

*University of Minnesota
Agricultural Experiment Station*

*Factors Affecting the Price of
Minnesota Potatoes*

*Holbrook Working
Division of Agricultural Economics*



UNIVERSITY FARM, ST. PAUL

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TECHNICAL BULLETIN 29

OCTOBER 1925

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FACTORS AFFECTING THE PRICE OF MINNESOTA POTATOES

By HOLBROOK WORKING

INTRODUCTION

Why does the price of potatoes change so much from one year to another? Why does the price of potatoes sometimes change so much during a single season? What is the average change in the price of potatoes from fall to spring? How much are prices affected by an increase of 10 per cent in production? What is a normal production of potatoes for the United States? Everyone who is financially interested in potatoes has asked himself all these questions and many more.

The purpose of this bulletin is to bring together information which helps in answering these questions, and to show as far as possible just what the answers are. The study of the factors which influence the price of potatoes or any other commodity is similar in many ways to the study of the influences which cause disease. Much can be learned about the causes of disease by common observation and without the use of special scientific methods and without any special studies by trained scientists. For example, everyone knows something of the common causes of colds. But it required careful scientific work to determine the cause of tuberculosis; even after it was known that bacteria were responsible for many diseases, only long and careful study made it possible for Robert Koch to demonstrate that tuberculosis was similarly caused by a specific bacterium.

Similarly, everyone knows much about the factors which influence prices, probably more than most people know about diseases. Common observation tells them that when the production is small, the price must be high; and that when other prices are rising rapidly, as they did during the war, the price of potatoes or wheat or any other product is likely to rise also. But only careful study reveals just how much the price will rise when production is decreased 10 per cent, or just how much the price of potatoes will go up on account of some force which is causing other prices to rise.

In the study of prices, as in the study of diseases, we have learned that careful scientific study discloses certain facts that we could not learn by ordinary observation. Many things are still to be learned, but for potatoes we already know just which are the most important factors that ordinarily affect the price, and for five of these factors it has been possible to get statistical measures and to estimate quite

accurately what the effect of these factors will be under any given conditions.

Many of the conclusions to be described have already been set forth in a Technical bulletin published in 1922,¹ but since then additional facts have been discovered which more completely explain the movements of the price of potatoes.

PRICES TO BE STUDIED FIRST

The best way to begin a study of the price of potatoes, is by considering the factors which affect the average price for the entire season. Some sections of Minnesota produce considerable quantities of potatoes which are ordinarily marketed in August, but the great bulk of the Minnesota production comes on the market after the first of September. In 1918-19, 13.6 per cent of the carlot shipments moved before the first of September, but for the last four years the average has been 5.1 per cent. Most of the Minnesota crop is usually disposed of by the end of May, only about one per cent being left, on the average, for shipment after June 1. Accordingly the principal interest in Minnesota centers upon the price of potatoes for the nine-month season from September to May.

Table I gives the price of potatoes in St. Paul and Minneapolis for each month from September to May since 1899, and the averages for each season.²

Figure 1 shows the average price of potatoes for each season, beginning with 1902-3 and ending with 1923-24. This is what is known as a "ratio chart," being drawn to a scale which gives a fair comparison of *relative* changes. A 10 per cent change, for example, is represented in any part of the chart by the same vertical distance, so that a change in price from 50 to 55 cents looks the same as a change from \$2 to \$2.20. A chart drawn with the more common arithmetical ruling makes a change from \$2 to \$2.05 look just as important as a change from 50 to 55 cents, but relatively it is only one quarter as important. The facts which we must consider are clearer if we note the relative changes, hence this ratio scale has been used in all the charts.

¹ Working, Holbrook. Factors Determining the Price of Potatoes in St. Paul and Minneapolis. Minn. Tech. Bul. 10. 1922.

² A detailed description of the method by which these figures were obtained is given in Minn. Tech. Bul. 10, pp. 10-14.

TABLE I

PRICE OF POTATOES PER HUNDREDWEIGHT IN ST. PAUL AND MINNEAPOLIS, MONTHLY, 1899-1923, BY CROP YEARS—AVERAGE TABLE STOCK

	1899-1900	1900-01	1901-02	1902-03	1903-04	1904-05	1905-06	1906-07	1907-08	1908-09	1909-10	1910-11
September	\$0.70	\$0.43	\$1.38	\$0.43	\$0.80	\$0.53	\$0.60	\$0.70	\$0.95	\$1.02	\$0.77	\$1.17
October	0.65	0.43	1.03	0.52	0.80	0.52	0.68	0.67	0.85	0.98	0.67	0.98
November	0.73	0.48	1.23	0.57	0.90	0.50	0.88	0.63	0.77	0.95	0.65	0.80
December	0.85	0.62	1.27	0.62	0.95	0.50	0.87	0.58	0.77	1.02	0.63	0.73
January	0.67	0.60	1.22	0.68	1.03	0.80	0.83	0.68	0.87	1.10	0.68	0.82
February	0.67	0.75	1.17	0.65	1.47	0.45	0.77	0.65	0.97	1.28	0.75	0.80
March	0.57	0.67	1.20	0.58	1.62	0.48	0.68	0.75	1.03	1.42	0.58	0.87
April	0.42	0.58	1.35	0.53	1.70	0.38	0.88	0.82	1.02	1.62	0.37	1.05
May	0.37	0.73	1.22	0.70	1.53	0.43	0.87	0.95	0.95	1.52	0.42	1.05
Annual average*	\$0.62	\$0.58	\$1.23	\$0.58	\$1.20	\$0.52	\$0.78	\$0.72	\$0.90	\$1.20	\$0.60	\$0.92
Harmonic mean	\$0.58	\$0.57	\$1.23	\$0.58	\$1.10	\$0.50	\$0.77	\$0.70	\$0.90	\$1.17	\$0.58	\$0.90

	1911-12	1912-13	1913-14	1914-15	1915-16	1916-17	1917-18	1918-19	1919-20	1920-21	1921-22	1922-23	1923-24
September ...	\$1.23	\$0.68	\$1.05	\$0.95	\$0.55	\$1.87	\$1.78	\$2.10	\$2.57	\$1.98	\$1.98	\$0.87	\$1.12
October	0.97	0.62	1.02	0.72	0.78	2.03	2.30	1.83	2.43	1.65	1.70	0.76	0.88
November	1.13	0.70	1.02	0.57	0.85	2.52	1.97	1.62	2.65	1.77	1.47	0.70	0.81
December	1.17	0.67	0.98	0.62	1.07	2.47	1.78	1.60	3.05	1.30	1.38	0.64	0.85
January	1.45	0.65	1.00	0.65	1.50	2.78	1.98	1.77	3.98	1.20	1.73	0.62	1.12
February	1.62	0.67	1.00	0.70	1.43	3.60	2.02	1.68	4.05	0.92	1.58	0.62	1.07
March	1.86	0.65	1.03	0.65	1.38	3.75	1.73	1.48	5.28	1.02	1.43	0.86	1.03
April	1.98	0.60	1.05	0.70	1.32	4.27	1.07	1.92	7.02	0.82	1.32	1.08	1.15
May	1.85	0.68	1.08	0.68	1.43	4.63	1.05	2.02	7.13	0.73	1.65	0.84	1.08
Annual average*	\$1.47	\$0.65	\$1.02	\$0.70	\$1.15	\$2.97	\$1.75	\$1.78	\$4.20	\$1.25	\$1.58	\$0.78	\$1.14
Harmonic mean	\$1.38	\$0.65	\$1.02	\$0.68	\$1.03	\$2.82	\$1.63	\$1.77	\$3.63	\$1.13	\$1.56	\$0.75	\$1.00

* Weighted average obtained by weighting monthly prices by the number of weeks included in each.

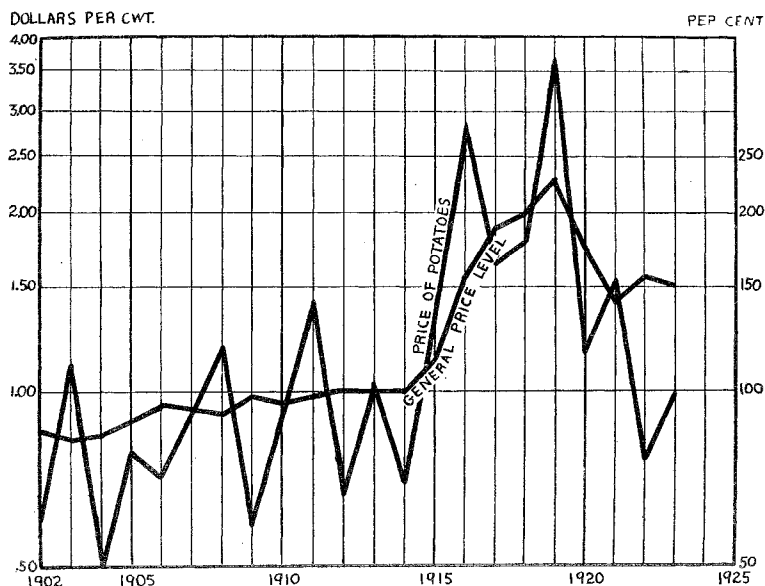


Fig. 1. Changes in Price of Potatoes and General Price Level
The price of potatoes goes up and down with the general price level.

FACTORS AFFECTING AVERAGE PRICE FOR THE SEASON

I. VALUE OF THE DOLLAR

The first factor which must be considered is the value of the dollar. Everybody knows that the value of the dollar changes. During 1919 and part of 1920 it fell to a point where on the average a dollar would buy only one half to one third of what it would during the years just before the war; in other words, prices were two or three times as high as before the war. During 1920 the value of the dollar rose very suddenly, which is just another way of saying that prices fell very rapidly, so that now a dollar will buy on the average about two thirds of what it would before the war.

Of course when discussing the changes in the value of the dollar or in the price level, one is really not talking of *causes* but of effects. We know pretty well what these causes are, but in studying their effects on any one product, the most accurate way is to take the average of the changes of a large number of different commodities as measured by price index numbers. Thus it is convenient to speak of the changes in the value of the dollar as causing the changes in the price of potatoes and to measure the influence by means of price index numbers.

Besides showing the changes in the price of potatoes, Figure 1 shows also the changes in the value of the dollar as measured by an index number of prices of "all commodities" as calculated by the United States Bureau of Labor Statistics from prices of about 400 different commodities representing practically every kind of goods sold in the United States. The figures for the index number are given in Table II. It is easy to see that the price of potatoes moves more or less in the same way as this index number made up from an average for 400 different commodities.

