Forecasting the Acreage, Yield, and Price of Cotton

BY

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Contents.

Letter of Transmittal

College Park, Maryland,
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To the Dean of the Graduate School and the Head of the Department of Agricultural Economics of the University of Maryland.

Sirs: There is transmitted herewith a report on the forecasting of the acreage, yield, and price of cotton in the United States, giving in a skeletonized form, yet, in sufficient detail to permit an immediate understanding of the problem, the results of four years' study and research. This work was commenced at the North Carolina State College of Agriculture, was carried on for one year in Washington, and has been completed at the University of Maryland.

The first part of the report deals with spot cotton prices, the factors upon which their fluctuations are dependent, and the extent to which they can be predicted on the basis of current cotton production. An analysis has been made of the causal relationship existing between cotton production and subsequent monthly prices, and the degree of this relationship is expressed as coefficients of correlation. Predictive equations are formulated from these expressions of correlation.

The second part of the report embodies an analysis of the extent to which acreage of cotton planted is influenced by monthly spot prices of cotton produced during the preceding year. Coefficients of correlation have been calculated from both deflated and undeflated prices, and the predictive equation is formulated in the same way as the equations for price predictions.

The third part of the report deals with the reliability of the par method of production estimate and with the yield of cotton as influenced by various weather factors. Relationship between weather factors and subsequent yields is expressed in the same way as the relationship between production and prices, and prices and subsequent acreage. In addition, the degree of accuracy of par estimates of production as related to actual production is expressed in terms of correlation coefficients. There is presented also a newly evolved procedure of production estimates, designated as the ratio method.

I cordially transmit to you this report.

F.H.Harper

Acknowledgments

So many have contributed information and assistance of one kind or another in the preparation of this report that I am unable to make mention of all who have aided me, but I hope they will understand that my thoughts are none-the-less sincere because of my failure to mention their names. In a few cases, however, the extent and special character of the service rendered make it quite necessary and proper that I should express publicly my obligation and indebtedness to those who have rendered these services.

If the writer has been successful in finding what he searched for, it has been largely due to the ready good-will and helpful cooperation of many specialists, most of them men whose time is much occupied, but whose interest in this work has led them willingly to place some of it at the writer's service, and to contribute freely of their knowledge to the perfection of this study.

I wish to acknowledge with grateful appreciation the suggestion from Dr. G. W. Forster, Head of the Department of Agricultural Economics at the North Carolina State College, that there is a place for such a report on cotton forecasting. It was he who first gave me assistance, and under whose direction the preliminary analysis was made. I desire to express particular thanks to him for his cooperation in the correlation studies of prices. He was of much service in advancing the general economic principles of forecasting, and the value of his suggestions regarding analytical technic is inestimable.

Further acknowledgments are due those two gentlemen of the University of Maryland, Dr. S. H. DeVault, Head of the Department of Agricultural Economics, and Professor W. B. Kemp, Assistant Dean of the College of Agriculture, who, not occasionally, but systematically and continuously, have advised with me to improve the work as a whole by criticism, or to enrich it by additions.

Dr. DeVault has spared no effort to perfect his many contributions on the purely economic phases of the problem, and in many instances his aid has been given under conditions which necessitated sacrifices of time on his part. He has diligently read and reviewed the proofs from the commencement of the work and improved them in a systematic way by valuable additions. Many sections owe much of their accuracy and completeness to his assiduous care, and his

criticisims and suggestions in regard to the economic aspects of the various phases of forecasting have enabled me to pursue my work without interruption.

Professor Kemp has devoted much of his time to a critical examination of the analysis, and his kindly criticism of statistical technic, together with his assistance in the more advanced concepts of correlation, have been a continuous and stimulating source of encouragement to me. Without them this study would have been carried forward less rapidly, and much of it would not have reached its final stages. Those who are familiar with Professor Kemp's work in correlation, and his numerous findings in other phases of statistics, know with what an amazing wealth of evidence he illustrates the subject upon which he touches. His extensive knowledge has been generously placed at the writer's service throughout the course of this study, and there is scarcely a principle in correlation in my work to which he has not added a part. It is impossible for me to estimate the value of his assistance in the multiple correlation studies, to the accuracy and completeness of which he has made many additions. He has contributed similarly to the correctness of the ratio-method of estimate, and has revised and corrected the more difficult mathematical equations that have been submitted to

him. Professor Kemp has been generous with his help on all phases requiring further investigation, and, by his personal interest in the field of statistics, has saved the writer many hours of work. The solution of some of the problems confronted seemed at times to be beyond my skill, but the suggestions which came from him encouraged me to renew my efforts in the task before me. I owe him an everlasting debt of gratitude.

The author gratefully acknowledges further the assistance received from Dr. G. F. Cadisch, Assistant Dean of the College of Arts and Sciences, University of Maryland. He has read certain sections of my report, and his criticisms have materially aided me in solving and substantiating various theoretical economic concepts. Those who know Dr. Cadisch are aware and appreciative of his marked ability, both as an economic theorist and as a practical economist. It is this ability, this exceptional power as a critic, that has been so generously placed at my service. I owe him a debt of gratitude which only feelings, not words, can express.

Acknowledgments are due also to members of the cotton trade throughout the country, especially the cotton merchants over the entire South, and the Secretary of the New Orleans Cotton Exchange. The author is indebted also to Dr. F. A. Pearson, Professor of Agricultural Economics at Cornell University, and to the corps of workers in the Cotton Division of the United States Department of Agriculture. Of the assistance received from the latter, that of Miss Elna Anderson of the Bureau of Agricultural Economics was outstanding.

Author's Note

To the student of economics present themselves these questions: What has been? What tends to be? What causes? The first necessitates historical economic study: the second involves theoretical statistical analysis: the third demands actual interpretation. In the analysis of causal economic relationships, historical tendencies as sources of aid cannot be dispensed with. It is upon these tendencies, these influencing causes and resultant factors, that we make our estimates of probable future conditions. The first two questions, in a way, are tributary to the third. Everything is interpreted in terms of past occurrences or tendencies, and in order to predict with any appreciable degree of accuracy what will happen in the future we must first know what has contributed to resultant effects of the past. Once the causal factors are known, the next step is to measure their relative influences upon the resultants.

It is the function of economic statistics to assemble, arrange, and analyze economic facts, and to make practical application of the knowledge gained by study and experience, in estimating what are most likely to be the immediate and ultimate effects of various groups of causes. Economic laws, therefore, are statements of tendencies expressed as the most probable occurrences and recurrences. They contribute, along with sound reasoning, a part of the basic material used in solving practical problems.

Historical analysis always involves varying conceptions of the time element, and there is no distinct line of division between those tendencies which are normal in behavior, abnormal, and occasional. The latter are those in which certain momentary factors exert a pronounced influence, while the former are those resulting in conditions ultimately attained if the economic factors under consideration have sufficient time to work out their full effect undisturbed. Abnormal tendencies are those which the economic factors under question do not allow sufficient time in which to work out their full effect. These tendencies shade into one another by continuous gradations, and those variations which may be regarded as normal if we are thinking of changes from day to day on a cotton exchange are but occasional variations in regard to the tendencies over the period of a year, and these in turn are occasional with reference to tendencies over a quarter of a century. The time element itself is continuous, and it is the factor of greatest difficulty in almost all economic problems. It has no absolute partitions into long and short periods, and what is a long period for one problem is a short period for another.

Foreword

Some economic phenomena can be subjected to accurate quantitative measurement. It is hardly conceivable that economic science could possibly have made much progress had there not been developed certain definite units of quantitative expression. When we wish to know the exact distance between points, we do not ask for speculation; we take a yardstick and measure it. If a patient is stricken with disease, the physician does not seek mere opinion, he makes an actual diagnosis. In the field of economics, however, though the need for units and applications of measurements in a quantitative sense is as great as in medicine, we have been guided in the past largely by guesses and opinions. The farmer plants his crop, cultivates it, and, with the forces of nature aiding him, brings it to maturity without giving any thought to potential demand for his product in relation to other products. Collectively, at least, the producers of agricultural commodities have failed to adjust their production in accordance with general economic principles. Their plantings fluctuate with prices, and they are not based upon the future economic aspects of market demand.

Agriculture has lagged behind industry for a number of years. The underlying causes of this are to be found in the fact that agriculture, being less centralized and less intensive, has been slower in taking advantage of those greater external economies. Farmers as a group are not lacking in internal economic efficiency, but rather in those broader economic spheres of orderly production, marketing, and others dependent upon the development of the industry as a whole.

Introduction

Some of the most important problems in economics deal with the inter-relationship between production, prices, and acreage of agricultural products. This inter-relationship is being more fully recognized as time goes on by both production and marketing specialists, and in some cases it is obvious that marketing organizations handling only a small part of total volume of a particular commodity have suffered losses, and even total failure, because of their attempts to procure higher prices later in the season or during the next crop year. The specialists in economics and marketing are beginning to comprehend the primary causes of abnormally low prices, but the progress of market investigation is making more evident each year the conclusion that in practically all cases the wide fluctuations in prices from year to year are conditioned upon a lack of orderly production. Explanation of the occurrence and extent of relatively low prices, therefore, requires not only the recognition of the causal factor, but also a detailed and comprehensive statistical analysis. In the case of most products the first has been easier than the second, since detecting a causal factor is simpler than the analysis of causal conditions. For this reason, we have much more nearly exact knowledge concerning the former. In fact, practically all of our exact data in agricultural economics deal with the causal factor, but such ideas as are sometimes held concerning the extent to which prices fluctuate in accordance with fluctuations in the causal factor are general and vague, chiefly based on observation (1) rather than on actual analysis.

The importance of a clearer understanding of the influence of production on prices becomes the more evident when we realize that prices themselves are influencing factors upon acreage of crops planted, and that prices at various times in the year affect quite differently the intentions to plant. It is to be expected, of course, that varying sizes of the crop harvested will react in many ways upon the probable crop of the following year as measured on the basis of preceding prices, which, as has been stated, are directly related to acreage planted. Convincing evidence of the causal inter-relationships existing between production, prices, and acreage of cotton will be found in the analysis following.

Experience in marketing problems leads one to believe that price changes can only be understood through exact

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(1) It is not, of course, to be inferred that economists have failed to recognize the importance of supply as related to prices and subsequent extent of planting. Even the earlier economists were aware of the relationship between supply and demand. They realized also the significance of the law of diminishing returns and the fact that market price cannot long remain below the cost of production.

analysis of their relations to conditioning factors, and cumulative evidence indicates this to be particularly true of cotton. The experience of southern farmers in 1926 presents further argument for prompt and critical attention to the relation of production to prices. With cotton selling at six and eight cents a pound it seems evident that recurring depressions can be prevented only through a comprehensive understanding of the price regime. Perhaps at some future time the production and marketing of agricultural products will be controled in much the same way as manufactured commodities.

It is, of course, obvious that there must be some comprehensive production program if agriculture is to maintain a proper balance over short periods of time. For long periods the tendencies have sufficient time in which to fully manifest themselves, and from this viewpoint there can scarcely be any problem of over-production. It is the seasonal and short time over-production which most seriously affects the producer, and it is because of the disastrous results that agriculture should be placed on a basis that is sound for all periods. It is recognized that the forces of nature are somewhat beyond the control of man, but is it not possible for producers to so organize that the relation between quantities of the various products and the demand for each of them will be more in accord with relative consumption?

Historical

In the statistical analysis of causal inter-relationships existing between production, price, and acreage of cotton the studies have been carried on exclusively in the United States. A thorough review of statistical literature shows that four publications, the work of two specialists, have been issued on the subject, and these constitute the total systematic work that has been done.

H. L. Moore (1) found a simple coefficient of correlation of minus .819 between cotton production in the United States and yearly spot prices. When purchasing power of money was taken into consideration as one of the independent variables the multiple coefficient was .859, and in holding the purchasing power of money constant he was able to obtain a coefficient of minus .808. He found that even though there is a coefficient of correlation of plus .492 between cotton prices and general purchasing power, no increased degree of accuracy is to be obtained by taking price level into account, neither by incorporating its effect in the predictive formula, nor by holding its effect constant by partial correlation.

Between accumulated effects of May rainfall, June temperature, and August temperature and the subsequent yield of cotton per acre in Georgia he found a multiple correlation of .732. Similar relationships were calculated for the states of Texas, Alabama, and South Carolina, and in most cases his errors of estimates were less than the errors involved in the forecasts of the United States Department of Agriculture.

B.B.Smith (2) in working with the relationship between production, value, and price of cotton and acreage subsequently harvested found the latter independent variable has more to do with determining the producer's mind with reference to acreage, though a portion of the effect of value may be considered as included in the price. His studies center around relative price changes as related to subsequent acreage, and he found from his correlations for the period studied that in 70 per cent. of the cases the estimates were within 3 per cent. of actual.

