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# WHEAT STUDIES

## OF THE FOOD RESEARCH INSTITUTE

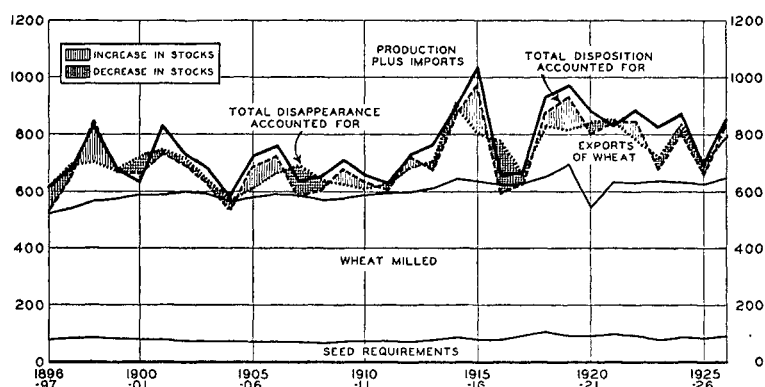
VOL. IV, NO. 4

FEBRUARY 1928

### DISPOSITION OF AMERICAN WHEAT SINCE 1896 WITH SPECIAL REFERENCE TO CHANGES IN YEAR-END STOCKS

WHEAT SUPPLIES AND DISPOSITION IN THE UNITED STATES,  
1896-97 TO 1926-27

(Million bushels)



Total production of wheat in the United States, plus imports, varies greatly from year to year, as shown by the heavy solid line on this chart. Quantities of wheat used for seed (shown by the lowest curve on the chart), and for seed and milling, together (shown by the second curve), vary little from year to year. Adding the exports gives the total disappearance accounted for (the line of round dots), which sometimes exceeds the production plus imports, and sometimes falls far short of the latter. Adding or subtracting changes in stocks between the beginning and the end of each year gives the total disposition accounted for (the line of short dashes), which follows quite closely the curve of production plus imports, leaving in most years a small margin unaccounted for, which theoretically represents feed and waste. The surplus from a large crop is absorbed by increased consumption only to a negligible extent; on the average, about half of such a surplus is exported and half absorbed in increases in stocks.

STANFORD UNIVERSITY, CALIFORNIA

February 1928

# W H E A T   S T U D I E S

## OF THE

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The central feature of the series is a periodic analysis of the world wheat situation, with special reference to the outlook for supplies, requirements, trade, and prices. Each volume includes a comprehensive review of the preceding crop year, and three surveys of current developments at intervals of about four months. These issues contain a careful selection of relevant statistical material, presented in detail in appendix tables for reference purposes, and in summary form in text tables and charts.

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Entered as second-class matter February 11, 1925, at the post-office at Palo Alto, Stanford University Branch, California, under the Act of August 24, 1912.  
Published by Stanford University for the Food Research Institute.

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#### FOOD RESEARCH INSTITUTE

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The Food Research Institute was established at Stanford University in 1921 jointly by the Carnegie Corporation of New York and the Trustees of Leland Stanford Junior University, for research in the production, distribution, and consumption of food.

# DISPOSITION OF AMERICAN WHEAT SINCE 1896

## WITH SPECIAL REFERENCE TO CHANGES IN YEAR-END STOCKS

### I. SUMMARY

Tabulations of the disposition of American wheat supplies over a period of years are of interest from at least three different points of view. First, they provide a record of the course of production, consumption, exports, and the other elements of disposition, satisfying the common desire to know what changes have taken place in these series over a period of years. Secondly, they furnish a basis for judgments, which must be formed anew each year, of the probable disposition of the current year's supplies, and of the prices to be expected from the current supply and demand situation. And finally, close study of the discrepancies between the statistics of supplies and of disposition in past years yields information on the defects and errors in the existing statistics—information which may be of the greatest value both in revealing the points at which current statistics are most in need of improvement, and in avoiding or removing mistaken interpretations of the data.

We undertake here to bring together the best existing data on supplies and disposition of wheat in the United States by crop years beginning with 1896-97, providing a more complete and accurate record than has previously been available, and to point out some of the more important conclusions suggested by a study of the data. The tabulation of supplies and disposition here presented differs most notably from those previously in use in employing our recent independent estimates of wheat ground in the United States by crop years and improved data on year-end stocks of wheat, including estimates of stocks not covered by the existing statistics.

The most significant result of this compilation and analysis is the demonstration that changes from year to year in the quantity of old wheat carried into the new crop year are much more important than has generally been realized. It now appears that the actual changes in year-end stocks over most of the last 30 years have been nearly twice as great as has been indicated by the existing statistics. In their relation to the supply and demand situation these

changes in year-end stocks rank in importance next to the changes in size of crop and on a par with the changes in exports. Between the beginning and the end of a single year as much as 173 million bushels of wheat have been added to the supplies for domestic consumption and export by merely reducing year-end stocks of old wheat. During the past 31 years there have been

20 in which stocks have been reduced and in 4 out of the 20 the reduction in stocks has amounted to over 50 million bushels. The absorption of wheat by increasing total stocks has run as high as 110 million bushels in one year of the last 31; and in the 11 years in which stocks were increased, the increase has 7 times exceeded 50 million bushels.

The importance of changes in stocks becomes clearer when viewed in its relation to the general supply and demand situation under varying conditions. Chart 1 (p. 136) presents the facts graphically. The wheat crop of the United States varies widely from year to year; the difference between crops of successive years has amounted to as much as 389 million bushels, and has exceeded 80 million bushels 16 times in the last 31

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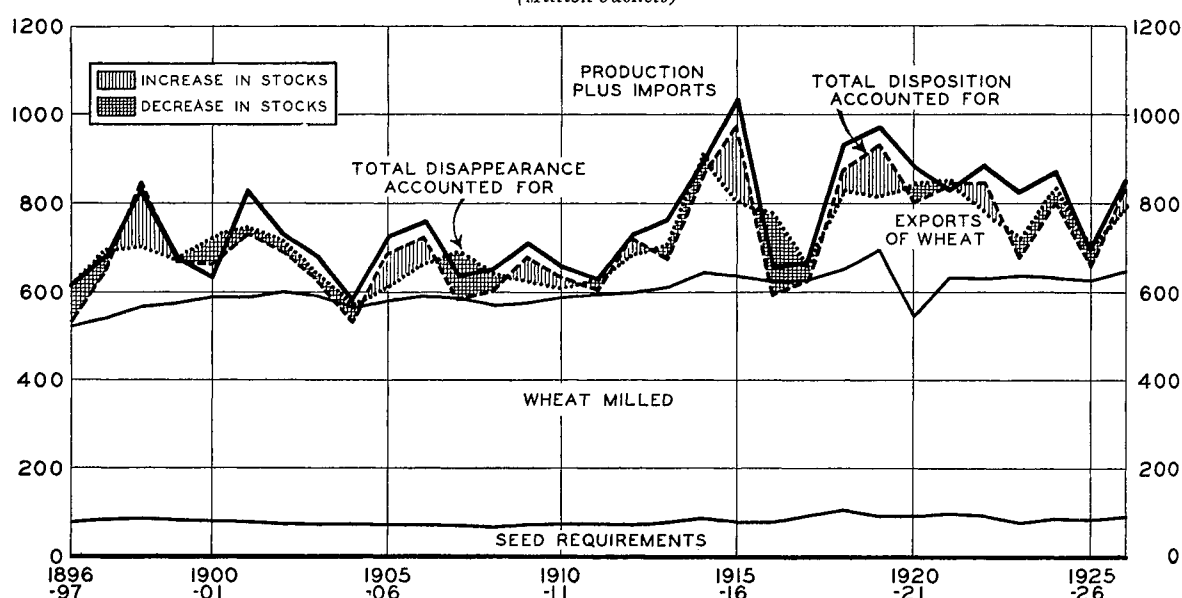
years. The quantity of wheat used for food in the United States, however, is practically unaffected by the supply and price situation. Seed requirements vary little from year to year, and though little is known of the variation in feed and waste, the changes from year to year can seldom exceed 20 or 30 million bushels. The variation in size of the crops must be absorbed almost entirely by variation in net exports and by reducing or increasing year-end stocks.

The important part played by exports in this respect is well known. It now appears,

ment of supplies to demand. Export demand is sometimes weak in years of large United States crops or strong when crops are short. Then in years of large crops and weak foreign demand the excessive supplies are absorbed entirely by increasing stocks as in 1905-6 and 1915-16, while the difficult situation of short domestic supplies and strong export demand is met by heavy reductions in stocks, as in 1907-8 and 1916-17.

The foregoing conclusions are based upon existing statistics of wheat stocks, supple-

CHART 1.—WHEAT SUPPLIES AND DISPOSITION IN THE UNITED STATES, 1896-97 TO 1926-27\*  
(Million bushels)



\* Data from Appendix Table I. Total disappearance accounted for is obtained by adding together seed requirements, wheat milled, and exports. The total disposition accounted for is the disappearance plus increases in stocks between the beginning and the end of each year, or minus decreases in stocks. This calculated total closely parallels the supplies from production and imports, with usually a small margin unaccounted for. The quantities milled and used for seed change little from year to year. The variation in the crops is absorbed about one-half by changes in exports and one-half by changes in stocks.

however, that changes in year-end stocks of wheat have played an equal part with variations in exports in absorbing the fluctuations in the crops. On the average the excess supplies from a large crop are absorbed nearly one-half by increased exports and one-half by additions to stocks, while the deficient supplies from a short crop are met about one-half by increased imports and reduced exports and again one-half by drawing down stocks. Nor does this statement reveal the full significance of changes in year-end stocks of wheat in the adjust-

mented by somewhat rough, but conservative, estimates of the large element of stocks not covered by the earlier statistics. A complete and accurate record might well show changes in stocks playing an even more important part than is here indicated. In any case, it becomes clear that for an accurate judgment of the supply and demand situation in any year, the need for complete and accurate information on year-end stocks of wheat is nearly as great as the need for accurate statistics of production. This need has recently been recognized in

the United States, and the statistics of year-end stocks of wheat in this country seem now to have been rendered practically complete. For many countries, however, statistics of year-end stocks are almost entirely lacking.

Recognition of the part played by the changes in wheat stocks in adjusting annual supplies to the demand raises many questions. With few exceptions the decision to increase or to decrease stocks is left wholly to the judgment of individuals acting independently. Is the judgment generally good and are stocks wisely regulated or not? The level of stocks clearly depends to a large extent on the price situation and at the same time reacts strongly on wheat prices. But what, precisely, are the relations of wheat prices to the level of year-end stocks? Are there important factors other than wheat prices which bear on the level of stocks, and through them on the prices of wheat? If so, what are their effects? These are pressing problems, the existence of which has scarcely been recognized. The primary function of this study is to demonstrate the existence and the outstanding importance of these problems. To find the answers is a task for numerous further investigations.

The principal further conclusions to which the study has led are two. First, it appears that there are important errors in the statistics of supplies and disposition of wheat in the United States for even the more recent years. It is not possible to determine with certainty the source of the errors, but in our opinion the larger ones are in the production estimates. The Department of Agriculture has greatly improved its methods of preparing these estimates, but with the radical changes in wheat acreage in recent years, the task of obtaining accurate acreage estimates has been very difficult. It may well be that something approaching an annual census of wheat acreage will be required to remove the danger of occasional serious errors.

It appears also that there is need for more information on the amounts of wheat used for feed in the United States. Calculations of "feed and waste" obtained by deducting from the statistics of supplies, the statistics and estimates for all the other items of disposition leave a balance subject to so

much error that it cannot be regarded as reflecting actual feed and waste with any accuracy whatsoever. The quantity of wheat used for feed is presumably subject to considerable variation, and it is important to have some basis for estimating this element in the disposition. Independent statistics on feed and waste would serve a useful purpose also in making it possible to draw up a complete balance sheet with independent estimates of each of the items of supply and of disposition; and thus the presence of important errors in any of the statistics involved would be revealed more quickly and accurately.

#### FORM OF DISPOSITION TABULATION

In bringing together the statistics of supplies and disposition in the following pages, we have adopted a plan of organization differing somewhat from that usually employed. Instead of starting with the statistics of stocks on hand at the beginning of the year, counted as part of the supplies, we leave stocks to be taken account of only at the end of the calculation, and then only in the form of *changes in stocks*. Total imports of wheat are added to the estimated production to obtain the apparent total supply of new wheat for the crop year. From this total are subtracted the several items of disappearance other than feed and waste, namely, the estimated requirements for seed, the estimates of total wheat ground, and the statistics of exports and other shipments out of the continental United States. From the remainder is deducted the amount of the increase in stocks between the beginning and the end of the year, if stocks were increased, or to it is added the amount of the decrease in stocks, if stocks were drawn down. The final figure thus obtained presumably represents feed and waste.

This method necessarily leads to the same final figures as would be obtained from the same data using the more common method in which stocks at the beginning of the year are included with supplies, and stocks at the end of the year are counted as one of the items of disposition. The more common method of calculation is undoubtedly simpler for most purposes, but when the attempt is made to follow it through the analysis of problems encoun-

tered in the following pages, it becomes much the more complicated and difficult of the two methods. The method here used has a further advantage in addition to its greater simplicity for present purposes: it emphasizes the one aspect of stocks which is important for a tabulation of disposition, namely, the changes in stocks between the beginning and the end of each crop year. If stocks stood at substantially the same levels at the close of each crop year, it would be quite immaterial whether stocks were included in the disposition tabulation or not. Only the changes in stocks are important, and by framing the disposition tabulation so as to include these changes explicitly, their significance becomes more readily apparent.

#### METHOD OF PROCEDURE

A brief preliminary outline of the method of procedure employed in the study may be of aid in following the successive steps as presented in subsequent pages. We assemble first the statistics of annual supplies and disappearance of wheat by crop years beginning with July 1, 1896,<sup>1</sup> and set up a tabulation of disposition in which "feed and waste" is treated as the residual item, obtained by subtracting all the other items of disposition from the total supply. Study of the resulting figures, together with other data, leads to the conclusion that the changes in "feed and waste" as thus calculated represent largely, not actual changes in feed and waste, but variations in the residual item consequent on the serious incompleteness of the statistics of changes in stocks used in the disposition tabulation. In short, changes in the apparent feed and waste represent chiefly changes in year-end stocks not covered by the statistics.

The deficiency in the statistics of changes in stocks we next undertake to remedy by

finding a basis for estimating the changes not recorded in the statistics. This requires first a close examination of the existing statistics, a selection of the most useful series from among those available, and the compilation of two new series from the existing data. Then follows an analysis from which is derived a method of estimating the annual changes in stocks not covered by the statistics. The stocks omitted in the statistics before 1925 belong to the class commonly designated as "outside commercial" stocks. In the final presentation in Appendix Table I, changes in stocks are shown separately for the four classes: farm stocks, eastern terminal elevator stocks (at 18 principal points), Pacific Coast terminal stocks, and total outside commercial stocks. The data for the last class are our estimates of changes in all wheat stocks other than those included in the first three classes. Changes in flour stocks are not considered, since we are concerned here only with the balance of supplies and disposition of wheat as such. Appendix Table II shows the corresponding figures for total stocks in each of these classes on or about July 1 of each year.

The estimates of changes in stocks not covered by the earlier statistics complete the data necessary for the final revised tabulation of supplies and disposition, shown in Appendix Table I. The more important items of disposition are shown graphically in Chart 1 (p. 136). "Feed and waste" remains the residual item in the final tabulation, the term being kept in quotation marks to emphasize the fact, discussed at some length, that it is little more than a convenient designation for a residual item which may be of little significance as an indication either of the average magnitude or of the year-to-year changes in the actual quantities fed to live stock, or wasted.

## II. SUPPLIES AND DISAPPEARANCE

As noted above, the present study makes use of a form of the disposition tabulation

in which changes in year-end stocks of wheat are given directly as one of the items in the disposition, rather than indirectly through the inclusion of stocks at the beginning of the year and stocks at the end of the year. The items to be included in supplies are the production and the total (general) imports. The items to be included

<sup>1</sup> This date is made the starting point of the investigation because it is the first for which we have an estimate of farm stocks of wheat seemingly comparable with subsequent estimates. The first official estimate of year-end stocks on farms applies to July 1, 1895, but appears to be on a somewhat different basis from subsequent estimates.

in the disposition are (1) the exports, including shipments to possessions of the United States, and, during the war years, certain other shipments which were not included in the Department of Commerce figures; (2) wheat milled in the continental United States; (3) wheat used for seed; (4) feed, waste, and other miscellaneous forms of consumption; and (5) changes in stocks of wheat.

The first four items of disposition as listed above may conveniently be classed under the general term of *disappearance*. They stand on a different footing from the fifth item, changes in stocks, since they represent a final disposition—a complete disappearance of the product, as wheat—while disposition in the form of increased stocks represents only a temporary disposition. The total disposition in any individual year may be either larger or smaller than the total disappearance. The change in stocks is an item which may be either positive or negative. When stocks are increased between the beginning and the end of a crop year, the total disposition is greater than the total disappearance; when stocks are decreased, the total disappearance is greater than the total disposition.

Statistics of stocks of wheat and of changes in stocks, for all except the most recent years, are very incomplete, as will presently be shown. Statistics on feed and waste and on the other miscellaneous forms of consumption which we include with feed and waste as the fourth item in the disposition, are almost completely lacking. Statistics of supplies and of all the other items of disposition, while not so accurate as might be wished, appear by comparison to approach perfection. For the present, the available statistics of supplies and the statistics for the several items of disappearance other than feed and waste may be taken as they stand.

We accordingly bring these data together in the first seven columns of Appendix Table I, obtaining a statement for each crop year beginning with 1896-97 of the total supply (neglecting stocks of old wheat) and of the total disappearance, other than feed and waste. The data are shown graphically in Chart 2 (p. 140).

A conspicuous and important fact brought out by the statistics and appearing

most clearly in the chart is that the domestic utilization of wheat in the United States, so far as it is reflected in these figures, does not change greatly from year to year. The changes in the disappearance arise chiefly from variations in the quantity of wheat exported. Indeed, even the relatively small changes in domestic utilization shown in this chart arise largely from changes in the quantity of wheat milled for export in the form of flour.<sup>1</sup>

In general, exports are large in years of large crops and small in years of small crops, but there are numerous exceptions. The correspondence between size of the crop and total exports is by no means close. Neither is there a close correspondence between total supplies and total disappearance other than feed and waste, as shown respectively by the heavy solid line and the line of round dots in Chart 2.

Imports, prior to 1915-16, were never sufficiently large to show on the chart, the maximum being slightly over 3 million bushels, recorded in 1904-5. Study of the figures, however, indicates that during this period, and indeed up to the end of the war, the volume of imports was closely related to the size of the domestic crop, large imports occurring only in years of unusually short crops. Since the war the larger fraction of the general imports has been entered for warehouse and subsequently milled in bond. The imports for consumption, however, have run many times larger than before the war; and the volume of such imports has been more closely related to the quality of the crop than to its size, Canadian wheat being imported chiefly to make up deficiencies in domestic supplies of high protein wheat.<sup>2</sup> The magnitude of the imports since 1915-16 is shown in the chart by the margin between the curve representing the domestic production and the curve showing the total supplies.

The compilation of the statistics of supplies and disappearance for Appendix Table I has required consideration of a

<sup>1</sup> See "Statistics of American Wheat Milling and Flour Disposition since 1879," WHEAT STUDIES, December 1927, IV, No. 2.

<sup>2</sup> This question has been discussed at length in "American Importation of Canadian Wheat," WHEAT STUDIES, November 1926, III, No. 1.

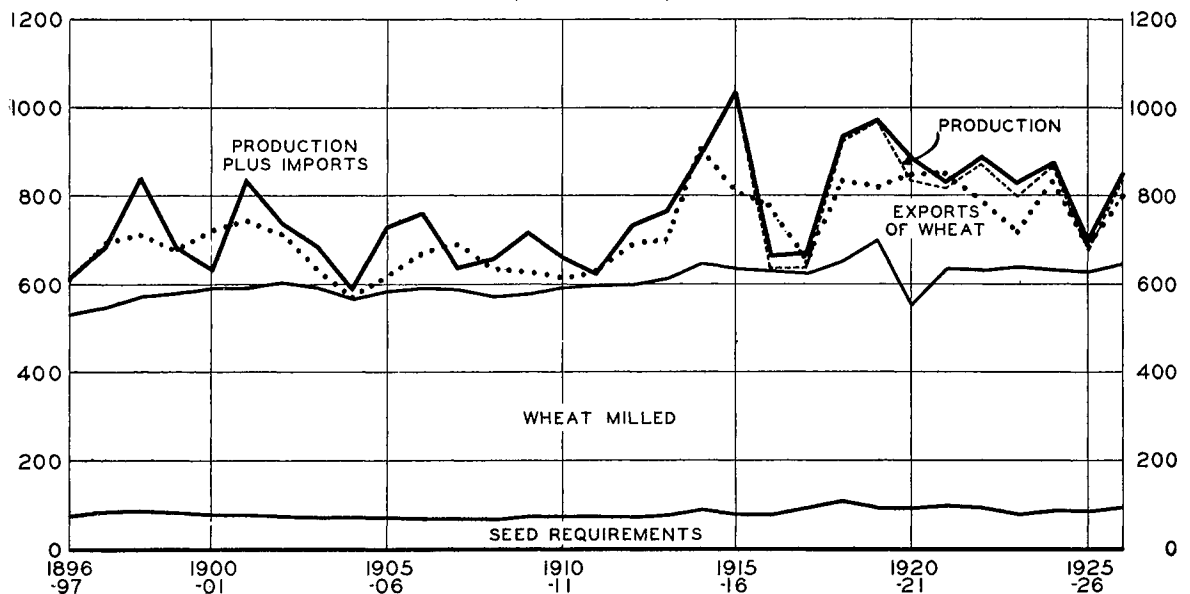


number of problems that should be mentioned for the benefit of those who study statistics of supplies and disposition critically. It is by no means easy to get together an entirely satisfactory and consistent series of such statistics over an extended period of years. When the statistics are to be analyzed closely, as in some of the following sections of this study, it is essential that they be as accurate and consistent as possible.

portant. In compiling the statistics of supplies, we have used the Food Research Institute figures for the years 1896-1910 inclusive and the latest official figures for subsequent years.

Statistics of imports of foreign wheat are available from the figures of the Bureau of Foreign and Domestic Commerce. It is most convenient and satisfactory, as a rule, to use the figures for "general imports" which presumably cover all wheat imported,

CHART 2.—SUPPLIES AND DISAPPEARANCE OF WHEAT IN THE UNITED STATES, 1896-97 TO 1926-27\*  
(Million bushels)



\* Data from Appendix Table I. Prior to 1915-16 wheat imports were too small to show on the chart, but for subsequent years are reflected in the varying margin between the line of short dashes, representing production, and the heavy solid line representing the total supplies from production plus imports. Domestic utilization for seed and milling reflects little influence from the size of the crop. Even exports do not vary closely with the size of the crop. The variations in the margin between the total of these three items of disappearance (represented by the dotted line) and the total supply are taken up chiefly by increasing or decreasing year-end stocks.