TABLE II
GENERAL PRICE LEVEL, 1902-3 TO 1923-24*
(AVERAGE FOR 1913=100)

1902-03.....	85.0
1903-04.....	83.7
1904-05.....	84.2
1905-06.....	89.0
1906-07.....	94.7
1907-08.....	92.7
1908-09.....	91.7
1909-10.....	97.6
1910-11.....	95.6
1911-12.....	97.5
1912-13.....	99.6
1913-14.....	99.3
1914-15.....	99.3
1915-16.....	111.0
1916-17.....	152.5
1917-18.....	185.8
1918-19.....	199.9
1919-20.....	227.8
1920-21.....	173.0
1921-22.....	141.7
1922-23.....	156.3
1923-24.....	150.8

* Harmonic mean of nine months, October to June, for 1902-14; September to May for 1915-23. Bureau of Labor Statistics "all commodities" index number, unweighted, 1902-12; 1919 weights, 1913-22.

From Figure 1, however, it is apparent that the changes in the value of the dollar explain only a part of the changes in the price of potatoes. This brings us to a very important step in the method to be used. Having found one cause of changes in the price of potatoes, we must *remove the changes due to that cause*, and then it will be easier to see just what changes remain to be explained. This is a step which will be repeated with every new factor discovered.

The effect of the changes in value of the dollar can be removed by dividing the price of potatoes by the index number of the general price level, which seems to be the best measure of the way the changes in the value of the dollar affect the price of potatoes. The result is shown in Figure 2. We may call this a chart of the *real value* of potatoes or, for brevity, merely the *value* of potatoes. The average

price level of 1913 is taken as 100 per cent and all changes are measured from that point. If the price of potatoes were \$1 per hundredweight during a season in which the price level was 100 per cent, we should say that the *value* of potatoes was \$1 per hundredweight. But if the price of potatoes were \$1 per hundredweight during a season in which the price level was 200 per cent, we should say that the *value* of potatoes was only 50 cents per hundredweight.

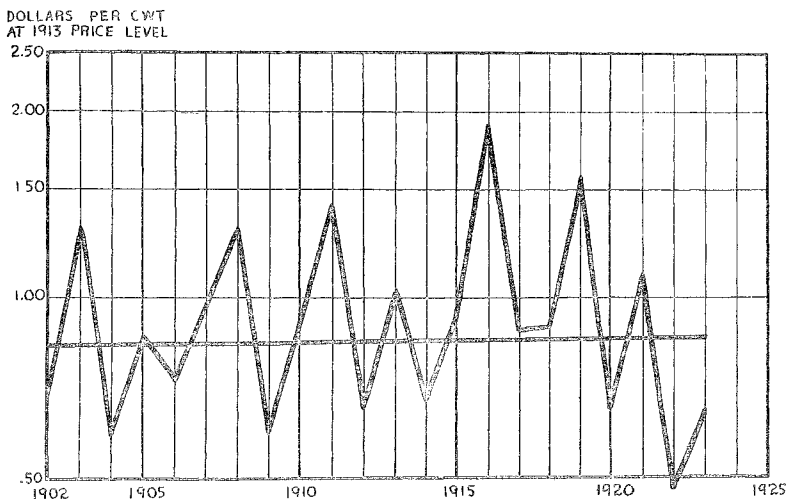


Fig. 2. Changes in Price of Potatoes with Effect of First Factor Removed

After making allowance for the changes in the general price level, the first factor considered, the price of potatoes still shows wide fluctuations from one year to another.

The most important facts to be noticed about Figure 2 are that fluctuations are somewhat smaller and that the changes after 1915 look more like the changes before 1915 than in the original chart of the price of potatoes (Fig. 1). This is the result of removing the effect of the first factor, the changes in the value of the dollar.

2. TREND OF THE VALUE OF POTATOES

Examination of Figure 2 suggests that there has been a gradual increase in the value of potatoes during the period covered, or at least up to 1919. Taking the period as a whole, the prices of potatoes have been rising a very little more than the prices of most other commodities, and when the value of potatoes is measured in terms of goods in general it shows a slight upward trend, as represented by the "normal" line. The change in this normal is not great, but its effects must be removed, just as the effects of the changes in value of the dollar were removed in order to determine how completely the changes in the price of potatoes are explained by these factors and the remaining factors

to be considered. In removing the effect of the changing normal value of potatoes, it is necessary to express the remaining fluctuations in terms of *percentages of normal* instead of in dollars. The result is shown in Figure 3, which looks exactly like Figure 2 except that the curve showing the fluctuations in the price of potatoes has a horizontal trend and is higher in the chart; and the scale is given in percentages of normal instead of in dollars. The changes are almost as great after removing the effects of this second factor as before.

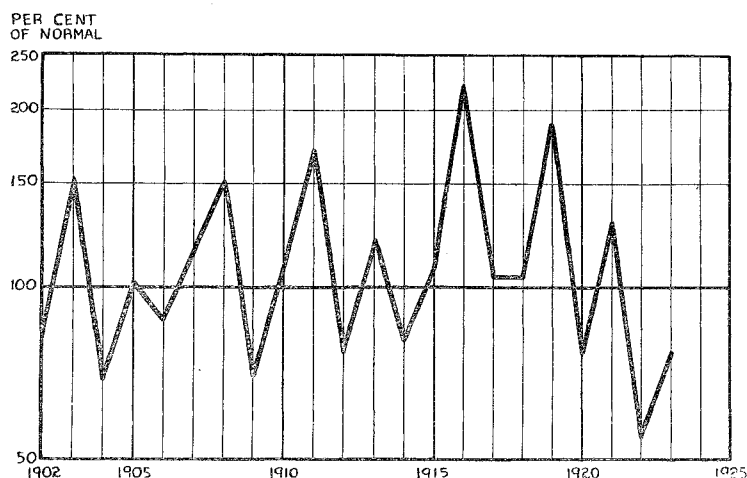


Fig. 3. Changes in Price of Potatoes with Effect of First and Second Factors Removed

The second factor considered is the change in the normal value of potatoes. Taking account of this factor makes only a slight change in the appearance of the price curve here as compared with that in Figure 2.

3. FLUCTUATIONS IN PRODUCTION OF POTATOES

Everyone knows that changes in the production of potatoes result in changes in price. When the crop is large the price must be low or they cannot all be sold; and when the crop is small, consumers are willing to pay a high price for what they can get. Of course, if anyone had a monopoly on most of the potatoes raised, it would pay to hold the price high even if the crop were large and let all the potatoes not used go to waste; but as it is, no producer or group of producers is willing to let his potatoes go to waste while all other producers sell their potatoes at a high price. Even if a single co-operative organization could get control of as large a proportion of the potatoes raised in the United States as the Sun Maid Raisin Growers' Association has of the raisins, they could not set the price so high as to cause large quantities of potatoes to go to waste, without being condemned by the courts as a monopoly.

While everybody knows that when the crop is large the price must be low in order to have the potatoes used, not everyone knows or remembers that much of the extra crop is used on the farm and can best be used there. When the crop is large, it never pays to ship small and inferior potatoes to market; it is much better to keep them on the farm and feed them to hogs or cattle.

TABLE III
TWENTY-SEVEN LATE CROP STATES*

1 Maine	10 West Virginia	19 South Dakota
2 New Hampshire	11 Ohio	20 Nebraska
3 Vermont	12 Indiana	21 Montana
4 Massachusetts	13 Illinois	22 Wyoming
5 Rhode Island	14 Michigan	23 Colorado
6 Connecticut	15 Wisconsin	24 Idaho
7 New York	16 Minnesota	25 Washington
8 New Jersey	17 Iowa	26 Oregon
9 Pennsylvania	18 North Dakota	27 California

* States usually making over half their potato shipments after the first of September.

While many people think of the production of potatoes for the entire United States as affecting the price for the late crop, this is not entirely true. It is only the part of the production which is available for use after the first of September that affects the price after the first of September. There are 27 states which make over half of their potato shipments after the first of September, as listed in Table III. While the production in these 27 states is not an entirely accurate indication of the total crop available for use after the first of September, owing to the fact that considerable quantities of potatoes are shipped out of these states before September, while states farther south continue shipping after that date, it is the best available figure on late crop production. Table IV, compiled from the reports of the United States Department of Agriculture with certain revisions in the acreage figures, shows the acreage, average yield per acre, and production for the 27 late crop states since 1902.

A crop of 300,000,000 bushels for these 27 states, which would have been a very large production in 1902, would be considered small now. In judging whether a crop is large or small, it must be considered in relation to a normal production which increases from year to year, allowing for the increase in population of the country and changes in consumption habits. The usual way of calculating a normal when it is not changing from year to year is to take an average. Fortunately, mathematical methods³ have been worked out for calculating

³ The most commonly used of these methods is called the "method of least squares." It is really not a method, but a principle, which is applied in various ways to suit different cases. As applied in the simplest cases, it is familiar to everyone, being merely the ordinary average.

a sort of average which allows for a regular change from year to year. Instead of a single value, this gives a series of values, and when they are plotted on a chart, a line may be drawn through them as shown by the line marked "normal" in Figure 4. The same method was used in calculating the "normal" value of potatoes shown in Figure 2.

TABLE IV
ACREAGE, PRODUCTION, AND AVERAGE YIELD PER ACRE OF POTATOES IN TWENTY-SEVEN LATE CROP STATES, 1902-24

Year	Acreage	Yield per acre	Production
	Thousands of acres	Bushels	Millions of bushels
1902	2621	96.0	251.6
1903	2567	87.1	223.6
1904	2629	115.2	302.8
1905	2575	88.1	226.8
1906	2538	105.9	271.0
1907	2622	98.4	258.1
1908	2686	86.6	232.6
1909	2874	111.1	319.3
1910	2841	96.5	274.2
1911	2797	88.4	247.3
1912	2907	118.5	344.5
1913	2866	94.8	271.7
1914	2910	119.5	347.7
1915	2932	94.8	278.0
1916	2771	78.5	217.5
1917	3079	103.6	318.9
1918	2998	100.5	301.3
1919	2950	93.0	274.5
1920	2967	114.6	340.0
1921	3169	95.5	302.5
1922	3470	110.1	381.9
1923	3021	115.1	347.7
1924	2829	132.3	374.3

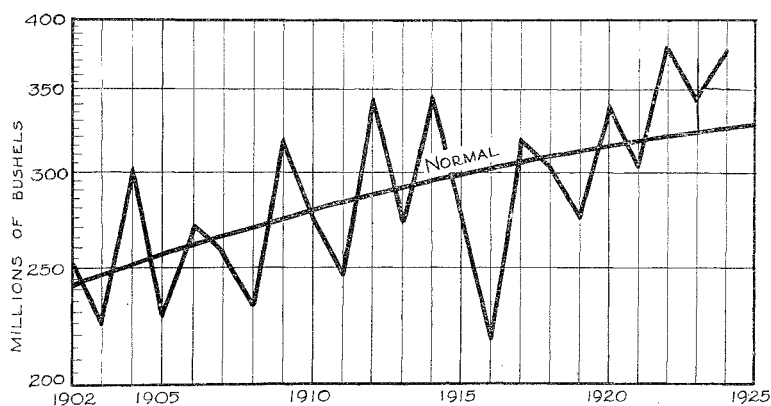


Fig. 4. Production of Potatoes in Twenty-seven Late Crop States

The normal production of potatoes is increasing about 3,400,000 bushels a year, but the actual production varies greatly above and below this normal. Comparison with Figure 3 will show that there is a close correspondence between the changes in production and the changes in price.