In another publication (3) he shows the relationship between certain weather factors and yield of cotton in Louisiana. From the combined effects of June, July, and August precipitation, and June and August temperature, he worked out a multiple regression equation which when used in estimating normal yields gives an error of estimate one-fourth as great as the standard deviation of actual yields.

In his latest bulletin (4) Smith discusses at length the fundamental factors affecting cotton prices, and he shows a very high degree of accuracy in estimates of the average of spot prices for the months of December and January taken together. In calculating the coefficients of correlation he takes into consideration supply and grade of cotton and the general price level. No attempt is made, however, to estimate prices for specific months. In this publication he shows also a high degree of approach to accuracy in acreage estimates, duplicating his results in a previous work (2).

Suggestions to Readers

A study of this kind involves so many concepts of statistical and analytical technic that it is not possible to give in complete detail all the calculations that have been made. The work has grown to twice the size originally contemplated, and any attempt to show more than general analytical procedure and ultimate conclusions would make it too burdensome for those who are interested in its perusal. The writer asks the reader to bear this in mind, particularly when studying the coefficients of correlation, where only reference is made to the method used. No report of this nature could include the details of solution of the many problems involved.

In statistical studies of historical data in which there is a decided trend it is important to know in interpreting the results whether or not any part of the trend has been removed. The reader is reminded that in this work where coefficients of correlation are calculated by the percentage change of first difference method the greater part of the trend is removed by the mere technic of the method itself. Series whose relationships are not expressed by the percentage change method, or in which the trend is not a greatly modifying factor, are correlated from residuals of lines of best fit or deviations from the mean. It is noteworthy that in the percentage change method the variables in the series are expressed as multiples of their respective standard deviations, which places them on a readily comparable basis.

The United States produces more of the world's supply of cotton than any other country. On an average, American mills consume about forty per cent. of the domestic production, and the other sixty per cent. enters into the world's channels of trade as exports of raw lint. As a consequence of these facts there is a greater causal relationship between production in the United States and prices at our own markets than there is between world production and prices at the American markets, or between domestic production and prices of American cotton at any one foreign market. There would probably be a reversal of the latter situation if the entire volume of domestic exports were sold on one foreign market. As it is, the foreign sales are divided among a number of markets, the more important ones being in England, France, and Germany, and the volume of American cotton sold at any one of them is less than the volume of sales at domestic markets.

Relationships between production and prices are expressed as coefficients of correlation on the basis of both deflated and undeflated prices, and the reader's attention is particularly called to the concepts involved in this analytical technic. Regardless of personal opinion, it must be remembered that the estimation of deflated prices has little significance in attempting to formulate equations from which changes in actual spot prices in the future are to be predicted, since a prediction in terms of deflated prices, if it is to have meaning to the cotton trade, must necessarily be expressed in terms which enter into the general scheme of composite price level. That is to say, a price prediction must always be undeflated.

Acreage predictions by means of an equation formulated from the relationship between cotton prices deflated with the price index number of farm products and subsequent acreage harvested involves a principle quite different from that alluded to in the preceding paragraph, and it is to be kept in mind that there are certain alternatives in agriculture, meaning that the decision on the part of the farmer to plant cotton is somewhat influenced by the relative values of farm products. This is the reason that acreage predictions can be fairly accurately made in December preceding the harvest year. Cotton prices deflated with the index numbers of all commodities do not afford a satisfactory coefficient of correlation for the predictive derivatives, since the deflation is involved with factors rather indirectly related to agriculture. The acreage estimates by the ratio method are based on that which is most likely to occur as expressed in terms of normal trends. This is thought to be one of the most reliable methods of making forecasts, and it is the general principle followed by the organized economic services throughout the Country.

For certain well-defined periods of time there are decided relationships between weather factors and subsequent yield of cotton per acre, but the reversal of yield response to varying climatic factors gives rise to serious errors in the formulation of rigid predictive equations. These variations in response, unless they occur in continuous succession for a number of years, cannot be incorporated into an expression of causal and resultant relationship. In the par method of estimate, each varying factor is weighted, regardless of the time and order of its occurrence, and its probable effect upon yield is more easily estimated. Likewise, the ratio method of estimate takes into account the composite effect of all factors influencing yield, since any prediction for the future is expressed in terms of what is most likely to occur in relation to preceding occurrences. In the predicitve equations formulated from coefficients of correlation between weather factors and yield there are numerous causes entering into final results which are rather difficult to measure in terms of numerical expressions of relationships.

Sources of Data.

In any statistical analysis it is essential that the problem be **studied** in its various phases in order to determine the possibility of statistical approaches. When it is found that the problem possesses analytical merit,one of the most important factors to be considered is the availability and collection of required data. There are often many sources from which data can be taken, but it is the duty of the investigator to decide which source is the most reliable. This fact, together with the necessity of sometimes converting original units and figures into other expressions, has been constantly in the foreground during the course of this study. This analysis, insofar, at least, as the applicability of data is concerned, is quite comprehensive, and in the collection of statistical material recourse has been taken in every case to official reports, either of the Federal Government, State Institutions, or other sources of high orders of excellence from which these agencies make their compilations.

The data relative to cotton production, acreage, exports, imports, consumption, and farm value of cotton were tabulated from unpublished official reports of the United States Department of Agriculture, the United States Department of Agriculture Yearbooks, and reports of the Bureau of Foreign and Domestic Commerce. In some cases it has been found advisable to take recourse to unpublished records because revised figures are often not given in the latest publications. Data from unpublished records were tabulated in the offices of the Departments of Agriculture and Commerce at Washington. In several instances it has been necessary to check over the records at the United States Department of Commerce in order to verify the production reports of the Department of Agriculture.

Monthly and yearly spot quotations for middling cotton at New York and New Orleans were obtained from records of the cotton exchanges, Weather and Crop Reports, unpublished records of the United States Department of Agriculture, and the Agriculture Yearbooks. A part of the data on prices were tabulated at the cotton exchange in New Orleans during the course of an investigation in the cotton states. The reports from the various sources have been very carefully compared. It is sometimes impossible to obtain an entire series from a single source. In taking data from various sources it is always imperative to take recourse to those from which the final official reports of the government or other agency are compiled. This is the procedure that has been followed in the tabulation of prices. The government's published statistics of cotton prices in the Agriculture Yearbooks and Weather and Crop Reports are obtained directly from the cotton exchanges.

Index numbers used in deflating cotton prices were taken from the official reports of the Bureau of Labor Statistics at Washington. Before deflating prices in this analysis a conference was held with officials in the offices of the Bureau to ascertain the method by which the indices were constructed, with a view of determining whether or not they were of such nature as to permit of price deflation. There are great differences in index numbers, and the aim has been in this study to select those indices which best represent general price changes.

Wool prices as reported by the Boston Market were used, and these were tabulated from the Agriculture Yearbooks. Silk prices and the monthly prices of industrial stocks were furnished by the Harvard University Business School. They are published in the Harvard Review of Economic Statistics. In each of these cases prices have been selected for those grades and classes which best reflect the wool, silk, and stock price situations.

Data on pig iron production in the United States were obtained from the New York State Chamber of Commerce, and bank clearings figures were furnished by the United States Treasury Department at Washington.

Stocks of cotton on hand at the beginning of the season, which constitute the carry-over from the preceding season, were compiled from Foreign Crops and Markets at the Department of Commerce.

Working spindles in the United States as of September first were obtained from Cotton Facts and from various members of the cotton trade during the course of a study comprising the entire country.

The yield of cotton per acre in Wake and

Cumberland Counties, North Carolina, were obtained in Raleigh at the State Department of Agriculture. Yields on the North Carolina Experiment Station plots were furnished by the Agronomy Department of the North Carolina State College, and the figures were compiled in the offices at Raleigh. These data show the actual yield of lint cotton in grams, and they represent the results of a carefully planned series of experiments.

Weather data by days were tabulated at the United States Weather Bureau in Raleigh. These data were taken from the official records.

All other statistical material not specifically referred to was obtained from official government reports and unpublished records of the various departments in Washington.

Procedure in General

When dealing with masses of quantitative data, the problem of condensation and statistical analysis is paramount. It is necessary that we condense the data in order for the mind to be able to comprehend them, and the analysis is essential for measuring and weighing facts. Statistical methods have been developed for making this condensation and analysis.

In all economic studies, particularly those involving causal relationships, we cannot entirely emancipate ourselves from the historical analysis. The concept of historical necessity has been handed down to us by the old German School of economic thought, and the significance of it is appreciated when we attempt an analysis of historical data. Probably no writings in the field of economics have been greater sources of enlightment to statisticians than those of this early School.

This report on cotton forecasting has been given a statistical and historical approach, and all correlations are prefaced by extensive evidence of statistical justification.

The first step in analysis has been the plotting of the various series of data in order to determine, by inspection, the extent of positive or negative relationship. This is always the introductory analytical procedure in historical correlation studies, and it is sometimes the means of a great saving of time.

Closely associated to the factor of relationship is the character of long-time movements of the series to be correlated. It is essential in any analysis to determine the nature and direction of cause and effect fluctuations. In this study, cotton production and prices have been represented by a straight line, commonly known as the straight line of least squares. Certain weather factors, together with the subsequent yield of cotton as measured in pounds of lint per acre, have been analyzed for their cause and effect relationships from the residuals of curved lines. This procedure was necessarily occasioned because of the reversal of yield response to varying climatic conditions.

Coefficients of correlation were calculated by various methods, depending upon the nature of the causal and resultant factors in question. The particular method of correlation used is designated wherever coefficients appear, but it may be stated that the percentage change of first difference method has been used to the greatest extent, especially between production and price and factors related to price.

The method of determinants was used in showing the relationship between actual and estimated yield of cotton per acre.

In determining the relationships between weather factors and yield, correlations were calculated by the percentage change of first difference method and from the residuals of second and third degree parabolas. Actual production and production as estimated by the United States Department of Agriculture for the various months were correlated by the sum-product method. Acreage harvested and prices for the preceding months were correlated by the percentage change method. Coefficients of correlation expressed as result of multiple effect were calculated by the method of determinants and by the regular methods of multiple correlation for historical data.

Prices from which the effect of the general price level has been removed were deflated with the Bureau of Labor Statistics Index Numbers, either of all commodities or of farm products, depending upon the factors to be correlated.

Predictions of prices were made by the formula as evolved from the coefficient of regression. Acreage predictions were made by the ratio method and by the predictive formula as evolved for prices. Production predictions were made by the ratio method, and in addition to these predictions the degree of accuracy of the par method of estimate is shown in detail.

In the discussions on correlation and results will be found a thorough interpretation of all the factors above referred to. It has been the aim to merely generalize the technic of analysis, and in order to obviate repetition, leaving detailed explanations and interpretations for discussion in the more appropriate places.

The Secular Trend

The methods of statistical analysis which are used in the interpretation of economic statistics are in many respects identical with those used in the physical, biological, and mental sciences. In fact, a considerable part of the calculus of mass phenomena has been evolved by scientists in these other fields. When, however, we approach the analysis of historical series we come to a problem which is essentially characteristic of economic and social facts. The time element enters into a very large proportion of economic data; the statistics of social phenomena are statistics of historical movements. A difference in the quantities of agricultural and other commodities produced during two periods, and the prices received by the various agencies of production may be influenced by wars or very unfavorable or favorable climatic conditions, or some other very unusual incident which materially affects prices and production. If we are to make comparisons of two or more historical series or the curves which represent them, we must, if our comparisons are to be significant, take these several factors into consideration. If we are interested in the relatively long-time movements we must isolate these elements in each curve. If we wish to determine the influence of the business cycle upon a given phenomenon, such as masonry employment, we must eliminate the long-time trend, and if we are using monthly data the seasonal variations must be removed also.

A computed trend is our best estimate of the general course of a time series, either expressed in numerical terms or represented by a graph. In the accompanying tables and graphs (Table XV and Charts III to XIV) both methods have been used to show the trend of cotton prices for the period studied. Strictly speaking, a secular trend, as distinguished from a cyclical movement, is determinable only from data applicable to period of time of sufficient length to enable the influence of certain fundamental tendencies to become evident.

A convenient method of obtaining an approximation of the general trend of a series is the one known as the moving average. A second method of determining the trend, and the one that has been used in this study, is to calculate the straight line which best fits the given data. The line of best fit is usually considered the line of least squares, which is the line so drawn that the sum of the squares of the vertical deviations of the curve representing the actual data from the given line is less than the squared deviations from any other line. The one line which satisfies these conditions may be found by means of the following calculations, the actual computations for which are shown in Table XV, and the results graphically shown in Charts III to XIV, inclusive.