The best available statistics of annual production from 1911 to date are the official estimates of the United States Department of Agriculture, as most recently revised. For years prior to 1911 there are available, in addition to the official estimates, the revised estimates of the Food Research Institute.<sup>1</sup> For the period 1902-10 the Food Research Institute estimates differ very little from the revised Department of Agriculture figures first published in 1918, but for earlier years the differences are im-

whether for domestic consumption, for re-export, or for grinding (in bond) into flour destined for export.

The statistics of general imports, prior to the last few years at least, appear to be not entirely complete. This fact appears clearly from a calculation of the annual excess of the general imports over the imports for consumption and the re-exports. The data are shown in Table 1. The general imports should always exceed the imports for consumption by an amount equal to the quantity imported and milled for export as flour, except as the balance is affected by changes in stocks of wheat in bonded warehouses.

<sup>1</sup> Published in *WHEAT STUDIES*, June 1926, II, 260-61; see also pp. 237-39 and 256-58.

Yet negative balances are common prior to 1921, and several of the negative balances

TABLE 1.—STATISTICS RELATING TO UNITED STATES IMPORTS OF WHEAT, 1896-1926\*

(Thousand bushels)

Year	General imports	Re-exports	Imports for consumption	Excess of general imports <sup>a</sup>
July-June				
1896-1897.....	1,534	1,496	5	+ 33
1897-1898.....	2,047	1,874	10	+ 163
1898-1899.....	1,871	1,930	6	— 65
1899-1900.....	317	297	5	+ 16
1900-1901.....	600	596	5	— 1
1901-1902.....	119	45	31	+ 43
1902-1903.....	1,077	1,258	7	— 188
1903-1904.....	7	6	6	— 5
1904-1905.....	3,103	570	2,247	+ 286
1905-1906.....	58	33	123	— 98
1906-1907.....	375	597	19	— 241
1907-1908.....	342	308	32	+ 2
1908-1909.....	41	4	38	— 1
1909-1910.....	164	137	36	— 9
1910-1911.....	509	1	509	+ 1
1911-1912.....	2,699	1	2,684	+ 14
1912-1913.....	798	79	690	+ 29
1913-1914.....	1,979	746	1,038	+ 195
1914-1915.....	426	181	271	— 26
1915-1916.....	5,703	575	4,291	+ 837
1916-1917.....	24,139	54	22,879	+ 1,206
1917-1918.....	28,177	1,054	28,166	— 1,043
Jan.-Dec.				
1918.....	17,036	1,552	17,026	— 1,542
1919.....	7,911	95	7,924	— 108
1920.....	35,809	41	35,809	— 41
1921.....	23,286	741	21,707	+ 838
1922.....	22,642	52	10,560	+12,030
1923.....	19,502	96	8,930	+10,476
1924.....	15,534	30	6,895	+ 8,609
1925.....	13,901	212	1,308	+12,381
1926.....	14,143	184	451 <sup>b</sup>	+13,508

\* Data from *Monthly Summary of Foreign Commerce of the United States and Foreign Commerce and Navigation of the United States*.

<sup>a</sup> Excess over the sum of imports for consumption and re-exports; theoretically representing changes in warehouse stocks and withdrawals for milling in bond (see text, p. 140). Withdrawals for milling in bond are available for the last few fiscal years, as follows in thousand bushels:

1921-22.....	6,173	1924-25.....	5,813
1922-23.....	9,281	1925-26.....	13,470
1923-24.....	13,905	1926-27.....	13,172

<sup>b</sup> In *Foreign Commerce and Navigation* for 1926, p. 435, imports for consumption are shown in two classes: "for grinding in bond and export," 15,429,102 bushels; "other," 451,029 bushels. Wheat imported for grinding in bond and export has not previously been counted in the imports for consumption and is therefore excluded here.

are too large to be accounted for on the ground of a reduction in wheat stocks in

bonded warehouses. These discrepancies can scarcely be due to overstatement in the figures for either the imports for consumption or the re-exports; it seems much more probable that they arise from understatement in the figures for general imports.

The statistics for each year since 1921 show a large balance of general imports over the sum of imports for consumption and re-exports. These balances may be checked against the statistics of withdrawals for milling in bond. Though the check is somewhat rough owing to the fact that the one set of figures applies to calendar years, the other to crop years, there is no evidence of discrepancies since 1922 at least.

Such defects as may exist in the import statistics are of small importance since total annual imports were so small prior to 1915 that the disposition tabulation would not be affected appreciably even though it were shown that total imports were twice as large as the statistics indicate. To minimize the possible understatement of imports, however, we have calculated for each year the sum of the imports for consumption plus the re-exports, and in Appendix Table I this sum has been used in place of the general imports figure wherever it is the larger.

For statistics of exports and shipments to possessions it is necessary to take the Department of Commerce figures as they stand. Some students of export statistics have held the view that the earlier United States statistics of exports, at least, are by no means complete, but we know of no specific evidence of incompleteness in the statistics of wheat exports, and there appears in any case to be no way of materially improving upon the existing figures. Since the import statistics employed are the "general imports," the statistics of exports of both foreign and domestic wheat must be employed. Foodstuffs shipped to the various relief organizations during the war and to the American Expeditionary Forces were not included in the Department of Commerce exports. The flour shipments thus omitted in the export statistics aggregated over 6 million barrels, but the reported wheat shipments were insignificant, amounting to only 6,150 bushels.

The estimates of wheat milled, for this

tabulation, are those of the Food Research Institute,<sup>1</sup> and are believed to be accurate to within 2 or 3 per cent at least.

The data on wheat used for seed, beginning with 1900, are either the official estimates, which are obtained by allowing 1.38 bushels per acre of winter wheat sown and spring wheat harvested, or have been calculated directly by us on this basis. For the years 1900 to 1910 our revised acreage figures have been used as the basis for the calculation, separating the revised totals into winter and spring wheat in the pro-

portion indicated by the Department of Agriculture's most recent estimates and accepting the Department's estimates of percentage abandonment of winter wheat to arrive at the winter-wheat acreage sown. For the years prior to 1900, in the absence of estimates of abandonment of winter wheat, the calculation has been made on the basis of our revised estimates of acreage harvested, allowing for the average abandonment of winter-wheat acreage by using a figure of 1.48 bushels of seed per acre harvested.

### III. A TRIAL BALANCE

The total disposition of wheat in each year, taking due account of changes in year-end stocks, must necessarily equal the total supplies for the year. The disposition table for each year may be viewed as an accounting statement in which the supplies of new wheat stand in the place of receipts in a financial account, disappearance stands in the place of expenditures, and changes in stocks, in the place of "profit and loss." In practice, an accurate balance is not expected in the disposition tabulation, but a study of the discrepancies yields valuable information on the nature and magnitude of the errors in the statistics of supplies and disposition. Taken with other facts, we are able to obtain from it, indeed, a basis for supplementing the existing data where they are most defective.

#### DISPOSITION STATISTICS

The statistics discussed in the previous section furnish all the data necessary for the supply side of a tabulation of supplies and disposition. The statistics of disappearance there presented omit two ele-

ments involved in the disposition: feed and waste (a further item in the disappearance) and changes in stocks.

For statistics of changes in year-end stocks we may take the statistics of stocks compiled by the United States Department of Agriculture two years ago,<sup>2</sup> brought down to date on a comparable basis. This seems to represent the most comprehensive statement available.<sup>3</sup>

Nothing is to be gained by including estimates of feed and waste in the disposition totals. No strictly independent official estimate of feed and waste has ever been made for the United States, so far as we are aware. The only approach to an official estimate of feed and waste are the estimates, prepared in 1923, of the percentage of the crop "usually" fed in the county where grown and the percentage to be fed in that year.<sup>4</sup> Other estimates are on varying bases and none can be regarded as more than a rough approximation. In this situation it is better to leave estimates of feed and waste out of the disposition totals entirely, and to make a corresponding change in the interpretation of discrepancies between the supply totals and the disposition totals. With feed and waste omitted from the disposition totals, it is to be expected that supplies should always be in excess of the disposition, as tabulated, by the amount of the feed and waste. The excess of supplies over disposition may be tentatively termed "feed and waste," keeping the words in quotation marks. The test of the accuracy and completeness of the statistics in the tabulation of supplies and disposition will

<sup>1</sup> Published in *WHEAT STUDIES*, December 1927, IV, No. 2.

<sup>2</sup> *Wheat and Rye Statistics* (U.S. Department of Agriculture Statistical Bulletin 12), January 1926, Table 43.

<sup>3</sup> We know of no statistics of wheat stocks omitted in this compilation; in fact, it includes some duplication of statistics and a considerable quantity of flour counted as wheat. These defects are minor, however, and of no importance for present purposes since it will shortly be demonstrated that the totals, despite certain duplications, fall far short of equaling the actual total stocks of wheat.

<sup>4</sup> *Agriculture Yearbook*, 1923, p. 660.

then be found in the reasonableness or unreasonableness of the calculated "feed and waste" item.

### "FEED AND WASTE"

Proceeding with the calculations suggested above, we may set down in the first column of Table 2 the total new supply of wheat for each year. In the second column is shown the total of the several items of disappearance previously discussed, and in the fourth column, the disappearance, other than feed and waste, plus (or minus) the changes in stocks shown by the statistics included in the Department of Agriculture compilation. This total, intended to include all the elements of disposition except feed and waste, is designated as "disposition, less feed and waste." Subtracting the fourth column from the first leaves a balance which should accurately represent feed and waste, provided the statistics employed in the calculation are complete and accurate. The uncertain significance of the figures, however, may be emphasized by keeping the term "feed and waste" in quotation marks.

Casual examination of the figures for "feed and waste" thus obtained reveals the presence of errors from some source. For three years the "feed and waste" is less than nothing. In five other years the figures are below 20 million bushels, while in eleven years they exceed 60 million bushels. The wide range in the figures is furthermore not the result of any marked upward or downward trend, for high and low figures are scattered irregularly throughout the series.

One explanation of the wide variation in the calculated feed and waste is suggested by a comparison of these figures with the statistics of changes in stocks. The relationship between the two sets of figures is most clearly apparent when the data are shown graphically, as in Chart 3 (p. 144). The dotted line connecting the circles, representing changes in stocks, is about as often below the zero line as above, since increases and decreases in stocks alternate with considerable regularity. The solid line connecting the dots, representing the calculated feed and waste, is usually above the zero line—barring errors and omissions in the data, it should remain always above.

Apart from the differences in position on the chart, however, the two lines show a striking similarity. The calculated "feed and waste" is quite uniformly high in years

TABLE 2.—PRELIMINARY TABULATION OF SUPPLIES AND DISPOSITION OF WHEAT IN THE UNITED STATES, 1896-97 TO 1925-26

(Million bushels)

Year July-June	Supplies <sup>a</sup>	Disappearance other than feed and waste <sup>a</sup>	Change in statistics of stocks <sup>b</sup>	Disposition less feed and waste <sup>c</sup>	"Feed and waste" <sup>d</sup>
1896-1897.....	614.1	608.5	— 67.7	540.8	+ 73.3
1897-1898.....	687.0	695.6	— 21.2	674.4	+ 12.6
1898-1899.....	833.5	708.7	+ 99.3	808.0	+ 25.5
1899-1900.....	682.5	679.3	+ 6.6	685.9	— 3.4
1900-1901.....	639.2	720.9	— 52.9	668.0	— 28.8
1901-1902.....	829.0	740.9	+ 3.4	744.3	+ 84.7
1902-1903.....	739.2	715.6	— 21.0	694.6	+ 44.6
1903-1904.....	681.5	635.0	— 9.7	625.3	+ 56.2
1904-1905.....	584.1	567.6	— 16.8	550.8	+ 33.3
1905-1906.....	727.4	617.4	+ 46.4	663.8	+ 63.6
1906-1907.....	760.3	667.2	+ 30.1	697.3	+ 63.0
1907-1908.....	637.1	686.3	— 65.3	621.0	+ 16.1
1908-1909.....	654.5	637.3	— 23.8	613.5	+ 41.0
1909-1910.....	712.9	624.3	+ 45.2	669.5	+ 43.4
1910-1911.....	660.4	610.4	+ 7.6	618.0	+ 42.4
1911-1912.....	624.0	625.4	— 15.2	610.2	+ 13.8
1912-1913.....	731.1	689.9	+ 12.4	702.3	+ 28.8
1913-1914.....	765.4	701.5	— 13.1	688.4	+ 77.0
1914-1915.....	891.5	903.8	— 24.1	879.7	+ 11.8
1915-1916.....	1,031.5	809.5	+113.5	923.0	+108.5
1916-1917.....	660.5	774.6	—117.7	656.9	+ 3.6
1917-1918.....	665.9	656.0	— 24.0	632.0	+ 33.9
1918-1919.....	932.6	829.3	+ 20.3	849.6	+ 83.0
1919-1920.....	972.8	819.5	+ 60.4	879.9	+ 92.9
1920-1921.....	884.0	843.3	— 16.4	826.9	+ 57.1
1921-1922.....	829.4	842.5	— 12.4	830.1	— 0.7
1922-1923.....	885.6	785.8	+ 21.0	806.8	+ 78.8
1923-1924.....	824.7	717.6	+ 3.8	721.4	+103.3
1924-1925.....	870.6	826.4	— 19.8	806.6	+ 64.0
1925-1926.....	692.0	688.2	— 23.5	664.7	+ 27.3

<sup>a</sup> Data from Appendix Table I.

<sup>b</sup> Calculated from statistics of stocks shown in *Wheat and Rye Statistics* (U.S. Department of Agriculture Statistical Bulletin No. 12), January 1926, Table 43, and comparable statistics for years since 1924.

<sup>c</sup> Column 2, plus column 3.

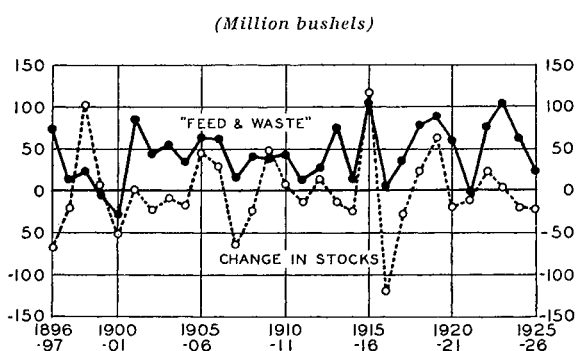
<sup>d</sup> Column 1, minus column 4.

in which stocks increased and low in years in which stocks decreased.

The tendency for the calculated "feed and waste" to be high or low according as stocks are increased or decreased suggests that the calculations are in error from an

incomplete statement of the changes in stocks. If stocks are increased by 100 million bushels between the beginning and the end of a crop year, but only 60 million bushels of this increase appears in the statistics of stocks, the calculated disposition is 40 million bushels smaller than it should be. When this incomplete disposition figure is subtracted from the total supply there remains an item for apparent feed and waste that is 40 million bushels too large.

CHART 3.—CHANGES IN STATISTICS OF YEAR-END STOCKS AND PRELIMINARY CALCULATION OF "FEED AND WASTE," 1896-97 TO 1925-26\*



\* Data from Table 2 (p. 143). The wide variations in the calculated "feed and waste," corresponding closely with changes in the statistics of year-end stocks, demonstrate the incompleteness of the stocks statistics. When, for example, supplies are large, and year-end stocks are increased by 100 million bushels, then if only 60 million bushels of the increase appear in the statistics, the other 40 million bushels appear as an addition to "feed and waste" (the residual item in the tabulation of disposition).

Similarly, in years in which stocks are decreased more than the statistics indicate, the calculated "feed and waste" must be correspondingly too small.

The suspicion that the statistics of changes in stocks used in the foregoing computation are seriously incomplete, as suggested by the character of the variations in the calculated "feed and waste," might have been difficult to support a few years ago. It might be argued, for example, that actual feed and waste tends to be high in the years in which stocks are increased and low in years in which stocks are decreased. On this hypothesis, the variations in the calculated "feed and waste" shown in Table 2 and Chart 3 would be taken as indicative of real changes in feed and waste rather than as evidence of defects in the data on changes

in stocks. This hypothesis is open to serious question on two grounds. First, it appears very doubtful whether actual feed and waste can vary as much as is indicated if these figures be taken as roughly indicative of the variations. In the absence of any direct information on variations in feed and waste, however, there is room for difference of opinion on this point. A clearer objection appears when the individual variations are studied in connection with the conditions existing in each year. The variations fail to conform at all uniformly with variations in price, with variations in quality of the crop, or, so far as we have been able to discover, with variations in any of the other influences commonly believed to affect the actual volume of feed and waste.

#### NEGLECTED STOCKS

Fortunately, it is not now necessary to pursue such an inconclusive line of argument to demonstrate the incompleteness of the statistics of wheat stocks used in the calculation in Table 2. Vigorous efforts on the part of the United States Departments of Agriculture and of Commerce to obtain complete statistics have brought to light surprising totals of stocks in excess of those covered by previous compilations. Most important has been the collection of statistics of mill stocks by the Department of Commerce, showing totals on June 30 ranging from 26 to 46 million bushels<sup>1</sup> in the past three years.

Of considerable importance also are the larger figures for terminal and interior elevator stocks shown by the recent figures of the Department of Agriculture. The most comprehensive figures previously obtainable were those given by combining *Bradstreet's* visible supply statement and the Department of Agriculture estimate for country mills and elevators. The Department of Agriculture now publishes a statement of "commercial grain stocks in store in principal United States markets," which showed 4 million bushels more wheat on July 2, 1927, than appeared in the *Bradstreet* visible.

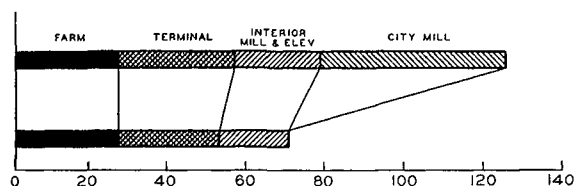
<sup>1</sup> Omitting stocks held by mills in country elevators and in public terminal elevators, presumably included also in other statistics of stocks.

Intended to supplement this statement of stocks in principal markets, without duplication, is the new estimate of stocks in "interior mills and elevators." Revising the estimate for July 1, 1926, to the new basis, the Department raised the former figures by 24 per cent.

The magnitude of the stocks "discovered" in the recent more complete compilation is strikingly demonstrated by a comparison of the total for July 1, 1927, in the three major classes, as shown by a compilation of the present data, with the total shown by a compilation of data from sources which were the most comprehensive available prior to 1925. The sections of the upper horizontal bar in Chart 4 represent

CHART 4.—WHEAT STOCKS ABOUT JULY 1, 1927, ON TWO BASES OF COMPILATION\*

(Million bushels)



\* The upper bar represents the total stocks of wheat in the United States on or about July 1, 1927, as shown by the best statistics now available; the lower bar represents the total stocks for the same date, as shown by statistics from the sources that were the most complete available prior to 1925. See text, pp. 144-45.

the total stocks in the various positions about July 1, 1927, as shown by the best figures now available. The data are drawn respectively from the Department of Agriculture estimate of farm stocks, the Department of Agriculture statement of "commercial stocks in principal markets," the Department of Agriculture estimate of interior mill and elevator stocks, and the Department of Commerce report of stocks held by mills either in their own elevators, in other private elevators, or in transit.

The lower bar represents the showing that would have been made for the same date using data from sources that were the most comprehensive available prior to 1925. The same figure is used for farm stocks as for the upper bar; the terminal stocks are represented by *Bradstreet's* statement of visible supplies; and the interior mill and elevator stocks are represented by the offi-

cial estimate for 1927 reduced by 19 per cent, which is the amount that the original estimate for July 1, 1926, fell below the revised estimate for the same date when it was placed on the new basis. Prior to 1925 no figures were available on city mill stocks, which are, therefore, omitted from the lower bar.

#### FURTHER STEPS

Since the recent compilations of wheat stocks statistics clearly demonstrate the incompleteness of the earlier figures, we may turn to another aspect of the situation. The fact that "feed and waste," as calculated above (p. 143), appears large in years in which stocks are increased and small in years in which stocks are reduced, indicates not only that the "feed and waste" item is affected by changes in stocks not recorded in the statistics, but also that these unrecorded stocks must move fairly closely with the recorded stocks. This being the case, it should be possible to employ the existing statistics as a basis for estimating the approximate changes that have taken place in stocks not included in the statistics.

The possibility is worth testing. If the changes in unrecorded stocks can be estimated with fair accuracy, a considerably more complete and trustworthy picture will be obtained of the actual disposition of American wheat supplies since 1896.

To lay the basis for these proposed estimates of changes in stocks not covered by the statistics, some further investigation is necessary. First, it is wise to make certain of the reliability and consistency of the available statistics of stocks and to obtain the data separately for stocks in different classes of positions. Study of the degree of correspondence, in direction and amount, between changes in stocks in different positions over the period under consideration will give some indication of the probable degree of correspondence between changes in any one or more of the statistical series and the changes in stocks not covered by the statistics. The next two sections are accordingly devoted to a critical examination of the available data on year-end stocks, a compilation of statistics for further use, and a study of similarities of movement of stocks in different positions.

## IV. STATISTICS OF CHANGES IN YEAR-END STOCKS

## AVAILABLE SOURCES

To provide a basis for the further study of changes in year-end stocks, it is necessary to review briefly the more important statistics available.<sup>1</sup> These may be considered, for the present, under the headings suggested by the common division of stocks into visible supply, outside commercial stocks, and farm stocks.

The visible supply statements currently published are those compiled by the New York Produce Exchange, by the Secretary of the Chicago Board of Trade, by *Bradstreet's*, and by the United States Department of Agriculture. The New York Produce Exchange statement of visible supplies antedated by several years any of the other statements of which we have record. Subsequently the Secretary of the Chicago Board of Trade began the collection of visible supply statistics, including supplies in Minneapolis and St. Paul, not covered in the New York statement, and *Bradstreet's* instituted a still more comprehensive weekly statement of stocks, with the result that the New York statement gradually fell into disuse. Though still published, it is not widely quoted.

The Chicago Board of Trade statement of visible supply has been prepared weekly since February 16, 1884,<sup>2</sup> and is now published in detail, usually on Monday, in the *Chicago Daily Trade Bulletin*, showing the stocks at each point of accumulation on the previous Saturday. The number of points is now 25, counting "on lakes" and "on canals" as points. The *Bradstreet* statement of visible supply has been compiled weekly since September 1, 1890, and is published on Saturday of each week in *Bradstreet's*, showing the stocks at each point of

accumulation on the previous Saturday. The *Bradstreet* compilation has included from the beginning stocks at all the points covered in the Chicago statement and also stocks at a considerable number of additional points, bringing the total at the present time (January 1928) to 51, including three points west of the Rocky Mountains. The United States Department of Agriculture statement has appeared weekly on Mondays since August 1926, and gives stocks for the previous Saturday. The figures are not published by points, but totals are given separately for domestic grain and for Canadian grain in store in bond in United States markets. Stocks of domestic grains are given separately for three classes of points: Atlantic and Gulf ports, interior and lake ports, and Pacific ports. The totals shown run appreciably larger than those shown by either the Chicago statement or the *Bradstreet's* statement, chiefly because of the inclusion of reports from a considerable number of elevators not reporting for the other statements.<sup>3</sup> The points covered are said to number about 42, 17 more than are covered in the Chicago statement, but 9 less than covered in the *Bradstreet's* statement.