The relationship between production and price can be seen quite clearly by arranging the years in the order of the size of the late crop (relative to normal) as in Figure 5 and drawing a vertical bar for each year having a height proportional to the price, after correcting the price for the effects of changes in the value of the dollar and for its trend.

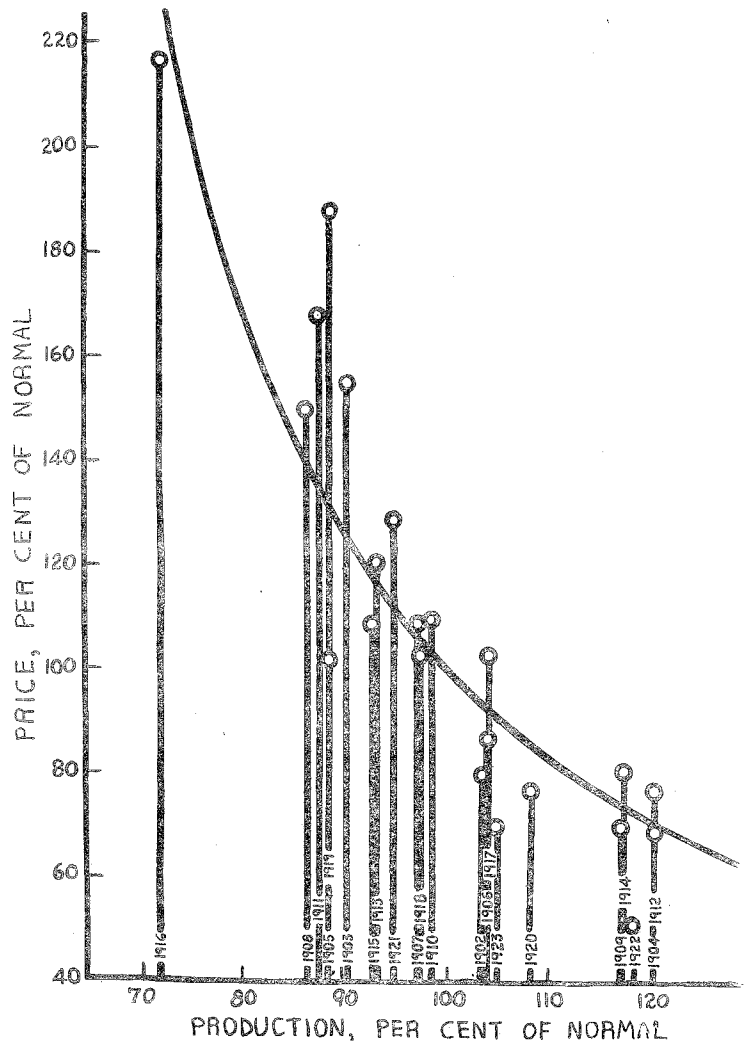


Fig. 5. Relation of Production and Price of Potatoes

When the production of potatoes is small the price tends to be high and when the production is large the price tends to be low. In 1916 the production was only 72 per cent of normal and the price was 217 per cent of normal; in 1912 the production was 120 per cent of normal and the price was 77 per cent of normal. Even in years of almost the same relative production, the price may vary considerably, as between 1902, 1906, 1917, and 1923. The curved line shows the average relationship between production and price.

It might be expected that when the same relative production was found in more than one year, the price would be the same in those years; but when it is remembered that there are other factors affecting price, it is clear that the price is likely to differ even between years when the relative production is the same. The price figures used in Figure 5 have already been corrected for the changes in the value of the dollar, but there are still other important factors which affect the price.

If we had figures for many years, we could pick several years in which the production was 5 per cent above normal, calculate the average price for those years, and thus get a good idea of the effect of a production 5 per cent above normal. Then we could take several years in which the production was 10 per cent above normal and find the average effect of that production; and so on. We cannot get figures for enough years to do this, but there is another way of getting almost the same result. When it was necessary to get an "average" production which showed the way in which the average was changing from year to year, we used the method of least squares. The method of least squares can also be used to get an average price which shows the way in which the average changes with changing production. The line drawn through the dots in Figure 5 shows the way in which price may be expected to vary with changing production as determined by this method. The results may be described briefly as follows:

When production is above normal (per cent)	Price will probably be below normal (per cent)
20	29
10	17
0	0
below normal 10	above normal 26
20	70

The normals from which these percentages should be figured for the next three years may be obtained from Table V.

TABLE V
 NORMAL PRODUCTION IN TWENTY-SEVEN LATE CROP STATES AND NORMAL VALUE OF POTATOES
 IN ST. PAUL AND MINNEAPOLIS, 1925-27

Year	Normal production	Normal value per cwt.*
	Millions of bushels	Cents
1925	334.9	85.3
1926	338.3	85.4
1927	341.7	85.4

* At 1913 price level. Multiplying these figures by the price level index number for the year gives the normal price of potatoes for that year.

Having found the relation between price and production, it is possible to remove the effect of changing production, just as the effect of the changing value of the dollar and the effect of the trend of the value have already been removed. The result is shown in Figure 6. By comparing Figure 6 with Figure 1, it will be seen that the three factors which have been considered—value of the dollar, trend, and production—explain a large part of the fluctuation in the price of potatoes, for after the effect of these factors has been removed, only a relatively small proportion of the original fluctuation remains.

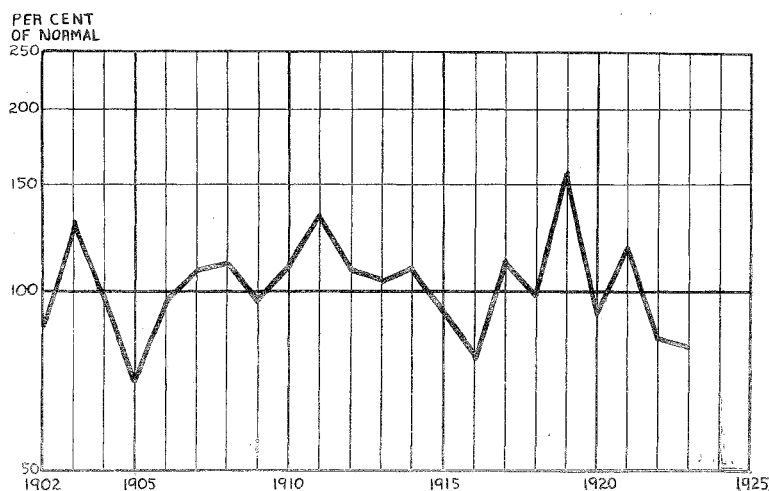


Fig. 6. Changes in Price of Potatoes with Effect of First, Second, and Third Factors Removed

The third factor is production in the late crop states. After making allowance for the changes in production as well as for the changes in general price level and normal value, the changes shown still remain to be explained.

4. PRICE OF POTATOES IN AUGUST

The effect of the price of potatoes in August on the price later in the season is indirect and would not have to be considered at all if we knew the quantity of potatoes actually available for use after the first of September. But in getting figures on the size of the crop, the best that can be done is to take the total production for the states that put more than half their crop on the market after the first of September. If the price of potatoes is high during August, a considerable part of the crop of these states will be put on the market before the first of September; while if the price is low during August, more of the crop will be left for sale after the first of September. Accordingly a high price in August will tend to increase the price later in the season, and a low price in August to decrease the price later in the season. The lateness of the season has an effect also, but no means has yet been worked out for measuring it.

The price of potatoes in August in St. Paul and Minneapolis is not a good indication of the price over most of the area which ships large quantities of potatoes in August, hence it is better to take the price of potatoes in New York City, which is the most representative market. The figures used are shown in Table VI. In estimating the effect of the price in New York in August, it is necessary to consider its relation to the normal price in August, just as it was necessary to consider the relation of production to its normal. The ratio of the actual price of potatoes in August, in New York City, to its normal may be obtained by first correcting for the change in the value of the dollar, thus obtaining the value of potatoes in August, and then calculating the trend of the value, as was done with the price of potatoes in St. Paul and Minneapolis, and taking the ratio of the actual value to the normal given by this trend. When this is done, it is found that for every 1 per cent that the price in New York in August diverges from its normal, the price of potatoes in St. Paul and Minneapolis for the season from September to May will diverge three tenths of 1 per cent from its normal.⁴ The normal values of New Jersey Giants and Cobblers in New York in August for the next three years are shown in Table VII.

TABLE VI
AVERAGE PRICE OF NEW JERSEY GIANTS AND COBBLERS IN NEW YORK CITY IN AUGUST, PER
150-POUND SACK, 1902-24

Year	Price
1902.....	\$1.01
1903.....	1.57
1904.....	1.28
1905.....	1.42
1906.....	1.26
1907.....	2.09
1908.....	2.31
1909.....	1.92
1910.....	1.74
1911.....	2.79
1912.....	1.80
1913.....	1.93
1914.....	1.80
1915.....	1.06
1916.....	2.48
1917.....	3.12
1918.....	3.88
1919.....	4.86
1920.....	3.22
1921.....	3.90
1922.....	1.40
1923.....	3.64
1924.....	1.90

⁴ This is as accurate a statement as can be given without taking account also of the size of the late crop. When the late crop is small, a 1 per cent variation in price in August has more effect than when the late crop is large. The only satisfactory way to take account of this is by the use of the formulas given on p. 37.

TABLE VII

NORMAL VALUES OF NEW JERSEY GIANTS AND COBBLERS IN NEW YORK CITY IN AUGUST,
1925-27, DOLLARS PER 150-POUND SACK*

Year	Value
1925.....	1.59
1926.....	1.58
1927.....	1.57

* At the 1913 price level. Multiplying these figures by the price level index number gives the *normal price* for the year.

Making use of this knowledge, we may now remove the effects of the price in August. The result is shown in Figure 7.

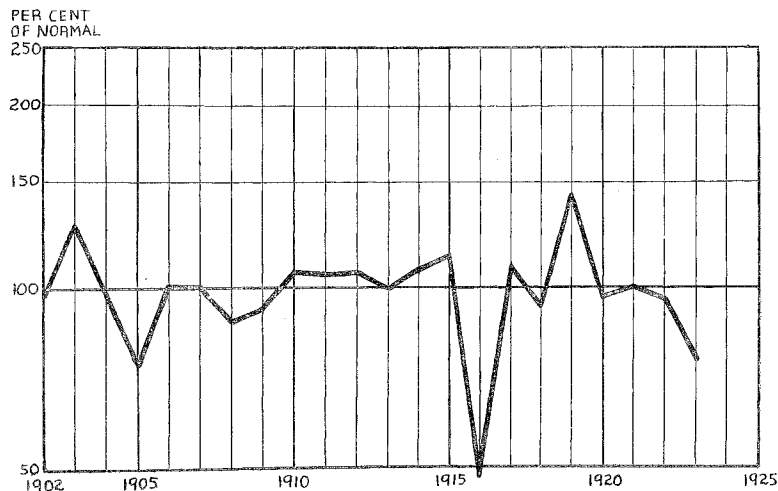


Fig. 7. Changes in Price of Potatoes with Effect of First Four Factors Removed

The fourth factor is price in August. The first four factors explain most of the changes in the price of potatoes, but the price was considerably higher in 1903 and 1919 and lower in 1905, 1916, and 1923 than can be accounted for by these factors alone.