1. Find the mid-point of the period for which the trend is to be computed.
2. Average the data for the entire period.

3. Plot the average as the ordinate of the straight line for the year at the mid-point.

4. Compute the rise or fall of the line of least squares from the determined point by means of the following formula: $S = \frac{Xy}{X2}$, in which the significance of the several factors is as follows: S = the slope of the line, rise or fall, measured by the vertical spread between any two successive points on the line: Xy = the sum, signs being considered, of the products obtained by multiplying the variable of any series by its deviation from the origin, or mid-point of the series: X^2 = the sum of the squares of the deviations from the point of origin.

The ordinate of trend is then found by adding to the mean of the series the product of the slope of the line and the deviation from the mid-point. The line of least squares can be drawn by connecting any two of the points determined.

The fitting of trends by a mathematical formula, for either the straight line or the more complex types, has the advantage that, once the type of curve is chosen, the placing of the line becomes a matter of mathematical computation rather than of judgment. The mathematical curve, and particularly the straight line, is very convenient for estimating the movement of the variable beyond the earliest or latest period given, though this must be done with caution. Then, too, where there is reason to believe the general movement of the series is caused by factors operating regularly enough to obey approximately a mathematical law which may be expressed or represented by an equation, the mathematical curve is clearly the most logical. Where a quick approximation is desired, or where the trend is irregular, there is much to be said for a judicious application of free-hand methods, or of the semi-average method.

To compute the monthly ordinate of secular trend from the yearly data we divide the annual slope by 12. At this point it is necessary to make one adjustment. The average for the series will lie somewhere between June 15th and July 15th. In order to spread the increment of monthly slope correctly it is imperative that it be divided by 2. If the series has an upward trend we add the resuld obtained by dividing by 2 to the average of the series to obtain the July ordinate in the year of origin, and subtract it to obtain the June ordinate. If the series is negatively inclined we subtract for the July ordinate and add for the June ordinate. In calculating the yearly trend of a series in which there is an even number of years the same principle must be observed in calculating the rise or fall of the line as is observed in the computation of the monthly trend from yearly data.

The Standard Deviation

The standard deviation is a measure of dispersion that may be defined as the distance from the mean of a frequency distribution to the point where the curve inflects, or changes from a concave to a convex surface.[1] It is found by extracting the square root of the mean of the squares of the deviations from the arithmetic average. The measure, which is an index of the extent to which items vary from their mean, is useful when special weight is to be given to the extreme deviations. In correlation studies, and particularly when coefficients are to be computed by the Pearsonian method or the method of percentage change of first differences, much time is saved if the standard deviation is used as a measure of dispersion. In the first method the product of the standard deviations and the number of pairs of items compared is divided into the sum of the products of the pairs of deviations from their means

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(1) W.B.Kemp, Lectures in Statistics, Univ. of Md.

to obtain the coefficient of correlation. In the latter method the standard deviation is divided into the deviations of the percentage changes from their mean to obtain the multiples of standard deviation, which are paired, and the products obtained, summated, and divided by the number of pairs of items.

The measure is useful also in reducing series which have widely different ranges of variation to a basis suitable for comparative plotting and subsequent analysis.

The standard deviation, as has been stated, is a measure of the extent to which items vary from their mean, but the coefficients of correlation do not necessarily vary with it directly. For example, the standard deviation of the percentage changes of first differences of July cotton prices for the period 1892-1912 inclusive is 20.00, and the coefficient of correlation between prices and production is -.340, while the standard deviation and the coefficient of correlation between December prices and production are 32.20 and -.878

respectively. There is a mathematical significance attached to this, and it is easily understood when we comprehend the fundamental factors involved in cotton price fluctuations.

There are certain short-cut methods of calculating the standard deviation, one of which is to assume a trial arithmetic mean, compute the mean-square deviation from the mean, subtract the square of the difference between the true and assumed means, and then extract the square root. Another method is to compute the mean-square of the actual items, subtract the square of the mean, and then extract the square root. In this method of computation the square of the mean is subtracted because there are no deviations from the mean. It is very useful in determining the degree of dispersion from the mean, and the method of calculation may be employed when coefficients of correlation are computed by pairing original items, or when the regular Pearsonian method is used. In the latter case, however, it is probably more satisfactory to compute the standard deviation from the deviations from the mean of the series. The same is true in the case of the method of percentage change of first differences, since the deviations of the percentage changes from their mean must be computed in order to express them in terms of multiples of the standard deviation. By squaring the deviations from the mean rather than the original items the magnitude of the product from which the standard deviation is to be obtained is reduced, and hence its calculation facilitated.

Correlation*

Statistics may be looked upon as an historical method of study, by which, out of past occurrences, we formulate statements of the most probable future. Analysis by statistical methods enables the economist to construct predictive equations which he hopes will be of practical value in anticipating changes in economic conditions. For example, he wants to be able to estimate the most probable change in the acreage of cotton on the basis of a given change in preceding prices, or the most probable change in monthly prices with a certain change in current production. For any such predictive equation the measures of correlation are the basis, since they express in quantitative form the relationships which have existed in the past.

Correlation may be defined as the typical amount of negative or positive similarity in variation existing between pairs of items in two series of variables (1). It is important to note that the term "typical" has significance, since the expressions of relationships as obtained may not represent actualities. As an illustration of this, let us refer to a

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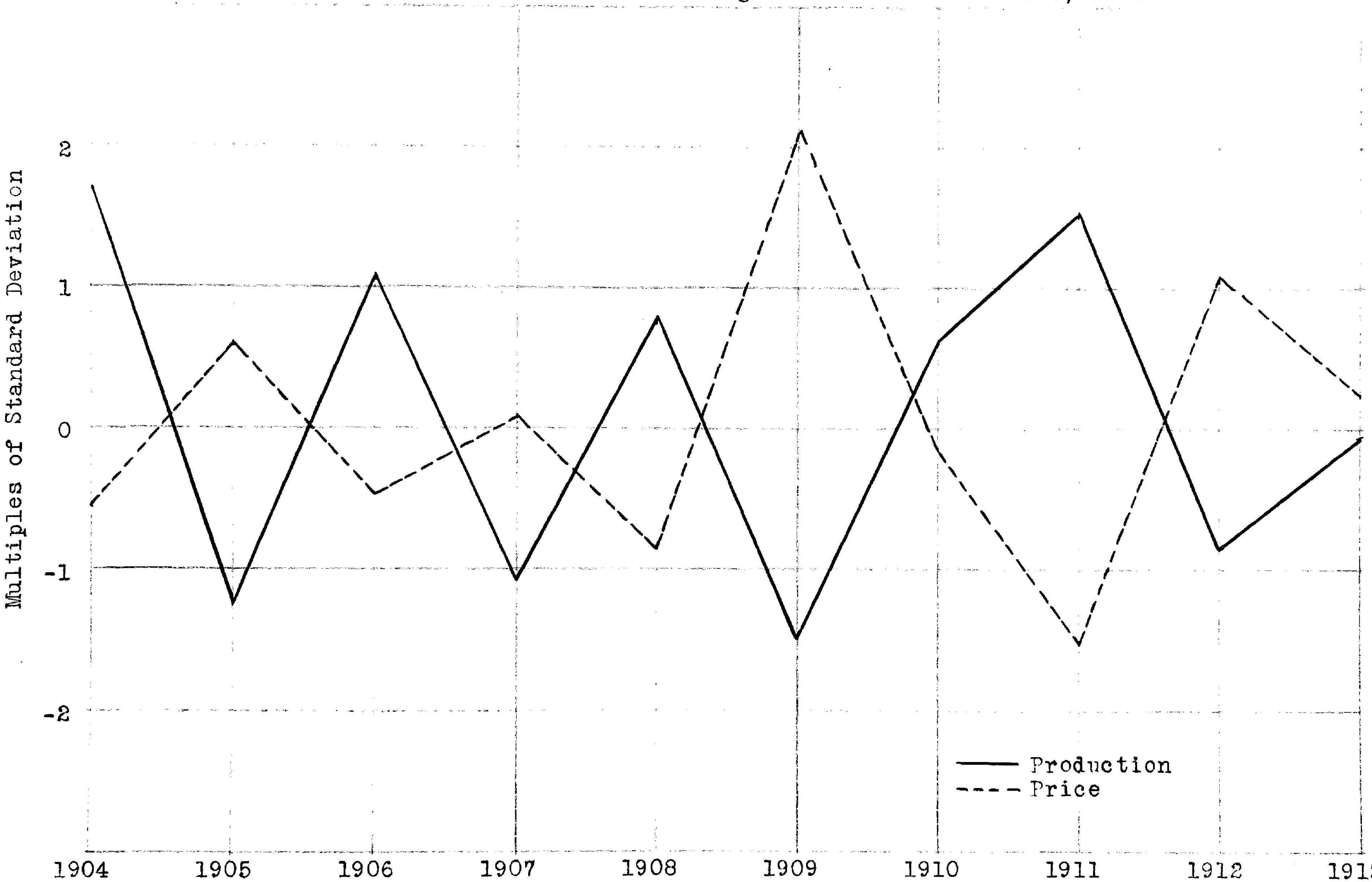
*Biometricians in their studies of inheritance were led to devise means of measuring the extent to which parents transmit their characteristics to offspring, and they are to be credited largely for the development of the theory of correlation. In the group of those to whom the general principles explained herein are to be credited should be mentioned G.U.Yule, Karl Pearson, and the economic statistician, Harry Jerome.

(1)When two or more independents are correlated with one dependent the measure of relationship is expressed by R.

study made of weather factors and yield of cotton per acre in Wake County, North Carolina, for the period 1900--27 inclusive. In 1915 the precipitation for the period of July 16th to July 19th inclusive increased 3800 per cent. over the same period of the preceding year, and for the period of August 20th to August 26th inclusive the increase was 13,350 per cent. in 1916 over 1915. In such cases as these it is obvious that no method of correlation would show normal relationships, unless numerous other factors were taken into consideration, since the magnitude of one item alone would likely be the determining factor in the coefficient. It is, therefore, the duty of the investigator to study his data for probable cause and effect, and to comprehend the significance of abnormally high and low magnitudes in any one of the series of variables.

In Chart I on the following page are plotted the data showing the relationship between cotton production and prices. It will be seen that there is a very high degree of uniformity in movements between the curve representing production of cotton and the curve representing prices. When production rises, prices fall; when production falls, prices rise. This movement of two variables is one type of relationship, known as inverse correlation because of the tendency for production and prices to move in opposite directions. A

Chart I. Inverse Relationship Between Cotton Production in the United States and November Spot Quotations for Middling Cotton at New Orleans, 1904--13*



*Based on data in 1923 U.S.D.A. Yearbook, page 796, Table 290, and 1924 Yearbook, page 756, Table 313, for the years 1900--13 inclusive. Plotted in terms of multiples of standard deviation.

close study of Chart I will raise these questions: What standard is to be used in measuring variation? What is the meaning of direction of variation? What is meant by degree of positive or negative similarity? It is convenient to recognize definitely that there are three norms from which variations in chronological data may be measured. These are the mean, the trend, either the straight line of least squares or the parabolae of higher degrees, and the preceding item. The nature of the particular problem, the purpose for which the results are to be used, and the uniformity in the data will determine the norm from which the variations are to be measured.

Variations from the mean. If we wish to know the extent to which yield of cotton per acre varies with acreage of cotton on individual farms, or the relationship between size of farms in the Cotton Belt and acreage of cotton planted per farm, we would measure the variations from the arithmetic mean. We would want to know whether a large acreage of cotton under single management produces a yield of lint above or below the average, and whether large or small acreages of cotton are planted on farms above or below the average. This phase of expressing relationship is known as static correlation, since it is in contrast with correlation in which the time element is involved. In correlation studies involving the time element, variations may be measured from the mean of the series if there is no trend, no downward or upward movement, in the data. If there is a trend, then this method of measuring variations often becomes unsatisfactory, inasmuch as the deviations from the means may tend in different degrees to equal zero in the series correlated. This involves the concept that abnormally high or low values may become associated.

Variations from trend. The measurement of variations in series from their trends is one of the most important phases of statistical method in economic studies. If it were desired to measure the general character of long-time movement of the original numerical data represented in Chart I, rather than the degree to which prices are influenced by production, a simple method would be to compare the slopes of the secular trends. We would then expect to procure evidence of correlation in similar direction, since both production and price show a general tendency to rise. (See Charts II and III). If we are attempting to determine the extent to which series have associated fluctuations, the deviations from the slope of lines of best fit may be used. The comparisons in this case would be with residuals of general movement, which may be represented by either straight lines or lines of higher degree.