All of the visible supply series, with the possible exception of the short series of the United States Department of Agriculture, have been somewhat changed in significance on several occasions by revisions of the list of points included. Each of the visible supply statements represents principally stocks in public elevators at the points covered. Wheat afloat on the lakes and at ports and on rivers and canals is also included. Wheat in mills and mill elevators and wheat in private elevators, with some exceptions, is not included, nor are quantities in transit by rail.

For stocks of wheat in second hands outside the visible supply—the so-called "outside commercial" stocks—the most complete figures, prior to 1925, are the estimates prepared by the United States Department of Agriculture for stocks in country mills and elevators. The Department published its first estimate of July 1 stocks in country mills and elevators in

<sup>1</sup> Cf. also the discussion of the statistics of wheat and flour stocks in *WHEAT STUDIES*, August 1925, I, 293–98. The description of the statistics in the following pages is written with a different purpose than the discussion in our earlier study, and while presenting additional information on some points, omits discussion of other points which may be of interest although not important for the purpose of this study.

<sup>2</sup> *Daily Commercial Bulletin* (Chicago), February 19, 1884.

<sup>3</sup> The scope of the reports is described in some detail in the *Agriculture Yearbook*, 1926, p. 766.

1919. In the summer of 1927 the Department revised the basis for these estimates and issued a new estimate for July 1, 1926, on the revised basis, which is about 24 per cent higher than the estimate on the old basis. The new estimates are designated as stocks of old-crop wheat in "interior mills and elevators."

The *Chicago Daily Trade Bulletin* and the *Minneapolis Daily Market Record* have published about the middle of each month since September 1891,<sup>1</sup> in their statement of "world's available supplies of bread-stuffs," as of the first of the month, a report of stocks of wheat and of flour in the United States, tabulated, since the first few months of publication, by states or small groups of contiguous states. The data for the United States are compiled jointly by the two publications. This statement frequently includes a small element of estimated stocks, but is primarily a tabulation of actual reports of stocks at a very large number of points. On December 17, 1913, the *Daily Trade Bulletin* stated that this compilation included, in addition to the Board of Trade visible, stocks at 62 points reporting stocks of 100,000 bushels or over and stocks at "a very large number" of points with stocks between 1,000 and 100,000 bushels each. The *Daily Trade Bulletin* publishes also an annual statement of "stocks in second hands" July 1.<sup>2</sup> This includes the wheat and also the flour, expressed as wheat, reported in their monthly statement for July, and in addition a rough estimate of other stocks in second hands.

The United States Department of Commerce instituted in 1925 a report of stocks of wheat and of flour held by mills. Reports were obtained for June 30 and December 31, 1925, and subsequently quarterly. The aim has been to obtain reports from all merchant mills producing 5,000 or more barrels of flour annually. The mills reporting on the various dates are

estimated to have represented between 87 and 91 per cent of the flour output of the country, the later reports being the more complete. As now published, the reports show separately stocks held by mills in country elevators, in public terminal elevators, in private terminal elevators not attached to mills, in transit and bought to arrive, and in mills and mill elevators attached to mills. The stocks held by mills in country elevators and in public terminal elevators are presumably included also in the country mill and elevator figure of the Department of Agriculture and in the visible supply statements, respectively. Wheat bought to arrive may also be included in part in other figures. The item of wheat held in mills and mill elevators attached to mills, usually representing over three-fourths of the total, is presumably not included in any other official statistics. For a calculation of total wheat stocks, the mill stocks figures, though incomplete, should be taken as they stand without attempting to raise them to 100 per cent, since the Department of Agriculture endeavors to cover stocks held by mills under the 5,000-barrel class in its estimate of interior mill and elevator stocks.<sup>3</sup> The Department of Commerce figures have thus far been published as totals for the United States with no classification by cities or regions.

Stocks of wheat on farms July 1 have been estimated by the United States Department of Agriculture for each year since 1895. The *Daily Trade Bulletin* and other private organizations have also published independent estimates of July 1 stocks. These unofficial estimates are usually published on or about July 1, while the official estimate is not released until about the tenth of the month. The chief purpose of the unofficial estimates is to supply advance information on stocks, and they have seldom been regarded as superior in accuracy to the government estimates.

<sup>1</sup> See the *Daily Trade Bulletin*, September 9, 1891.

<sup>2</sup> In recent years this statement has been omitted from the *Daily Trade Bulletin* and published only in the annual Howard Bartels *Red Book*.

<sup>3</sup> A description of the measures being taken to make available a complete and accurate statement of total wheat stocks, quarterly, is contained in the *Agriculture Yearbook*, 1926, pp. 765-67. The Department of Agriculture has not yet been able to carry through the plan of preparing its estimates quarterly.

#### CHOICE OF DATA

In selecting from the available data those which will prove most useful for the further study of changes in stocks, a number of considerations need to be borne in mind. Other things being equal, those data should be used which give the most com-



prehensive statement of stocks, without duplication. It is necessary, however, to have the stocks series consistent throughout, so far as may be possible. If a shift is made in any year from a less complete to a more complete series, there will be an appearance of an increase in stocks which represents merely an increase in the comprehensiveness of the figures. It is desirable also to have the data separately for stocks in the more important classes of positions.

The choice of data for further study and the plan of compilation depend in part upon the purposes for which the data are subsequently to be employed. In the course of the investigation on which this study is based, the data were used in several different combinations, and at one stage the analysis was carried into great detail. The form of the analysis as it appears in the following pages is that which proved simplest and most satisfactory. It involves two related steps: an examination of the degree of correspondence between movements of stocks in the more important different classes of positions, and a derivation of a method of estimating the changes in stocks not covered by the available statistics.

For the purpose of demonstrating the essential facts regarding the correspondence between movements of stocks in the different classes of positions, it is sufficient to have data covering the four broad classes: farm stocks, terminal elevator stocks east of the Rockies, other commercial stocks east of the Rockies, and Pacific Coast commercial stocks. These data suffice also for the subsequent derivation of a method of estimating changes in stocks not covered by the available statistics. For the latter purpose, however, it proves most satisfactory to have two of the stocks series expressed as deviations from "normal."

For farm stocks July 1, there seems to be no ground for preferring any other original series to the official estimates of the United States Department of Agriculture. Since the official estimates are arrived at by obtaining an estimate of the percentage of the previous crop remaining on farms July 1, they are affected by all errors in the production estimates. We have accordingly prepared a revised series of figures for the years 1896-1910 by applying the official esti-

mate of percentage stocks to our revised estimates of production.<sup>1</sup> The resulting figures, together with the official estimates for subsequent years, are shown in Appendix Table II, which presents the basic statistics of stocks employed in this study. The data are shown graphically in Chart 6 (p. 154).

Our designation, "terminal elevator stocks," is equivalent in a general way to the more common term, "visible supply." Neither term is precise without further definition. Obviously there is always room for difference of opinion as to which markets should be classed as terminal markets. There is difference also in practice as to the classes of elevators for which reports of stocks are obtained in the markets generally recognized as terminals. For our purposes the essential requirements are that the statistics cover at least the more important terminal markets and that they be consistent, in the sense of covering stocks at the same group of markets throughout, with no important change during the period in the classes of stocks reported for any market. The existing visible supply statistics seem to satisfy these requirements except for the fact that changes have been made in the number of points for which stocks are reported.

In order to obtain a consistent series of data on terminal elevator stocks east of the Rockies it is necessary to tabulate the stocks for a fixed group of points throughout the period to be covered instead of using the published visible supply totals. Since the object is to obtain a series reflecting the changes in stocks at large terminal markets, figures for the smaller points, of which many are included in the Bradstreet visible, are better omitted. We have accordingly compiled from the *Daily Trade Bulletin* the figures for total stocks at 18 points east of the Rockies on the Saturday nearest July 1 of each year.<sup>2</sup> A few of the

<sup>1</sup> We have used percentages calculated from the published totals for production and stocks rather than the published percentages, which are given to only one decimal place.

<sup>2</sup> The points included are as follows: (1) Baltimore, (2) Boston, (3) Buffalo, (4) Chicago, (5) Detroit, (6) Duluth, (7) Galveston, (8) Indianapolis, (9) Kansas City, (10) Milwaukee, (11) Minneapolis, (12) New Orleans, (13) New York, (14) Peoria, (15) Philadelphia, (16) St. Louis, (17) Toledo, and (18) Canals and Lakes. Stocks afloat at these points, when shown,

points included are no longer important terminal markets and now carry stocks much smaller than those at points which are omitted. Nevertheless, the series is dominated throughout by the stocks at the important terminal markets and includes in all years such a large portion of the public elevator stocks at truly terminal markets that it may be considered accurately representative of such stocks.

The term "outside commercial stocks" is, like "terminal elevator stocks," not precise until defined. Total outside commercial stocks east of the Rockies must logically be regarded, for present purposes, as comprising all commercial stocks of wheat east of the Rockies not included in the terminal elevator stocks series described above. The available statistics, however, cover only a fraction of this total. They are, furthermore, not published in the form of a statement of outside commercial stocks but in the form of totals for all reported (or reported and estimated) commercial stocks, including the terminal elevator stocks.<sup>1</sup> Given such totals, however, the terminal elevator stocks may be subtracted to obtain a series for outside commercial stocks.

Two series are available from which to compile data on outside commercial stocks over an extended period of years: The monthly statement of supplies of the *Daily Trade Bulletin* and the *Daily Market Record* and the annual statement of "stocks in second hands" compiled by the *Daily Trade Bulletin*. In the monthly statement, wheat and flour stocks are shown separately; but in the annual statement of stocks in second hands, the reported stocks of flour shown in

the monthly statement are expressed in terms of wheat and included with the reported wheat stocks, and to this combined total is added a rough estimate of unreported stocks, both of wheat and of flour as wheat, expressed always in even millions of bushels. The series which omits flour stocks and includes only wheat stocks actually reported<sup>2</sup> is clearly preferable for present purposes.

It is to be supposed that numerous changes have been made in the list of points represented in the monthly statement of stocks, but the data are not given in sufficient detail to permit correction for these changes in the original compilation. The monthly statement of stocks includes, of course, the wheat at points included in our tabulation of terminal elevator stocks. To obtain a series properly representing outside commercial stocks east of the Rockies, the statistics of terminal stocks previously compiled must be subtracted from the figures given in the *Bulletin's* monthly totals for commercial stocks east of the Rockies.<sup>3</sup> The data thus obtained are shown in column 5 of Appendix Table II.

The *Daily Trade Bulletin* figures for Pacific Coast stocks are more comprehensive than the Bradstreet figures, but when studied separately showed certain peculiarities which led to questioning their consistency. If the *Daily Trade Bulletin* figures be compared with the Pacific Coast stocks reported by Bradstreet's, which are published in detail by points, numerous discrepancies appear. The most reasonable conclusion seems to be that the *Daily Trade Bulletin* compilation must have been changed several times to cover an altered list of points, the changes being important enough, relative to the totals, to affect materially the consistency of the series. The Bradstreet figures, though covering a somewhat smaller proportion of the total stocks, seem to furnish the more trustworthy index of year-to-year changes in stocks on the Pacific Coast. In Table 3 (p. 150) are shown the Bradstreet figures, by points and in total, compared with the *Daily Trade Bulletin* totals. The Bradstreet's totals are reproduced also in Appendix Table II (column 3) with the other statistics of stocks.

Even the Bradstreet's figures do not constitute an entirely consistent series. Between

are included. The Chicago Board of Trade visible supply statement now includes also stocks at Newport News, Fort Worth, Omaha, Sioux City, St. Joseph, and Wichita. At various times in the past it has included also stocks at Albany, Cincinnati, Fort William and Port Arthur, Mississippi River, Montreal, Oswego, St. Paul, and Toronto.

<sup>1</sup>The Department of Agriculture's estimates of country mill and elevator stocks, published since 1919 only, constitute an exception to this statement.

<sup>2</sup>The monthly statement frequently includes some figures described as "partly estimated" or "largely estimated," but these estimates appear to be made merely to fill temporary gaps in the reports and stand on a very different footing from the item of estimated stocks in the second hands statement.

<sup>3</sup>Canadian stocks are of course also excluded. The term "east of the Rockies" is somewhat ambiguous, but is employed in conformity with common usage; stocks in the mountain states are included.

1902 and 1903 some California stocks outside San Francisco were dropped from the series appears serious, and there is, in any event, no possibility of compiling the data

TABLE 3.—PACIFIC COAST WHEAT STOCKS ABOUT JULY 1, AS REPORTED BY *Bradstreet's* AND *Daily Trade Bulletin*, 1892-1927\*

(Thousand bushels)

July 1	Bradstreet's						Daily Trade Bulletin
	Date <sup>a</sup>	San Francisco <sup>b</sup>	Portland	Tacoma	Seattle	Total	Total
1892 .....	2	1,700	500	142	30	2,372	1,475
1893 .....	1	2,170	290	352	30	2,842	3,448
1894 .....	30	7,600	365	284	4	8,253	8,470
1895 .....	29	5,800	488	257	4	6,549	6,251
1896 .....	27	1,267	467	153	40	1,927	2,907
1897 .....	26	856	150	38	68	1,112	1,499
1898 .....	2	1,444	774	440	277	2,935	2,200
1899 .....	1	2,231	600	522	56	3,409	8,920
1900 .....	30	4,217	998	587	101	5,903	11,002
1901 .....	29	2,145	743	336	4	3,228	6,740
1902 .....	28	1,262	884	505	25	2,676	7,157
1903 .....	27	593	818	100	280	1,791	2,281
1904 .....	2	851	430	264	122	1,667	2,151
1905 .....	1	250	332	257	...	839	4,129
1906 .....	30	1,090	689	667	140	2,586	3,330
1907 .....	29	993	334	345	193	1,865	3,290
1908 .....	27	"	"	"	"	1,300	2,410
1909 .....	3	530	88	135	100	853	1,597
1910 .....	2	326	665	304	203	1,498	2,512
1911 .....	1	"	670	452	358	1,480	2,795
1912 .....	29	"	524	727	643	1,894	2,587
1913 .....	28	"	942	848	506	2,296	2,927
1914 .....	27	"	522	795	330	1,647	1,493
1915 .....	3	"	716	524	232	1,472	1,261
1916 .....	1	"	307	856	563	1,726	3,130
1917 .....	30	"	405	1,277	377	2,059	1,126
1918 .....	29	"	5	208	96	309	1,032
1919 .....	28	"	599	282	272	1,153	1,449
1920 .....	3	"	830	768	495	2,093	4,314
1921 .....	2	"	788	191	294	1,273	1,718
1922 .....	1	"	"	"	"	1,399	2,913
1923 .....	30	"	980	269	466	1,715	3,015
1924 .....	28	"	1,140	308	653	2,101	3,901
1925 .....	27	"	436	362	585	1,383	1,783
1926 .....	3	"	1,979	573	661	3,213	3,663
1927 .....	2	"	919	550	503	1,972	2,431

\* Compiled from *Bradstreet's* weekly visible supply statement and from the *Daily Trade Bulletin* monthly statement of supplies.

<sup>a</sup> The Bradstreet figures are for Saturdays; dates from 26 to 30 are in June, from 1 to 3 in July. The *Daily Trade Bulletin* figures are totals of reports made for different dates about the first of July in each year.

<sup>b</sup> Prior to 1903, includes stocks at some points outside San Francisco.

<sup>c</sup> No statistics published.

tabulation and after 1910 San Francisco stocks are omitted entirely. Neither of these alterations in the character of the on any better basis. To omit California stocks throughout would indeed give a consistent series, but would practically destroy

its significance for earlier years. Prior to 1903 the California stocks regularly exceeded all the other reported Pacific Coast stocks combined and in a number of years were several times as large as the other stocks.

#### CONSISTENCY OF SERIES

Each of the four series of stocks figures described above has been subjected to a close study after being compiled, to verify, so far as possible, the substantial consistency of each. As noted above, the series for Pacific Coast stocks is not strictly homogeneous. The more important of the two changes in character of the series, that resulting when San Francisco stocks were dropped, can be quite satisfactorily allowed for in the calculation of year-to-year changes in stocks by calculating the change in stocks between 1909 and 1910 on the basis of the data for the three northern ports only.

Other evidence of lack of homogeneity has been discovered only in the series for outside commercial stocks east of the Rockies (obtained, as described above, by subtracting the eastern terminal stocks from the total commercial stocks east of the Rockies, as reported in the monthly statement of the *Daily Trade Bulletin*). The stocks included in this series are presumably all included also in the more comprehensive figures for "country mill and elevator" stocks as estimated by the Department of Agriculture since 1919. It seems reasonable to expect a close correspondence in movement between the Department of Agriculture series and the series derived from the *Daily Trade Bulletin* statistics. Putting both series into the form of percentages of their respective nine-year averages, 1919-27, considerable discrepancies appear, as indicated in the following tabulation.

The discrepancies indicated in the tabulation below may be explained in considerable measure on the assumption that the reports represented in the *Daily Trade Bulletin* series were rendered progressively more complete during the period. This possibility suggests that it is desirable to employ the Department of Agriculture series to measure the changes in outside commercial stocks since 1919. A further reason for

employing the latter series is that it is more complete and therefore presumably more representative.

PERCENTAGES OF 1919-27 AVERAGE STOCKS

Year	U.S.D.A. series	D.T.B. series	Difference
1919.....	70.0	39.5	-30.5
1920.....	132.8	123.1	- 9.7
1921.....	96.7	82.4	-14.3
1922.....	102.4	98.6	- 3.8
1923.....	132.2	159.1	+26.9
1924.....	130.4	106.9	-23.5
1925.....	90.0	86.7	- 3.3
1926.....	81.8	99.5	+17.7
1927.....	63.7 <sup>a</sup>	104.2	+40.5

<sup>a</sup> Based on the 1927 estimate for "interior mills and elevators" reduced by 19 per cent to render it roughly comparable with the earlier estimates. (See comment on p. 147.)

#### JOINING TWO SERIES

We undertake therefore to construct an index of outside commercial stocks of wheat based on the *Daily Trade Bulletin* statistics for the period 1896-1918 and on the more comprehensive Department of Agriculture statistics for the period 1919-27.

Probably the simplest method of putting the two series into comparable form so that they may be joined is to express each of the figures in both series as a percentage of the figures for 1919 in the series to which it belongs. Various modifications of this plan involving the same principle might be suggested. Another method is to express each of the figures in both series as a percentage of the average of all the figures in the series to which it belongs. When the two methods are applied and the results compared, with allowance for systematic differences to be expected in the absolute values of the percentages obtained by the two methods, it appears that they are far from consistent. The first method yields figures for the years since 1919 averaging far below those for earlier years, while the second method, of necessity, shows the average for years since 1919 exactly equal to the average for earlier years. On the whole, the results of the latter method appear the more reasonable. We know of no reason for supposing that outside commercial stocks have averaged ma-

terially lower in the years from 1919 to 1927 than for the earlier years. For the entire period from 1896 to 1919 the series derived from the *Daily Trade Bulletin* figures shows a substantially horizontal trend, and the period 1919-27 has included a fairly normal proportion of years in which conditions encouraged the carrying of large stocks on July 1. We have therefore adopted the second method of joining the two series and have derived the "index of eastern outside commercial stocks," designated in Table 4 as "index I," by using the series compiled from the *Daily Trade Bulletin* statistics for the years 1896-1918 and the Department of Agriculture estimates for the years 1919-27, expressing each figure as a percentage of the average for its own series, as indicated in the table.

#### AN ALTERNATIVE INDEX

Despite the indications discussed above, that variations in outside commercial stocks since 1919 are reflected more accurately in the Department of Agriculture estimates of country mill and elevator stocks than in the *Daily Trade Bulletin* series, there are also contrary indications. Mr. Howard, of the *Daily Trade Bulletin*, informs us that he is not aware of any substantial increase in the comprehensiveness of their statistics in recent years. While the figures, since 1920, run larger than for years prior to the war, it is quite possible that this is not the consequence of a change in the scope of the data, but a result of a tendency for mills generally to carry larger stocks of wheat into the new crop year than formerly, a practice induced by the increased importance of assuring themselves of adequate supplies of high protein wheat. The reports of wheat stocks at the smaller points of accumulation are obtained chiefly from mills. Though presumably covering all elevator stocks at those points as well as mill stocks, they would be affected by any tendency for mills to carry larger stocks in recent years.

It may be, then, that the Department of Agriculture estimates are weighted more heavily with elevator stocks as compared with mill stocks than are the *Daily Trade Bulletin* figures, and that the combined index derived above is in this respect in-

consistent as between its two parts.<sup>1</sup> Though the general considerations suggest

TABLE 4.—INDEXES OF TERMINAL AND OUTSIDE COMMERCIAL STOCKS OF WHEAT EAST OF THE ROCKIES, JULY 1, 1896-1927  
(Per cent of "normal")

July 1	Eastern terminal <sup>a</sup>	Eastern outside commercial	
		Index I <sup>b</sup>	Index II <sup>c</sup>
1896 .....	153.5	116.6	116.6
1897 .....	57.9	81.9	81.9
1898 .....	50.6	28.1	28.1
1899 .....	112.7	142.2	142.2
1900 .....	166.6	127.5	127.5
1901 .....	114.2	108.5	108.5
1902 .....	74.0	86.7	86.7
1903 .....	62.7	77.9	77.9
1904 .....	49.1	92.6	92.6
1905 .....	50.0	68.5	68.5
1906 .....	111.2	112.6	112.6
1907 .....	188.8	166.3	166.3
1908 .....	54.4	83.5	83.5
1909 .....	48.8	56.5	56.5
1910 .....	60.2	99.5	99.5
1911 .....	119.3	112.5	112.5
1912 .....	116.5	93.1	93.1
1913 .....	149.3	106.0	106.0
1914 .....	74.8	102.2	102.2
1915 .....	39.6	50.5	50.5
1916 .....	205.7	186.9	186.9
1917 .....	70.7	32.3	32.3
1918 .....	3.9	15.9	15.9
1919 .....	42.7	70.0	51.5
1920 .....	97.3	132.8	160.3
1921 .....	39.2	96.7	107.3
1922 .....	85.3	102.4	128.5
1923 .....	120.9	132.2	207.2
1924 .....	161.3	130.4	139.3
1925 .....	140.0	90.0	112.9
1926 .....	52.0	81.8	129.7
1927 .....	94.5	63.7	135.8

<sup>a</sup> Percentages of ordinates of the trend shown in Chart 5, based on statistics of stocks shown in Appendix Table II, column 2.

<sup>b</sup> Percentages of average; for the years 1896-1918, based on statistics of stocks shown in Appendix Table II, column 5, using the average for years 1896-1916 as 100 per cent; for the years 1919-27, based on the U.S. Department of Agriculture estimates of country mill and elevator stocks (the 1927 estimate reduced 19 per cent to render it approximately comparable with previous estimates), using the average for all 9 years as 100 per cent.

