, but the 27 low yields averaged 3.3 bushels below the 71-year average. The yield exceeded 30 bushels (4 bushels above average) only three times, but it fell below 22 bushels (4 bushels below average) eight times. There were many large crops, but they were only moderately large; there were comparatively few small crops, but when they did come they were very small.

Mathematical Measures of Fluctuations in Production

Fluctuations in production can be computed mathematically and expressed in numerical form by the use of some average measure of the fluctuations. This gives an objective measure of fluctuation, except for the subjective element involved in choosing the mathematical measure to be used. But even before the choice of the average is made, the meaning of "fluctuation" must be defined. Production in a certain State might remain constant; there would be no fluctuation in that case, and any average such as the standard deviation would be zero. But what if production rose by a constant amount each year? Would that be a fluctuation? The standard deviation would be high; but the fluctuation, from the point of view of grain storage, would be zero. For grain storage is intended to smooth out fluctuations over a few years at a time, not over 20- or 30-year periods

One can come closer to the sort of fluctuation that concerns a storage program by measuring changes from one year to the next. This can be done by subtracting each year's production from the next year's production, converting the data into a series that is usually called "first differences." One would come closer yet by using first differences between some such items as 2- or 3-year averages; for while a storage operation would not cover 20 or 30 years, it would often cover 2 or 3 years, or sometimes a few more. However, this would get into more complications and subjective judgments than the results would justify. It is probably best to use first differences, a simple and standard measure.

If only first differences are considered, what average of these should be used—the standard deviation, or the simple arithmetic average, or some other average? The standard deviation gives a larger than proportional weight to the larger fluctuations. That may be desirable from the point of view of a grain-storage program; yet it is questionable whether even from that point of view one bushel should be given more weight than another. Perhaps it is worth while to compute both averages and compare them. Accordingly, both the standard deviation and the simple average deviation of the first differences (in each case, divided by the mean of the original series) are shown in table 10. They are shown separately for the period 1901–20, for the period 1921–40, and for the entire period 1901–40, for each of the nine Corn Belt States.

Comparisons of the two measures show that the standard deviations run from about 25 percent to about 30 percent higher than the average deviations. The differences of course are the greatest where a few large changes in production occur, as when these are squared they add more than proportionally to the total of which the square root is extracted. By and large, however, the relation between the two measures is so nearly uniform that it makes very little difference which one is used. The standard deviation (divided by the mean of the original series in each case to convert it to a coefficient of variation) is chosen for use in the body of this report because it is the most universally accepted measure of fluctuation.

TABLE 10.—*Measures of fluctuation in corn production, by States, 1901–40* [1]

Measures of fluctuation	Iowa	Illinois	Indiana	Ohio	Minnesota	South Dakota	Nebraska	Kansas	Missouri	Wisconsin	Michigan
1901–20											
$\frac{\sigma \times 100}{M}$	10.0	21.4	20.0	16.5	17.0	20.1	31.6	54.7	43.6	20.3	14.1
$\frac{Md \times 100}{M}$	16.5	17.1	16.0	14.1	12.4	16.6	25.0	44.4	34.8	14.4	11.9
1921–40											
$\frac{\sigma \times 100}{M}$	20.7	29.6	29.0	28.1	26.3	44.8	49.4	45.4	31.3	24.5	26.0
$\frac{Md \times 100}{M}$	21.8	24.3	25.2	23.0	24.8	30.1	40.5	35.7	24.0	19.0	22.3
1901–40											
$\frac{\sigma \times 100}{M}$	25.5	25.4	24.2	22.6	27.6	37.5	40.5	52.9	40.7	23.3	20.7
$\frac{Md \times 100}{M}$	19.4	20.4	20.2	18.4	20.7	20.1	32.7	40.0	30.3	17.1	16.8

[1] Let—
σ = Standard deviation of the first differences.
M = Mean of the original series.
Md = Mean of the first differences.
The dates refer to the difference between production in the year specified, and production the year before. The date 1901, for example, refers to the difference between production in 1900 and 1901.

EVER-NORMAL GRANARIES FOR OTHER FEED GRAINS

Corn is the chief feed grain in the United States, but it is not the only one. Even if corn supplies were completely stabilized, total feed grain supplies would still fluctuate to some extent with fluctuations in the production of other feed crops. A corn-stabilization program by itself may not be sufficient; perhaps the total supply of all feed grains needs to be stabilized.

On a tonnage basis, corn constitutes about 75 percent of the total feed grains. Oats make up about 20 percent, and barley and grain sorghums together, the remaining 5 percent. Wheat is not ordinarily included as a feed grain, but 2 or 3 million tons of wheat are usually fed annually—about equal to the quantity of grain sorghum. The correlation between the fluctuation in the production of these feed crops is not perfect, and while stabilizing supplies of corn would take out most of the fluctuation in total feed supplies, it would not take out all of it.

Study of the production data for the different feed crops shows that production of oats is more stable than production of corn. The other crops, however, fluctuate more than does corn.

The situation may perhaps be summarized in these words: Stabilizing supplies of corn would take out most of the fluctuation in total production of feed grains but before total supplies of feed can be completely stabilized, it will be necessary to set up stabilization programs for the other feed crops too.

U. S. GOVERNMENT PRINTING OFFICE: 1942

END