<u>Deviations from preceding item</u>. There are certain problems in economics in which we are not concerned so much with the deviations from the average or trend, but with the deviations from the item immediately preceding. For example, we wish to know if an increase in the price of cotton in December is followed by an increase in cotton planted the next year, or whether an increase in cotton production is followed by an increase or decrease in subsequent monthly prices. In problems of this kind the correlation of first differences is involved, and the actual differences may be correlated, or they may be reduced to percentage changes and multiples of standard deviation. In the latter procedure, the magnitudes would be reduced, and, therefore, the calculations facilitated.

The second problem is that of direction of variation. The relationship between two variables may be direct or inverse. If they tend to fluctuate in the same direction, one increasing when the other increases, and decreasing when the other decreases, we have direct correlation. If one series, however, decreases when the other increases, as in Chart I, we have inverse correlation. We would expect direct correlation between prices of cotton before planting time and acreage of cotton subsequently planted, and inverse correlation between size of crop and subsequent prices.

It is not sufficient to merely state that there is inverse correlation between cotton production and prices. We wish to know whether the relationship is invariable, and whether production and price always vary to the same extent, or if there is a variation in the degree of relative change. The coefficient of correlation may be perfect, high, or low, or there may be no correlation at all. If production and price, for example, always fluctuate in opposite directions and in constant ratio to each other, there is perfect inverse correlation. If they always move in the same direction, and to the same degree, there is perfect direct correlation. If the fluctuations are such that there is only random association between them, so that an increase in production is equally likely to be accompanied by either an increase or decrease in price, then there is an absence of correlation. As a fact, many series show some degree of similarity in fluctuations, but very few reach perfection. The problem of the statistical analyst is to find some method of measuring the extent of similarity. As a measure of this relationship the coefficient of correlation has been devised. The computation is such that it reaches plus 1 for perfect direct correlation, minus 1 for perfect inverse correlation, and 0 if there is no relationship. All other expressions range between plus 1 and minus 1.

The Probable Error

In making a statistical analysis of distributions which follow the normal law of error it has been found advisable to make use of some measure of dispersion. This is true when we are calculating arithmetic averages as well as when computing correlation coefficients. The measure of dispersion which has been generally employed in such cases is termed the probable error. The name of this measure is derived from the fact that the probability of a given observation varying from the mean of all the observations by an amount greater than the probable error is exactly one-half. It follows that when the observations are arranged in the from of a frequency table in the order of magnitudes an amount equal to the probable error laid off on each side of the arithmetic mean will include one-half of the total number of cases.

This same measure is applied to the coefficients of correlation. If we find that twelve pairs of multiples of standard deviation out of twenty are concurrent, that is, if twelve of the multiples of standard deviation of the "y" series are negative, and the corresponding multiples of the "x" series are also negative, and eight divergent, we would presume that the inequality was due entirely, or largely, to chance, but if eighteen pairs were concurrent, and only two divergent, the probability of this being due to chance alone would be slight.

Therefore, the probable error of a coefficient of correlation is seen to vary inversely both with the number of pairs of items and with the size of the coefficient. The law of probable error has been calculated by mathematicians and the following formula evolved: $P.E. = .6745 \frac{(1 - r2)}{\sqrt{N}}$. This means that the coefficient of correlation should always be written in the following way: r = plus or minus $.6745 \frac{(1 - r2)}{\sqrt{N}}$. When so written, the indications are that fifty per cent. of the coefficients similarly calculated will actually lie between r plus or minus $.6745 \frac{(1 - r2)}{\sqrt{N}}$

(1)
Probable errors of coefficients of correlation calculated from time series of economic statistical data do not have the usual meaning of probability. Any period selected for the study of historical data is, as a matter of fact, a special period, with definite characteristics distinguishing it from other periods of time. The data, therefore, cannot be considered a random selection, since the individual items in the series are not chosen independently, but rather constitute a succession of items with definite characteristics of conformation. Hence, the probable error of a coefficient of correlation calculated from a time series does not indicate, as might ordinarily be concluded from the theory of probability, that if a coefficient is calculated for any other actual period the chances are equal that it will fall within the range of the coefficient of the first period plus or minus the probable error. The probable error of the coefficient of correlation between time series has no practical significance.

Therefore, the probable errors of the coefficients of correlation in Tables XVIII to Table E, pages 145 to 158, inclusive, and Tables LVI to LIX, pages 224 to 227, inclusive, do not imply the usual meaning of probability, since the data from which they are calculated constitute time series, with their own definite characteristics, and are not random selections.

The fraction .6745 is one-half the distance between quartiles. It is .6745 of the standard deviation. That is to say, the distance from the mean to the **quartile** is .6745 of the standard deviation.

The Predictive Equation

Coefficients of correlation being calculated, the first step in formulating the predictive equation is to determine the regression coefficient, which is the quantity showing the slope of the line of average relationship between independent and dependent variables. When the relationship is linear the regression equation is a direct derivative of the coefficient of correlation, but when the relationship is non-linear other means are necessarily employed. The regression equation is then developed through specific application of the technic of curve fitting to the original data. In this report the predictive equations are formulated from linear regression relationships.

The coefficient of regression is determined by means of the following formula: $b = r \frac{SDy}{SDx}$, in which b = the regression coefficient, r the coefficient of correlation between the dependent and independent variables, SDy the standard deviation of the dependent variables, and SDx the standard deviation of the independent variables. The regression coefficient being determined, the predictive equation may be developed. For this the following formula is used: $y = Ay - bAx$ plus bx, in which the symbolic equivalents are as follows:

y = the percentage change in the dependent variable

Ay = the arithmetic average of the percentage changes in the dependent variable

b = the coefficient of regression of the dependent variable on the independent variable

x = the percentage change in the independent variable

Ax = the arithmetic average of the percentage changes in the independent variable.

$Ay - bAx$ becomes a constant, so that any prediction is the quantity obtained by adding to $Ay - bAx$ the product of the regression coefficient and the percentage change in the independent variable for a particular year.

The concept involved in the formulation of the predictive equation is that for any change in the independent variable there is a corresponding positive or negative change, depending upon the direction of correlation, in the dependent variable.

Error of Estimate

In statistical analysis involving predictions by means of equations formulated from expressions of causal relationship, it is always interesting to know the degree of accuracy accompanying the predictions. Ordinarily, the extent to which they can be made varies directly in proportion to the size of the coefficient of correlation, though this is not always the case. If there are abnormally large variables in one series not compensated for in the other, then we may obtain a high expression of relationship which is not a true index of actual cause and effect. This is one of the problems encountered in all methods of correlation, percentage change, sum-product, and others, and equations formulated from the derived regression coefficient in such a case would not be satisfactory in making predictions of any kind. It is only when the coefficient of correlation is an expression of consistent relationship that predictive equations can be evolved from the numerical measure of regression.

By means of the equation y = Ay - Ax plus bx are obtained the normal values of the dependent variable corresponding to the values of each of the given independent variables. The root-mean-square deviations of the actual values from the computed normal values is a measure of dispersion about the line of normal fit, and it is known as the standard error of estimate. In the expression of relationship by the method of determinants the least square residuals of the independent variables are multiplied by their respective weights and summated algebraically to obtain the normal value of the corresponding dependent variable. The root-mean-square of actual value deviations from normal values is an expression of reliability of estimate, and it is termed the standard error of estimate. If in a normal curve of estimate a distance equal to the standard error is measured off on each side of the mean the area will include 68 per cent. of the total number of cases, just as in the case of the standard deviation.

Shifts and Changes in Cotton Production in the United States.

As the cultivable area of the United States has developed and expanded, the production of cotton has moved from the eastern section of the country to the far West. In 1839 cotton was being grown in Maryland and Delaware. Other areas north of those in which the crop is now grown have been tried out. In fact, practically all available areas for production in the country have been given a trial. In general, climatic factors being considered, the production of cotton increases or decreases with changes in price or profitableness. The shifts and changes in the crop are shown in the accompanying table.

At the time of Whitney's invention, cotton was being raised in Georgia and South Carolina only (1). Then it spread to North Carolina and Virginia during the early years of the century, and at the outbreak of the second war with England a beginning had been made in Tennessee and Louisiana. After the war,

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(1) Bogart, Readings in American Economic History.

Table I. Shifts in Cotton Production*

State	Production in Bales		
	1839	1859	1879
Mississippi	386,803	962,006	963,111
Alabama	234,278	791,964	699,654
Louisiana	305,111	622,190	508,569
Georgia	326,785	561,472	814,441
South Carolina	123,421	282,730	522,548
North Carolina	103,852	116,411	389,598
Tennessee	55,403	237,171	330,621
Florida	24,221	52,122	54,997
Arkansas	12,057	293,914	608,256
Virginia	6,989	10,182	19,595
Kentucky	1,383		1,367
Illinois	402	1,186	
Missouri	242	32,950	20,318
Maryland	11		
Delaware	1		
Texas		345,170	805,284
Utah		109	
Kansas		49	
New Mexico		15	
Oklahoma			
Nevada			
Arizona			
California			
Other			(1) 17,000
Total	1,580,959	4,309,641	5,755,359

*Compiled from records of the U.S.D.A.
(1) Indian Territory.

Table I. (Continued)

State	Production in Bales		
	1899	1921	1926
Mississippi	1,286,680	812,867	1,930,000
Alabama	1,093,697	579,965	1,490,000
Louisiana	699,521	278,805	820,000
Georgia	1,232,684	787,052	1,475,000
South Carolina	843,725	754,551	1,030,000
North Carolina	433,014	776,206	1,250,000
Tennessee	235,008	301,949	475,000
Florida	53,994	10,905	33,000
Arkansas	705,928	796,863	1,620,000
Virginia	10,332	16,368	55,000
Kentucky	1,371		
Illinois			
Missouri	25,732	69,931	255,000
Maryland			
Delaware			
Texas	2,584,810	2,197,644	5,900,000
Utah	5		
Kansas	70		
New Mexico		6	72,000
Oklahoma	72,012	481,286	1,950,000
Nevada	18		
Arizona	15	45,323	115,000
California		34,109	128,000
Other	155,729(1)	8,709	20,000
Total	9,434,345	7,952,539	18,618,000(2)

(1) Indian Territory.
(2) Revised figure 17,977,000.

Alabama and Mississippi also began to attract attention as cotton-producing areas, and a steady stream of immigrants migrated into those fertile districts.

The United States Department of Agriculture reports that in 1839 the cotton crop occupied only about half the area it now occupies.(This does not refer to acreage) Texas and the Indian Territory west of Arkansas, as is shown, were not producing cotton. East of Texas all of the territory of the Cotton Belt had been opened to occupation by cotton planters, and was being rapidly developed. The addition of large areas of new land that was well suited to the cultivation of cotton increased production so rapidly in the decade 1839-49 that prices fell to a very low point. Notwithstanding this fact, however, production increased 50 per cent. Prices were better during the decade 1849-59, and production continued to increase in all parts of the Cotton Belt, the greatest gains being made in the States of the Southwest. It was during this period that Texas and Arkansas began to contribute to the annual crops of the United States.

Railroads were constructed in these two decades from the Atlantic Coast to the interior in North Carolina, South Carolina, Georgia, and Alabama, increasing the transportation facilities, and encouraging further development of cotton production.

The war between the States temporarily ruined the cotton industry of the South. During the war some cotton was produced, but most of the agricultural activities were diverted to the production of food commodities. The recovery of production after the war was slow, as will be observed by the fact that in 1866 only 1,750,000 bales were produced, whereas in 1859 the crop amounted to 4,309,641 bales. The crop of 1866 was but 169,041 bales greater than the crop of 1839. By 1878 and 1879 conditions in the South were fairly stable again, and the crop of the latter year was the largest that had ever been produced. All the states, with the exception of Missouri, Louisiana, and

Alabama produced more cotton that year than in 1859.

Between 1879 and 1898 production almost doubled, increasing from 5,755,359 bales to 11,189,000 bales. In the western states, or rather in the western areas, the increase in production was largely from new lands. The building of railroads in Texas was followed by the development of production in the prairie regions, where grazing and grain farming gave way to cotton. The increase in production in the East was largely the result of extensive use of fertilizer on light soils and of improved production methods.

During the decade 1900--10 Oklahoma and western Texas were more fully developed, adding a large acreage to the cotton producing area, the total acreage increasing from 24,933,000 in 1900 to 32,403,000 in 1910. The acreage in 1926 was 47,087,000. From 1914 to 1923 the production of cotton was decreased considerably by the ravages of the boll weevil. The crop in 1915 was 11,192,000 bales, and in 1922 it was 9,755,000, representing an average yearly decline in production of 258,881 bales. The crop of 1921 was only 7,954,000 bales, being the shortest since 1895, when 7,161,000 bales were produced. Since 1922 there has been a general increase in production. The crop of that year was 10,140,000 bales, and in 1926 it reached 17,977,000 bales, representing an average yearly increase of 2,791,000 bales.