<sup>c</sup> Based throughout on the statistics shown in Appendix Table II, column 5, using the average for the years 1896-1916 as 100 per cent.

that the combined index makes the best use of the available statistics of outside com-

<sup>1</sup> It is of course clearly inconsistent in that for the period 1919-27 it is based on figures which include Pacific Coast stocks, not included previously. This degree of inconsistency is unavoidable and, we believe, entirely negligible in importance.

mercial stocks of wheat, it is advisable to have also an alternative index based on the *Daily Trade Bulletin* statistics throughout. For this purpose the 1896-1916 average may be used as 100 per cent, as in the portion of the other index that is based on the *Daily Trade Bulletin* statistics, giving altered figures only for the years since 1919. The data are shown in Table 4 as "index II."

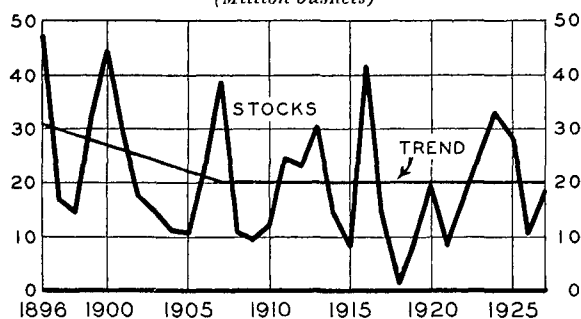
#### INDEX OF EASTERN TERMINAL STOCKS

For part of the subsequent analysis it is distinctly preferable to have measures of changes in stocks in different positions expressed as changes in percentage deviations from normal.<sup>1</sup> In the course of the investigation on which this paper is based, all of the stocks series which showed pronounced secular trends were reduced to indexes in which the ordinates of secular trend represented 100 per cent. For present purposes it is necessary to present only one of these additional indexes, that for eastern terminal stocks. The series for outside commercial stocks show substantially horizontal trends and are entirely satisfactory in the form of the indexes already presented.

The series for eastern terminal stocks shows a marked downward trend from 1896 to about 1907, clearly apparent in Chart 5. It is to be supposed that the downward trend of the earlier years merged

gradually into the subsequent horizontal trend. The reliability of any possible method of determining the trend is not sufficient, however, to justify the use of any more complicated method than is involved in obtaining two connected straight lines to describe the trend, as shown in Chart 5.<sup>2</sup>

CHART 5.—EASTERN TERMINAL WHEAT STOCKS  
ABOUT JULY 1, 1896-1927\*  
(Million bushels)



\* Data from Appendix Table II. The figures represent the Chicago Board of Trade visible supply statistics, omitting stocks at Canadian points and at a few other points for which data are available over only part of the period. The trend line forms the basis for calculating "normal" stocks in each year, employed in computing the index of terminal stocks for Table 4.

Removing this trend by throwing the data into the form of percentage deviations from trend, we obtain a series which may be designated as an "index of eastern terminal stocks." The data are shown in Table 4.

#### V. SIMILARITIES IN MOVEMENTS OF STOCKS

As stated at the close of Section III, the first object of the analysis to follow is to obtain a basis for estimating from the existing statistics the approximate changes in wheat stocks not covered by the statistics available for past years. The belief that

reasonably trustworthy estimates can be made rests on the supposition that the changes in the recorded stocks are in each year fairly closely representative of the changes in the unrecorded stocks. This sup-

<sup>1</sup> It is commonly stated that by correlating changes (first differences) in two series the influence of secular trends on the results is eliminated. This is only partly true in most cases. Quite commonly the changes in each of the series tend to be larger during the portions of the period in which the magnitude of the individual values run larger, and vice versa, and this tendency somewhat disturbs the correlation.

<sup>2</sup> Even so, the problem of obtaining clearly trustworthy results proved extremely difficult. In view of some of the inherent difficulties of the problem, the data were carried back to 1885 to obtain a broader basis for judgment and statistical analysis. The trend first calculated was checked by employing it in the calculation of percentage deviations of the original series from trend, correlating the deviations with a

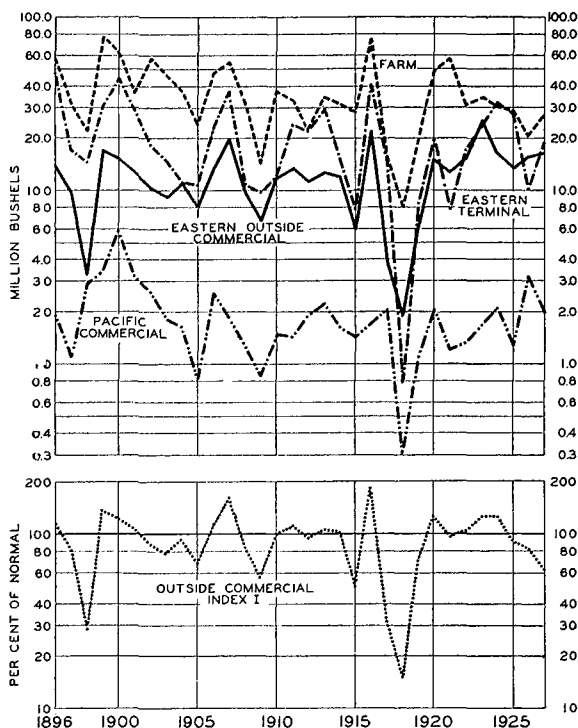
closely related series known from external evidence as well as direct observation to have a substantially horizontal trend, and calculating and charting the residuals. This check proved the trend first calculated to be seriously in error. A second attempt yielded better results, but was still unsatisfactory. The trend shown in Chart 5 represents the final result after a series of such successive approximations.

To give a full account of the method, outlined above, by which the trend was obtained, would require several pages and involve lengthy discussion of points not pertinent to the present study. The extreme care used in determining the trend was in fact not necessary for the purposes of the present study and was exercised only because of requirements of another related investigation. Present requirements would be met by any trend sufficiently accurate to appear satisfactory on a visual study of the chart.

position cannot be investigated directly, but valuable light may be thrown on its validity by determining the degree of similarity in movement of the various classes of stocks covered by the statistics.

The general fact that there is a fair degree of correspondence between the changes in year-end stocks of wheat in different positions is evident from a study of Chart 6. All the curves except that for

CHART 6. — STATISTICAL SERIES REFLECTING CHANGES IN STOCKS OF WHEAT ABOUT JULY 1 IN VARIOUS POSITIONS, 1896-1927\*



\* Data from Table 4 and Appendix Table II. July 1 stocks of wheat in the various positions show a close agreement in all the major movements, though Pacific Coast commercial stocks show several points of divergence from the other series. The logarithmic scale used for the chart makes any given percentage change appear the same on all the curves, whatever the absolute magnitude of the figures. It appears that Eastern terminal stocks vary somewhat more, relatively, than any of the other classes of stocks.

Pacific Coast commercial stocks show a striking resemblance; years of high stocks in one position are quite uniformly years of high stocks in the other positions, and vice versa; in years in which stocks in one position are increased over the level at the close of the previous year, stocks in the other positions are quite uniformly in-

creased in similar proportion, and vice versa. Still neglecting Pacific Coast stocks, the principal dissimilarities in movement among the curves appear in the peaks reached by eastern terminal stocks in 1900 and in 1924 and the peaks reached by farm stocks in 1902 and in 1921. Farm stocks also failed to decline as much in 1915 as stocks in other positions.

In a comparison of the curve for Pacific Coast commercial stocks with that for eastern terminal stocks, which it appears to resemble most closely, the principal points of discrepancy appear in the sharp increase in Pacific Coast stocks in 1898, the decrease in 1907, and the increases in 1917 and 1926.

Chart 6 has been drawn to a logarithmic scale in order to render the changes in the various curves comparable in terms of percentage changes. A given vertical movement of any curve, in any position on the chart, represents the same percentage change as the same vertical movement of any other curve. Bearing this in mind, it becomes evident that eastern terminal stocks are subject to larger percentage changes than any of the other stocks.<sup>1</sup>

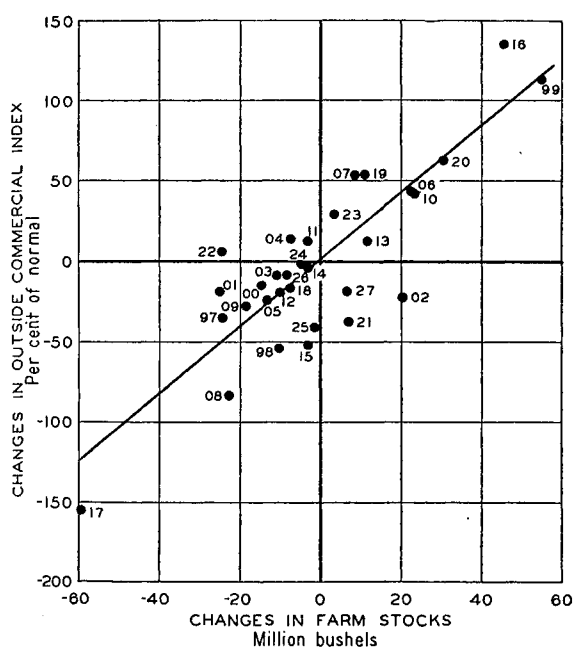
A somewhat clearer indication of the degree of correspondence between changes in the different series of stocks statistics may be obtained from charts designed to show the average relationship, and deviations in individual years from this average relationship. It may be supposed that the unrecorded stocks fall chiefly in the class commonly designated as outside commercial stocks, that is, stocks other than those on farms and in terminal elevators. It is especially interesting, therefore, to note the degree of accuracy with which changes in the existing statistics of outside commercial stocks might have been estimated from changes in the other stocks series.

Chart 7 shows the relationship between changes in the index of outside commercial stocks east of the Rockies and changes in farm stocks, each dot representing the relationship in one year and the heavy diagonal line representing the average relationship. The dot near the extreme lower

<sup>1</sup> The averages of the percentage changes from year to year, neglecting signs, are, for the period 1896-97 to 1926-27: farm stocks, 55 per cent; eastern terminal stocks, 96 per cent; Pacific Coast stocks, 54 per cent; eastern outside commercial stocks, 64 per cent.

left corner of the chart, for example, represents the relation between the changes in the two stocks series between July 1, 1916, and July 1, 1917. Its position indicates that between these dates farm stocks declined nearly 60 million bushels (read on the horizontal scale), and the index of outside commercial stocks declined slightly more than 150 points (read on the vertical scale). The slope of the heavy diagonal line indicates that on the average a change of 10 million bushels in farm stocks is accompanied by a change of 21 points in the index of outside commercial stocks.

CHART 7.—RELATION BETWEEN CHANGES IN THE INDEX OF OUTSIDE COMMERCIAL STOCKS EAST OF THE ROCKIES AND CHANGES IN FARM STOCKS, JULY 1 TO JULY 1, 1896-97 TO 1926-27\*



\* See note to Chart 9, p. 156.

On the whole, the dots representing the changes in individual years are grouped quite closely about the line of average relationship, showing a close correspondence between changes in the two stocks series and indicating accordingly that changes in the statistics of outside commercial stocks can usually be estimated quite accurately from changes in farm stocks. The most extreme departure from the average relationship appears in 1902, the position of the dot for that year in Chart 7 indicating that the

index of outside commercial stocks decreased 20 points while the change in farm stocks would have led to the expectation (based on the line of average relationship) of an increase of over 40 points. Nearly as great a departure from the average relationship occurred in 1921, followed by an approximately equal but opposite departure in 1922. The index of outside commercial stocks, having fallen sharply in 1921, when a slight increase would have been expected from the change in farm stocks, increased only slightly the following year in the face of a sharp decline in farm stocks, thereby re-establishing something like the normal relationship between the absolute values of the two series.

The departures from the average relationship between changes in the index of outside commercial stocks and the changes in farm stocks revealed by Chart 7 may also be noted in Chart 6. The principal advantages gained by placing the data in the form shown in Chart 7 are that the facts may be studied with more precision. The precise nature of the average relationship is clearer, the relative magnitudes of the various departures from the average relationship are more readily compared, and, when several similar charts are compared, the relative closeness of the relationships shown in the different charts is more readily judged.<sup>1</sup>

In Charts 8 and 9 (p. 156) are shown the relation of changes in the index of outside commercial stocks east of the Rockies to the changes in the index of eastern terminal stocks and to the changes in Pacific Coast commercial stocks, respectively. Changes in eastern terminal stocks would have proved a fairly reliable basis for estimating changes in the index of outside commercial stocks in most years. The estimates would have been worst in 1899 and 1900 and rather poor in 1898, 1914, and 1917. On the whole, changes in eastern terminal stocks would have formed about as good a basis for estimating changes in outside commercial stocks as would changes in farm stocks.

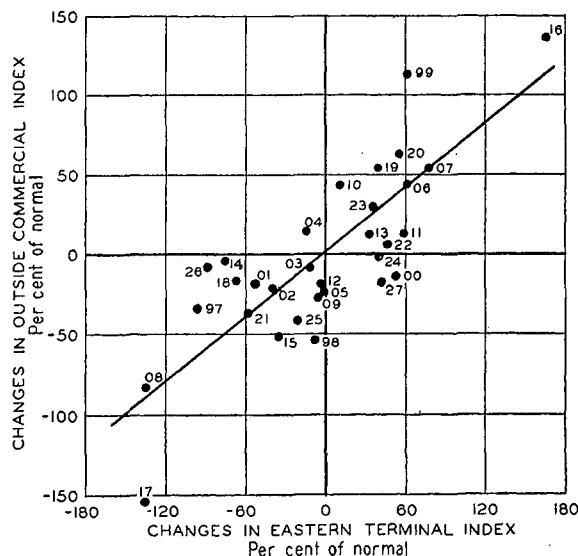
<sup>1</sup> The closeness of the relationships may be measured by correlation coefficients, which have been calculated and are shown in footnote 1 on page 168. The correlation coefficients fail to reveal a number of facts, however, that appear clearly in the scatter diagrams; and they contribute nothing of importance for present purposes.



Even changes in Pacific Coast commercial stocks would provide a useful basis for estimating changes in eastern outside commercial stocks in most years. In Chart 9 the line of average relationship shown is not an average for all cases, but is based on

what is not apparent from a study of the curves in Chart 6, that Pacific Coast commercial stocks and eastern outside commercial stocks move quite closely together in most years, despite the wide divergence of movement in some years. It also indi-

CHART 8.—RELATION BETWEEN CHANGES IN THE INDEX OF OUTSIDE COMMERCIAL STOCKS EAST OF THE ROCKIES AND CHANGES IN THE INDEX OF EASTERN TERMINAL STOCKS, JULY 1 TO JULY 1, 1896-97 TO 1926-27\*

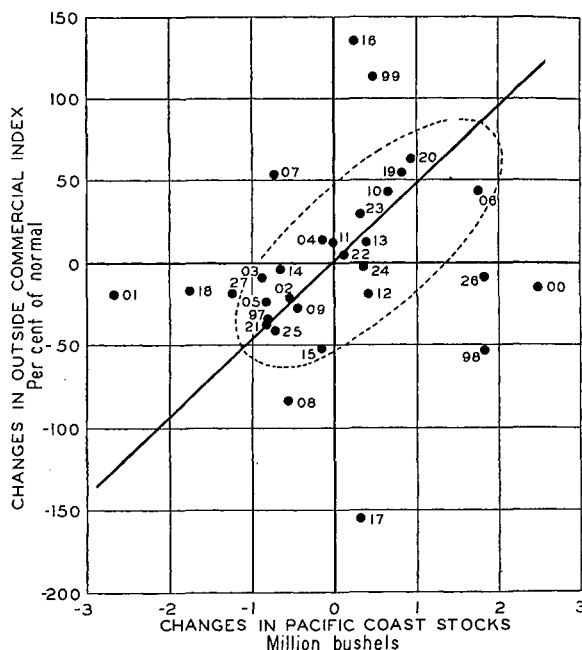


\* See note to Chart 9.

the relationship in the "typical" years only, those represented by the dots included within the area bounded by the line of short dashes.<sup>1</sup> This chart shows clearly,

<sup>1</sup> It is unnecessary to discuss here the vexing statistical problem of obtaining an objective basis for discarding observations before calculating a relationship. It is perfectly clear that in this case we have to deal with observations falling in two distinct classes, one group showing a moderate dispersion about the regression line, the other a wide dispersion. The frequency distribution of the residuals approximates that which would be obtained by combining two normal distributions, one with three or four times the dispersion of the other. The frequency distributions of residuals derived from Charts 7-11 inclusive, with this single exception, show approximately normal distributions, as do other similar charts that have been studied. It suffices for present purpose to point out the fact that there exists a typical relationship, to which the variables conform in the majority of cases, but from which there are occasional wide departures, and to indicate roughly what that relationship is. There is no occasion, therefore, for applying refined methods for selecting what we have called the "typical" years.

CHART 9.—RELATION BETWEEN CHANGES IN THE INDEX OF OUTSIDE COMMERCIAL STOCKS EAST OF THE ROCKIES AND CHANGES IN PACIFIC COAST COMMERCIAL STOCKS, JULY 1 TO JULY 1, 1896-97 TO 1926-27\*



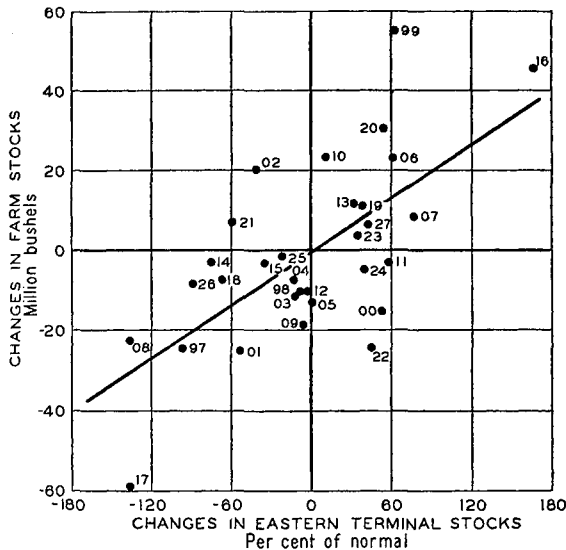
\* Data from Table 4 and Appendix Table I. The three charts on this and the previous page reveal somewhat more clearly than Chart 6 (p. 154) the relation between changes in eastern outside commercial stocks and changes in stocks in other positions. The numerals indicate the years, "97" for example representing changes between July 1, 1896, and July 1, 1897. The relations of changes in eastern outside commercial stocks to changes in farm stocks and to changes in eastern terminal stocks are fairly close, while the relation to changes in Pacific Coast commercial stocks, fairly close in most years, breaks down entirely in a few years. The diagonal lines represent the average relationship (in Chart 9, based only on the relationship in the "typical" years—those represented by the dots in the area bounded by the line of short dashes).

cates that wide divergence of movement in one year is quite uniformly followed by an opposite divergence in the following year. In 1916, for example, eastern outside commercial stocks increased sharply while Pacific Coast stocks remained practically stationary; in 1917 eastern outside commercial stocks declined sharply while Pacific Coast stocks again changed but little. Special conditions in 1916 threw Pacific

Coast stocks out of line with stocks elsewhere. Having remained relatively low in 1916, they did not decline in 1917 as did other stocks.

Two other charts of relationships throw significant light on the behavior of stocks in different positions. We have noted that changes in eastern outside commercial stocks may be estimated quite closely either from changes in farm stocks or from changes in terminal stocks. Chart 10, how-

CHART 10.—RELATION BETWEEN CHANGES IN FARM STOCKS AND CHANGES IN THE INDEX OF EASTERN TERMINAL STOCKS, JULY 1 TO JULY 1, 1896-97 TO 1926-27\*



\* Data from Table 4 and Appendix Table I. There is a fairly close relationship between changes in farm stocks and changes in eastern terminal stocks, but the relationship is not so close as that between the changes in either of these classes of stocks and the changes in eastern outside commercial stocks (see Chart 7, p. 155, and Chart 8). Eastern outside commercial stocks appear to reflect most clearly the effects of influences common to all three classes of stocks.

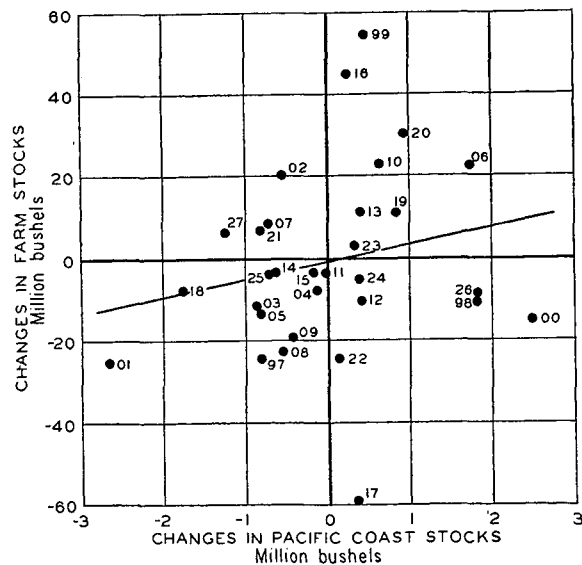
ever, shows that changes in farm stocks cannot be estimated at all accurately from changes in terminal stocks. This is somewhat surprising and may appear inconsistent with the facts previously noted, but may readily be explained in general terms. Eastern outside commercial stocks, as represented in the statistics, respond to many of the influences affecting farm stocks and likewise to many of the influences affecting terminal stocks. Apparently, however, there are important influences affecting farm and outside commercial stocks similarly that do not affect terminal stocks, or affect them differently, and likewise im-

portant influences affecting terminal and outside commercial stocks similarly that do not affect farm stocks, or affect them differently.

This is an important fact to be borne in mind and may well be emphasized by citing a similar situation in which the conditions involved are more readily visualized. Consider the variation in rainfall from year to year in adjacent states. One would expect to be able to estimate Illinois rainfall fairly well from information on rainfall in Iowa and likewise to be able to estimate Illinois rainfall fairly well from information on rainfall in Indiana. But one would not expect to do so well in estimating Indiana rainfall from information on rainfall in Iowa.

Comparing changes in Pacific Coast commercial stocks with changes in farm stocks, as shown in Chart 11, we find again a rela-

CHART 11.—RELATION BETWEEN CHANGES IN FARM STOCKS AND CHANGES IN PACIFIC COAST COMMERCIAL STOCKS, JULY 1 TO JULY 1, 1896-97 TO 1926-27\*



\* Data from Appendix Table I. There appears to be only a slight relationship between changes in farm stocks and changes in Pacific Coast commercial stocks. Study of Chart 9 indicated that Pacific Coast commercial stocks and eastern outside commercial stocks respond to similar influences in most years and that it was only in occasional years that the unrelated influences were important; as between Pacific Coast commercial stocks and farm stocks, however, the cases in which unrelated influences are important are much more common.

tionship that is not nearly so close as the relationship between changes in either series and changes in eastern outside com-

mercial stocks. In studying the relationship between changes in eastern outside commercial stocks and Pacific Coast commercial stocks (Chart 9) it appeared that, while in some years there was no correspondence between the movements of the two classes of stocks, in most years there was a fairly close correspondence. Years showing extreme lack of correspondence seemed to be exceptional. In Chart 11, however, most years appear to be exceptional.