5. VARIATION IN QUALITY

Another factor which influences the price of potatoes is variation in quality. In some years the quality of Minnesota potatoes averages very high, in other years, low. No absolute standards of quality have ever been worked out for potatoes, partly because it is so difficult to define what constitutes good quality and partly because opinions as to quality differ. The only reliable basis for judging quality is a knowledge of what consumers want and for what they will pay.

The best way to determine the effect of the quality of potatoes seems to be to compare the prices at which Minnesota potatoes are selling with those of other potatoes. The comparison should be made with the prices of potatoes from various other districts, or with the average price of potatoes from a large district, in order to be sure that an unusually favorable price for Minnesota potatoes, for example,

is really the result of good quality in the Minnesota potatoes and not merely of poor quality in those with which they are compared.

The best measure of quality found for statistical purposes, when it is necessary to have figures back to 1902, is the difference between the price of Minnesota potatoes in St. Paul and Minneapolis and the price of what are known as "Maine" and "State and Western" potatoes in New York City, in November or later. This difference must be compared with the normal difference, which varies with changes in freight rates and changes in the price level. The difference is affected also by the size of the late crop and the percentage of the crop produced in the western states. This renders the comparison rather difficult, and many people may prefer to base their own conclusions on a study of the prices of Minnesota potatoes in comparison with those of other potatoes in markets where both are sold side by side.

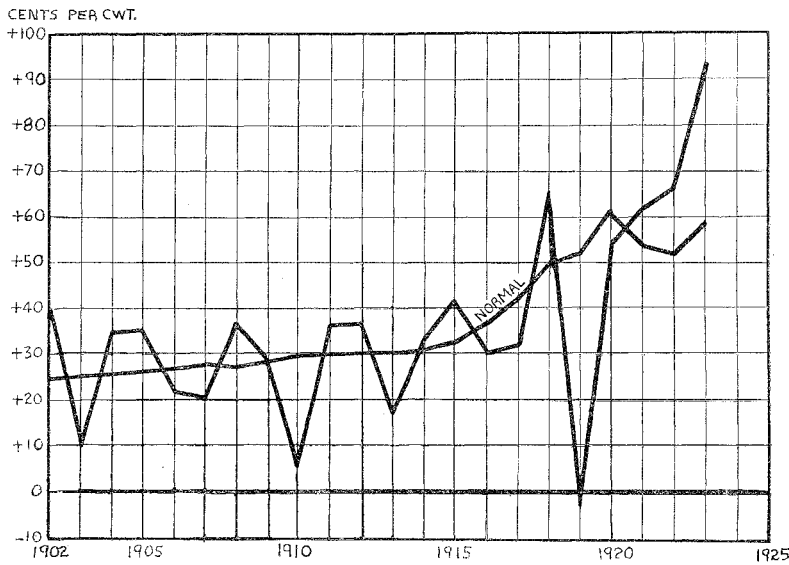


Fig. 8. Difference between Price of Potatoes in St. Paul and Minneapolis and Price in New York City

New York prices are on Maine and New York State potatoes. Taking the average of the potatoes from these two states together, the quality usually does not change greatly from year to year. When the difference is small or even in favor of Minnesota, as in 1919, it is a good indication of unusually high quality in Minnesota potatoes. When the difference is above normal, as in 1923, it is a good indication of unusually poor quality in Minnesota potatoes. After making allowance for certain other factors affecting the difference, an excellent indication of changes in quality is given.

If it is desired to judge the quality of Minnesota potatoes by a comparison of the price of Minnesota potatoes in St. Paul and Minneapolis with the price of "Maine" and "State and Western" potatoes in New York City, the formula given on p. 39 may be used. This formula applies specifically to the difference in November, but is usually quite accurate for any date after the first of November. Before the first of November, the difference is not a very reliable indication of the difference in quality. Figure 8 and Table VIII show the fluctuations in this difference for November of each year since 1902 and the normal difference for each year.

TABLE VIII
PRICE OF POTATOES PER HUNDREDWEIGHT IN ST. PAUL AND MINNEAPOLIS AND IN NEW YORK CITY, NOVEMBER AVERAGE, 1902-24

Year	Price		Actual Difference	Normal Difference‡
	In St. Paul and Minneapolis*	In New York City†		
1902.....	\$0.57	\$0.97	\$0.40	\$0.26
1903.....	0.90	0.98	0.08	0.26
1904.....	0.50	0.85	0.35	0.26
1905.....	0.88	1.23	0.35	0.26
1906.....	0.63	0.85	0.22	0.27
1907.....	0.77	0.97	0.20	0.28
1908.....	0.95	1.32	0.37	0.28
1909.....	0.65	0.93	0.28	0.28
1910.....	0.80	0.85	0.05	0.29
1911.....	1.13	1.50	0.37	0.29
1912.....	0.70	1.07	0.37	0.30
1913.....	1.02	1.18	0.16	0.30
1914.....	0.57	0.90	0.33	0.30
1915.....	0.85	1.27	0.42	0.32
1916.....	2.52	2.82	0.33	0.36
1917.....	1.97	2.23	0.26	0.41
1918.....	1.62	2.28	0.66	0.49
1919.....	2.65	2.62	-0.03	0.51
1920.....	1.77	2.30	0.53	0.61
1921.....	1.47	2.08	0.61	0.54
1922.....	0.70	1.37	0.67	0.52
1923.....	0.81	1.77	0.96	0.59
1924.....	0.68	1.16	0.48	0.59

* Prices apply to average quality Minnesota potatoes, table stock.

† U.S.D.A. Yearbook, 1922, page 676, supplemented by information supplied by the U.S. Bureau of Agricultural Economics. Prices apply to "Maine" and "State and Western" table stock.

‡ The "normal" difference is given by the equation:

$$\text{Normal difference (cents)} = 0.0474L + 0.00335tL + 0.891F$$

Where L=price level, (1913=100);

t=time, measured in years from 1900;

F=freight rate in cents per hundredweight, as shown in Table IX.

TABLE IX
 FREIGHT RATE PER HUNDREDWEIGHT ON POTATOES IN CAR LOTS FROM ST. PAUL OR
 MINNEAPOLIS, 1902-24*

Year	To Cincinnati	To Pittsburgh	Mean
	Cents	Cents	Cents
1902.....	22.0	25.0	23.5
1903.....	22.0	25.0	23.5
1904.....	22.0	25.0	23.5
1905.....	22.0	25.0	23.5
1906.....	22.0	25.0	23.5
1907.....	22.0	25.0	23.5
1908.....	22.0	25.0	23.5
1909.....	22.0	23.0	23.5
1910.....	22.0	25.0	23.5
1911.....	23.0	25.0	23.5
1912.....	22.0	25.0	23.5
1913.....	22.0	25.0	23.5
1914.....	22.0	25.9	23.9
1915.....	23.1	26.3	24.7
1916.....	23.1	26.3	24.7
1917.....	23.1	26.3	24.7
1918.....	29.0	33.0	31.0
1919.....	29.0	33.0	31.0
1920.....	38.5	44.0	41.5
1921.....	38.5	44.0	41.5
1922.....	34.5	39.5	37.0
1923.....	41.5	47.5	44.5
1924.....	41.5	47.5	44.5

* Rates in force in November of each year.

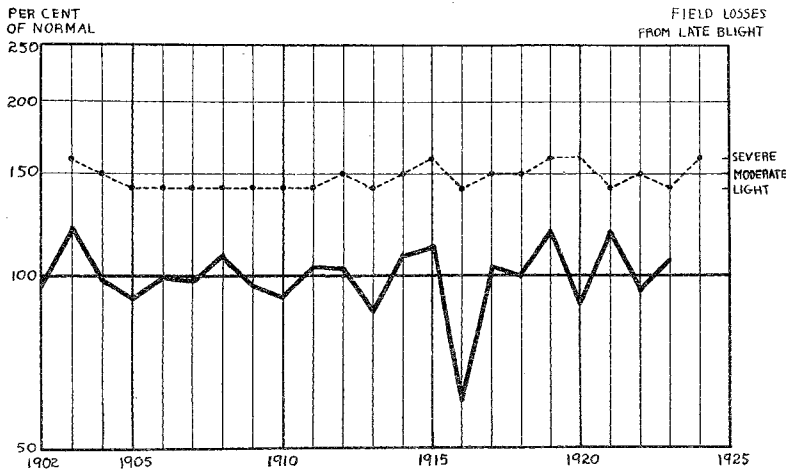


Fig. 9. Changes in Price of Potatoes with Effect of Five Factors Removed

The fifth factor is variation in quality. The five factors together explain most of the changes in the price of potatoes, as may be seen by comparing the changes shown in Figure 1 with those that remain after allowing for the effects of the five factors, as shown here. Losses from late blight rot will explain part of the remaining changes. When late blight is heavy, there is usually a good deal of rot in storage and the price of good potatoes goes up.

The extent to which the actual price in 1916 fell below the expected price suggests an underestimate of the production for that year, indicated also by a study of Figure 12.