The Cotton Situation in the United States.

Acreage, Production, and Yield per Acre

From 1866 to 1926, inclusive, the acreage of cotton harvested increased more than six times. On an average the yearly increase during the period was 578,000 acres over each preceding year. Following the Civil War there was a rapid economic recovery on the part of the Southern States, and from 1866 to 1890 there was an average increase of 616,000 acres harvested per year. The expansion from 1890 to 1906 was at the rate of 440,000 acres per year, and this was occasioned largely by the westward extension of the cotton-growing areas. From 1906, and until after the World War, the acreage remained fairly constant, and up to 1923 the yearly average increase was only 13,852 acres. In 1923 the acreage harvested increased 4,087,000 over 1922, and from then until 1927 the increase continued gradually, the average for the four years, 1923-26, being 3,454,000 acres per year. This marked upward trend in acreage may be largely attributed to the recovery of prices after 1921 and 1922, which had a tendency to reduce acreages of other crops in the South and to encourage the breaking up of large ranches in the Southwest.

Production fluctuates with both acreage and yield per acre, and the trend lies between the two. As a rule a large acreage is followed by a large production, though the latter is not always commensurate with the former. In 1914 there were 36,832,000 acres of cotton harvested, yielding a total production of 16,135,000 bales of lint, the largest crop that had been produced up to that time. Twelve years later, in 1926, 17,977,000 bales, the record crop of the United States, were harvested from 47,087,000 acres. It will be observed that the increase in total production did not vary in direct proportion to acreage. The difference was due to yield per acre, which was 209.2 pounds in 1914, and 182.5 pounds in 1926.

From 1866 to 1890 production increased at the yearly average rate of 238,000 bales. After 1890, and up to 1906, there was a slight tendency toward decrease in production, the yearly average rate of increase being only 234,000 bales. Following 1905, and continuing until 1921, there was a marked decrease in total production, the yearly average decline being at the rate of 17,000 bales. The seasons of 1921 and 1922 were the poorest that had been experienced for many years, the crop of 1921 being the shortest since 1895. During the four years following 1922 the production increased at the rate of 2,600,000 bales per year. This was due to both the extensive increase in acreage and to the very marked increase in yield per acre.

From year to year the yields per acre fluctuate greatly, due mainly to boll-weevil infestation and to adverse weather conditions, which, incidentally, may be favorable to boll-weevil activity. The trend from 1866 to 1890 was downward at the rate of .322 pounds per acre, after which, until 1906, it was upward at the rate of .503 pounds, and then again downward, until 1923, at the rate of 2.95 pounds per acre. For the four years, 1923-26, there was a very marked increase in yield per acre of 16.6 pounds. The average yield for 1921 was the lowest that has ever been recorded in this country, being 4.5 pounds less than the average for 1866. The highest average yield of which there is a record was in 1898, when it reached 220.6 pounds, which was 95.1 pounds greater than the lowest average, in 1921. During the period 1866-90 cotton production was extended into low-yielding areas, and this accounts largely for the downward trend in yields during those years. The upward trend from 1890 to 1906 was due to improvements in methods of cultivation and to the increased use of commercial fertilizer, which was used in only very small quantities prior to the beginning of this period, and the downward trend from 1906 to 1922 was due mainly to boll-weevil infestation. Ths marked upward trend during the four-year period, 1923-26, was caused largely by exceedingly favorable weather conditions.

Table II. Acreage, Production, and Yield per Acre of Cotton in the United States, 1866---1926*

Year	Acres (1,000)	Production (1,000 bales)	Yield per Acre (lbs)
1866	7,599	1,750	129.0
1867	7,828	2,340	189.8
1868	6,799	2,380	192.2
1869	7,743	3,012	196.9
1870	8,885	3,800	198.9
1871	7,558	2,553	148.2
1872	8,483	3,920	188.7
1873	9,510	3,683	179.7
1874	11,764	3,941	147.5
1875	11,934	5,123	190.6
1876	11,677	4,438	167.8
1877	12,133	4,370	163.8
1878	12,344	5,244	191.2
1879	14,480	5,755	181.0
1880	15,951	6,343	184.5

*Yearbook of the U.S.D.A., 1919, page 590, Table 125, and 1926, page 962, Table 235.

Table II. (Continued)

Year	Acres (1,000)	Production (1,000 bales)	Yield per Acre (lbs)
1881	16,711	5,456	149.8
1882	16,277	6,957	185.7
1883	16,778	5,701	164.8
1884	17,440	5,682	153.8
1885	18,301	6,575	164.4
1886	18,455	6,447	169.5
1887	18,641	7,020	182.7
1888	19,059	6,941	180.4
1889	20,175	7,473	159.7
1890	19,512	8,674	187.0
1891	19,059	9,618	179.4
1892	15,911	6,664	209.2
1893	19,525	7,493	149.9
1894	23,688	9,476	195.3
1895	20,185	7,161	155.6
1896	23,273	8,533	184.9
1897	24,320	10,898	182.7

Table II. (Continued)

Year	Acres (1,000)	Production (1,000 bales)	Yield per Acre (lbs)
1898	24,967	11,189	220.6
1899	24,327	9,345	183.8
1900	24,933	10,123	194.4
1901	26,774	9,510	170.0
1902	27,175	10,631	187.3
1903	27,052	9,851	174.3
1904	31,215	13,438	205.9
1905	27,110	10,575	186.6
1906	31,374	13,274	202.5
1907	29,660	11,107	179.1
1908	32,444	13,242	194.9
1909	30,938	10,005	154.3
1910	32,403	11,609	170.7
1911	36,045	15,693	207.7
1912	34,283	13,703	190.9
1913	37,089	14,156	182.0
1914	36,832	16,135	209.2

Table II. (Continued)

Year	Acres (1) (1,000)	Production (2) (1,000 bales)	Yield per Acre (lbs) (3)
1915	31,412	11,192	170.3
1916	34,985	11,450	156.6
1917	33,841	11,302	159.7
1918	36,008	12,041	159.6
1919	33,566	11,421	161.5
1920	35,878	13,440	178.4
1921	30,509	7,954	124.5
1922	33,036	9,755	141.2
1923	37,123	10,140	130.6
1924	41,360	13,628	157.4
1925	46,053	16,104	167.2
1926(4)	47,087	17,977	182.5

(1) The slope of the line of least squares is 577,752, indicating an average increase of 577,752 acres per year.

(2) The slope of the line of least squares is 199,111, indicating an average increase of 199,111 bales per year.

(3) The slope of the line of least squares is -.135, indicating an average decrease of .135 pounds per year.

(4) Revised figure.

Comparison of Cotton Production in the United States and Other Leading Countries.

The United States is the most important cotton-producing country in the world, the average production being more than half the total world product. The other leading countries in the order of their importance are India, China, Egypt, and Brazil.

India is characterized by crude methods of production and lack of sufficient rainfall in the cotton regions, so that the average yield per acre is less than half that of the United States. For the period 1900--26 inclusive the average yield per acre in India was 79.6 pounds, while for the same period the average yield in the United States was 173.8 pounds. The statistics for China present so many apparent inaccuracies that a comparison of the yields with those of the United States is being purposely omitted. Egypt, the fourth largest producer, maintained an average of 384.4 pounds per acre for the period 1900-27, inclusive, as compared with an average of 167.1 pounds for the United States, while Brazil, the fifth country in importance, produced an average yield of 207.6 pounds per acre during the period 1911--26,inclusive, and the average production per acre in the United States for the same period was 168.4 pounds.

The total production of cotton in India for the years 1900-26,inclusive,was 29.3 per cent. as great as the production in the United States. Egypt, during the period 1900-27,inclusive, produced 10.7 per cent. as much cotton as the United States, while Brazil, during the period 1911-26,inclusive, reported a production 3.6 per cent. as great as that of the United States for the same years.

As will be observed in the accompanying tables, the yield per acre in India is extremely low, while that of Egypt is high as compared with the yield in the United States. For the period 1900-26,inclusive, the yield per acre in India was 45.7 per cent. as great as the yield in the United States, while in Egypt for the period 1900-27, inclusive,it was 130 per cent. greater, and in Brazil during the period 1911-26,inclusive,the yield per acre was 23.3 per cent. greater than the yield in the United States.

Table III. Comparison of Cotton Acreage
Harvested in the United States,
India, and Egypt, 1900-27*

Year	Thousands of Acres		
	United States	India	Egypt
1900	24,933	14,231	1,277
1901	26,774	14,506	1,298
1902	27,175	16,581	1,324
1903	27,052	18,205	1,384
1904	31,215	19,918	1,492
1905	27,110	21,072	1,627
1906	31,374	22,484	1,563
1907	29,660	21,630	1,664
1908	32,444	19,999	1,702
1909	30,938	21,005	1,658
1910	32,403	23,040	1,705
1911	36,045	21,415	1,767
1912	34,283	22,028	1,787
1913	37,089	25,027	1,788
1914	36,832	24,595	1,822
1915	31,412	17,773	1,231
1916	34,985	21,771	1,719
1917	33,841	25,337	1,741
1918	36,008	21,037	1,366
1919	33,566	23,383	1,634
1920	35,878	21,339	1,897
1921	30,509	18,451	1,339
1922	33,036	21,804	1,869
1923	37,123	23,631	1,780
1924	41,360	26,801	1,856
1925	46,053	28,491	1,998
1926	47,087	24,976	1,854
1927	40,168		1,574

*Compiled from records of the U.S.D.A.
Slope of line of least squares:

United States	526,454
India	297,123
Egypt	22,797

Table IV. Comparison of Total Cotton Production in the United States, India, and Egypt, 1900--27*

Year	Thousands of Bales (1)		
	United States	India	Egypt
1900	10,123	2,471	1,126
1901	9,510	2,297	1,320
1902	10,631	2,818	1,210
1903	9,851	2,645	1,349
1904	13,438	3,172	1,308
1905	10,575	2,859	1,235
1906	13,274	4,129	1,440
1907	11,107	2,613	1,499
1908	13,242	3,090	1,399
1909	10,005	3,998	1,036
1910	11,609	3,254	1,555
1911	15,693	2,730	1,530
1912	13,703	3,702	1,554
1913	14,156	4,239	1,588
1914	16,135	4,359	1,337
1915	11,192	3,128	989
1916	11,450	3,759	1,049
1917	11,302	3,393	1,304
1918	12,041	3,328	999
1919	11,421	4,853	1,155
1920	13,440	3,013	1,251
1921	7,954	3,752	902
1922	9,755	4,245	1,391
1923	10,140	4,320	1,353
1924	13,628	5,095	1,507
1925	16,104	5,230	1,629
1926	17,977	4,162	1,497
1927	12,782		1,250

*Compiled from records of the U.S.D.A.
(1) 478 pounds net.
Slope of line of least squares: United States 35,374
India 75,124
Egypt 10,443

Table V. Comparison of Cotton Production per Acre in the United States, India, and Egypt, 1900--27*

Year	Production per Acre in Pounds		
	United States	India	Egypt
1900	194	83	421
1901	170	76	486
1902	187	81	437
1903	174	70	466
1904	206	76	419
1905	187	65	363
1906	203	88	440
1907	179	58	431
1908	195	74	393
1909	154	91	299
1910	171	68	436
1911	208	61	412
1912	191	80	416
1913	182	81	425
1914	209	85	351
1915	170	84	384
1916	157	83	291
1917	160	64	358
1918	160	76	350
1919	162	99	338
1920	178	68	315
1921	125	97	322
1922	141	93	356
1923	131	87	363
1924	157	91	388
1925	167	88	390
1926	183	80	386
1927	152		380

*Based on data in tables III and IV.
Slope of line of least squares:

United States	-1.56
India	.55
Egypt	-3.35

Cotton Acreage Harvested, by States

The cotton acreage of Texas is greater than that of any other state in the Union. During the period 1912-26, inclusive, the acreage was 35 per cent. of the total acreage harvested in the country. The smallest acreage in the state during the period was in 1918 and 1919, when, in both years, it comprised 31.2 per cent. of the total, and the largest was in 1924, it being 41.5 per cent. of the total of all states.

Georgia is the second state in importance so far as acreage is concerned, which amounted to 12.5 per cent. of the total during the period 1912-26, inclusive. In 1924 she fell to fourth place in importance, but in 1925 and 1926 she again occupied second place. On an average the acreage harvested in Georgia is appreciably greater than that of any other state but Texas.