#### CONCLUSIONS

Viewing the evidence of relations between movements of stocks in different classes of positions from the standpoint of its bearing on the problem of estimating the approximate changes in unrecorded stocks, we find that three facts may be set down as significant. First, it is clear that in most years there is a close agreement between the direction and amount of change in stocks in each of the major classes of positions east of the Rockies. Statistics of changes in any class of stocks east of the Rockies seem to furnish a fair basis for estimating changes in any other class of

stocks in the same region. Secondly, it appears that the statistics of outside commercial stocks, as compiled, represent a class of stocks less influenced by special conditions, peculiar to itself, than any other class of stocks for which we have examined the statistics, and accordingly that the changes in the series for outside commercial stocks are more broadly representative of changes in stocks in other positions than are any other series. This suggests that the outside commercial series may prove the most useful as a basis for estimating changes in unrecorded stocks. Finally, it appears that each class of stocks shows in some years the influence of conditions that have not affected other classes of stocks or have affected them differently. This being the case, it is to be expected that the unrecorded stocks were affected in some years by conditions the influence of which does not appear in any of the recorded stocks, and that in consequence the estimates of changes in unrecorded stocks, on whatever basis they are made, will be appreciably in error in a few years, although it may be possible to estimate the changes in most years very accurately.

### VI. ESTIMATES OF CHANGES IN UNRECORDED STOCKS

#### STATEMENT OF THE PROBLEM

The general nature of the next step to be taken is now clear. Since it is evident that the changes in the recorded statistics of stocks east of the Rockies must be quite accurately indicative, in most years, of changes in the unrecorded stocks, the problem of preparing estimates of changes in unrecorded stocks becomes merely a problem of finding which stocks series, or which combination of series, is best adapted to the purpose, and of determining the amount of change in unrecorded stocks, in millions of bushels, usually accompanying a change of one point or of one million bushels in the stocks series to be used as a basis for the estimates. This may appear a difficult task in view of the absence of any data whatever on the magnitude of these unrecorded stocks, except for the last three years. We have, however, for the entire period, figures which indicate the approximate magnitude of the change in the unre-

recorded stocks in each year. We have noted that when we subtract from the statistics of supplies for each year the available statistics of disposition other than feed and waste, the remainder varies widely from year to year (see Chart 3, p. 144, and discussion in the text on pp. 143-44). If the statistics were otherwise complete, this remainder should represent feed and waste, but on investigation it appeared that the variations in the remainder were to be attributed largely to the influence of changes in stocks that had not been included in the statistics. The remainder is therefore to be regarded as a measure of changes in unrecorded stocks, plus feed and waste. By subtracting from the remainders reasonable estimates of the amount of feed and waste we might obtain a series of figures which would represent more or less accurately the actual changes in unrecorded stocks.

Obviously, the figures for changes in unrecorded stocks thus calculated cannot be expected to be entirely accurate in any

year. They will reflect not only the actual changes in unrecorded stocks, but also the net result of any errors in the data on supplies and disposition employed in the calculation. These errors in the calculated figures for apparent change in unrecorded stocks, however, need have no serious effect on a calculation of the average relation between changes in the statistics of stocks and changes in the unrecorded stocks. It is one of the merits of averages that in them errors tend to cancel out. If we should find, for example, that out of several years in each of which terminal stocks increased 5 million bushels, unrecorded stocks appeared (owing to errors in the data) to have remained constant in some years, to have increased 10 million bushels in other years, but as an average over all such years, to have increased 5 million bushels, then we should feel considerable confidence in the conclusion that actual unrecorded stocks tended quite uniformly to increase 5 million bushels in years in which terminal stocks increased 5 million bushels. On the basis of the facts developed in the foregoing section, we should suppose that in some years the correspondence was far from perfect, but that in most years it was fairly close, and that the average relationship revealed in the study of the imperfect data available furnished a trustworthy statement of the general tendency.<sup>1</sup>

#### METHOD OF ANALYSIS

The general method of procedure suggested by these considerations requires to be slightly modified in order to deal advantageously with certain technical difficulties.<sup>2</sup> Because there is some question whether

<sup>1</sup> A more rigorous demonstration of the fact that errors in the data for the dependent variable need not affect a calculated regression beyond the limits of the fluctuations of sampling is given by Holbrook Working, "The Statistical Determination of Demand Curves," *Quarterly Journal of Economics*, August 1925, XXXIX, 526-39.

<sup>2</sup> In the investigation on which this study is based the data were first handled by the more obvious method, the results demonstrating the need for using the modified method here employed.

<sup>3</sup> On the assumption that the estimates of farm stocks give a substantially complete and accurate statement of actual farm stocks, the unrecorded stocks must be commercial stocks. In line with common usage, they may be designated as "outside" commercial stocks, in the sense of commercial stocks outside the recorded terminal stocks.

the statistics of outside commercial stocks east of the Rockies, as derived from the *Daily Trade Bulletin* data for recent years, are consistent with the similar statistics for earlier years, it is safer not to include the changes in these statistics in the disposition data to be subtracted from the statistics of supplies. The remainder in each year will then represent apparent feed and waste plus changes in both unrecorded stocks and in the recorded outside commercial stocks east of the Rockies. The unrecorded stocks are presumably outside commercial stocks,<sup>3</sup> so that this remainder may be designated as the apparent change in total outside commercial stocks plus "feed and waste." We continue to employ the term "feed and waste" in quotation marks for the reason previously indicated (see pp. 142-43).

Owing to the difficulty of obtaining satisfactory estimates of feed and waste, it proves simpler in the end to deal with these figures for apparent change in outside commercial stocks plus "feed and waste" in the form in which they stand without attempting first to remove the "feed and waste" element. Instead, we derive methods for removing the element of changes in total outside commercial stocks, leaving "feed and waste" as the final residual.

The consequence of these modifications in the method of approach will not be to divert the aim of the study in any sense from the original objective of obtaining a basis for estimating changes in unrecorded stocks. The modifications merely combine with the main objective two subsidiary objectives: to check in some degree the consistency of the available statistics of outside commercial stocks east of the Rockies, and to simplify the calculation of the final "feed and waste" residual.

#### SIMPLE RELATIONS

To provide the basic data for the analysis, we make a revised calculation of the balance of statistics of supplies and disposition. Instead of using the statistics of changes in stocks employed in the preliminary calculation of "feed and waste" (Table 2, p. 143), we take the revised statistics discussed in Section IV, omitting the relatively small element of statistics of outside commercial stocks east of the Rockies.

The data are shown in Table 5. The figures in the final column, designated "apparent changes in total outside commercial stocks,

TABLE 5.—CALCULATION OF APPARENT CHANGES IN TOTAL OUTSIDE COMMERCIAL STOCKS PLUS "FEED AND WASTE," 1896-97 TO 1926-27

(Thousand bushels)

Year July-June	Supplies <sup>a</sup>	Disappearance other than feed and waste <sup>a</sup>	Change in farm and terminal stocks <sup>a</sup>	Apparent change in total outside commercial stocks plus "feed and waste" <sup>b</sup>
1896-1897	614,134	608,478	-55,108	+ 60,764
1897-1898	687,047	695,609	-11,178	+ 2,616
1898-1899	833,536	708,722	+72,359	+ 52,455
1899-1900	682,517	679,343	+ 679	+ 2,495
1900-1901	639,201	720,940	-43,232	- 38,507
1901-1902	829,019	740,907	+ 8,580	+ 79,532
1902-1903	739,165	715,601	-15,686	+ 39,250
1903-1904	681,512	634,999	-11,694	+ 58,207
1904-1905	584,103	567,569	-14,576	+ 31,110
1905-1906	727,356	617,377	+36,558	+ 73,421
1906-1907	760,316	667,227	+22,309	+ 70,780
1907-1908	637,142	686,308	-49,972	+ 806
1908-1909	654,541	637,284	-20,390	+ 37,647
1909-1910	712,873	624,297	+25,941	+ 62,635
1910-1911	660,410	610,385	+ 8,452	+ 41,573
1911-1912	624,037	625,377	-10,344	+ 9,004
1912-1913	731,065	689,923	+18,598	+ 22,544
1913-1914	765,359	701,468	-18,823	+ 82,714
1914-1915	891,469	903,840	-10,483	- 1,888
1915-1916	1,031,504	809,509	+79,232	+142,763
1916-1917	660,457	774,606	-85,781	- 28,368
1917-1918	665,875	656,040	-22,656	+ 32,491
1918-1919	932,559	829,335	+19,791	+ 83,433
1919-1920	972,759	819,543	+42,155	+111,061
1920-1921	884,031	843,267	- 5,287	+ 46,051
1921-1922	829,371	842,541	-14,999	+ 1,829
1922-1923	885,611	785,793	+10,967	+ 88,851
1923-1924	824,665	717,570	+ 3,550	+103,545
1924-1925	870,597	826,403	- 6,589	+ 50,783
1925-1926	692,012	688,174	-24,166	+ 28,004
1926-1927	844,275	799,060	+13,646	+ 31,569

<sup>a</sup> Data from Appendix Table I.

<sup>b</sup> Column 1, minus columns 2 and 3.

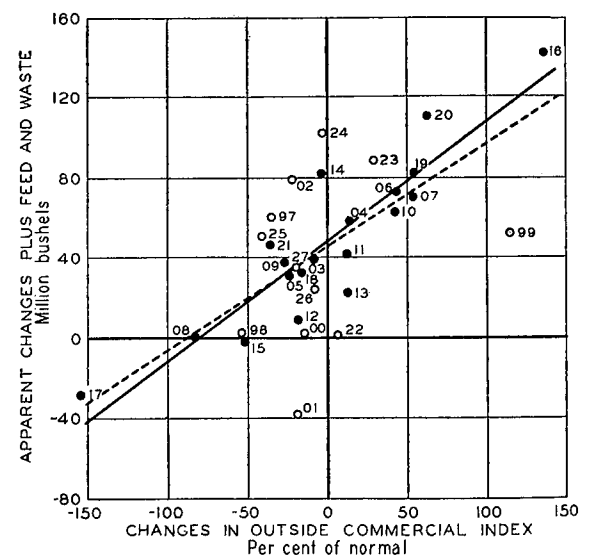
plus 'feed and waste,' are composites of three elements. It is the object of the following analysis to separate out each of these three elements, so far as may be possible. The elements are (1) errors in the statistics employed in the calculation, (2) actual feed and waste, and (3) changes in all stocks other than farm stocks (as estimated) and the recorded terminal stocks at

18 points east of the Rockies and three or four points on the Pacific Coast.

First we undertake to separate out the element of changes in stocks. This may readily be done with considerable accuracy on the assumption that any correlation found to exist between the composite series and any series of changes in statistics of stocks must reflect the influence of the element of changes in stocks in the composite series. We know of no reason to expect either of the other elements in the composite series to show a significant correlation with changes in any stocks series.

Charts 12, 13, and 14 show respectively the relation between the composite series and the changes in each of the principal stocks series which might be expected to

CHART 12.—RELATION OF APPARENT CHANGES IN TOTAL OUTSIDE COMMERCIAL STOCKS PLUS "FEED AND WASTE" TO CHANGES IN THE INDEX OF OUTSIDE COMMERCIAL STOCKS EAST OF THE ROCKIES, JULY 1 TO JULY 1, 1896-97 TO 1926-27\*



\* See note to Chart 14.

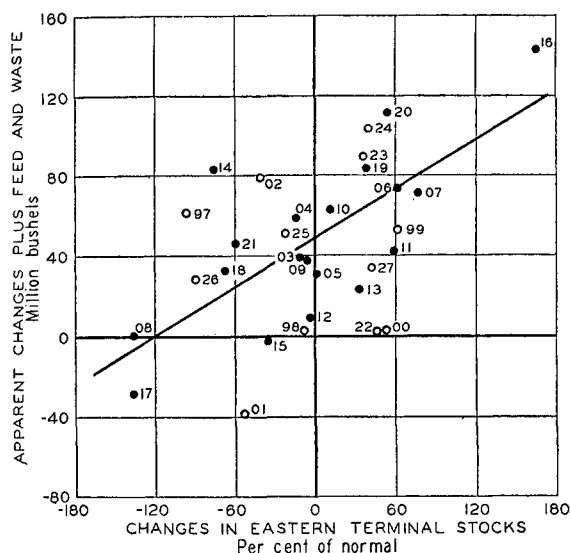
be closely related to the element of changes in stocks in the composite series. For reasons that will be made clear shortly, observations for the years 1903-21 are designated by solid dots, observations for other years, by circles. All three of the charts show a fair degree of relationship, especially if only the solid dots be considered, but it is at once apparent that changes in terminal

stocks are less closely related to the element of changes in stocks in the composite series than are changes in either of the other stocks series.

Calculating the average relation between the composite series and the changes in the index of outside commercial stocks east of

waste was as low in the three years 1898-99 to 1900-1901 as is indicated by the data shown in Chart 15, nor is it likely that in the three years 1922-23 to 1924-25 it was as far above that in earlier years as is there indicated. The relatively low figures in the first period and the relatively high figures

CHART 13.—RELATION OF APPARENT CHANGES IN TOTAL OUTSIDE COMMERCIAL STOCKS PLUS "FEED AND WASTE" TO CHANGES IN THE INDEX OF EASTERN TERMINAL STOCKS, JULY 1 TO JULY 1, 1896-97 TO 1926-27\*



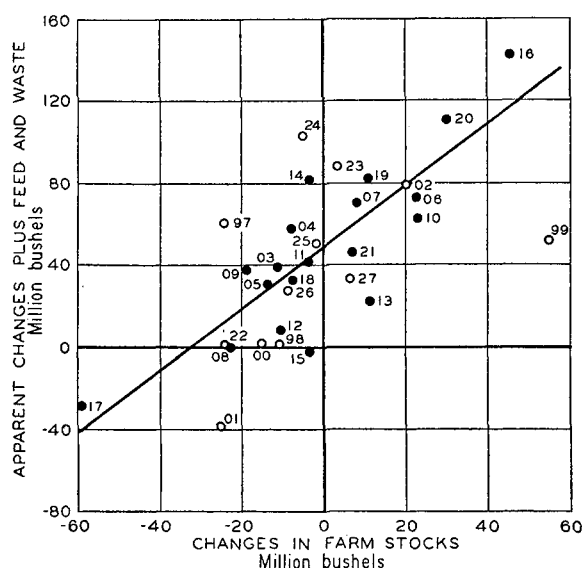
\* See note to Chart 14.

the Rockies (the dotted diagonal line in Chart 12), we obtain a basis for estimating from the latter series for each year the approximate value of the element of change in stocks in the composite series. We may then subtract these estimates from the figures in the composite series, leaving a residual or "feed and waste" item which represents a combination of actual feed and waste and the effects of all errors in the data of supplies and disposition. The series of values for the "feed and waste" item, thus calculated, are shown graphically in Chart 15 (p. 162).

#### DEALING WITH ERRORS IN DATA

Obviously, the calculated "feed and waste" must be influenced in considerable measure by errors in the data employed in the calculation. In particular, it is not reasonable to suppose that actual feed and

CHART 14.—RELATION OF APPARENT CHANGES IN TOTAL OUTSIDE COMMERCIAL STOCKS PLUS "FEED AND WASTE" TO CHANGES IN FARM STOCKS, JULY 1 TO JULY 1, 1896-97 TO 1926-27\*

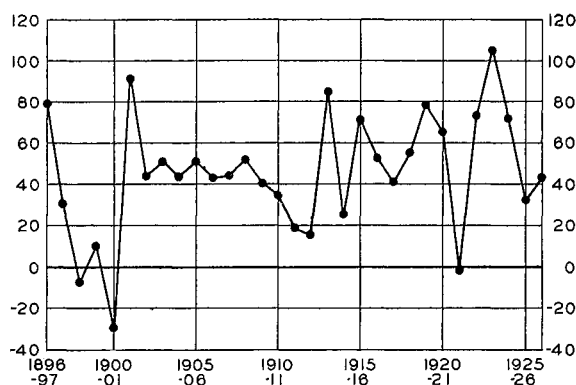


\* Data from Table 4 and Appendix Table I. The apparent change in total outside commercial stocks plus "feed and waste" is a composite of three elements: (1) actual changes in total outside commercial stocks, (2) actual feed and waste, and (3) the effects of errors in the data employed in the computation. The actual changes in total outside commercial stocks are so large and so closely related to the changes in the statistics of stocks in various positions as to result in a fairly close relationship between the composite series and the changes in statistics of stocks. The relationships are closer over the period 1902-3 to 1920-21 (the years represented by the solid dots), in which the element of error in the data appears to be less important.

in the second must arise largely from some inconsistencies in the statistics of supplies and disposition, most probably from inconsistencies in the production estimates. For the earlier period the production estimates employed in the calculation are our revised figures. Our revised estimates are much above the official figures, but on this showing appear to be still too low for the crops of 1898, 1899, and 1900. The evidence here suggests also that our revised estimates for the crops of 1896 and of 1901 (affecting the

observations for 1896-97 and 1901-2 on the chart) are too high, by comparison with later estimates. These indications are all in line with the opinions expressed in connection with the publication of our revised estimates.<sup>1</sup> The evidence in Chart 15 that the

CHART 15.—SECOND PRELIMINARY CALCULATION OF  
"FEED AND WASTE," FOR CROP YEARS,  
1896-97 TO 1926-27\*  
(Million bushels)



\* Data from Table 5 (p. 153). A calculation of the "feed and waste" residual in the disposition tabulation, making use of preliminary estimates of changes in total outside commercial stocks to supplement the statistics of changes in stocks, reveals peculiarities that are difficult to explain on any ground other than that of errors in the data. In particular, it appears that the calculated apparent changes in total outside commercial stocks plus "feed and waste" are affected by unusually large errors prior to 1902-3 and after 1920-21.

production estimates for the crop years 1922-23, 1923-24, and 1924-25 also are out of line with earlier and later estimates may be accepted as sufficient ground for excluding from consideration the data for these years, for the present at least. The negative "feed and waste" figure for 1921-22, though standing alone and possibly the result of a defect in the estimate of change in total outside commercial stocks for that year, is so far out of line with the other figures as to justify omitting the data for this year also in the subsequent calculations of average relationships.

In the nineteen-year period, 1902-3 to 1920-21, inclusive, there are several cases in which the "feed and waste" figure ap-

pears extraordinarily high or low compared with other years, but on the whole the figures for these years appear consistent. The isolated extreme values, especially when the deviations from the average are in opposite directions in successive years, as in 1913-14 and 1914-15, especially, may be attributed to defects in the index of outside commercial stocks as a basis for estimating changes in total outside commercial stocks quite as well as to defects in the production estimates. It seems best, therefore, in investigating the relation of changes in the several stocks series to the apparent changes in total outside commercial stocks, to use all the data for the nineteen years, 1902-3 to 1920-21, but to omit the data for earlier and later years. These, however, are retained in the charts for study, but are represented by hollow circles instead of solid dots.

Recomputing the curve of average relationship for Chart 12, we obtain the solid diagonal line. It turns out to deviate only slightly from the dotted line computed from all the data, indicating that the large errors in the data excluded in the second calculation had, as a matter of fact, cancelled out fairly well in the original calculation of the average relationship. The lines of average relationship shown on the two succeeding charts, like the solid line in Chart 12, are computed from the data for the years 1902-3 to 1920-21 only.

Comparing the closeness of the relationships shown in Charts 12, 13, and 14 on the basis of the data for the years 1902-3 to 1920-21, it is more than ever apparent that changes in terminal stocks form the least satisfactory basis for estimating changes in total outside commercial stocks. Changes in the index of outside commercial stocks east of the Rockies appear slightly better for the purpose than changes in farm stocks.<sup>2</sup>

#### JOINT RELATIONSHIPS

There remains the question of determining whether changes in two or more stocks series taken in combination may not furnish a better basis than changes in any one series alone for estimating changes in total outside commercial stocks. Outside commercial stocks, in the mass, form a hetero-

<sup>1</sup> See especially note 2, p. 258 in "Wheat Acreage and Production in the United States since 1866," WHEAT STUDIES, June 1926, II, No. 7.

<sup>2</sup> The Pearsonian coefficients of correlation are +0.73, +0.83, and +0.90 in the order in which the relationships have been discussed in this paragraph.

geneous total that may contain various constituent elements, some moving in closest sympathy with one of the classes of stocks covered by the statistics, some with another.

A purely statistical answer is readily obtained from a multiple correlation. The results, taken at face value, indicate that the best estimates of the apparent changes in total outside commercial stocks may be obtained by considering the changes in all of the statistical series together. The improvement in the technical accuracy of the estimates is not great enough, however, to be clearly significant, as judged by statistical tests,<sup>1</sup> and on analysis it appears that the assumptions implied in the "best" formula are not at all reasonable.

Only one joint basis for estimating changes in total outside commercial stocks which seems to deserve serious consideration has been discovered. That one involves the use of the index of outside commercial stocks east of the Rockies and the index of eastern terminal stocks, jointly. The statistical tests indicate that there is fair ground for supposing that the improvement in the estimates is statistically significant<sup>2</sup> and the assumptions involved appear reasonable.<sup>3</sup>

<sup>1</sup> The differences between the multiple correlation coefficients and the two best simple correlation coefficients are of the same order of magnitude as the probable errors of the coefficients. The test by comparison of the partial regression coefficients with their computed probable errors seems to be invalidated by the high intercorrelations between the independent variables. In particular, one of the regression coefficients obtained in a multiple correlation appeared almost certainly significant when judged by its computed probable error, but in the light of the known facts was ridiculous.

<sup>2</sup> The partial correlation coefficient is  $-0.43$  with a probable error of  $\pm 0.13$ . By the usual criteria there appears therefore to be about one chance in eighty that this appearance of a negative partial correlation is "accidental." At a subsequent stage in the study the correlation was recomputed, using index II for the outside commercial stocks, resulting in a somewhat lower partial correlation coefficient, namely,  $-0.34 \pm 0.14$ . This indicates about one chance in sixteen that the appearance of a negative partial correlation is "accidental."

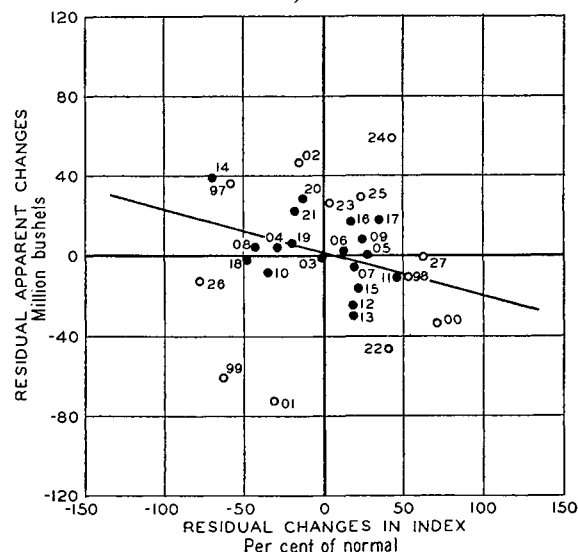
<sup>3</sup> The regression equation is  $A = 45.3 + 0.83C - 0.22T$ , where,

$A$  = apparent change in total outside commercial stocks plus "feed and waste," in million bushels,  
 $C$  = change in index of outside commercial stocks (index I),  
 $T$  = change in index of eastern terminal stocks.