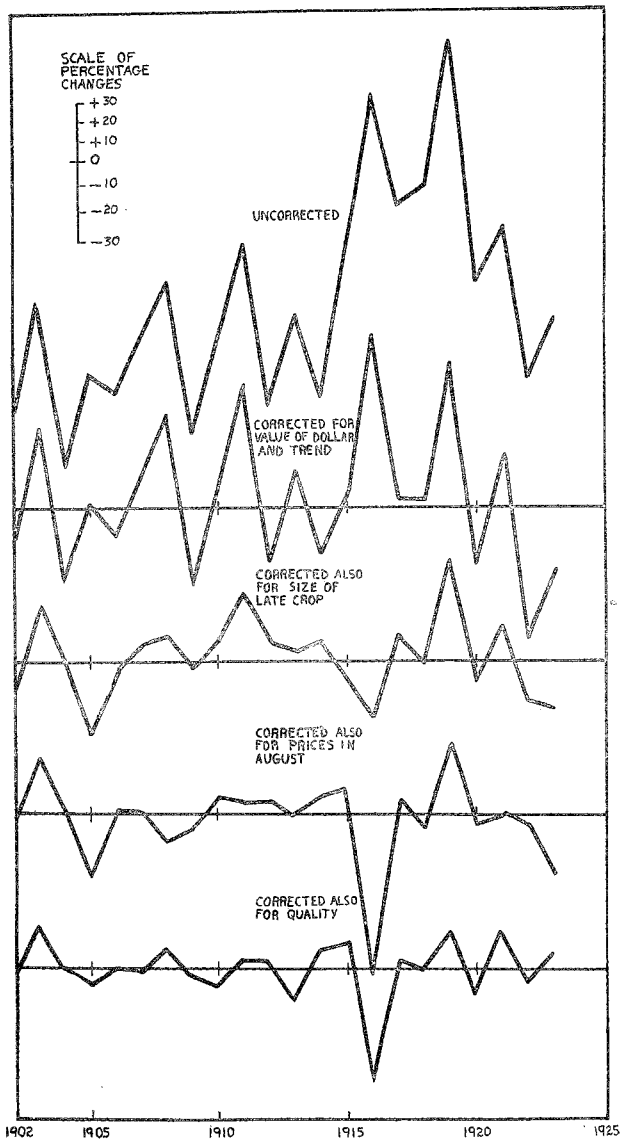


Fig. 10. Changes Remaining To Be Explained at Successive Stages in the Study

When the curves shown in the preceding charts are brought together, it is easy to see that each factor considered has helped to explain the changes which actually occur. The top curve shows the actual changes in the price of potatoes; the second curve, the changes which remain to be explained after allowing for the effect of changes in the general price level and in the normal value of potatoes; the lower curves, the changes remaining after allowing also for the effects of the third, fourth, and fifth factors, respectively. Most of the changes in the top curve are accounted for by the five factors, but some still remain in the last curve.

If the variations in quality of potatoes are determined in this way and their effects removed, the fluctuations which remain are those shown in Figure 9. As this is the last of the factors determining the changes in the price of potatoes from one year to the next for which it has been possible to get a measure, it is interesting to note how far we have gone in explaining the changes which actually occur in the price of potatoes from one year to another. Figure 10 shows the curves of five preceding charts brought together for comparison. The top curve shows the actual changes in the price of potatoes; the second, the changes which remained after removing the effects of the first two factors considered, namely the changes in the general price level, and of the upward trend in the real value of potatoes. The remaining curves show the changes which remain unexplained after removing successively the effects of changes in production in the late crop states, of changes in the price in August, and of changes in quality. The changes which remain unaccounted for, as indicated by the last curve on the chart, are relatively small compared with those shown in the first curve.

Another way to make the comparison is to show the changes which actually occurred as compared with the changes which would have occurred if the price had been affected only by the five factors whose effect has been measured. Table X gives the actual price, the "calculated price" (obtained by taking account of the five factors which have been considered), and the percentage difference between the two. The comparison is made graphically in Figure 11.

TABLE X
CALCULATED AND ACTUAL PRICE OF POTATOES PER HUNDREDWEIGHT IN ST. PAUL AND
MINNEAPOLIS, NINE-MONTH AVERAGE, SEPTEMBER TO MAY, 1902-23

Year	Calculated price	Actual price	Per cent difference
1902-03	\$0.61	\$0.58	- 6
1903-04	0.96	1.10	+15
1904-05	0.51	0.49	- 4
1905-06	0.84	0.77	- 8
1906-07	0.72	0.70	- 3
1907-08	0.93	0.90	- 3
1908-09	1.10	1.17	+ 7
1909-10	0.61	0.58	- 5
1910-11	0.98	0.90	- 8
1911-12	1.35	1.39	+ 3
1912-13	0.63	0.66	+ 4
1913-14	1.14	1.02	-10
1914-15	0.62	0.68	+ 9
1915-16	0.92	1.03	+11
1916-17	3.33	2.82	-16
1917-18	1.58	1.63	+ 3
1918-19	1.76	1.76	0
1919-20	3.28	3.64	+11
1920-21	1.29	1.13	-12
1921-22	1.35	1.56	+16
1922-23	0.83	0.75	-10
1923-24	0.90	1.00	+11

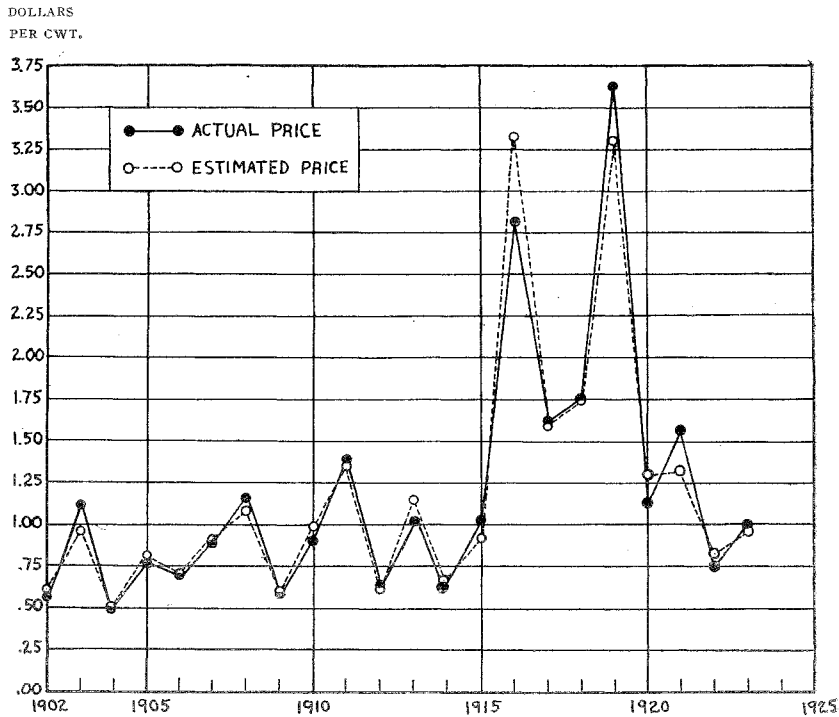


Fig. 11. Actual and Estimated Prices of Potatoes, 1902-23

The hollow circles connected by the dotted lines show what the price would have been each year since 1902 if it had been affected by these five factors only. The solid circles show what the price actually was. The five factors explain most of the changes in the price of potatoes.

It is noticeable that the differences between the calculated prices and the actual prices are greater since 1916 than in earlier years. This may be due to increased difficulty in getting reliable production figures. There has been considerably more fluctuation in acreage of potatoes in recent years than previously and the United States Department of Agriculture finds it very difficult to get accurate estimates of these changes in acreage. Errors in the acreage figures result in corresponding errors in the production figures and any error in the production estimates results in about twice as great an error in the calculation of the price which will move the crop. For example, Figure 12 shows the estimated acreage for 1916 considerably below the acreage for 1915.⁵ If this estimate for 1916 was too low, then the price calculated from the production figures for that year would have been too high. This may be the explanation of the fact that the calculated price for 1916 was considerably above the actual price.

⁵ Data from Table IV.

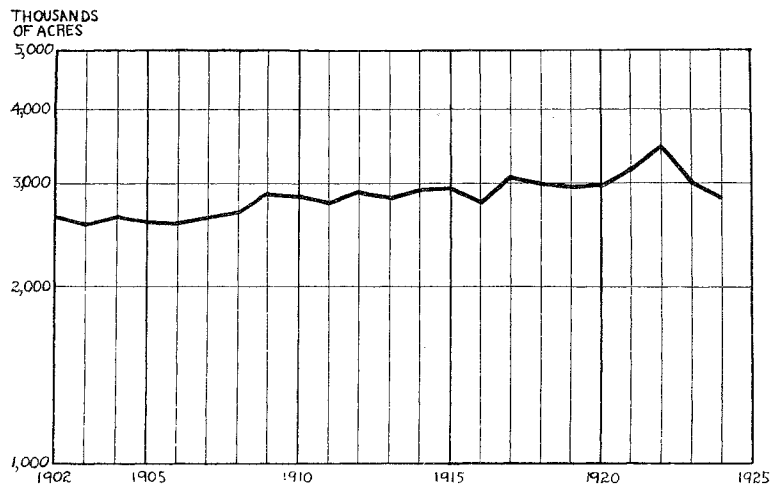


Fig. 12. Acreage of Potatoes in Twenty-seven Late Crop States, 1902-24.

The acreage of potatoes usually does not change much from year to year except for a steady increase. This fact opens to question the drop in acreage shown for 1916. In recent years, however, the changes have been greater owing to the readjustments of the post-war years.

6. LOSS IN STORAGE

One other important factor is known to influence the price of potatoes, namely, variations in the quantity of potatoes lost in storage and in transit, owing principally to rot. In some years potatoes suffer seriously from rot in storage, especially from late blight rot, while in other years losses are very small. These losses have at least as much effect on price as a reduction in the quantity dug. Unfortunately, however, no accurate statistics have ever been kept on loss in storage, and it is not possible to predict the loss with any accuracy or even to know what it has been in any one year.

Since 1903 the Plant Disease Survey of the United States Department of Agriculture has kept records of reports on the prevalence of late blight in the fields. By going over these reports it is possible to make an estimate of whether late blight was light, moderate, or severe in any one year. Losses in storage from late blight rot are not exactly proportional to the extent of late blight in the fields, but it is interesting to compare the estimates of the extent of late blight with the fluctuations in the price of potatoes which remain after removing the effect of the five other factors considered. The dotted line in Figure 9 shows the variation in the extent of late blight in the fields. The data are so inadequate that no attempt was made to distinguish between years when the blight was "light" and those when it was "very light," or between years when it was "severe" and when it was "very severe." It is readily seen, however, that variations in

loss in storage will explain a considerable proportion of the fluctuations in the price of potatoes which remain after removing the effects of the factors previously considered.

PRICE CHANGES DURING THE SEASON

Thus far we have considered only the changes from one year to the next in the average price for the season. It has been found possible not only to tell what are the factors which cause most of these changes, but also to measure the average effect of the five factors which explain most of the changes, namely, (1) value of the dollar; (2) an upward trend in the value of potatoes; (3) production in the late crop states; (4) the price of potatoes in August; and (5) variations in quality. It is not so easy to explain the changes in price during any one season. A general explanation of the causes of the changes can be given but no method has been found for determining what part of each change is due to each cause. Figure 13 shows the changes which actually occurred in the price of potatoes in St. Paul and Minneapolis from month to month for each season from September, 1899, to May, 1923. Figure 14 shows the changes from day to day during the 1923-24 season.

NORMAL SEASONAL CHANGE

One factor which we know must affect the price of potatoes during any one season is the fact that no one is willing to store potatoes from fall until spring unless he expects the price to rise enough to cover the costs of storage, including the inevitable shrinkage. Table XI shows the average price of potatoes for each month of the season for the 16 years from 1899 to 1915 and also the percentage relation of the price each month to the average price for the season. It is more convenient, however, to calculate seasonal variation in terms of cents rather than of percentages. The figures in the first column of Table XI cannot be used for this purpose under present conditions, as a greater change in prices from fall to spring must be expected than in the years before the war. Prices of potatoes and most costs of storage are higher now than in the years from which the averages shown in Table XI were calculated, and farmers and dealers require a greater increase in price from fall to spring to pay them to hold potatoes.