Alabama, Oklahoma, and Mississippi are the next states in order of importance. They harvest on an average 8.5, 8.4, and 8.3 per cent. respectively of the total cotton acreage of the country. Taken collectively, these five States comprise about 73 per cent. of the cotton acreage harvested in the United States, and when grouped with Arkansas, South Carolina, North Carolina, and Louisiana, the relative importance of which states is the order in which they are named, the acreage of the nine states represents approximately 96 per cent. of the total.

Table VI. Cotton Acreage Harvested, by States, 1912-26*

State	Thousands of Acres			
	1912	1913	1914	1915
Texas	11,338	12,597	11,931	10,510
Oklahoma	2,665	3,009	2,847	1,895
Mississippi	2,889	3,067	3,054	2,735
Arkansas	1,991	2,502	2,480	2,170
Alabama	3,730	3,760	4,007	3,340
Georgia	5,335	5,318	5,433	4,825
North Carolina	1,545	1,576	1,527	1,282
South Carolina	2,695	2,790	2,861	2,516
Louisiana	929	1,244	1,299	990
Tennessee	783	865	915	772
Missouri	103	112	145	96
California	9	14	47	39
Arizona				
New Mexico				
Virginia	47	47	45	34
Florida	224	188	221	193
All other			20	15
Total U.S.	34,283	37,089	36,832	31,412

*Yearbook of the U.S.D.A., 1926, page 962, Table 236, and 1921, page 611, Table 170.

Note: States arranged in descending order of total production for 1926.

Table VI. (Continued)

State	Thousands of Acres			
	1916	1917	1918	1919
Texas	11,400	11,092	11,233	10,476
Oklahoma	2,562	2,783	2,998	2,424
Mississippi	3,110	2,788	3,138	2,848
Arkansas	2,600	2,740	2,991	2,725
Alabama	3,225	1,977	2,570	2,791
Georgia	5,277	5,196	5,341	5,220
North Carolina	1,451	1,515	1,600	1,490
South Carolina	2,780	2,837	3,001	2,835
Louisiana	1,250	1,454	1,683	1,527
Tennessee	887	882	902	758
Missouri	133	153	148	125
California	52	136	85	85
Arizona		41	95	107
New Mexico				
Virginia	42	50	44	42
Florida	191	183	167	103
All other	25	15	12	10
Total U.S.	34,985	33,841	36,008	33,566

Table VI. (Continued)

State	Thousands of Acres			
	1920	1921	1922	1923
Texas	11,898	10,745	11,874	14,150
Oklahoma	2,749	2,206	2,915	3,197
Mississippi	2,950	2,628	3,014	3,170
Arkansas	2,980	2,382	2,799	3,026
Alabama	2,858	2,235	2,771	3,079
Georgia	4,900	4,172	3,418	3,421
North Carolina	1,587	1,403	1,625	1,679
South Carolina	2,964	2,571	1,912	1,965
Louisiana	1,470	1,168	1,140	1,405
Tennessee	840	634	985	1,172
Missouri	136	103	198	355
California	150	55	67	83
Arizona	230	90	101	127
New Mexico				60
Virginia	42	34	55	74
Florida	100	65	118	147
All other	24	18	44	13
Total U.S.	35,878	30,509	33,036	37,123

Table VI. (Continued)

State	Thousands of Acres		
	1924	1925	1926
Texas	17,175	17,608	18,363
Oklahoma	3,861	5,214	4,912
Mississippi	2,981	3,466	3,768
Arkansas	3,094	3,738	3,782
Alabama	3,055	3,504	3,713
Georgia	3,046	3,589	4,029
North Carolina	2,005	2,017	2,023
South Carolina	2,404	2,654	2,732
Louisiana	1,616	1,874	1,960
Tennessee	996	1,173	1,178
Missouri	493	520	488
California	130	169	160
Arizona	180	162	167
New Mexico	101	107	120
Virginia	102	100	101
Florida	80	101	109
All other	41	57	48
Total U.S.	41,360	46,053	47,653(1)

(1)The revised figure for 1926 is 47,087

Yield per Acre, by States

Table VII shows the yield of lint cotton per acre, by states, for the years 1912-26, inclusive. As will be seen, California produces by far the largest yield per acre, though her total production on an average is only .4 per cent. of the total production of the country. Since 1912 yield per acre in the various states has ranged from 40 pounds in Florida in 1923 to 500 pounds in California in 1913 and 1914. In 1923 the yield per acre in California was 285 pounds, and in 1913 and 1914 it was 150 and 175 pounds respectively in the State of Florida.

In Table VIII the states are arranged in descending order of average yield per acre for the period 1912-26. California with an average of 316 pounds for the fifteen-year period exceeds Florida, the state with the lowest average, by 202 pounds. All other states fall within this range. The Table shows also the relative rank of the states on the basis of yield per acre in 1926 as compared with the yield for the entire period. California in this year, with a yield of 382 pounds per acre, exceeded Florida by 237 pounds. It will be observed that all states, with the exception of South Carolina, produced a yield in 1926 greater than the average for the fifteen years.

Table VII. Yield of Cotton per Acre, by States, 1912-26*

State (1)	Yield per Acre in Pounds						
	1912	1913	1914	1915	1916	1917	1918
California	450	500	500	380	400	242	270
Arizona	...	...	...	...	...	285	280
North Carolina	267	239	290	260	215	194	268
New Mexico	...	...	...	...	...	...	...
Virginia	250	240	265	225	310	180	270
Missouri	260	286	270	240	225	190	200
Mississippi	173	204	195	167	125	155	187
Arkansas	190	205	196	180	209	170	158
Louisiana	193	170	165	165	170	210	167
Tennessee	169	210	200	188	206	130	175
Alabama	172	190	209	146	79	125	149
Oklahoma	183	132	212	162	154	165	92
South Carolina	209	235	255	215	160	208	250
Georgia	159	208	239	189	165	173	190
Texas	206	150	184	147	157	135	115
Florida	113	150	175	120	105	100	85
U.S.	191	182	209	170	157	160	160

*Yearbook of the U.S.D.A., 1920, page 640, Table 142, 1921, page 612, Table 174, and 1926, page 963, Table 237.

(1) States arranged in descending order of yield per acre in 1926.

Table VII. (Continued)

State	Yield in Pounds							
	1919	1920	1921	1922	1923	1924	1925	1926
California	268	240	258	188	285	284	340	382
Arizona	270	222	242	222	292	285	350	330
North Carolina	266	264	264	250	290	196	261	295
New Mexico					230	266	298	287
Virginia	255	230	230	230	325	180	250	260
Missouri	257	275	325	360	171	185	275	250
Mississippi	160	140	148	157	91	176	275	245
Arkansas	155	194	160	173	98	169	205	205
Louisiana	93	126	114	144	125	145	232	200
Tennessee	195	180	228	190	92	170	210	193
Alabama	122	111	124	142	91	154	185	192
Oklahoma	195	225	104	103	98	187	155	190
South Carolina	240	254	140	123	187	160	160	180
Georgia	152	135	90	100	82	157	155	175
Texas	140	160	98	130	147	138	113	154
Florida	74	86	80	102	40	130	180	145
U.S.	162	171	125	141	131	157	167	187

Table VIII. Average Yield of Cotton per Acre, by States, for the Period 1912--26 and for the Year 1926*

State	Average 1912-26		Year 1926	
	Yield in lbs.	Rank	Yield in lbs.	Rank
Calif.	316	1	382	1
Ariz.	277	2	330	2
N. C.	256	3	295	3
N. M.	182	7	287	4
Va.	247	4	260	5
Mo.	242	5	250	6
Miss.	176	9	245	7
Ark.	162	12	205	8
La.	164	10	200	9
Tenn.	181	8	193	10
Ala.	150	14	192	11
Okla.	159	13	190	12
S. C.	203	6	180	13
Ga.	163	11	175	14
Tex.	145	15	154	15
Fla.	114	16	145	16

*Average for the period 1912-26 computed from data in 1926 U.S.D.A. Yearbook, page 963, table 238, and page 962, table 236; 1921 Yearbook, page 611, table 171, and page 611, table 170.

Note: For New Mexico the average yield per acre for the period 1912-26 is based on four years only, 1923 to 1926, inclusive.

For Arizona the average yield per acre for the period 1912-26 is based on ten years, 1917 to 1926 inclusive.

Total Production, by States

Production of lint cotton in the United States during the fifteen-year period, 1912-26, has ranged from 7,954,000 bales in 1921 to 17,977,000 bales in 1926. Table IX shows the production by states and for the country as a whole. Texas ranks first in importance, the total production for the period being 30.6 per cent. of the total of all states. Georgia, with 12.2 per cent. of the total production, is the second in order, and Mississippi and South Carolina, each with 8.8 per cent., rank third. These four states during the period 1912-26 produced 60 per cent. of the total crop of the country. Arkansas, Oklahoma, Alabama, and North Carolina are next in importance in the order named. Their combined production represents approximately 31 per cent. of the total of all states, which when added to the production of Texas, Georgia, Mississippi, and South Carolina comprises 91 per cent. of all the cotton produced in the United States. It will be seen, therefore, that cotton production in this country, so far as final ginnings are concerned, is confined almost exclusively to eight states.

Table IX. Production of Lint Cotton in 500 Pound Gross Weight Bales, by States, Year Beginning with August, 1912-26*

State	Production in Thousands of Bales (1)				
	1912	1913	1914	1915	1916
Texas	4,880	3,945	4,592	3,227	3,726
Oklahoma	1,021	840	1,262	640	824
Mississippi	1,046	1,311	1,246	954	812
Arkansas	792	1,073	1,016	816	1,134
Alabama	1,342	1,495	1,751	1,021	533
Georgia	1,777	2,317	2,718	1,909	1,821
North Carolina	866	792	931	699	655
South Carolina	1,182	1,378	1,534	1,134	932
Louisiana	376	444	449	341	443
Tennessee	277	379	384	303	382
Missouri	56	67	82	48	63
California	8	23	50	29	44
Arizona					
New Mexico					
Virginia	24	23	25	16	27
Florida	53	59	81	48	41
All other	3	10	14	7	14
Total U.S.	13,703	14,156	16,135	11,192	11,450 (2)

*Yearbook of the U.S.D.A., 1921, page 611, Table 171, and 1926, page 963, Table 238.

(1) Excluding linters.

(2) Production of individual States totals 11,451.

Note: States arranged in descending order of production for 1926.

Table IX. (Continued)

State	Production in Thousands of Bales				
	1917	1918	1919	1920	1921
Texas	3,125	2,697	3,099	4,345	2,198
Oklahoma	959	577	1,016	1,336	481
Mississippi	906	1,226	961	895	813
Arkansas	974	987	884	1,214	797
Alabama	518	801	713	663	580
Georgia	1,884	2,122	1,660	1,415	787
North Carolina	618	898	830	925	776
South Carolina	1,237	1,570	1,426	1,623	755
Louisiana	639	588	298	388	279
Tennessee	241	330	310	325	302
Missouri	61	62	64	79	70
California	58	67	56	75	34
Arizona	22	56	60	103	45
New Mexico					6
Virginia	19	25	23	21	16
Florida	38	29	16	18	11
All other	6	6	5	13	3
Total U.S.	11,302	12,041	11,421	13,440	7,954

Note: 1917 totals 11,305.
1920 totals 13,438
1921 totals 7,953

Table IX. (Continued)

State	Production in Thousands of Bales				
	1922	1923	1924	1925	1926
Texas	3,222	4,340	4,949	4,163	5,900
Oklahoma	627	656	1,511	1,691	1,950
Mississippi	989	604	1,099	1,991	1,930
Arkansas	1,012	622	1,094	1,600	1,620
Alabama	823	587	985	1,357	1,490
Georgia	715	588	1,002	1,164	1,475
North Carolina	852	1,020	825	1,102	1,250
South Carolina	492	770	807	889	1,030
Louisiana	343	368	493	910	820
Tennessee	391	226	354	515	475
Missouri	149	127	193	299	255
California	21	54	77	122	128
Arizona	47	78	108	119	115
New Mexico	12	30	57	66	72
Virginia	27	51	39	53	55
Florida	25	12	22	38	33
All other	7	8	14	26	20
Total U.S.	9,755	10,140	13,628	16,104	18,618 (1)

(1) Revised figure 17,977.

Note: 1922 totals 9,744.
1923 totals 10,141.
1924 totals 13,629.
1925 totals 16,105.