The negative sign of the coefficient for  $T$  is not to be interpreted as meaning that  $A$  decreases as  $T$  increases, but that  $A$  decreases when  $T$  increases more than would be expected from the change in  $C$ . On this interpretation a negative coefficient appears entirely

When the statistical evidence is investigated further, however, it appears even less clearly significant than might be expected

CHART 16.—RELATION OF RESIDUAL CHANGES IN INDEX OF EASTERN TERMINAL STOCKS TO RESIDUAL APPARENT CHANGES IN TOTAL OUTSIDE COMMERCIAL STOCKS, 1896-97 TO 1925-26\*



\* The residuals are the changes in the series not accounted for by changes in the index of outside commercial stocks east of the Rockies. On the basis of the more homogeneous data, indicated by the dots, there is evidence that when terminal stocks increase more than would be expected from the change in the index of outside commercial stocks east of the Rockies, total outside commercial stocks increase less. This is not unreasonable, yet we regard the evidence as inconclusive (see text, p. 164).

from the formal statistical measure for probable significance. Chart 16 presents this evidence<sup>4</sup> graphically, the diagonal

reasonable. The statistics of outside commercial stocks employed as the basis for  $C$  are heavily weighted with stocks at the larger outside points, and it may well be that these tend to move more closely with  $T$  than does the general total of outside commercial stocks; that in consequence, the best estimates of  $A$  are obtained by including a correction for a tendency of  $C$  to move too closely with  $T$ .

<sup>4</sup> Using for brevity the notation given in the previous note, this chart shows the correlation of  $A$  with  $T$  when both are corrected for the values of  $C$  on the basis of the calculated regression equations, based on the simple correlations. A simple correlation of the "corrected" values thus obtained gives the partial correlation coefficient  $r_{AT.C}$  (using the notation of Yule) and the regression of the corrected values of  $A$  on the corrected values of  $T$  (represented by the regression line here shown) is the partial regression coefficient  $b_{AT.C}$ . For a demonstration of these facts, see W. L. Crum, "A Special Application of Partial Correlation," *Quarterly Publications of the American Statistical Association*, December 1921, n.s. No. 136, p. 951. Professor Crum's discussion deals specifically only with the case in which time is one of the independent variables, but is valid for any set of variables.



solid line representing the observed average tendency for apparent changes in total outside commercial stocks to vary inversely with changes in terminal stocks, after making the necessary allowance for changes in the index of outside commercial stocks east of the Rockies.

Neglecting the observations represented by the hollow circles, which have been shown to be probably less trustworthy than the other observations, there still appears no definite concentration of the points about the line of average relationship. On the contrary, such tendency to concentration as does appear is in the neighborhood of the horizontal zero line. There is, therefore, ground for supposing that the general tendency is for the observations to group themselves symmetrically about the horizontal zero line, indicating that there is no relationship, and that the fact that one large positive deviation from this line appears at the left and two large negative deviations at the right, giving a formally measurable relationship, is a pure coincidence. On the whole, we consider it quite as likely as not that the apparent advantage gained by using the index of terminal stocks as part of the basis for estimating changes in total outside commercial stocks is spurious.

We have now derived three separate bases for estimating the changes in total outside commercial stocks of wheat, no one of which is clearly much more trustworthy than any other. We may estimate the changes in total outside commercial stocks from the changes in the index of outside commercial stocks east of the Rockies, from the changes in the estimates of farm stocks, or jointly from the changes in the index of outside commercial and in the index of terminal stocks, all with substantially the same evidence of probable accuracy. In such a case, the most reasonable course to pursue is to derive the estimates on all three bases and see if more cannot be learned from a joint consideration of the three sets of results than from any one by itself.

#### THE ALTERNATIVE INDEXES AGAIN

At this point, however, we must return to the question whether the index of outside commercial stocks east of the Rockies is best used in the form in which it has thus

far been employed in the analysis (a composite series, derived from the *Daily Trade Bulletin* statistics for the years 1896-1918 and from the Department of Agriculture estimates of country mill and elevator stocks for subsequent years) or in its alternative form in which it is derived from the *Daily Trade Bulletin* statistics throughout. (See pp. 151-53.) It is now apparent that, so far as it is used at all, this index must form the basis, either alone, or with the index of terminal stocks as a subsidiary factor, for estimates of changes in total outside commercial stocks of wheat. Under these conditions, it is particularly important that the series be consistent throughout, in the sense of reflecting changes in the same classes of stocks. When the series is to be used alone for estimating changes in total outside commercial stocks it is important also that it be derived by the method that will probably render it most representative of changes in total outside commercial stocks.

The fact that the *Daily Trade Bulletin* statistics of outside commercial stocks seem to cover mill stocks at least as adequately as elevator stocks at the smaller points,<sup>1</sup> suggests that they may be more representative of total outside commercial stocks than the Department of Agriculture estimates. In the total outside commercial stocks, mill stocks apparently bulk much larger than elevator stocks (see Chart 4, p. 145). While the *Daily Trade Bulletin* figures cover country rather than city mills, together with country elevators, the country mill element in the figures may reflect very well the changes in city mill stocks. This supposition is supported by a study of statistics for the past three years, during which time city mill stocks statistics are also available.

In the following tabulation, the three series of statistics are expressed as percentages of the figure for 1925 in each series.

	City mill stocks	"Outside commercial" stocks	
		D.T.B.	U.S.D.A.
1925 .....	100	100	100
1926 .....	113	115	91
1927 .....	173	121	71

For these years at least the Department of Agriculture series would furnish a quite

<sup>1</sup> See comment on p. 152 above.

erroneous index of the movement of all outside commercial stocks (including city mill stocks as the largest constituent), while the *Daily Trade Bulletin* series would furnish an index that would be useful in the absence of more complete data.

It appears, therefore, that the evidence definitely favors use of this index in the second form, based throughout on the *Daily Trade Bulletin* statistics. It is desirable, therefore, to recalculate the relationships involving changes in the index of outside commercial stocks, using the index in its second form. The second form of the index differs from the first only in the values for 1919 and subsequent years, and since the relationships are determined for the period 1902-3 to 1920-21 only, there are but three values affected, the changes in the index for the crop years 1918-19, 1919-20, and 1920-21. As might be expected, the revised calculations show results differing little from those obtained in the original calculations. The equations of relationship, omitting the constant terms, which represent average "feed and waste," are given in a note to Table 6 (p. 166).

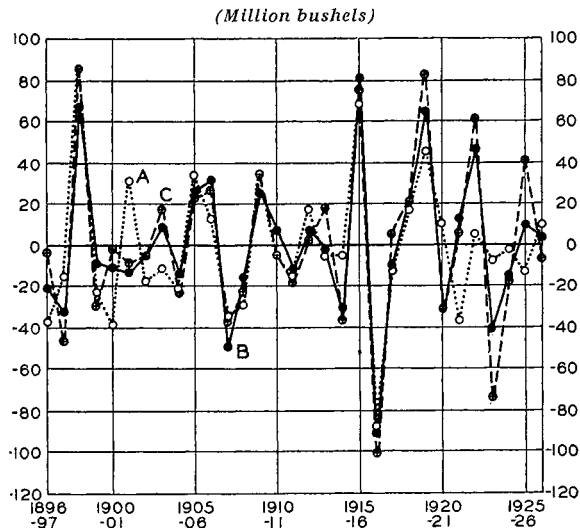
#### THE ESTIMATES

Proceeding with the necessary calculations, we obtain the three sets of estimates of changes in total outside commercial stocks shown in Table 6. Corresponding to each set of estimates of changes in total outside commercial stocks is a different set of figures for "feed and waste," the residuals remaining after the estimates of changes in total outside commercial stocks are subtracted from the composite items for "changes in total outside commercial stocks, plus 'feed and waste.'" These figures are shown in the last 3 columns of Table 6. When these data are put in graphic form, as in Chart 17, showing the alternative estimates of changes in stocks, and Chart 19 (p. 174), showing the alternative series for feed and waste, it appears that the differences are after all seldom large.

Although the broadest basis for forming conclusions is to be found in a joint consideration of the three alternative sets of estimates of changes in total outside commercial stocks and the three corresponding sets of figures for "feed and waste," it is

desirable for some purposes to be able to designate one among the three series of estimates of changes in total outside commercial stocks as probably the best. As already noted, the statistical tests failed to yield conclusive proof of superiority of any one of the three sets of estimates over either of the others. They did indicate, however, that

CHART 17.—ALTERNATIVE ESTIMATES OF CHANGES IN TOTAL OUTSIDE COMMERCIAL STOCKS, JULY 1 TO JULY 1, 1896-97 TO 1926-27\*



\* Data from Table 6. The analysis presented in the text develops three different bases for estimating changes in total outside commercial stocks. The series of estimates designated A is based on the changes in farm stocks; B, on changes in the index of eastern outside commercial stocks; and C, on changes in the index of eastern outside commercial stocks and changes in the index of eastern terminal stocks, jointly. There is little ground for choosing between the three sets of estimates, though series B appears to deserve somewhat greater confidence than the other series.

the estimates based on changes in the index of outside commercial stocks east of the Rockies are probably better than the estimates based on changes in farm stocks. It appears eminently reasonable that this should be the case. As between the estimates based on changes in the index of outside commercial stocks east of the Rockies and the estimates based on a joint consideration of that series and the changes in eastern terminal stocks, the statistical evidence of superiority was ambiguous. In such a case the estimates on the simpler basis are to be preferred as being possibly more trustworthy and certainly easier to interpret. We therefore regard the estimates based on changes in the index of out-

side commercial stocks east of the Rockies as probably superior to either of the other series and represent it by the solid line (B) For the last two crop years there is available a more reliable basis for obtaining the changes in total outside commercial stocks

TABLE 6.—ALTERNATIVE ESTIMATES OF CHANGES IN TOTAL OUTSIDE COMMERCIAL STOCKS AND CORRESPONDING CALCULATIONS OF "FEED AND WASTE," 1896-97 TO 1926-27

(Million bushels)

Year July 1 to July 1	Estimated change in total outside commercial stocks <sup>a</sup>			Calculated "feed and waste" <sup>b</sup>		
	A	B	O	A	B	O
1896-1897.....	-36.5	-19.7	- 9.0	+ 97.3	+ 80.5	+ 69.8
1897-1898.....	-15.5	-30.5	-38.7	+ 18.1	+ 33.1	+ 41.3
1898-1899.....	+82.6	+64.7	+73.9	- 30.2	- 12.3	- 21.5
1899-1900.....	-22.5	- 8.3	-20.4	+ 25.0	+ 10.8	+ 22.9
1900-1901.....	-37.8	-10.8	- 4.9	- .7	- 27.7	- 33.6
1901-1902.....	+30.3	-12.4	- 9.1	+ 49.2	+ 91.9	+ 88.6
1902-1903.....	-17.1	- 5.0	- 4.5	+ 56.3	+ 44.2	+ 43.7
1903-1904.....	-11.7	+ 8.3	+13.3	+ 69.9	+ 49.9	+ 44.9
1904-1905.....	-20.3	-13.7	-18.1	+ 51.4	+ 44.8	+ 49.2
1905-1906.....	+33.9	+25.0	+22.0	+ 39.5	+ 48.4	+ 51.4
1906-1907.....	+12.5	+30.5	+26.2	+ 58.3	+ 40.3	+ 44.6
1907-1908.....	-33.8	-47.0	-37.8	+ 34.6	+ 47.8	+ 38.6
1908-1909.....	-28.2	-15.3	-19.1	+ 65.9	+ 53.0	+ 56.8
1909-1910.....	+34.5	+24.4	+29.9	+ 28.1	+ 38.2	+ 32.7
1910-1911.....	- 5.1	+ 7.4	- .7	+ 46.7	+ 34.2	+ 42.3
1911-1912.....	-15.3	-11.0	-13.9	+ 24.3	+ 20.0	+ 22.9
1912-1913.....	+17.4	+ 7.3	+ 3.8	+ 5.1	+ 15.2	+ 18.7
1913-1914.....	- 5.0	- 2.2	+10.3	+ 87.7	+ 84.9	+ 72.4
1914-1915.....	- 5.0	-29.3	-32.2	+ 3.1	+ 27.4	+ 30.3
1915-1916.....	+68.8	+77.4	+72.1	+ 74.0	+ 65.4	+ 70.7
1916-1917.....	-88.7	-87.7	-91.1	+ 60.4	+ 59.4	+ 62.8
1917-1918.....	-11.3	- 9.3	- .4	+ 43.8	+ 41.8	+ 32.9
1918-1919.....	+16.8	+20.2	+19.6	+ 66.6	+ 63.2	+ 63.8
1919-1920.....	+45.5	+61.7	+71.2	+ 65.5	+ 49.3	+ 39.8
1920-1921.....	+10.8	-30.1	-29.2	+ 35.2	+ 76.1	+ 75.2
1921-1922.....	-36.5	+12.0	+ 7.6	+ 38.3	- 10.2	- 5.8
1922-1923.....	+ 5.3	+44.7	+52.2	+ 83.6	+ 44.2	+ 36.7
1923-1924.....	- 7.4	-38.5	-57.5	+111.0	+142.1	+161.1
1924-1925.....	- 2.4	-15.0	-15.8	+ 53.2	+ 65.8	+ 66.6
1925-1926.....	-12.6	+ 9.5	+28.0	+ 40.6	+ 18.5	.0
1926-1927.....	+ 9.6	+ 3.5	- 3.0	+ 22.0	+ 28.1	+ 34.6
Average .....	25.2	25.2	27.0	....	....	....

<sup>a</sup> Series A calculated from changes in farm stocks (*F*), using the equation  $Y = 1.502 F$ ; series B calculated from changes in the index of outside commercial stocks east of the Rockies (*C*), using the equation  $Y = 0.567 C$ ; series C calculated from changes in the index of outside commercial stocks east of the Rockies (*C*) and changes in the index of eastern terminal stocks (*T*), using the equation  $Y = 0.743 C - 0.176 T$ . These are the equations obtained from the correlations of apparent changes in total outside commercial stocks plus "feed and waste" with the changes in the several stocks series, as discussed in Section VI, with the constant terms omitted.

<sup>b</sup> Obtained by subtracting the corresponding estimates of change in total outside commercial stocks from the apparent change in total outside commercial stocks plus "feed and waste" (Table 5, p. 160).

in Chart 17. This series alone is reproduced in Appendix Table I, and likewise forms the chief basis for the series of estimates of total outside commercial stocks discussed subsequently and shown in Appendix Table II.

than that furnished by any of the estimates shown in Table 6. The Department of Agriculture estimates of interior mill and elevator stocks and the Department of Commerce statistics of city mill stocks, together, probably cover most of the outside

commercial stocks of wheat in the United States. These figures are available for July 1 of the last three years as follows, in million bushels:

	1925	1926	1927
Interior mill and elevator <sup>a</sup>	31.4	28.5	22.1
City mills <sup>b</sup> : . . . . .	26.7	30.3	46.1
Total . . . . .	58.1	58.8	68.2

<sup>a</sup> Department of Agriculture estimates, for 1926 and 1927, as published in 1927; for 1925, the original estimate raised 24 per cent.

<sup>b</sup> Department of Commerce figures, omitting stocks reported as held in country elevators and in public terminal elevators.

The changes in total outside commercial stocks indicated by these figures are, for 1925-26, an increase of 0.7 million bushels, and for 1926-27, an increase of 9.4 million bushels. These are the changes shown in column 14 of Appendix Table I for these two crop years.<sup>1</sup>

It is interesting to compare the changes in outside commercial stocks as thus calculated from the fairly complete statistics available for these two years with the estimates shown in Table 6. It is at once apparent that the estimates based on changes in the index of outside commercial stocks (series B) conform better with these figures than the estimates on either of the other bases. If the changes indicated by the above tabulation be taken as accurately representing the facts, the estimates in series A of Table 6 appear to be in error by 13 and 0 million bushels, respectively, the estimates in series B, by 9 and 6 million bushels, and the estimates in series C by 27 and 12 million bushels.

#### ACCURACY OF ESTIMATES

The estimates of changes in total outside commercial stocks may be interpreted more intelligently if some criterion can be obtained for judging their probable accuracy. It is, of course, quite impossible to judge whether the estimate for any individual year is close to the truth or far from it. It is quite possible, however, to deter-

mine approximately the range within which the majority of the errors will fall.

The errors in the estimates of changes in total outside commercial stocks are undoubtedly similar to the errors that would be made in estimating changes in one of the existing statistical series of stocks from changes in another statistical series. We have in the data discussed in Section V illustrations of the errors that would have occurred in estimating changes in one series from a closely related series and illustrations of the errors that would have occurred in estimating changes in one series from changes in much less closely related series. Which class of situation is involved in the case of the estimates of changes in total outside commercial stocks?

Briefly, it appears that the estimates of changes in total outside commercial stocks must be at least as good as, probably somewhat better than, the best estimates that might have been made of changes in any one of the statistical series from changes in any other. The relative accuracy with which various series may be estimated from other series may conveniently be judged from a comparison of the Pearsonian coefficients of correlation. We noted in Section V, for example, that changes in the index of outside commercial stocks east of the Rockies might be estimated with considerable accuracy from changes in farm stocks, and vice versa. The coefficient of correlation between the two series of changes is +0.81 for the entire period 1896-97 to 1925-26, and +0.91 for the 19-year period, 1902-3 to 1920-21.

We have, of course, no measure of the correlation between changes in total outside commercial stocks and changes in the index of outside commercial stocks east of the Rockies, but we can calculate the coefficient of correlation between the latter series and the series representing apparent changes in total outside commercial stocks plus "feed and waste." This coefficient is +0.90. The series representing apparent changes in total outside commercial stocks plus "feed and waste," as previously noted, is composed of three elements: (1) actual changes in total outside commercial stocks, (2) feed and waste, and (3) the net resultants of all the errors in the data employed in the computation. There is no reason to

<sup>1</sup> In Appendix Table I all of the figures have been shown to thousands of bushels: some of the figures deserve to be shown in this detail, and it has seemed desirable to maintain uniformity despite the fact that others of the figures are probably not significant beyond the millions.

suppose that there is a close correlation between either the second or the third element in this composite series and the changes in the index of outside commercial stocks. In consequence, the observed correlation of +0.90 between the latter series and the composite series must arise largely from the existence of a correlation considerably above +0.90 between the changes in the index of outside commercial stocks and the changes in the one element of the composite series with which it is closely correlated, namely, the changes in total outside commercial stocks. Applying the same reasoning to judge the probable closeness of the relationships involved in the two alternative series of estimates of changes in outside commercial stocks, it appears that the correlations between actual changes in total outside commercial stocks and changes in farm stocks would exceed +0.83, and between actual changes in total outside commercial stocks and changes in the index of outside commercial stocks and changes in the index of terminal stocks, taken together, would exceed +0.92. As previously indicated, we regard the closeness of the latter relationship as probably partly spurious ("accidental"). There is a similar, though smaller, chance of a spurious element in the other correlations, but on the whole it appears that all three sets of estimates of changes in total outside commercial stocks rest on relationships as close as, or closer than, the relationship between changes in farm stocks and changes in the index of outside commercial stocks east of the Rockies.<sup>1</sup>

<sup>1</sup> The several coefficients of correlation given above and some additional coefficients may be tabulated for convenient reference. In the following tabulation, designations of the coefficients are based on the notation used by Yule, substituting letters for numbers. A designates apparent changes in total outside commercial stocks, plus feed and waste; C, changes in the index of outside commercial stocks east of the Rockies; F, changes in farm stocks; P, changes in Pacific Coast stocks; and T, changes in the index of eastern terminal stocks. The coefficients of correlation, calculated from the data for the periods indicated, are as follows:

	1902-3 to 1920-21		1902-3 to 1920-21	1896-97 to 1925-26
$r_{AC}$ .....	0.904	$r_{CT}$ .....	+0.886	+0.752
$r_{AT}$ .....	0.733	$r_{CF}$ .....	+0.909	+0.806
$r_{AF}$ .....	0.833	$r_{CP}$ .....	...	+0.628 <sup>a</sup>
$r_{ACF}$ .....	0.916			+0.212

<sup>a</sup> For "typical" years only (see p. 156).

This being the case, a more detailed study of the errors in estimates of changes in one of the statistical series, based on the observed changes in the index of outside commercial stocks east of the Rockies, will throw light on the magnitude of changes in total outside commercial stocks. Table 7

TABLE 7.—RECORDED AND "ESTIMATED" CHANGES IN JULY 1 FARM STOCKS, 1896-97 TO 1926-27

(Million bushels)

Year	Recorded change <sup>a</sup>	Estimated change <sup>b</sup>	Difference
1896-1897.....	-24.3	-12.8	+11.5
1897-1898.....	-10.3	-19.4	- 9.1
1898-1899.....	+55.0	+38.5	-16.5
1899-1900.....	-15.0	- 5.9	+ 9.1
1900-1901.....	-25.2	- 7.4	+17.8
1901-1902.....	+20.2	- 8.4	-28.6
1902-1903.....	-11.4	- 3.9	+ 7.5
1903-1904.....	- 7.8	+ 4.2	+12.0
1904-1905.....	-13.5	- 9.2	+ 4.3
1905-1906.....	+22.6	+14.4	- 8.2
1906-1907.....	+ 8.3	+17.7	+ 9.4
1907-1908.....	-22.5	-29.4	- 6.9
1908-1909.....	-18.8	-10.2	+ 8.6
1909-1910.....	+23.0	+14.0	- 9.0
1910-1911.....	- 3.4	+ 3.6	+ 7.0
1911-1912.....	-10.2	- 7.5	+ 2.7
1912-1913.....	+11.6	+ 3.6	- 8.0
1913-1914.....	- 3.3	- 2.2	+ 1.1
1914-1915.....	- 3.3	-18.7	-15.4
1915-1916.....	+45.8	+46.2	+ .4
1916-1917.....	-59.1	-54.2	+ 4.9
1917-1918.....	- 7.5	- 6.5	+ 1.0
1918-1919.....	+11.2	+11.4	+ .2
1919-1920.....	+30.3	+36.7	+ 6.4
1920-1921.....	+ 7.2	-19.1	-26.3
1921-1922.....	-24.3	+ 6.5	+30.8
1922-1923.....	+ 3.5	+26.3	+22.8
1923-1924.....	- 4.9	-24.3	-19.4
1924-1925.....	- 1.6	-10.0	- 8.4
1925-1926.....	- 8.4	+ 5.0	+13.4
1926-1927.....	+ 6.4	+ 1.2	- 5.2
Average.....	16.8	15.4	10.7

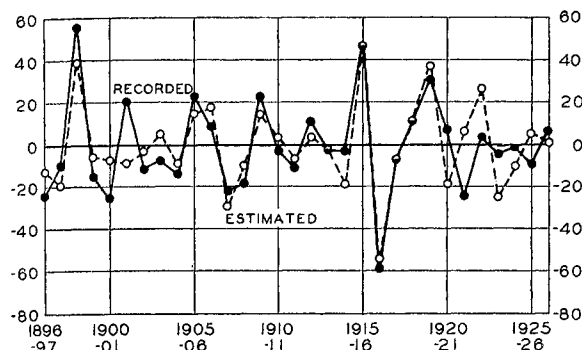
<sup>a</sup> Data from Appendix Table I, column 9.