TABLE XI

SEASONAL VARIATION OF PRICE OF POTATOES IN MINNEAPOLIS AND ST. PAUL (SIXTEEN-YEAR AVERAGE, SEPTEMBER, 1899, TO MAY, 1915)

Month	Average price per cwt.	Per cent of average for season
	Cents	
September	82.3	96.2
October	75.8	88.6
November	78.5	91.7
December	79.8	93.2
January	85.8	100.3
February	91.3	106.6
March	92.6	108.3
April	95.1	111.1
May	94.0	109.9
Average (harmonic mean).....	85.6	100.0

A good indication of the price changes to be expected during the average season at the present time is given in Table XII. The first column in Table XII shows the figures from the second column of Table XI expressed as percentages above and below the average for the season. The second column shows these percentages applied to a price of \$1.28 per hundredweight, which is about normal for potatoes in St. Paul and Minneapolis with the general price level which has prevailed since 1920.

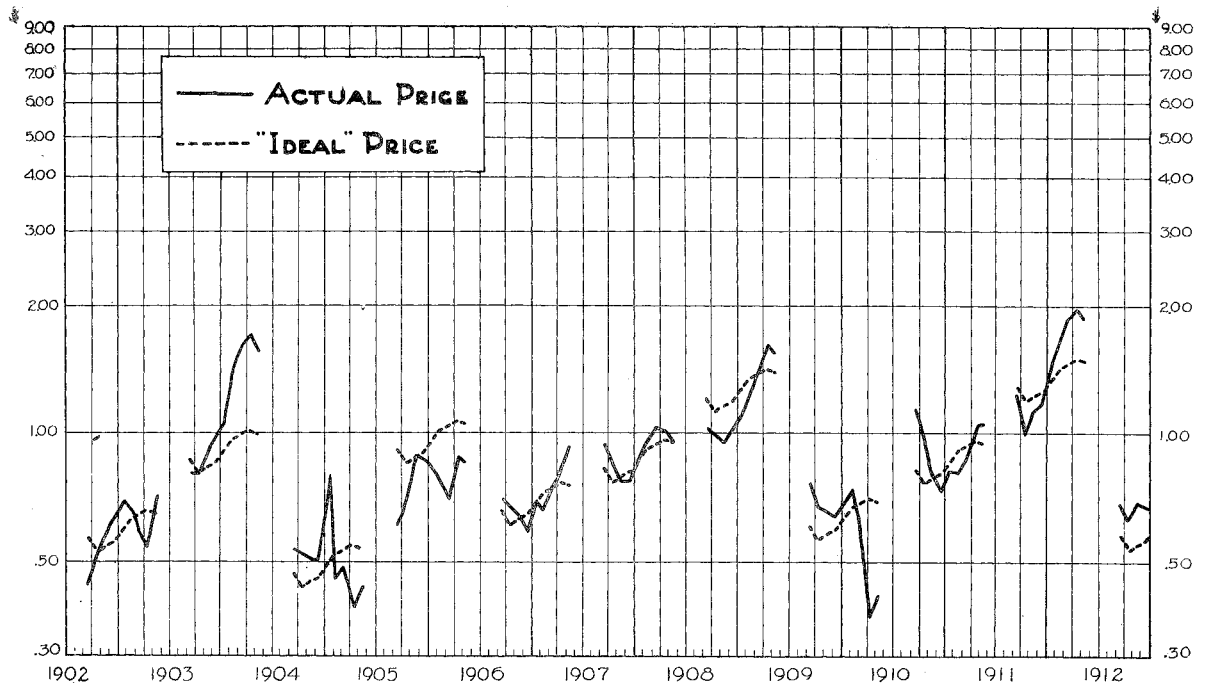
TABLE XII

SEASONAL VARIATION TO BE EXPECTED IN PRICE OF POTATOES ON PRESENT BASIS

Month	Percentage below or above average for season	Cents per cwt. below or above average for season*
		Cents
September	- 3.8	- 4.9
October	-11.4	-14.6
November	- 8.3	-10.6
December	- 6.8	- 8.7
January	+ 0.3	+ 0.4
February	+ 6.6	+ 8.4
March	+ 8.3	+10.6
April	+11.1	+14.2
May	+ 9.9	+12.7

* Based on average price of \$1.28.

From this table it is easy to calculate the increase in price to be expected between any two months. For example, comparing October and April we expect a price in October 14.6 cents below the average for the season and a price in April 14.2 cents above the average for the season, which means that we expect an increase in price from October to April amounting to 28.8 cents per hundredweight. Every farmer should figure out for himself whether he can make money storing potatoes for this increase in price.



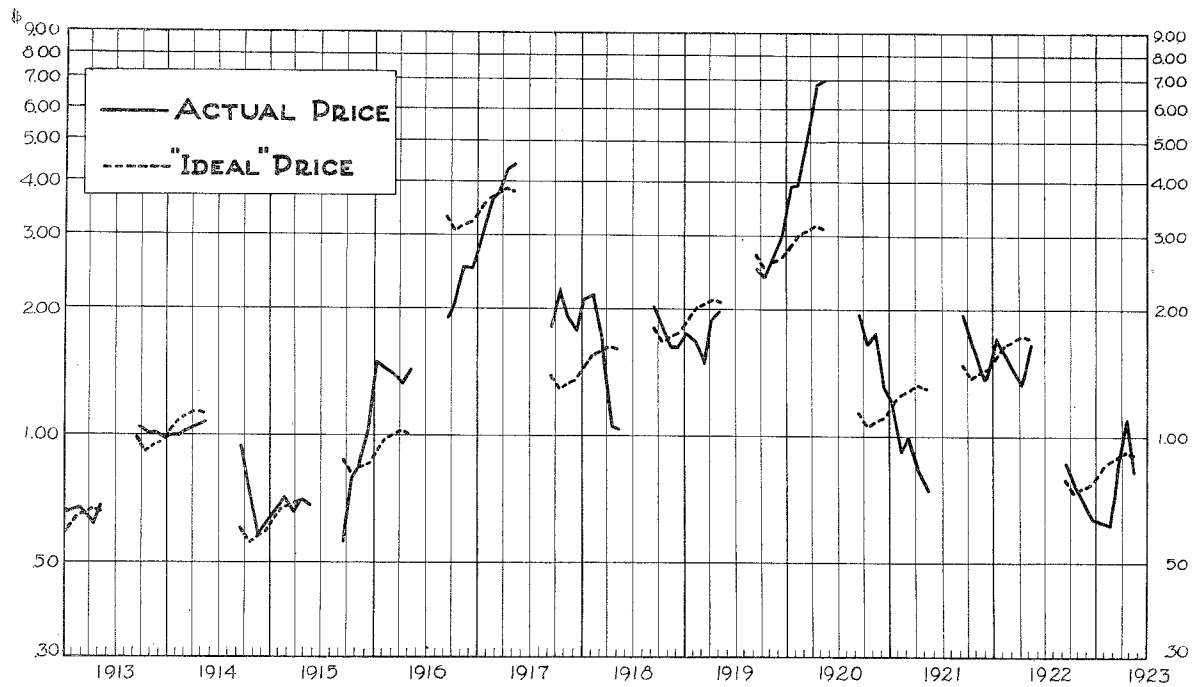


Fig. 13. Actual and "Ideal" Price of Potatoes Monthly, 1902-23

The "ideal" price shown is the price which would have prevailed if the percentage changes from month to month had always been the same as in the average year and if the average price for the season had been that justified by the first four factors considered in this bulletin. Frequently the price starts too low in the fall and rises sharply before spring or else starts too high in the fall and has to be lowered before spring in order to move the crop.

A glance at Figure 13 will show that it is very unusual for the price during any one year to show the normal or average seasonal change. The dotted lines marked "ideal" price show how the price would have varied each year if the average for the season had been affected only by the first four of the five factors affecting the seasonal average price which we considered above, and if the price had changed during the season so as to give the average percentage change from month to month. Perhaps "ideal" is not the best term to apply to a price which would change in this way; anyone who wishes may call it by a different name. The purpose is to show what the price would have been each month if it had been affected only by the value of the dollar, the trend of value, the price in August, and the normal change from month to month.

OTHER REASONS FOR CHANGES FROM MONTH TO MONTH

Of course the principal reason that the price of potatoes changes so much from month to month, and even from day to day, sometimes upward, sometimes downward, is that no one ever knows just what the price ought to be. For example, in 1923-24 the price started fairly high in September, as may be seen from Figure 14. The crop of early potatoes was short and the price was high throughout the summer. The late crop was about normal and most people recognized that the price could not stay as high as it was in September. Farmers wanted to sell at September prices and dealers hesitated to buy, hence the price fell. As it went lower, more farmers felt inclined to hold their potatoes or more dealers were willing to buy potatoes for storage, or both, and finally the price stopped falling. As a matter of fact, farmers and dealers, between them, had allowed the price to go too low, and late in December it was discovered that, at the prices then existing, there probably would not be enough potatoes to go around. The result was a sudden jump in the price from 80-85 cents a hundredweight on December 26 to \$1.25-\$1.30 on January 8. But many farmers and dealers thought this price too high and it was gradually forced down a few cents a week. Late in May it was discovered that the supply of old potatoes was running short and the price rose again, going from \$1.10 a hundredweight on May 24 to \$1.40 to \$1.45 on the last of May and still higher during June.

Clearly the principal cause of these changes during the season is to be found in the mistakes farmers and dealers make in guessing what the price ought to be. In fact, it has been found possible to predict these mistakes of judgment pretty accurately. When the production is very large, farmers and dealers are usually too opti-

mistic in the fall; they do not appreciate how low the price will have to go to sell all the crop. As a result the price stays too high in the fall and later has to be lowered to move the crop. Similarly, when the crop is unusually short, farmers and dealers seldom realize how high a price can be got for what potatoes there are, and the price starts too low in the fall and rises before spring. Farmers' Bulletin No. 1317, (p. 6) of the United States Department of Agriculture, entitled "Marketing Main-Crop Potatoes," gives the following summary:

As a rule, whenever production has approached or exceeded 4 bushels per capita, the price has tended downward, but the price trend has been upward whenever the average yield fell below 3.2 bushels per capita.

During the last twenty years, the grower was apparently justified in holding only when the indicated crop was far below the average, or not much over 3 bushels per capita. In other years, the chance of profit to the grower was too uncertain to balance the added risk, cost, and shrinkage.