Cotton Exports

Since 1866, when we exported 75.6 per cent. of our domestic production, foreign consumption of American cotton has been increasing. Over the entire sixty-year period, 1866-1925, this increase has been at the rate of 96,000 bales per year. The increase was fairly constant until 1915, when exports declined rather sharply, and continued to decline until the season of 1919. During the World War, 1914-18, our domestic consumption increased at an average rate of approximately 50,000 bales per year, and exports decreased during the same period at an average rate of 775,000 bales per year. The decrease in exports may be attributed to the disturbance of trade conditions abroad and to the increased exportation from the United States of manufactured fabrics. Table X shows the trend of exports from 1866 to 1926. On an average we export 60 per cent. of the total cotton production, which ranks first in value among all of our exported commodities. From 1900 to 1919 we exported 66 per cent. of the crop, and since 1919, including the year 1926, our exports amounted to 55 per cent. of the total production. A comparison of Tables II and X will show that the years of large crops have been associated with large exports from the United States, with the exception of 1914, the first year of the World War. This tendency for record crops to be followed by correspondingly large exports may be explained by the fact that domestic consumption cannot be increased in the same ratio as the crop increases. This is shown by the fact that for the years 1921-25, inclusive, our domestic production increased at the yearly rate of 2,017,000 bales, while domestic consumption during the same period increased at the rate of only 61,000 bales per year. Associated with the increase in production was a yearly average increase in exports of 690,000 bales. The difference between production and consumption and exports constituted the annual carry-over. This, together with the fact that years of short crops are ordinarily associated with a decrease in exports, indicates that changes in crops are reflected more in volume of exports than in domestic consumption.

Europe is the greatest buyer of American cotton exports. In 1926,81.7 per cent. of the domestic production passing into the world's channels of trade as lint cotton entered the European markets. The United Kingdom, the greatest individual buyer, took 28.1 per cent. of our exports in 1926, Germany, 20.4 per cent., Japan, 13.8 per cent., France, 11.4 per cent., and Italy, 9.2 per cent.

Table X. Cotton Exported from the United States, 1866-1926*

Year	Exports (1)	
	Total (1,000 bales)	Per cent. of Production
1866	1,323	75.6
1867	1,570	67.1
1868	1,289	54.2
1869	1,917	63.6
1870	2,926	77.0
1871	1,867	73.1
1872	2,400	61.2
1873	2,717	73.8
1874	2,521	64.0
1875	2,983	58.2
1876	2,891	65.1
1877	3,215	73.6
1878	3,257	62.1
1879	3,644	63.3
1880	4,382	69.1

*Yearbook of the U.S.D.A., 1919, page 590, Table 125, and 1926, page 962, Table 235.
(1) Domestic.

Table X. (Continued)

Year	Exports	
	Total (1,000 bales)	Per cent. of Production
1881	3,481	63.8
1882	4,576	65.8
1883	3,725	65.3
1884	3,783	66.6
1885	4,116	62.6
1886	4,339	67.3
1887	4,529	64.5
1888	4,770	68.7
1889	4,944	66.2
1890	5,815	67.0
1891	5,870	61.0
1892	4,424	66.4
1893	5,367	71.6
1894	7,035	74.2
1895	4,670	65.2
1896	6,208	72.8
1897	7,726	70.9

Table X. (Continued)

Year	Exports	
	Total (1,000 bales)	Per cent. of Production
1898	7,575	67.7
1899	6,252	66.9
1900	6,718	66.4
1901	7,058	74.2
1902	7,138	67.1
1903	6,180	62.7
1904	8,679	64.6
1905	7,268	68.7
1906	9,036	68.0
1907	7,634	68.7
1908	8,896	67.2
1909	6,413	64.1
1910	8,068	69.5
1911	11,070	70.5
1912	9,125	66.6
1913	9,522	67.3
1914	8,581	53.2

Table X. (Continued)

Year	Exports	
	Total (1,000 bales)	Per cent. of Production
1915	5,917	52.9
1916	5,702	49.8
1917	4,455	39.4
1918	5,442	45.2
1919	7,036	61.6
1920	5,570	41.4
1921	6,592	82.9
1922	5,206	53.4
1923	5,784	57.0
1924	8,239	60.5
1925	8,110	50.4
1926 (1)	8,292	44.6

(1) Estimated.

The slope of the line of least squares for the period 1866 to 1925, inclusive, is 96,053, meaning that on an average the exports have increased 96,053 bales a year. In computing the line of least squares the figure for 1926 has been omitted. Since the War, up to and including the year 1926, we have exported 55 per cent. of our total production. Up to the end of the War, that is, from 1900 to 1918, inclusive, we had exported on an average 66 per cent. of the total production, and from 1900 to the present time our exports have amounted to 60 per cent. of the production.

Table XI. Destination of Domestic Cotton Exports, 1924-26*

Country to which exported	Exports in 500 pound bales (1)		
	1924	1925	1926
United Kingdom	1,685,377	2,605,456	2,278,372
Germany	1,271,738	1,765,673	1,657,070
France	738,841	932,866	927,184
Italy	559,833	747,594	742,677
Other Europe	764,695	1,089,700	1,019,018
Japan	583,957	849,584	1,118,246
Other Countries	179,258	247,944	366,977
Total	5,783,699	8,238,817	8,109,544
Total Europe	5,020,484	7,141,289	6,624,321

*Yearbook of the U.S.D.A., 1926, page 1185, Table 498.

(1) Excluding linters, for year ending June 30th.

Cotton Imports

The net imports of cotton into the United States during the five-year period, 1921-25, were equivalent to 5.5 per cent. of the total quantity of cotton consumed in the country, exclusive of linters. The largest annual ratio during this period was 6.0 per cent., in 1921, and the smallest was 4.8 per cent., in 1923[1]. These small amounts are brought in for special purposes. Most of the imported cotton is long-staple Egyptian, which is used largely in the manufacture of knit goods, lace, automobile tires, and thread.

Table XIII shows the principal countries from which the United States imports. As will be seen, Mexico ranks next to Egypt in importance as a source of supply, with China third, and Peru fourth. Over the entire period, 1867-1925, our imports have increased at the yearly average rate of 7,342 bales. There is no causal relationship between the size of the domestic crop in this country and the volume of imports. Most of the lint cotton bought by American manufacturers from foreign countries is used for purposes in which the American short-staple grades cannot be substituted, and, therefore, a short crop in the United States is equally likely to be followed by either an increase or decrease in imports.

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(1) Foreign Crops and Markets, Volume 13, Number 19, Nov. 8, 1926, page 624.

Table XII. Cotton Imported into the United States, 1867-1925*

Year	Imports	
	Total (500 lb. bales)	Per cent. Imports are of Exports
1867	345	.02
1868	1,870	.15
1869	3,026	.16
1870	1,802	.06
1871	6,374	.34
1872	10,016	.42
1873	3,541	.13
1874	3,784	.15
1875	4,498	.15
1876	4,832	.17
1877	5,046	.16
1878	5,049	.15
1879	7,578	.21
1880	5,447	.12

*Yearbook of the U.S.D.A., 1906, page 603, 1922, page 711, Table 221, and 1926, page 962, Table 235.

Table XII. (Continued)

Year	Imports	
	Total (500 lb. bales)	Per cent. Imports are of Exports
1881	3,261	.09
1882	4,716	.10
1883	11,247	.30
1884	7,144	.18
1885	8,270	.20
1886	7,552	.17
1887	11,983	.26
1888	15,284	.32
1889	18,334	.37
1890	45,580	.78
1891	64,394	1.09
1892	85,735	1.94
1893	59,405	1.11
1894	99,399	1.41
1895	112,001	2.40
1896	103,798	1.67
1897	105,321	1.36

Table XII. (Continued)

Year	Imports	
	Total (500 lb. bales)	Per cent. Imports are of Exports.
1898	100,316	1.32
1899	134,797	2.15
1900	93,263	1.39
1901	197,431	2.80
1902	149,749	2.10
1903	97,681	1.58
1904	121,017	1.39
1905	141,927	1.95
1906	209,584	2.32
1907	142,146	1.86
1908	173,036	1.94
1909	172,075	2.68
1910	227,537	2.82
1911	219,560	1.98
1912	243,704	2.67
1913	246,694	2.59
1914	370,409	4.31

Table XII. (Continued)

Year	Imports	
	Total (500 lb. bales)	Per cent. Imports are of Exports.
1915	465,602	7.86
1916	294,123	5.16
1917	206,651	4.64
1918	207,184	3.81
1919	690,628	9.81
1920	251,878	4.52
1921	358,330	5.44
1922	493,981	9.49
1923	305,489	5.28
1924	324,461	3.94
1925	338,230	4.17

Years from 1896 to 1925, inclusive begin with July first of the year named. Years from 1867 to 1895, inclusive, begin with January of the year named. Bales recorded for the years 1922 to 1925, inclusive, are 478 pounds net. Bales recorded for the years 1867 to 1921, inclusive, are 500 pounds gross. A 500 pound gross bale is approximately equivalent to a 478 pound bale net.

The slope of the line of least squares for the period 1867 to 1925 inclusive is 7,342, meaning that on an average the imports have increased 7,342 bales a year.

Table XIII. Origin of Cotton Imported into the United States, 1919-26*

Country from which imported	Per cent. of Cotal Imports			
	1919	1920	1921	1922
British India	2.8	2.3	1.4	4.1
Egypt	49.3	60.0	52.5	34.6
Mexico	17.6	12.7	28.2	35.0
Peru	11.5	8.5	9.3	9.0
United Kingdom	10.6	4.7	5.1	5.2
China (1)				9.2
Other Countries	8.2	11.8	3.5	2.9
Total	100.0	100.0	100.0	100.0

*Yearbook of the U.S.D.A., 1922, page 979, Table 522, 1923, page 1130, Table 660, and 1926, page 1194, Table 499.

(1) Accurate statistics for China not available prior to 1922.

Table XIII. (Continued)

Country from which imported	Per Cent. of Total Imports (1)			
	1923	1924	1925	1926
British India	2.9	11.2	8.4	6.9
Egypt	61.9	53.8	59.3	69.7
Mexico	15.0	9.2	14.4	7.3
Peru	9.7	6.8	3.6	4.6
United Kingdom	3.1	(2)	(2)	(2)
China	4.3	14.8	10.3	7.9
Other Countries	3.1	4.2	4.0	3.6
Total	100.0	100.0	100.0	100.0

(1) Year ending June 30th. Data for 1919, 1920, and 1921 are for year ending December 31st.

(2) Accurate statistics for United Kingdom not available.

Holding of Cotton by Farmers.

The holding of cotton for higher prices naturally involves the problem of marketing. In the United States we consume less of our domestic production of cotton than we export. Every year since 1919, in which year our exports were 7,036,000 bales, or 61.6 per cent. of the current production, we have sent to foreign markets an average increase of 521,000 bales [1] over the preceding year, while our domestic consumption has increased on an average of but 219,000 bales [2]. Our farm production since 1920 has increased at the rate of 878,000 bales [3] per year. The difference between production and imports, and consumption and exports, constitutes the annual carry-over. Our exports for the years 1919-26, inclusive, amounted to 55 per cent. of the total lint cotton production. From 1866 to 1914, inclusive, we exported on an average 66 per cent.of our production, and from 1900 to 1926 our exports constituted 60 per cent. of the production[4].

It is quite difficult, even after a detailed and careful study of the monthly movement of prices received by producers, as shown in Table A on the following page, and of spot quotations on the leading markets, of which the prices at New York and New

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(1) Slope of line of least squares, calculated from data in Foreign Crops and Markets, Volume 13, Nov. 8, 1926, No. 19, p. 624.
(2) Slope of line of least squares, based on data in Table X.
(3) Slope of line of least squares, based on data in Table II.
(4) See footnote to Table X.

Table A.
Estimated Price Per Pound Received by Producers for Cotton in the United States, 1909-27*

Year beginning with August	Aug. 15	Sept. 15	Oct. 15	Nov. 15	Dec. 15	Jan. 15
Average:	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1909-13	12.3	12.2	12.1	12.1	12.2	12.2
1914-20	21.7	21.2	21.1	20.8	20.2	19.9
1921-25	21.4	21.4	22.5	22.1	22.4	22.7
1909	11.5	12.2	13.2	13.8	14.2	14.3
1910	14.4	13.8	13.6	14.0	14.2	14.4
1911	12.5	11.0	9.6	8.8	8.6	8.7
1912	11.6	11.2	11.0	11.4	12.0	12.0
1913	11.6	12.6	13.2	12.6	12.0	11.8
1914	10.6	8.2	7.0	6.6	6.7	7.0
1915	8.3	9.8	11.4	11.4	11.4	11.4
1916	13.6	15.0	16.8	18.8	18.4	17.0
1917	23.8	23.4	25.3	27.5	28.3	29.3
1918	30.0	32.0	30.6	28.4	28.2	26.8
1919	31.4	30.8	33.9	36.0	35.8	36.0
1920	34.0	28.3	22.4	16.6	12.7	11.6
1921	11.2	16.2	18.8	17.0	16.2	15.9
1922	20.9	20.6	21.2	23.1	24.2	25.2
1923	23.8	25.6	28.0	29.9	32.1	32.5
1924	27.8	22.2	23.1	22.5	22.2	22.7
1925	23.4	22.5	21.5	18.1	17.4	17.4
1926	16.1	16.8	11.7	11.0	10.0	10.6
1927	17.1	22.5	21.0	20.0	18.7	

*Yearbook of the U.S.D.A., 1926, page 972, Table 248, and unpublished records of the Bureau of Agricultural Economics, U.S.D.A.