<sup>b</sup> Calculated from changes in the index of outside commercial stocks east of the Rockies (C), using the equation  $Y = -0.85 + 0.345C$ .

shows in the first column the recorded changes in farm stocks, in the second column the series of estimates of changes in farm stocks, based on the changes in the index of outside commercial stocks east of the Rockies and the observed average rela-

tionship between the two series, and in the third column the difference, in millions of bushels, between the recorded and the estimated values. The recorded and the estimated series are shown graphically in Chart 18. The differences, or errors, aver-

CHART 18.—RECORDED AND "ESTIMATED" CHANGES IN YEAR-END STOCKS OF WHEAT ON FARMS, 1896-97 TO 1926-27\*



\* Data from Table 7. The probable accuracy of the estimates of changes in total outside commercial stocks (Chart 17) may be judged from a study of the errors in a similar set of estimates of changes in farm stocks. The estimates here shown, based on changes in statistics of outside commercial stocks east of the Rockies, usually agree fairly closely with the recorded changes, but are seriously in error in a few years.

age 10.7 million bushels (neglecting signs). Half of the errors amount to less than 8.6 million bushels, while the largest error is 30.8 bushels.

The errors in the estimates of changes in total outside commercial stocks must be expected to run somewhat larger than these, when expressed in bushels, owing to the fact that the changes involved are larger; the estimated changes in total outside commercial stocks average 64 per cent larger than these estimates of changes in farm stocks. Because the relationship involved is probably somewhat closer, the percentage errors are probably somewhat smaller for the estimates of changes in total outside commercial stocks. The errors in the estimates of changes in total outside commercial stocks, in million bushels, probably average somewhat less, therefore, than 64 per cent above the errors in the estimates of farm stocks. Concretely, the average error in the estimates of changes in total outside commercial stocks is probably somewhat under 17 million bushels

and probably less than half of the errors are in excess of 14 million bushels.<sup>1</sup>

It should be noted also that the actual changes in total outside commercial stocks must average larger than the estimated changes, probably by nearly 10 per cent. This results necessarily from the fact that the method employed serves to estimate accurately the influence of part of the factors affecting total outside commercial stocks, but not the influence of all the factors.<sup>2</sup> A similar result is observable in the "estimates" of changes in farm stocks shown in Table 7, which average 9 per cent under the average of the recorded changes.

The general conclusion reached after the study of similarities in movements of stocks (Section V), that changes in one class of stocks may usually be estimated fairly accurately from changes in another class of stocks, but that in a few years large errors are to be expected in such estimates, is pertinent here.

#### TOTAL OUTSIDE COMMERCIAL STOCKS, JULY 1, 1896-1927

Setting up the disposition table in the form used for this study, it has not been necessary to estimate the actual totals of outside commercial stocks for individual years, but merely the changes from year to year. For some purposes, however, it is important to have a series showing these totals as accurately as possible. Calculations of disposition stated in the usual form require use of the actual figures, and it is frequently more convenient to study the changes in a chart of the actual figures rather than in a chart showing merely the changes from year to year.

<sup>1</sup> The observed errors in the similar estimates of changes in farm stocks throw no light, of course, on the question of which estimates of changes in total outside commercial stocks are most in error or in what direction any particular estimate errs.

<sup>2</sup> Expressed mathematically the estimates have a standard deviation  $\sigma_e$ , while the actual changes have a standard deviation  $\sigma_a$ , which is the result of a combination of the portion of the changes which is accurately estimated and the residual changes, the latter with a standard deviation  $\sigma_r$ . Since the residual changes are necessarily uncorrelated with the estimated changes,  $\sigma_a^2 = \sigma_e^2 + \sigma_r^2$ . If the coefficient of correlation between the estimates and the actual changes is +0.90,  $\sigma_e = 0.90\sigma_a$ . The arithmetic means of the changes may be expected to show approximately the same relations as the standard deviations of the changes.

If the more comprehensive statistics now available may be assumed to give a substantially complete and accurate statement of outside commercial stocks about July 1, 1927, it is possible to estimate the approximate total outside commercial stocks for earlier years by using the estimated changes to work back from the 1927 total. On further analysis we find some evidence for believing that the existing statistics for stocks of wheat in the United States on July 1, 1927, may be somewhat under the actual total (see p. 177), but we find no trustworthy basis for estimating the amount of the understatement, if such there be. This being the case, the existing statistics of outside commercial stocks July 1, 1927, furnish the best available starting point. Applying the estimated changes in total outside commercial stocks, as shown in Appendix Table I, to work back from the 1927 total derived from the existing statistics<sup>1</sup> we obtain the figures shown in the sixth column of Appendix Table II.

These estimates of total outside commercial stocks are chiefly significant for the year-to-year changes shown, the probable accuracy of which has been discussed above. Whether the absolute values of the figures are approximately accurate or not it seems impossible to determine with certainty.<sup>2</sup> The estimates necessarily show the same trend as the statistics of outside commercial stocks compiled from the *Daily Trade Bulletin* reports: an approximately horizontal trend from 1896 to the war period, followed by an increase to an average level for the last eight years approxi-

mately 50 per cent above the pre-war level. It may be that total outside commercial stocks have not in fact averaged in recent years so much higher than in previous years, in which case our estimates for the earlier years are too low.

There is, however, one substantial indication that the level of the estimates for the earlier years is approximately correct. If the general level of the estimates is too low over any considerable portion of the period the changes, when expressed as percentages, will run too large; or if the general level is too high, the changes, expressed in percentages, will run too small. We may reasonably suppose that the average of the percentage changes in total outside commercial stocks must be approximately the same as the average of the percentage changes in the recorded outside commercial stocks, namely about 64 per cent. This supposition is the more reasonable since all the statistics of year-end stocks, other than eastern terminal elevator stocks, show roughly the same average percentage change, the averages ranging from 54 to 64 per cent (see p. 154). Taking account of the fact, demonstrated above, that the estimates of the changes in total outside commercial stocks must average about 10 per cent under the actual changes, it appears, then, that if the level of the estimated totals is correct, they should show an average percentage change of about 58 per cent. This is in fact precisely the average of the year-to-year percentage changes in the estimates of total outside commercial stocks as given in column 6 of Appendix Table II.

## VII. ANALYSIS AND CONCLUSIONS

### PROBLEMS OF INTERPRETATION

Having obtained reasonably trustworthy estimates of changes in what we have called total outside commercial stocks of wheat, which are in fact estimates of the

changes in total unrecorded stocks of wheat combined with a small element of recorded outside commercial stocks, we have gone as far as it now appears pos-

<sup>1</sup> To obtain the most complete figure for total wheat stocks on July 1, 1927, the Department of Agriculture figure for commercial stocks in the principal markets must be used in place of other visible supply statistics. This figure is 8,689,000 bushels above the total of "terminal stocks" as defined for the purpose of this study and this 8,689,000 bushels must be counted as part of the total "outside commercial"

stocks, as here defined. To this are added the reported city mill stocks (omitting stocks held in country elevators and in public terminal elevators) and the Department of Agriculture estimate of stocks of old crop wheat in interior mills and elevators.

<sup>2</sup> If the estimates had been constructed by working back from the 1927 total by using either of the alternative series of estimates of year-to-year changes ("A" or "C" of Table 5, p. 160), the estimates for earlier years would have run much higher.

sible to go toward providing a complete and accurate account of the disposition of American wheat supplies since 1896. We may therefore proceed to the second main problem of this study, that of discovering what important conclusions may be drawn from a study of the data on supplies and disposition.

One important conclusion that must be drawn is already evident: changes in year-end stocks of wheat represent a considerably more important element in the disposition than could have been supposed from an examination of existing statistics of stocks. We may now go farther, however, and determine with some precision the importance of changes in total stocks of wheat relative to other elements in the disposition. A second question deserving investigation is the significance of the figures for "feed and waste," the residual items in the disposition table as we have set it up. These residuals represent a combination of actual feed and waste and the net resultant of all the errors in the data used in the computation. What light do they throw on the changes that have occurred in actual feed and waste and what evidence do they give regarding errors in the data entering into the computation? Finally, we may review such evidence as is available on the question whether with the addition of the Department of Commerce figures on city mill stocks, and with the improved statistics of the Department of Agriculture on commercial stocks at the principal markets and on interior mill and elevator stocks, we may expect to have available for future years substantially complete statements of total year-end stocks of wheat.

#### IMPORTANCE OF CHANGES IN STOCKS

In investigating the importance of changes in total year-end stocks of wheat we may examine first the question of the magnitude of the changes in the unrecorded stocks, as we are now able to estimate them, compared with the changes in the recorded stocks. The compilation of changes in statistics of stocks employed in Table 2 (p. 143) involves some duplication of statistics. To obtain a complete statement of recorded stocks, prior to 1919, with-

out duplication, we have only to add the totals of farm stocks as estimated by the United States Department of Agriculture, and commercial stocks as recorded in the figures compiled by the *Daily Trade Bulletin* and the *Daily Market Record* for their monthly statement of stocks, after deducting from the latter Canadian stocks where they were included.<sup>1</sup> The changes in the statistics of stocks thus compiled are shown in the first column of Table 8 (p. 172). In 1919 the first of a series of improvements in existing statistics of stocks was made. The net result of these extensions of the record of stocks will be considered separately. For the present we are concerned only with the completeness of the record of changes in stocks obtainable from sources available prior to 1919, and for this purpose the figures in Table 8 may well be brought down to date on a comparable basis. In the last three columns of Table 8 are shown our three alternative estimates of changes in unrecorded stocks of wheat.<sup>2</sup>

The principal interest in the figures in Table 8 attaches to the average magnitude of the changes. The changes in the recorded stocks average 30 million bushels over the 31 years, 1896-97 to 1926-27, whereas the changes in the unrecorded stocks appear from these estimates to have averaged between 19 and 21 million bushels. The three sets of estimates are in close agreement as regards the average magni-

<sup>1</sup> The *Daily Trade Bulletin* "stocks in second hands" represent merely the total wheat stocks reported in their "monthly statement," plus reported flour stocks, expressed as wheat, and a small additional item of roughly estimated stocks of wheat and of flour. Only the figures in the "monthly statement" are therefore to be used here, since we are concerned only with stocks of wheat, as such, and can class as "recorded" only such figures on wheat stocks as have a definite statistical basis. Stocks reported in the Chicago visible supply statement are included as a part of the *Daily Trade Bulletin's* "monthly statement," and *Bradstreet's* visible supply statements seem to cover no stocks which can be shown to have been omitted from the *Daily Trade Bulletin's* "monthly statement."

<sup>2</sup> Our estimates of changes in total outside commercial stocks of wheat, as shown in Table 6, represent estimates of a total, part of which is covered by existing statistics of changes in outside commercial stocks. To obtain the strictly unrecorded portion of these estimated changes for this table, we have first added the recorded changes in farm and terminal stocks to the estimates of changes in total outside commercial stocks and then subtracted from these totals the changes in recorded stocks as shown in column 1.



tude of the changes in unrecorded stocks. The changes in unrecorded stocks appear to average two-thirds as large as the changes

TABLE 8.—CHANGES IN RECORDED STOCKS AND ESTIMATED CHANGES IN UNRECORDED STOCKS, JULY 1 TO JULY 1, 1896-97 TO 1926-27  
(Million bushels)

Year	Recorded stocks <sup>a</sup>	Unrecorded stocks <sup>b</sup>		
		A	B	C
1896-1897.....	- 59.8	-31.8	-15.0	- 4.3
1897-1898.....	- 18.7	- 8.0	-23.0	-31.2
1898-1899.....	+ 92.2	+62.8	+44.9	+54.1
1899-1900.....	- 1.5	-20.4	- 6.2	-18.3
1900-1901.....	- 47.1	-33.9	- 6.9	- 1.0
1901-1902.....	+ 6.9	+32.0	-10.7	- 7.4
1902-1903.....	-20.7	-12.1	.0	+ .5
1903-1904.....	- 9.9	-13.5	+ 6.5	+11.5
1904-1905.....	-14.6	-20.3	-13.7	-18.1
1905-1906.....	+ 39.3	+31.2	+22.3	+19.3
1906-1907.....	+ 29.4	+ 5.4	+23.4	+19.1
1907-1908.....	-60.2	-23.6	-36.8	-27.6
1908-1909.....	-24.0	-24.6	-11.7	-15.5
1909-1910.....	+ 31.3	+29.1	+19.0	+24.5
1910-1911.....	+ 10.3	- 7.0	+ 5.5	- 2.6
1911-1912.....	-13.3	-12.4	- 8.1	-11.0
1912-1913.....	+ 20.1	+15.9	+ 5.8	+ 2.3
1913-1914.....	-20.1	- 3.7	- .9	+11.6
1914-1915.....	-16.7	+ 1.2	-23.1	-26.0
1915-1916.....	+ 97.1	+50.9	+59.5	+54.2
1916-1917.....	-106.6	-67.9	-66.9	-70.3
1917-1918.....	-23.0	-11.0	- 9.0	- .1
1918-1919.....	+ 23.6	+13.0	+16.4	+15.8
1919-1920.....	+ 57.1	+30.6	+46.8	+56.3
1920-1921.....	-13.4	+18.9	-22.0	-21.1
1921-1922.....	-11.4	-40.1	+ 8.4	+ 4.0
1922-1923.....	+ 20.1	- 3.9	+35.5	+43.0
1923-1924.....	- 4.1	+ .2	-30.9	-49.9
1924-1925.....	-11.1	+ 2.1	-10.5	-11.3
1925-1926.....	-22.1	-14.6	+ 7.5	+26.0
1926-1927.....	+14.4	+ 8.9	+ 2.7	- 3.7
Average .....	30.3	21.0	19.3	21.3

<sup>a</sup> Change in the total obtained by adding farm stocks (Column 1, Appendix Table II), to total recorded commercial stocks compiled from the *Daily Trade Bulletin* (see p. 171).

<sup>b</sup> See footnote 2, p. 171. The three series of estimates of changes in unrecorded stocks correspond to the three series of estimates of changes in total outside commercial stocks as shown in Table 6, p. 166.

in the recorded stocks. By inference, the recorded stocks must have covered only about 60 per cent of the actual stocks. Comparison of the averages in Appendix Table II likewise shows the recorded stocks aver-

aging 60 per cent of the estimated total of stocks in all positions.

The method of preparing the estimates has been such that it is practically impossible that this calculation should overstate the average magnitude of the changes in unrecorded stocks. Rather, they probably understate the average magnitude of the changes in the unrecorded stocks by nearly 10 per cent.<sup>1</sup> It is clear, therefore, that any impressions as to the importance of changes in stocks gathered from a knowledge of the changes shown by the statistics of stocks alone must greatly underrate the importance of changes in stocks in their effect on the disposition.

To judge the true significance of changes in year-end stocks of wheat, the figures must be studied in connection with the other items of supply and disposition. The data are shown graphically in Chart 1 (p. 136). The changes in stocks here shown are totals obtained by adding the estimated changes in total outside commercial stocks, as calculated from the changes in the index of outside commercial stocks east of the Rockies, to the recorded changes in farm and terminal stocks.

The heavy solid line in Chart 1, usually the highest line on the chart, represents the total supplies from production, plus imports. Falling slightly below it in most years is the line of short dashes, representing the total disposition other than "feed and waste." Annual seed requirements are represented by the space under the lowest line on the chart and constitute a relatively small element in the total, showing only minor changes from year to year. Wheat milled in the United States, represented by the next space, constitutes approximately two-thirds to three-fourths of the total disposition, but, with the exception of the period from 1918-19 to 1921-22, shows only slight changes from year to year. Such changes as appear arise chiefly from variations in the quantity of wheat milled for export.

Exports of wheat are represented by the space between the highest light solid line and the line of round dots. This space is cut into by all the double cross-hatched

<sup>1</sup> See the discussion in the text and accompanying footnote on p. 169.

areas, but if attention be fixed on the line of round dots, the varying width of the space can readily be followed. The great variation in the volume of exports is at once apparent, contrasting sharply with the relative stability of the two items of disappearance to which it is added. The line of round dots bounding the upper edge of the space representing the exports, deserves special emphasis again because its height above the base line represents the combined total of all the items of disappearance other than feed and waste.

Changes in stocks are represented by the shaded areas shown above and below the line of total disappearance other than feed and waste, the single cross-hatched areas representing increases in stocks, the double cross-hatched areas representing decreases. The line of short dashes forming the upper boundary of the single cross-hatched areas and the lower boundary of the double cross-hatched areas deserves special emphasis also, for its height above the base line represents the total disposition other than feed and waste out of the current year's crop plus imports. This total disposition is larger than the total disappearance in years in which stocks are increased, while in years in which stocks are decreased the total disappearance exceeds the total disposition.

This line of total disposition other than feed and waste closely parallels, for the most part, the line of total supplies, with a small margin for feed and waste. There are a few exceptional years in which the margin is negative and a few others in which the margin appears extraordinarily large. The fluctuation in this margin may be studied to better advantage from another chart and will be discussed later (p. 174).

It is at once apparent from Chart 1 that the only items in the total disposition capable of much variation under any ordinary circumstances are the exports and the changes in stocks. It is through changes in these items chiefly that variations in the size of the crops must be taken up. Averaging the data for the thirty years from 1896-97 to 1925-26, it appears that the fluctuations in the size of the crop have been absorbed in almost exactly equal amounts by adjustments in these two items of dis-

position. The facts are conveniently set forth in the following tabulation, the figures being in million bushels.

	AVERAGE DEVIATIONS FROM 10-YEAR MOVING AVERAGE		
	Production	Exports <sup>a</sup>	Changes in stocks
13 years of large crops....	+80.3	+38.1	+38.1
17 years of small crops....	-63.6	-30.3	-29.3

<sup>a</sup> Including flour expressed in terms of wheat on the basis of the estimated milling ratios for the years in question.

The averages, however, reveal only part of the facts. Variations in the crops as they occurred over this 30-year period were absorbed in approximately equal amounts by variations in exports, and by changes in stocks, but viewing the facts more realistically, it must appear that the relative importance of these two flexible elements in absorbing changes in the size of the crops must depend on the nature of the changes. In prolonged periods of large or small crops such as result from expansion or contraction of acreage, changes in stocks can count for little in absorbing the excess or deficiency; disposition must be adjusted to the supply chiefly by adjustments in exports. The variations in crops which arise from varying weather conditions—high or low yields, and light or heavy winter-killing—are more largely absorbed by changes in stocks.

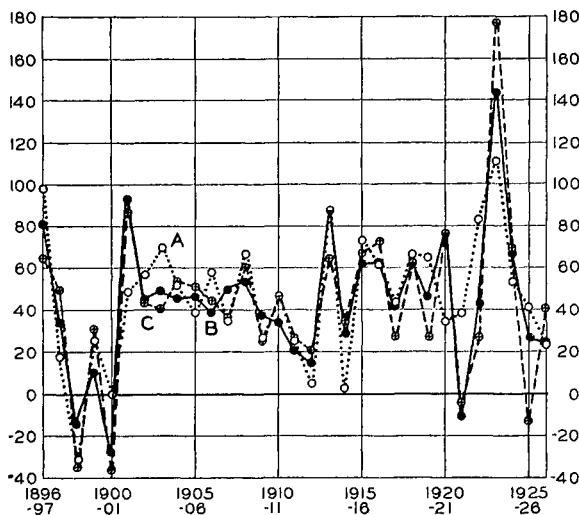
#### "FEED AND WASTE"

Turning next to the interpretation of the calculated figures for "feed and waste," we may advantageously study as a group the three sets of figures shown in Table 6 (p. 166) and reproduced graphically here in Chart 19 (p. 174). The question of chief interest on which some light may be thrown are: (1) To what extent do variations in the calculated values for "feed and waste" probably arise from errors in the estimates of changes in total outside commercial stocks of wheat? (2) To what extent do variations in the calculated values for "feed and waste" probably arise from errors in other data employed in the computation? And (3) To what extent may the figures be regarded as probably indicative of actual feed and waste?

The second question may best be answered first: some of the extreme values obtained for "feed and waste" must almost certainly arise from errors in data other than the estimates of changes in stocks. The most conspicuous case is the series of three low figures for the years 1898-99 to

CHART 19.—ALTERNATIVE CALCULATED SERIES FOR "FEED AND WASTE," BY CROP YEARS, 1896-97 TO 1926-27\*

(Million bushels)



\* Data from Table 6 (p. 166). Each series of estimates of changes in total outside commercial stocks, when employed in the tabulation of supplies and disposition, results in a different series of values for "feed and waste"—the residual item. The three series of calculated values are in agreement in indicating certain errors in the production estimates and also certain probable errors in the estimates of changes in total outside commercial stocks. No calculation of "feed and waste" as the residual item in a tabulation of supplies and disposition appears capable of giving a trustworthy indication of changes in actual feed and waste over this period.

1900-1901. The average "feed and waste" figure for these three years, according to each of the three alternative calculations, is less than zero. A single extremely low figure is usually open to possible explanation on the assumption that actual outside commercial stocks may have declined more than the estimated amount (or increased less). To apply this explanation to this series of three low values, however, would involve the assumption of an accumulation of errors in the estimates amounting to some 160 million bushels over the three years (assuming actual feed and waste to have been maintained at the average of the calculated values for the next ten years). Such an

assumption is, of course, quite untenable. The chief explanation, at least, of these low figures must lie in errors in other data used in the computation, and among these data only the production estimates seem to offer opportunity for such large errors.

A similar, though less extreme case is presented by the series of low values for "feed and waste" for the four years 1909-10 to 1912-13, inclusive. The average calculated "feed and waste" for these four years is from 18 to 25 million bushels (depending on which set of calculated values is used) under the average for the previous 7 years. To account for this series of low values on the ground of errors in the estimates of changes in total outside commercial stocks would involve the assumption of an accumulation of errors amounting to from 72 to 100 million bushels. We estimate that total outside commercial stocks increased from 35 million bushels on July 1, 1909 to 63 million bushels on July 1, 1913.<sup>1</sup> It is hard to believe that this estimated increase of 28 million bushels should be changed to an estimated decrease of 44 million bushels, as would be called for on the assumption of the smallest accumulation of error capable of furnishing such an explanation of the low "feed and waste" figures. Nor does it appear likely that actual feed and waste was much lower in these years than in previous years. It seems probable that other data employed in the calculation must be at fault in some of these years at least.

For the crop year 1921-22 two of the sets of estimates show negative quantities for "feed and waste," as in the preliminary calculations shown in Chart 15. The third set of estimates, however—that based on changes in farm stocks—shows a reasonable value for the feed and waste in this year. The difference arises from the fact that farm stocks decreased sharply between the beginning and the end of this year, whereas terminal stocks and the recorded outside commercial stocks increased. In the spring of 1921 many farmers held tenaciously to the belief that the drop in prices that had continued through the year would be followed by a reaction, and maintained stocks on farms at high levels at the end of

<sup>1</sup> See Appendix Table II.

the year. During 1921-22 this hope was generally abandoned and farm stocks were reduced accordingly. We know of no reason to suppose that the unrecorded mill and elevator stocks moved with farm stocks under these peculiar conditions, and consider that the evidence indicates strongly that the crop for this year was underestimated.