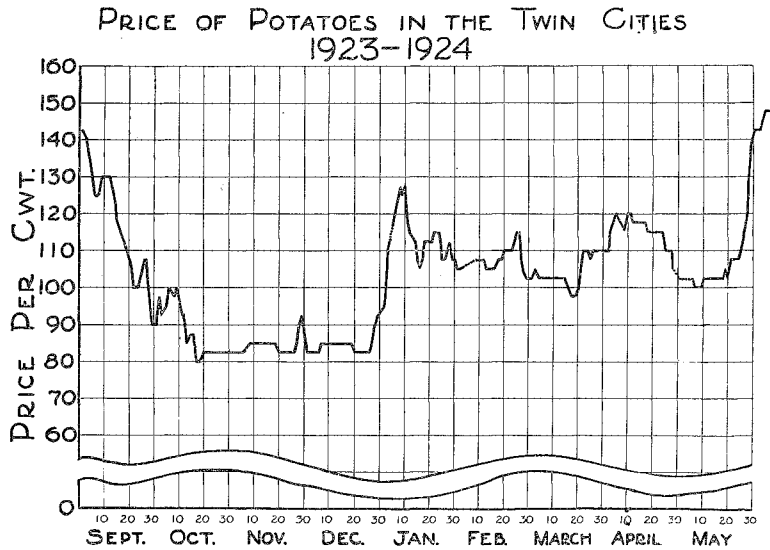


Fig. 14. Daily Changes in Price of Potatoes During 1923-24

The crop of early potatoes was short in 1923 and prices were high. When the late crop came on, prices fell sharply to a range of 80 to 85 cents. In the last days of December, fear of a shortage of potatoes caused the price to rise again. The market remained uncertain throughout the rest of the year, finally rising sharply because of a shortage at the end of the season.

Of course, if most farmers followed this rule and held their potatoes until spring in years of short crops, the rule would cease to work; their holding in the fall would force the price up in the fall and when they began to sell it would drop again.

TABLE XIII
RELATION OF PRICES TO OWNERSHIP OF STOCKS OF POTATOES ON JANUARY 1, 1916-24^o

Year	Production per capita in 27 late crop states	Price per cwt. in St. Paul and Minneapolis		Stocks on hand January 1		Proportion of stock January 1 held by			
		Fall†	Spring‡	Nineteen late crop states	Minnesota	Dealers		Growers	
						Nineteen states	Minnesota	Nineteen states	Minnesota
	Bu.			Per cent of crop	Per cent of crop	Per cent	Per cent	Per cent	Per cent
1915-16.....	2.77	\$0.90	\$1.38	32.6	29.9	17.6	28	82.4	72
1916-17.....	2.14	2.34	4.22	26.1	24.0	26.3	38	73.7	62
1917-18.....	3.10	2.02	1.28	32.2	32.5	14.6	20	85.4	80
1918-19.....	2.89	1.68	1.81	29.9	27.3	16.2	24	83.8	76
1919-20.....	2.62	2.71	6.48	26.0	21.5	20.6	24	79.4	76
1920-21.....	3.20	1.57	0.86	35.3	32.5	14.8	20	85.2	80
1921-22.....	2.81	1.52	1.47	31.4	30.1	20.0	27	80.0	73
1922-23.....	3.46	0.70	0.93	36.3	41.1	14.2	26	85.8	74
1923-24.....	3.08	0.85	1.09	33.8	33.0	13.3	24	86.7	76

^o Figures from U.S.D.A. Yearbook, 1922, pp. 673-74; and 1923, pp. 765-66.

† October, November, and December.

‡ March, April, and May.

Another thing worth noticing about these mistakes in guessing what the price ought to be is that on the average dealers guess a little better than farmers. Table XIII shows that averaging the 6 years in which prices have risen between fall and spring, Minnesota dealers held 27 per cent of the stocks on January 1, while in the 3 years in which prices fell, dealers held only 22 per cent of the total stocks on January 1. Apparently, dealers generally use somewhat better judgment than farmers in deciding when to hold potatoes and when not.

CARLOT SHIPMENTS OF POTATOES

Many farmers and dealers consider it worth while to keep track of carlot shipments of potatoes. Table XIV shows the number of cars shipped from Minnesota and certain other important states, and from all states during each month since the figures have been collected, also the percentage of the total United States shipments each month to the total for the season.

Table XV shows the estimated production for the states included in Table XIV for each year since 1917, and the percentage of the crop entering into carlot shipments. The percentages for 1917-18 appear small and probably indicate that the figures were less complete during the first year. No figures are collected on shipments by wagon and truck direct to cities where the potatoes are consumed. In both Table XIV and Table XV, space is left for filling in figures for future years.

CALCULATING EFFECTS OF FACTORS THAT INFLUENCE PRICE

In connection with the foregoing discussion of each factor influencing the price of potatoes, figures have been given which will enable any one to calculate the effect of that factor in each year from 1925 to 1927. The effects may be calculated more simply, however, from the following formulas, which are merely short-cut methods of doing the figuring already described.

For the benefit of those who find it difficult to get the latest estimates of production in the 27 late crop states, the Bureau of Labor Statistics index number, and other statistics on the current situation, the Minnesota Agricultural Experiment Station issues a potato market letter each month from September to January and at appropriate times during the remainder of the season. This letter contains the latest figures on the price situation and a discussion of the way in which each factor is likely to affect the price of potatoes. It may be obtained regularly by applying to the Division of Publications, University Farm, St Paul.

TABLE XIV
MONTHLY AND YEARLY CAR LOT SHIPMENTS OF POTATOES, 1917-18 TO 1923-24*

State and year	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Total
	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars
Minnesota																	
1917-18	15	1,312	1,918	4,074	1,445	675	1,261	1,510	2,119	1,328	625	179	16	16,477
1918-19	96	3,099	4,573	4,623	1,733	758	1,839	1,359	2,365	1,612	1,018	434	6	23,515
1919-20	83	2,438	5,359	5,817	1,324	693	1,875	1,162	1,900	1,027	262	117	1	22,058
1920-21	64	1,344	2,770	6,870	3,279	934	1,469	1,723	2,542	1,133	863	214	9	23,214
1921-22	960	4,869	9,029	2,197	892	1,894	1,442	4,443	2,514	1,080	248	....	29,568
1922-23	508	1,432	4,167	7,062	2,466	659	1,724	1,532	4,215	3,274	1,390	481	21	28,931
1923-24	15	1,755	6,157	7,904	2,712	1,095	2,560	3,845	3,815	2,426	1,008	289	3	33,584
1924-25																	
1925-26																	
1926-27																	
Wisconsin																	
1917-18	118	1,158	3,707	1,383	575	887	1,461	1,643	1,452	1,011	447	10	13,852
1918-19	1	134	2,768	4,630	2,464	1,545	2,460	1,598	2,122	1,608	963	362	....	20,655
1919-20	127	3,250	7,019	2,810	1,567	2,137	1,754	1,923	893	344	148	3	21,975
1920-21	18	450	3,189	2,876	1,214	2,337	1,933	2,385	2,234	1,592	431	2	18,661
1921-22	76	754	2,125	719	626	1,367	1,201	1,993	1,166	755	260	3	11,045
1922-23	205	1,377	3,685	2,018	1,635	2,495	1,906	2,992	2,716	1,735	944	58	21,766
1923-24	189	1,294	2,629	1,476	1,102	1,954	2,200	2,009	1,860	1,678	609	8	17,008
1924-25																	
1925-26																	
1926-27																	

* U. S. D. A. Yearbook, 1924, pp. 713, 714, 715, and 716.

TABLE XIV—Continued
MONTHLY AND YEARLY CAR LOT SHIPMENTS OF POTATOES, 1917-18 TO 1923-24*

State and year	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Total
	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars
Michigan																	
1917-18	16	388	1,572	1,296	598	458	751	938	1,326	1,553	531	4	9,431
1918-19	20	328	1,547	2,072	743	790	592	1,154	1,725	1,291	770	30	11,062
1919-20	50	601	2,687	2,329	1,043	1,099	1,011	1,714	1,134	543	26	....	12,237
1920-21	2	39	577	2,210	3,116	1,253	1,630	990	1,657	2,174	2,632	813	26	17,119
1921-22	3	789	3,210	1,886	880	1,516	1,240	2,041	1,522	1,414	718	3	15,222
1922-23	76	1,216	2,600	2,477	1,380	1,474	1,419	2,170	2,924	2,321	1,630	149†	†19,836
1923-24	46	878	2,490	2,587	1,292	1,823	2,201	2,567	2,880	2,599	1,032	10	20,405
1924-25																	
1925-26																	
1926-27																	
New York																	
1917-18	36	733	1,052	2,228	1,043	478	913	1,145	1,104	891	413	74	....	10,110
1918-19	80	608	1,169	2,067	1,265	875	902	687	1,012	927	374	116	7	10,089
1919-20	117	782	516	2,920	2,071	982	1,298	1,153	1,929	817	214	15	3	12,817
1920-21	53	336	999	2,363	2,636	1,008	1,316	1,787	2,317	2,063	1,429	192	3	16,502
1921-22	203	1,360	2,121	4,914	1,946	1,356	2,138	1,517	1,818	1,129	428	57	1	18,988
1922-23	93	815	1,770	3,396	2,662	1,830	2,207	2,058	2,851	1,159	354	91	3	19,291
1923-24	6	65	1,866	1,716	2,346	1,903	1,070	1,771	1,839	2,321	2,143	1,396	183	....	18,625
1924-25																	
1925-26																	
1926-27																	

† Includes 8 cars in August.

TABLE XIV--*Concluded*
MONTHLY AND YEARLY CAR LOT SHIPMENTS OF POTATOES, 1917-18 TO 1923-24*

Year	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Total
Total U. S.	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars	Cars
1917-18	1483‡	6835	13,923	15,478	12,910	14,292	23,542	13,536	7,120	9,555	11,009	12,619	10,212	6,714	2287	81	161,596
1918-19	1321§	6006	14,702	14,075	11,805	19,841	24,902	15,442	8,891	12,753	8,998	13,739	12,653	7,657	3596	171	176,552
1919-20	781§	2226	9,707	13,684	13,626	22,257	32,535	17,362	9,532	12,883	8,725	12,771	8,359	2,922	492	8	167,870
1920-21	87‡	4038	14,285	15,614	13,592	18,155	31,522	25,075	9,755	14,106	11,970	16,039	12,957	9,561	2347	62	199,165
1921-22	2051||	5426	15,298	16,979	16,115	26,040	43,250	16,729	10,496	16,705	13,717	22,109	17,489	11,910	4161	71	238,546
1922-23	2780¶	8304	17,869	18,758	18,238	24,420	35,188	21,047	12,447	17,261	14,606	24,416	22,043	10,989	5,520	291††	254,177
1923-24	1183**	5311	14,774	16,450	16,727	24,044	35,220	20,732	11,977	19,739	20,688	22,816	17,780	11,110	3,171	25	241,747
1924-25																	
1925-26																	
1926-27																	
Total season for U. S.	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
1917-18	0.9	4.3	8.7	9.6	7.4	8.9	14.6	8.4	4.4	6.0	6.9	7.8	6.4	4.2	1.4	0.1	100.0
1918-19	0.7	3.4	8.3	8.0	6.7	11.2	14.1	8.8	5.0	7.2	5.1	7.8	7.2	4.3	2.1	0.1	100.0
1919-20	0.5	1.3	5.8	8.1	8.1	13.3	19.4	10.3	5.7	7.7	5.2	7.6	5.0	1.7	0.3	0.0	100.0
1920-21	0.1	2.0	7.2	7.8	6.8	9.1	15.8	12.6	4.9	7.1	6.0	8.1	6.5	4.8	1.2	0.0	100.0
1921-22	0.8	2.3	6.4	7.1	6.8	10.9	18.3	7.0	4.4	7.0	5.7	9.2	7.4	5.0	1.7	0.0	100.0
1922-23	1.1	3.3	7.0	7.4	7.2	9.6	13.8	8.3	4.9	6.8	5.7	9.6	8.7	4.3	2.2	0.1	100.0
1923-24	0.5	2.2	6.1	6.8	6.9	9.9	14.6	8.6	5.0	8.2	8.6	9.4	7.3	4.6	1.3	0.0	100.0
1924-25																	
1925-26																	
1926-27																	

‡ Includes 1 car in March.