Among the figures for later years, the only ones which clearly indicate the presence of errors in data other than the estimates of changes in total outside commercial stocks are the figures for 1923-24. The most conservative of the three figures for this year shows "feed and waste" at 111 million bushels. Probably an unusually large amount of wheat was used for feed in this year: an inquiry made by the Department of Agriculture in November 1923 indicated that farmers contemplated feeding some 28 million bushels more wheat than usual in that year.<sup>1</sup> But even allowing for such unusually heavy feeding of wheat, the minimum calculated figure for "feed and waste" is still some 30 million bushels above a reasonable estimate of actual feed and waste (taking as the "usual" feed and waste, the average of the calculated figures for the years 1913-14 to 1920-21) while the alternative figures for the same year are 31 and 50 million bushels higher yet.

The excess of the most conservative figure over a reasonable estimate of actual feed and waste may quite reasonably be attributed to a defective estimate of the change in total outside commercial stocks, but such an explanation for the other values does not accord with such evidence as we have on the probable accuracy of the estimates. There is therefore good

reason for suspecting an error in the other data on supplies and disposition for 1923-24. Again suspicion must fall first on the crop estimate.

An answer to the first question stated above may now be attempted: to what extent do variations in the calculated values for "feed and waste" probably arise from errors in the estimates of changes in total outside commercial stocks? Omitting the special cases just discussed, none of the variations, individually, is too large to be accounted for on this ground. Variations in opposite directions in successive years, as in 1913-14 and 1914-15, naturally suggest the presence of such errors.<sup>2</sup> Even more important, the average magnitude of the variations, excluding the exceptional cases already noted, does not exceed a value that might reasonably be expected from errors in the estimates of changes in total outside commercial stocks alone.<sup>3</sup>

Having shown first that certain of the variations in the calculated "feed and waste" figures must apparently be accounted for on the ground of errors in data employed in the calculation, other than the estimated changes in stocks, and second, that the remaining variations may reasonably be accounted for entirely on the ground of errors in the estimates of changes in total outside commercial stocks, there remains nothing which must of necessity be accounted for on the ground of actual variations in feed and waste. The fact is, of course, that actual feed and waste does vary from year to year, probably sufficiently to render the variations a significant factor in the supply and demand situation. To the extent that the variations in actual feed and waste account for the variations in the calculated figures shown in Chart 19, the variations to be accounted for on the ground of errors in the data, including errors in the estimated changes in total outside commercial stocks, are reduced.

It appears probable, however, that the variations in the calculated feed and waste arise so much more largely from errors in the data employed in the calculation than from actual changes in feed and waste that such calculated figures are of little if any value as an index of actual changes in feed and waste. This is probably the most significant conclusion to be drawn from a

<sup>1</sup> The reports showed an intention to feed 11.6 per cent of the crop of 1923 as against a reported "usual" figure of 8.1 per cent. See *Agriculture Yearbook*, 1923, p. 660.

<sup>2</sup> The errors in the estimates of farm stocks shown in Table 7 (p. 168) show a marked tendency to such alternation in direction. More conspicuous cases were noted in the discussion of the relation of changes in Pacific Coast stocks to changes in the index of outside commercial stocks (p. 156).

<sup>3</sup> Assuming that it is not reasonable to expect the estimates of these changes to be more accurate than such estimates of changes in the existing statistical series as might be made from changes in other statistical series, this conclusion follows necessarily from a study of the correlation coefficients shown in the footnote on p. 168.

study of the calculated figures for "feed and waste" and related data.

The data give some basis, however, for judging the amount of variation in actual feed and waste. Though the judgment must be viewed as strictly tentative until direct data on feed and waste over a period of years have been made available, it appears worth while to give quantitative expression to the conclusions suggested by the evidence here assembled. As noted above, the "feed and waste" figures shown in Chart 19 represent the sum of three elements, (1) actual feed and waste, (2) errors in the estimates of change in total outside commercial stocks of wheat, and (3) errors in data on the other items of supply and disposition. It is clear from the moderate degree of variation in the total that the variations in the constituent elements must be smaller than some have supposed them to be. After weighing the various probabilities, it is the opinion of the present writer that the variations in actual feed and waste, in particular, must be smaller than is commonly supposed—specifically, that actual feed and waste can seldom deviate from the average by more than 10 or 15 million bushels.

Such variations, implying a possible change from one year to the next of, say, 25 million bushels, are still by no means negligible. We need more definite information on the amount of variation, and especially we need to know what circumstances are most influential in contributing to large (or small) disappearance as feed and waste. Is the quality of the crop the most important factor, or is it the price of the usual feed grains that is most important?

There is some ground for questioning whether even the general average of the calculated "feed and waste" figures is representative of the general average of actual feed and waste. The calculated figures run most commonly in the neighborhood of 40 to 50 million bushels, representing 5.5 to 7 per cent of an average crop. The reports obtained by the Department of Agriculture in 1923 showed 8.1 per cent of the crop as "usually" fed to livestock in the county where it was grown.<sup>1</sup> Making allowance for additional wheat fed to live stock, for dockage, and for industrial uses not covered in

the estimates of wheat milled, it appears that if this estimate is trustworthy, the total of the items of disappearance to be represented under the term "feed and waste" must run considerably above 40 or 50 million bushels. The question whether this is the case or not is of no importance, however, for analysis of the supply and demand situation. For such purposes it is not the absolute volumes of feed and waste that need to be known, but the changes from year to year.

#### ADEQUACY OF PRESENT STATISTICS

The fact that the statistics of year-end stocks of wheat available prior to 1919 covered only about 60 per cent of the actual total stocks and yet were commonly regarded as substantially complete, makes pertinent the question whether the statistics have even yet been rendered really complete. The best compilation of total year-end stocks of wheat that can now be made is to be obtained by adding together the Department of Agriculture estimates of farm stocks and of interior mill and elevator stocks, the Department of Agriculture statistics of commercial stocks in principal markets (the "United States Department of Agriculture visible supply"), and the Department of Commerce reports of mill stocks of wheat held in mills and mill elevators attached to mills, in private terminal elevators not attached to mills, and in transit and bought to arrive. The tabulation as of about July 1, 1927, is as follows, in thousand bushels:

Farm stocks .....	27,359
Interior mill and elevator stocks.....	22,075
U.S.D.A. visible supply	
Domestic wheat .....	22,083
Foreign wheat in store in bond....	7,472
City mill stocks	
In mills and mill elevators.....	34,149
In other private elevators.....	1,605
In transit and bought to arrive....	10,395
Total .....	125,138

At first thought it may appear reasonable to expect the results of the foregoing analysis to furnish an answer to the question of the adequacy of the present statistics. Such an analysis, however, is capable of demonstrating only gross inadequacies in the data. If it had indicated that the statistics over

<sup>1</sup> *Agriculture Yearbook*, 1923, p. 660.

the whole period omitted only 10 per cent of the total outside commercial stocks, for example, the evidence of incompleteness would be regarded as inconclusive.

A more serious limitation of the results of the analysis, for the purpose of judging the adequacy of the existing statistics of stocks, arises from the fact that conditions at present are radically different from conditions over most of the period available for study. It was shown above (p. 170) that the estimates of total outside commercial stocks given in Appendix Table II, column 6, satisfy the most rigorous test we have been able to apply as to the correctness of the general level of the estimates before the war. Since the level of the whole series of estimates is determined by the assumption that the present statistics of stocks are complete, this may be interpreted as a verification of that assumption. Regarding it as a verification, however, implies the further assumption that the great increase in the recorded outside commercial stocks east of the Rockies between the pre-war period and the last few years, is accurately representative of the increase in total outside commercial stocks over the same period. This assumption is not unreasonable, but it may quite possibly be in error. In consequence we must conclude that, while the results of the foregoing analysis indicate that the existing statistics of stocks are substantially complete, no great confidence can be placed in this particular evidence.

To demonstrate clearly the adequacy (or the inadequacy) of the existing statistics of stocks it would be necessary to analyze critically the methods employed in collecting the existing statistics and to devise adequate checks to determine: (1) whether the

estimates of "interior mill and elevator stocks" cover all commercial stocks of old wheat not included either in the Department of Agriculture compilation of commercial stocks at principal markets or in the Department of Commerce reports on mill stocks, and (2) whether the estimates of farm stocks are substantially complete and accurate. In our opinion, such an analysis and investigation can most advantageously be made by the Department of Agriculture itself. It would undoubtedly reveal many facts of interest both to the grain trade and to professional statisticians and economists.

For the present we must rely on the judgment of the Department of Agriculture on these points. That judgment seems to be that these estimates of stocks in interior mills and elevators and on farms omit no important body of stocks, but are subject to certain errors, which the Department is endeavoring to remove through improvements in the estimating methods.

In two minor respects the existing statistics are recognized by the Department of Agriculture to be incomplete: they omit wheat stocks held by mills producing over 5,000 barrels of flour annually but not reporting to the Department of Commerce, and they omit stocks in transit except such as are reported by mills.<sup>1</sup> It should be noted also that the statistics of stocks in principal markets (the United States Department of Agriculture visible supply) and of mill stocks are defective for the purpose of disposition tabulations in that the July 1 figures undoubtedly include appreciable quantities of new-crop wheat in some years.

<sup>1</sup> Cf. *Agriculture Yearbook*, 1926, p. 767.

*This study has been prepared by Holbrook Working. The directors of the Institute and other members of the staff have contributed information on a number of points. Most of the tabulations and computations have been made by Adelaide M. Hobe, and the charts have been prepared by Douglas L. King*

# APPENDIX

TABLE I.—SUPPLIES AND DISPOSITION OF WHEAT IN THE UNITED STATES, CROP YEARS 1896-97 TO 1926-27  
(Thousand bushels)

Year July-June	Supplies			Disappearance				Apparent change in total stocks plus "feed and waste"
	Production <sup>a</sup>	Imports <sup>b</sup>	Total	Exports <sup>c</sup>	Milled <sup>d</sup>	Seed <sup>e</sup>	Total exclu- sive of feed and waste	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1896-1897.....	612,600	1,534	614,134	81,058	451,200	76,220	608,478	+ 5,656
1897-1898.....	685,000	2,047	687,047	150,105	464,000	81,504	695,609	— 8,562
1898-1899.....	831,600	1,936	833,536	141,380	483,900	83,442	708,722	+124,814
1899-1900.....	682,200	317	682,517	102,265	496,300	80,778	679,343	+ 3,174
1900-1901.....	638,600	601	639,201	132,657	508,600	79,683	720,940	— 81,739
1901-1902.....	829,900	119	829,019	154,901	508,200	77,806	740,907	+ 88,112
1902-1903.....	737,900	1,265	739,165	115,485	525,800	74,316	715,601	+ 23,564
1903-1904.....	681,500	12	681,512	44,281	519,100	71,618	634,999	+ 46,513
1904-1905.....	581,000	3,103	584,103	5,011	492,200	70,358	567,569	+ 16,534
1905-1906.....	727,200	156	727,356	35,057	513,300	69,020	617,377	+109,979
1906-1907.....	759,700	616	760,316	77,225	522,500	67,502	667,227	+ 93,089
1907-1908.....	636,800	342	637,142	100,753	519,400	66,155	686,308	— 49,166
1908-1909.....	654,500	41	654,541	67,005	505,300	64,979	637,284	+ 17,257
1909-1910.....	712,700	173	712,873	46,891	506,700	70,706	624,297	+ 88,576
1910-1911.....	659,900	510	660,410	23,805	513,400	73,180	610,385	+ 50,025
1911-1912.....	621,338	2,699	624,037	30,266	522,700	72,411	625,377	— 1,340
1912-1913.....	730,267	798	731,065	91,796	526,700	71,427	689,923	+ 41,142
1913-1914.....	763,380	1,979	765,359	93,270	532,600	75,598	701,468	+ 63,891
1914-1915.....	891,017	452	891,469	259,943	558,900	84,997	903,840	— 12,371
1915-1916.....	1,025,801	5,703	1,031,504	173,953	557,100	78,456	809,509	+221,995
1916-1917.....	636,318	24,139	660,457	149,962	547,100	77,544	774,606	—114,149
1917-1918.....	636,655	29,220	665,875	35,196	530,900	89,944	656,040	+ 9,835
1918-1919.....	921,438	11,121	932,559	179,109	545,000	105,226	829,335	+103,224
1919-1920.....	967,979	4,780	972,759	122,580	605,900	91,063	819,543	+153,216
1920-1921.....	833,027	51,004	884,031	294,115	458,200	90,952	843,267	+ 40,764
1921-1922.....	814,905	14,466	829,371	208,392	537,900	96,249	842,541	— 13,170
1922-1923.....	867,598	18,013	885,611	155,180	539,200	91,413	785,793	+ 99,818
1923-1924.....	797,381	27,284	824,665	78,923	560,500	78,147	717,570	+107,095
1924-1925.....	864,428	6,169	870,597	195,655	546,600	84,148	826,403	+ 44,194
1925-1926.....	676,429	15,583	692,012	63,527	542,900	81,747	688,174	+ 3,838
1926-1927.....	831,040	13,235	844,275	156,397	554,100	88,563	799,060	+ 45,215

<sup>a</sup> Data, 1896-97 to 1910-11, are Food Research Institute revised estimates, from WHEAT STUDIES II, 7, 260; 1911-12 to 1926-27, from *Agriculture Yearbook, 1926*, and *Crops and Markets*.

<sup>b</sup> "General imports" or "imports for consumption" plus "re-exports," whichever was the larger (see pp. 140-41); data from *Monthly Summary of Foreign Commerce of the United States*.

<sup>c</sup> Domestic exports plus re-exports and shipments to possessions (from *Monthly Summary of Foreign Commerce of the United States*) plus shipments of 6,150 bushels to the American Red Cross in 1918-19 (from United States Grain Corporation, *Supplement to Grain and Flour Statistics during the War, 1920*).

<sup>d</sup> Food Research Institute estimates, from WHEAT STUDIES IV, 2, 101.

<sup>e</sup> Calculated at 1.38 bushels per acre sown (see p. 142).

TABLE I.—SUPPLIES AND DISPOSITION OF WHEAT IN THE UNITED STATES, CROP YEARS 1896-97 TO 1926-27  
—Concluded  
(Thousand bushels)

Year July-June	Change in stocks <sup>f</sup>							Total dispo- sition other than feed and waste <sup>g</sup>	Calculated "feed and waste" <sup>h</sup>
	On farms	Terminal			Outside commercial		Total recorded and estimated		
		Eastern	Pacific Coast	Total	Recorded	Total (estimated)			
	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1896-1897 .....	-24,270	-30,023	- 815	-30,838	- 4,136	-19,690	- 74,798	533,680	+ 80,454
1897-1898 .....	-10,304	- 2,697	+1,823	- 874	- 6,428	-30,528	- 41,706	653,903	+ 33,144
1898-1899 .....	+55,001	+16,884	+ 474	+17,358	+13,611	+64,744	+137,103	845,825	- 12,289
1899-1900 .....	-15,017	+13,202	+2,494	+15,696	- 1,751	- 8,341	- 7,662	671,681	+ 10,836
1900-1901 .....	-25,249	-15,308	-2,675	-17,983	- 2,262	-10,781	- 54,013	666,927	- 27,726
1901-1902 .....	+20,194	-11,062	- 552	-11,614	- 2,600	-12,370	- 3,790	737,117	+ 91,902
1902-1903 .....	-11,444	- 3,357	- 885	- 4,242	- 1,056	- 4,993	- 20,679	694,922	+ 44,243
1903-1904 .....	- 7,782	- 3,788	- 124	- 3,912	+ 1,753	+ 8,341	- 3,353	631,646	+ 49,866
1904-1905 .....	-13,463	- 285	- 828	- 1,113	- 2,872	-13,675	- 28,251	539,318	+ 44,785
1905-1906 .....	+22,642	+12,169	+1,747	+13,916	+ 5,256	+25,024	+ 61,582	678,959	+ 48,397
1906-1907 .....	+ 8,296	+14,734	- 721	+14,013	+ 6,413	+30,471	+ 52,780	720,007	+ 40,309
1907-1908 .....	-22,544	-26,863	- 565	-27,428	- 9,884	-46,983	- 96,955	589,353	+ 47,789
1908-1909 .....	-18,809	- 1,134	- 447	- 1,581	- 3,210	-15,321	- 35,711	601,573	+ 52,968
1909-1910 .....	+23,018	+ 2,278	+ 645	+ 2,923	+ 5,125	+24,399	+ 50,340	674,637	+ 38,236
1910-1911 .....	- 3,359	+11,829	- 18	+11,811	+ 1,544	+ 7,377	+ 15,829	626,214	+ 34,196
1911-1912 .....	-10,195	- 563	+ 414	- 149	- 2,303	-11,008	- 21,352	604,025	+ 20,012
1912-1913 .....	+11,639	+ 6,557	+ 402	+ 6,959	+ 1,528	+ 7,320	+ 25,918	715,841	+ 15,224
1913-1914 .....	- 3,279	-14,895	- 649	-15,544	- 449	- 2,156	- 20,979	680,489	+ 84,870
1914-1915 .....	- 3,264	- 7,044	- 175	- 7,219	- 6,162	-29,336	- 39,819	864,021	+ 27,448
1915-1916 .....	+45,759	+33,219	+ 254	+33,473	+16,264	+77,397	+156,629	966,138	+ 65,366
1916-1917 .....	-59,120	-26,994	+ 333	-26,661	-18,439	-87,725	-173,506	601,100	+ 59,357
1917-1918 .....	- 7,548	-13,358	-1,750	-15,108	- 1,958	- 9,306	- 31,962	624,078	+ 41,797
1918-1919 .....	+11,198	+ 7,749	+ 844	+ 8,593	+ 4,248	+20,201	+ 39,992	869,327	+ 63,232
1919-1920 .....	+30,285	+10,930	+ 940	+11,870	+12,984	+61,736	+103,891	923,434	+ 49,325
1920-1921 .....	+ 7,161	-11,628	- 820	-12,448	- 6,322	-30,074	- 35,361	807,906	+ 76,125
1921-1922 .....	-24,348	+ 9,223	+ 126	+ 9,349	+ 2,527	+12,030	- 2,969	839,572	- 10,201
1922-1923 .....	+ 3,535	+ 7,116	+ 316	+ 7,432	+ 9,390	+44,657	+ 55,624	841,417	+ 44,194
1923-1924 .....	- 4,913	+ 8,077	+ 386	+ 8,463	- 8,101	-38,528	- 34,978	682,592	+142,073
1924-1925 .....	- 1,624	- 4,247	- 718	- 4,965	- 3,151	-14,980	- 21,569	804,834	+ 65,763
1925-1926 .....	- 8,384	-17,612	+1,830	-15,782	+ 1,999	+ 734	- 23,432	664,742	+ 27,270
1926-1927 .....	+ 6,386	+ 8,501	-1,241	+ 7,260	+ 730	+ 9,415	+ 23,061	822,121	+ 22,154

<sup>f</sup> Calculated from data in Appendix Table II.

<sup>g</sup> Column 7, plus column 15.

<sup>h</sup> Column 3, minus column 16.



## DISPOSITION OF AMERICAN WHEAT SINCE 1896

TABLE II.—STOCKS OF WHEAT IN THE UNITED STATES IN VARIOUS POSITIONS ABOUT JULY 1, 1896–1927  
(Thousand bushels)

July 1	On farms <sup>a</sup>	In terminal elevators			In outside commercial hands		Total, all positions
		Eastern <sup>b</sup>	Pacific Coast <sup>c</sup>	Total	Recorded <sup>d</sup>	Estimated total <sup>e</sup>	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1896 .....	57,161	47,284	1,927	49,211	13,912	68,862	175,234
1897 .....	32,891	17,261	1,112	18,373	9,776	49,172	100,436
1898 .....	22,587	14,564	2,935	17,499	3,348	18,644	58,730
1899 .....	77,588	31,448	3,409	34,857	16,959	83,388	195,833
1900 .....	62,571	44,650	5,903	50,553	15,208	75,047	188,171
1901 .....	37,322	29,342	3,228	32,570	12,946	64,266	134,158
1902 .....	57,516	18,280	2,676	20,956	10,346	51,896	130,368
1903 .....	46,072	14,923	1,791	16,714	9,290	46,903	109,689
1904 .....	38,290	11,135	1,667	12,802	11,043	55,244	106,336
1905 .....	24,827	10,850	839	11,689	8,171	41,569	78,085
1906 .....	47,469	23,019	2,586	25,605	13,427	66,593	139,667
1907 .....	55,765	37,753	1,865	39,618	19,840	97,064	192,447
1908 .....	33,221	10,890	1,300	12,190	9,956	50,081	95,492
1909 .....	14,412	9,756	853	10,609	6,746	34,760	59,781
1910 .....	37,430	12,034	1,498	13,532	11,871	59,159	110,121
1911 .....	34,071	23,863	1,480	25,343	13,415	66,536	125,950
1912 .....	23,876	23,300	1,894	25,194	11,112	55,528	104,598
1913 .....	35,515	29,857	2,296	32,153	12,640	62,848	130,516
1914 .....	32,236	14,962	1,647	16,609	12,191	60,692	109,537
1915 .....	28,972	7,918	1,472	9,390	6,029	31,356	69,718
1916 .....	74,731	41,137	1,726	42,863	22,293	108,753	226,347
1917 .....	15,611	14,143	2,059	16,202	3,854	21,028	52,841
1918 .....	8,063	785	309	1,094	1,896	11,722	20,879
1919 .....	19,261	8,534	1,153	9,687	6,144	31,923	60,871
1920 .....	49,546	19,464	2,093	21,557	19,128	93,659	164,762
1921 .....	56,707	7,836	1,273	9,109	12,806	63,585	129,401
1922 .....	32,359	17,059	1,399	18,458	15,333	75,615	126,432
1923 .....	35,894	24,175	1,715	25,890	24,723	120,272	182,056
1924 .....	30,981	32,252	2,101	34,353	16,622	81,744	147,078
1925 .....	29,357	28,005	1,383	29,388	13,471	66,764	125,509
1926 .....	20,973	10,393	3,213	13,606	15,470	67,498	102,077
1927 .....	27,359	18,894	1,972	20,866	16,200	76,913	125,138
Average 1896–1927 .....	37,520	20,493	1,962	22,454	12,380	61,221	121,196

<sup>a</sup> For the years 1896–1911, based on the Department of Agriculture estimates of percentage stocks and Food Research Institute revised estimates of production (see p. 140); for subsequent years, Department of Agriculture estimates, from *Wheat and Rye Statistics*, p. 37, and *Crops and Markets*.

<sup>b</sup> Chicago Board of Trade "visible supply" at 18 points (see footnote 2, p. 148), compiled from the *Chicago Daily Trade Bulletin*.

<sup>c</sup> Compiled from *Bradstreet's*; see also Table 3, p. 150.

<sup>d</sup> Total reported United States stocks of wheat east of the Rockies, from *Daily Trade Bulletin* monthly statement of "world's available supply of breadstuffs," minus eastern terminal stocks as shown in column 2, above.

<sup>e</sup> Food Research Institute estimates; see pp. 169–70, above.

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