§ Includes 5 cars in March.

|| Includes 115 cars in March.

¶ Includes 1 car in February and 221 cars in March.

** Includes 36 cars in March.

†† Includes 8 cars in August.

TABLE XV
ESTIMATED QUANTITIES OF POTATOES SHIPPED IN CAR LOTS AND PERCENTAGES OF TOTAL CROP FOR CERTAIN STATES, 1917-18 TO 1923-24

	1917-18	1918-19	1919-20	1920-21	1921-22	1922-23	1923-24	1924-25	1925-26
<i>Thousand Bushels</i>									
ESTIMATED NUMBER OF BUSHELS IN CARLOT SHIPMENTS:									
Minnesota	9,886	14,109	13,235	13,928	17,741	17,345	19,999	.....	.....
Wisconsin	8,311	12,393	13,185	11,197	6,627	13,658	9,341	.....	.....
Michigan	5,659	6,637	7,342	10,271	9,133	11,897	10,586	.....	.....
New York	6,066	6,053	7,690	9,901	11,393	11,577	10,866	.....	.....
Maine	8,876	11,416	14,066	10,690	22,822	14,631	20,746	.....	.....
New Jersey	7,025	3,533	6,245	10,288	6,286	11,001	3,818	.....	.....
Total United States	96,958	105,931	100,722	119,499	143,128	203,302	140,664	.....	.....
<i>Thousand Bushels</i>									
ESTIMATED PRODUCTION:									
Minnesota	33,600	32,760	28,844	31,581	32,200	43,740	40,698	.....	.....
Wisconsin	34,998	33,040	28,388	33,264	21,400	40,672	26,112	.....	.....
Michigan	35,910	28,560	27,000	36,225	27,200	37,842	35,796	.....	.....
New York	38,000	34,960	33,790	40,625	34,000	37,400	39,729	.....	.....
Maine	20,250	22,400	25,530	21,771	38,400	25,245	31,992	.....	.....
New Jersey	11,172	8,464	7,968	14,040	9,000	16,435	7,790	.....	.....
Total United States	442,108	411,860	322,867	403,296	361,659	453,396	416,105	.....	.....
PERCENTAGE OF PRODUCTION IN CARLOT SHIPMENTS:									
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Minnesota	29.4	43.1	45.9	44.1	55.1	39.7	49.1	.....	.....
Wisconsin	23.8	37.5	46.4	33.7	31.0	32.1	35.8	.....	.....
Michigan	15.8	23.2	27.2	28.4	33.6	31.4	29.6	.....	.....
New York	16.0	17.3	22.8	24.4	33.5	31.0	28.8	.....	.....
Maine	43.8	51.0	55.1	49.1	59.4	58.0	64.8	.....	.....
New Jersey	62.9	41.7	78.4	73.3	69.8	67.0	49.0	.....	.....
Total United States	21.9	25.7	31.2	29.6	39.6	44.8	33.8	.....	.....

CONVENIENT TABLES AND FORMULAS

- A. TO CALCULATE THE EFFECT OF (1) VALUE OF THE DOLLAR;
 (2) TREND OF VALUE; (3) PRODUCTION IN LATE CROP
 STATES; AND (4) PRICE IN AUGUST

The price which would result if these four factors only affected it, is given by the following formulas. The formula must be changed slightly for each year to allow for changes in the normal value of potatoes, the normal production, and the normal value in August in New York City. The price obtained applies to the U. S. No. 1 round whites in St. Paul and Minneapolis.

$$\begin{array}{l} 1923 \\ \text{Price per cwt.} = \frac{L}{.733 C + .58 \frac{L_A}{P_A} - 159} \\ \text{(dollars)} \end{array}$$

$$\begin{array}{l} 1924 \\ \text{Price per cwt.} = \frac{L}{.725 C + .58 \frac{L_A}{P_A} - 159} \\ \text{(dollars)} \end{array}$$

$$\begin{array}{l} 1925 \\ \text{Price per cwt.} = \frac{L}{.717 C + .57 \frac{L_A}{P_A} - 159} \\ \text{(dollars)} \end{array}$$

$$\begin{array}{l} 1926 \\ \text{Price per cwt.} = \frac{L}{.710 C + .57 \frac{L_A}{P_A} - 159} \\ \text{(dollars)} \end{array}$$

$$\begin{array}{l} 1927 \\ \text{Price per cwt.} = \frac{L}{.703 C + .57 \frac{L_A}{P_A} - 159} \\ \text{(dollars)} \end{array}$$

The proper figures must be substituted for the letters in the formulas as follows:

L=estimated price level for the season, based on the Bureau of Labor Statistics "All Commodities" index number

C=estimated crop in 27 late crop states (as listed in Table III) expressed in millions of bushels

L_A =price level in August, as shown by the Bureau of Labor Statistics index number

P_A =average price of New Jersey Giants and Cobblers in New York City during August, dollars per 150-pound sack.

The use of this formula may be illustrated with the figures for 1923. The figures to be used in the formula for 1923 are as follows:

L=151 per cent of 1913
 C=343.9* million bushels
 L_A=150 per cent of 1913
 F_A=3.64 dollars per 150-pound sack.

Applying these figures in the formula for 1923 we get:

$$\text{Price per cwt.} = \frac{151}{.733 \times (343.9) + .58 \left\{ \frac{150}{3.64} \right\} - 159}$$

Making the necessary calculations one step at a time, this gives:

$$\text{Price per cwt.} = \frac{151}{252 + 24 - 159} = \frac{151}{117} = \$1.29$$

B. TO CALCULATE THE EFFECT OF VARIATIONS IN QUALITY

As noted on p. 18 the quality of Minnesota potatoes is quite reliably indicated by a comparison of prices in St. Paul and Minneapolis and prices of Maine and New York State potatoes in New York City, provided the other factors affecting the difference are considered also. To make this comparison, it is necessary to have the following data, represented by the letters as indicated:

- L†—Estimated price level for the season, based on the Bureau of Labor Statistics index number of wholesale prices of "all commodities."
- C†—Estimated crop in 27 late crop states, expressed in millions of bushels.
- C_w—Estimated crop in 7 western states,‡ expressed in millions of bushels.
- F—Mean of freight rates per hundred pounds on potatoes from St. Paul or Minneapolis to Cincinnati and to Pittsburgh.
- D—Difference between the price per hundredweight of Minnesota round whites in St. Paul and Minneapolis and the average of prices of Maine Green Mountains and New York round whites in New York City.

These figures are then to be substituted in one of the following formulas, the formulas for different years being slightly different.

* This estimate of the 1923 production was revised in December, 1924, but is used in the illustration because it was the best figure available in 1923.

† These are the same figures already used.

‡ North Dakota, South Dakota, Minnesota, Wisconsin, Iowa, Nebraska, and Illinois.

$$\begin{aligned}
 1923 \quad & \text{Correction for quality (cents)} = L(.00083 C - .152) + F(7.47 \frac{C_w}{C} - 1.64) - .98 D \\
 1924 \quad & \text{Correction for quality (cents)} = L(.00082 C - .149) + F(7.47 \frac{C_w}{C} - 1.65) - .98 D \\
 1925 \quad & \text{Correction for quality (cents)} = L(.00081 C - .145) + F(7.47 \frac{C_w}{C} - 1.67) - .98 D \\
 1926 \quad & \text{Correction for quality (cents)} = L(.00080 C - .142) + F(7.47 \frac{C_w}{C} - 1.68) - .98 D \\
 1927 \quad & \text{Correction for quality (cents)} = L(.00080 C - .139) + F(7.47 \frac{C_w}{C} - 1.70) - .98 D
 \end{aligned}$$

The use of the formula may be illustrated with figures for 1923, a year in which it was especially important to correct for quality. For 1923 we have the following values:

- L=151 per cent of 1913
- C=343.9 million bushels
- C_w=110.5 million bushels
- F=44.5 cents per cwt.
- D=95 cents per cwt.

Substituting these figures in the formula for 1923 gives the following:

$$\begin{aligned}
 \text{Correction for quality} &= 151(.00083 \times 343.9 - .152) + 44.5(7.47 \frac{110.5}{343.9} - 1.64) - .98 \times 95 \\
 &= 151(.285 - .152) + 44.5(2.40 - 1.64) - .98 \times 95 \\
 &= 151(.133) + 44.5(.76) - .98 \times 95 \\
 &= 20.1 + 33.8 - 93.1 \\
 &= -39.2 \text{ cents per cwt.}
 \end{aligned}$$

Note that in this case the correction for quality is to be subtracted, as it is a minus quantity. The quality of Minnesota round whites was unusually poor in 1923. In some years the quality is unusually good and the correction for quality is a plus and is added to the price calculated from the four other factors included in the first formula. The final figure for 1923 is therefore:

Calculated price based on 4 factors.....	\$1.29 per cwt.
Correction for quality.....	— .39
Calculated price based on 5 factors.....	\$.90 per cwt.

The actual average price for 1923, as shown in Table I, was \$1 per hundredweight. The quality of Minnesota potatoes in 1923 was really not so poor as the market rated it in November. Later in the season prices of Minnesota round whites improved as compared with other potatoes.

C. TO CALCULATE THE PRICE JUSTIFIED BY THE FIVE FACTORS IN ANY ONE MONTH

The formulas given above apply to the average price for the nine months from September to May for U.S. No. 1 round whites in St. Paul and Minneapolis. To calculate the price which these factors justify for any one month, it is necessary to subtract or add a certain amount to allow also for the normal seasonal variation.

NORMAL SEASONAL VARIATION IN THE PRICE OF POTATOES

Month	Deviation from average price for season [*] Cents per cwt.
September	- 4.9
October	-14.6
November	-10.6
December	- 3.7
January	+ 0.4
February	+ 2.4
March	+10.6
April	+14.2
May	+12.7

* Calculated on the assumption of a normal price of potatoes of \$1.25 per cwt.