Table A. (Continued)

Year beginning with August	Feb. 15	Mar. 15	Apr. 15	May 15	June 15	July 15
Average:	Cts.	Cts.	Cts.	Cts.	Cts.	Cts.
1909-13	12.3	12.4	12.4	12.7	12.7	12.7
1914-20	19.5	19.7	20.1	20.4	21.2	21.8
1921-25	22.9	22.5	22.5	22.1	22.5	22.3
1909	14.0	14.0	14.0	14.1	14.0	14.1
1910	14.1	13.9	14.0	14.4	14.5	13.8
1911	9.4	10.0	10.5	11.0	11.1	11.6
1912	11.8	11.8	11.7	11.6	11.6	11.6
1913	12.2	12.2	12.0	12.3	12.4	12.4
1914	7.4	7.8	8.6	8.8	8.6	8.4
1915	11.3	11.3	11.5	11.8	12.4	12.6
1916	16.4	17.0	18.4	19.6	22.4	24.5
1917	30.0	31.0	30.2	28.0	28.0	28.2
1918	24.4	24.2	25.2	27.8	30.3	31.8
1919	36.2	36.8	37.5	37.4	37.3	37.1
1920	11.0	,9.8	9.4	9.6	9.7	9.7
1921	15.7	16.0	16.0	17.3	19.6	20.6
1922	26.8	28.0	27.6	26.2	25.9	24.8
1923	31.4	27.7	28.7	28.1	27.8	27.3
1924	23.0	24.5	23.7	23.0	23.0	23.4
1925	17.6	16.5	16.6	16.0	16.1	15.4
1926	11.5	12.5	12.3	13.9	14.8	15.5
1927						

Orleans as shown in Table XIV are typical, to reach a satisfactory conclusion regarding the extent to which the storing and holding of cotton on farms and in warehouses is a paying venture under present economic conditions. Since 1920, increases in spot quotations on the New York Market for cotton sold in April have been as high as 48 per cent. over the preceding year, and decreases have been as great as 71 per cent.[1] In Table A are shown the prices received by producers as reported for the fifteenth of each month. These prices on an average show very little change from October to May. In general, the prices paid to producers increase after October in years of a short crop, and tend to decrease in years when there is a heavy crop. The writer, of course, is mindful of the fact that the prices reported by the United States Department of Agriculture for the fifteenth of each month are not entirely satisfactory for the basis of specific conclusions, but they adequately serve the purpose for which we wish to use them.

On the following page, Table B, are shown the percentages of monthly marketings by farmers. As will be seen, by the end of November for the years 1912-26, inclusive, the per cent. of the cotton crop that had passed from the hands of the producers into the channels of the cotton trade ranged from 45 in 1920 to 70 in 1923. The per cent. of current production that is marketed by the end of November does not vary directly in proportion to the size

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(1) See Table XIV.

Table B.
Estimated Monthly Marketings of Cotton by Farmers, 1912-25*

Year beginning August 1st.	Percentage of year's sales					
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
1912-13	....	17.2	25.8	20.3	12.8	8.0
1913-14	....	18.2	24.4	19.7	13.3	8.3
1914-15	1.2	6.8	14.8	18.0	16.1	11.0
1915-16	2.7	11.3	19.3	20.4	16.4	8.4
1916-17	3.9	14.6	23.0	21.6	15.0	6.4
1917-18	2.5	11.3	23.0	22.7	16.2	8.2
1918-19	3.3	10.9	18.1	16.4	13.6	5.4
1919-20	1.4	9.5	21.0	22.2	17.4	8.8
1920-21	3.1	10.0	16.2	15.7	11.0	6.4
1921-22	3.6	14.0	22.3	17.1	12.1	5.9
1922-23	5.2	16.8	25.3	19.8	12.8	5.9
1923-24	4.1	16.3	24.6	24.9	13.3	5.8
1924-25	3.3	15.2	25.2	22.3	14.5	7.0
1925-26	6.5	19.3	23.1	17.6	12.0	6.5

*Yearbook of the U.S.D.A., 1923, page 805, Table 302, and 1926, page 970, Table 246.

On an average, about 13 per cent. of the cotton crop is marketed by farmers in September, 21 per cent. in October, 19 per cent. in November, and 14 per cent. in December. The data in Tables IV and XIV, showing production and spot prices, and the prices received by producers, as reported in Table A,(preceding page), all seem to indicate that there is a stronger tendency for prices to fluctuate in accordance with the size of the crop than with the quantity of cotton actually offered on the market during any one month. Unwarranted holdings by producers would ultimately tend to encourage importation by American manufacturers. The more immediate results would be the stimulation of foreign production and the restriction of foreign markets for American cotton.

Table B. (Continued)

Estimated Monthly Marketings of Cotton
by Farmers, 1912-25.

Year	Percentage of year's sales						
	Feb.	Mar.	Apr.	May	June	July	Season
1912-13	5.2	4.5	2.6	1.5	1.1	1.0(1)	100
1913-14	5.3	4.4	2.7	1.5	1.2	1.0(1)	100
1914-15	8.3	7.7	6.1	2.5	7.5(2)	...	100
1915-16	5.4	5.2	3.9	3.6	3.4(2)	...	100
1916-17	4.0	3.9	3.0	2.5	1.6	.5	100
1917-18	5.8	4.5	2.6	1.3	1.0	.9	100
1918-19	4.4	4.6	4.6	7.5	6.8	4.4	100
1919-20	5.6	4.9	3.2	2.7	1.7	1.6	100
1920-21	5.6	6.0	6.7	6.9	6.8	5.6	100
1921-22	4.3	4.6	4.6	5.9	3.0	2.6	100
1922-23	4.4	3.7	2.0	1.0	1.5	1.6	100
1923-24	3.1	2.4	1.7	1.3	.9	1.6	100
1924-25	5.3	3.4	1.6	1.0	.6	.6	100
1925-26	4.2	3.1	2.3	1.7	2.1	1.6	100

(1) Includes August
(2) Includes July.

of the crop, nor inversely, as to that matter, since stocks on hand at the beginning of the season constitute an influencing factor. In 1921 the current production was 7,954,000 bales, the smallest crop since 1895. Ordinarily, an increase in the percentages of monthly marketings would have been expected during the first few months of the season, but, as shown in Table C, the stocks on hand amounted to 6,590,000 bales, which were equivalent to about 83 per cent. of the current production.

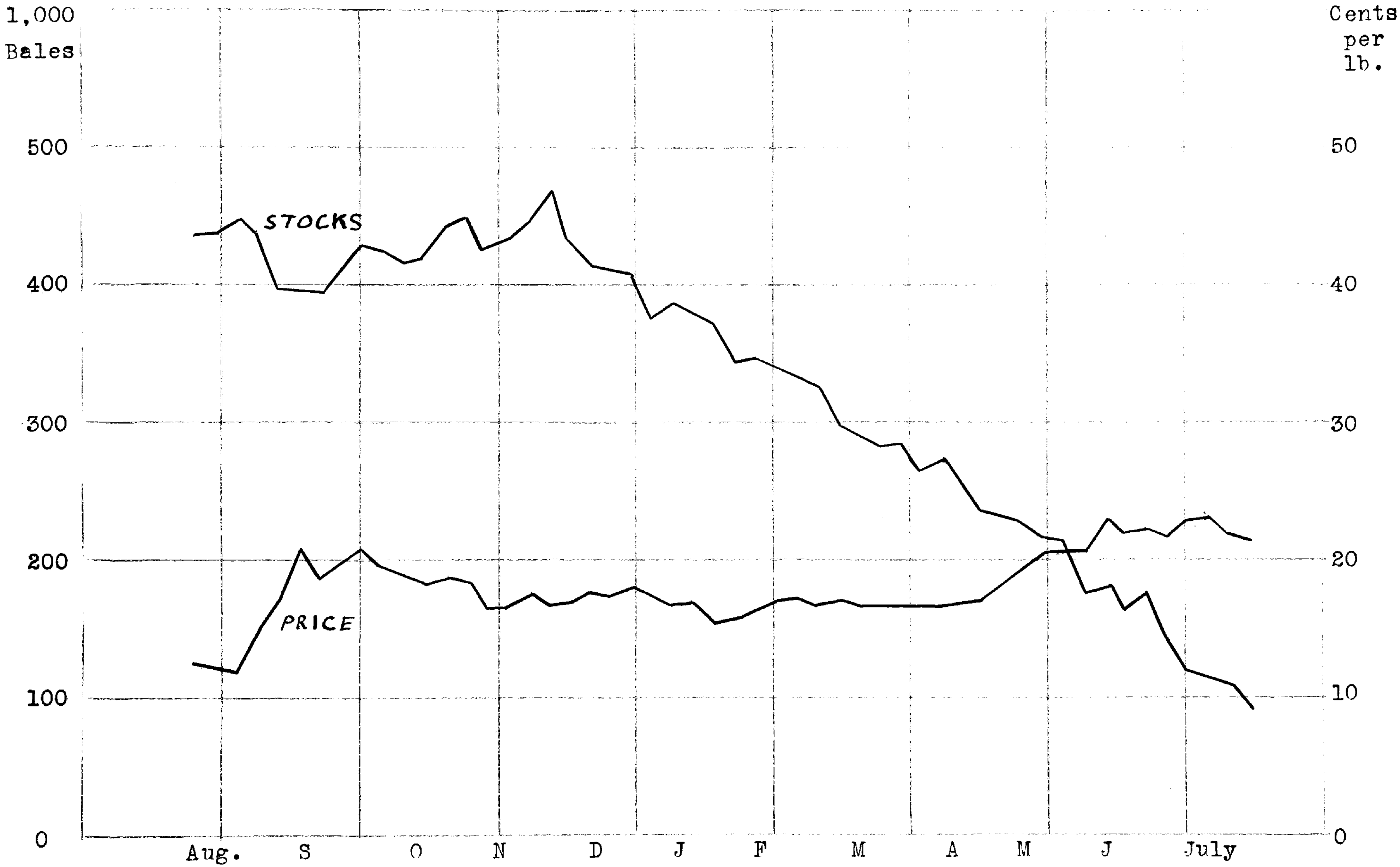
It must not be concluded that the producer acts as a bear on his own market. There is,undoubtedly, some relation between the quantity of cotton marketed in early fall and the prices received, but this relationship is not so marked as is sometimes thought, except that quantity marketed at harvest time may have some relation to aggregate supply, including both production and carry-over. Cotton prices depend largely upon the size of the crop, rather than upon the time the crop is marketed. In Charts A and B are plotted the prices of cotton and cotton stocks arriving for sale at New Orleans for the seasons of 1921-22 and 1922-23. There is, the reader will observe, no relation between the movements of the curves representing the two factors. An increase in receipts is equally likely to be accompanied by either a rise or fall in prices. In Table D the analysis is continued, and there will be seen the expressions of relationship between prices and stocks at the New Orleans Market. There seems

Table C.
Stocks on Hand, Aggregate Supply, and Consumption of Cotton in the United States, 1905--25*

Year (1)	Stocks on hand at beginning of year (2)	Aggregate supply (3)	Consumption
	:1,000 bales	1,000 bales	1,000 bales
1905	1,935	12,794	4,909
1906	1,349	14,857	4,985
1907	1,515	12,982	4,539
1908	1,236	14,833	5,241
1909	1,484	12,021	4,799
1910	1,040	13,237	4,705
1911	1,375	17,713	5,368
1912	1,777	16,093	5,786
1913	1,511	15,760	5,577
1914	1,366	17,636	5,597
1915	3,936	15,425	6,398
1916	3,140	14,792	6,789
1917	2,720	14,185	6,566
1918	3,450	15,553	5,766
1919	4,287	16,295	6,420
1920	3,563	17,045	4,893
1921	6,590	14,920	5,910
1922	2,832	13,011	6,666
1923	2,325	12,768	5,681
1924	1,556	15,638	6,193
1925	1,610	17,934	6,451

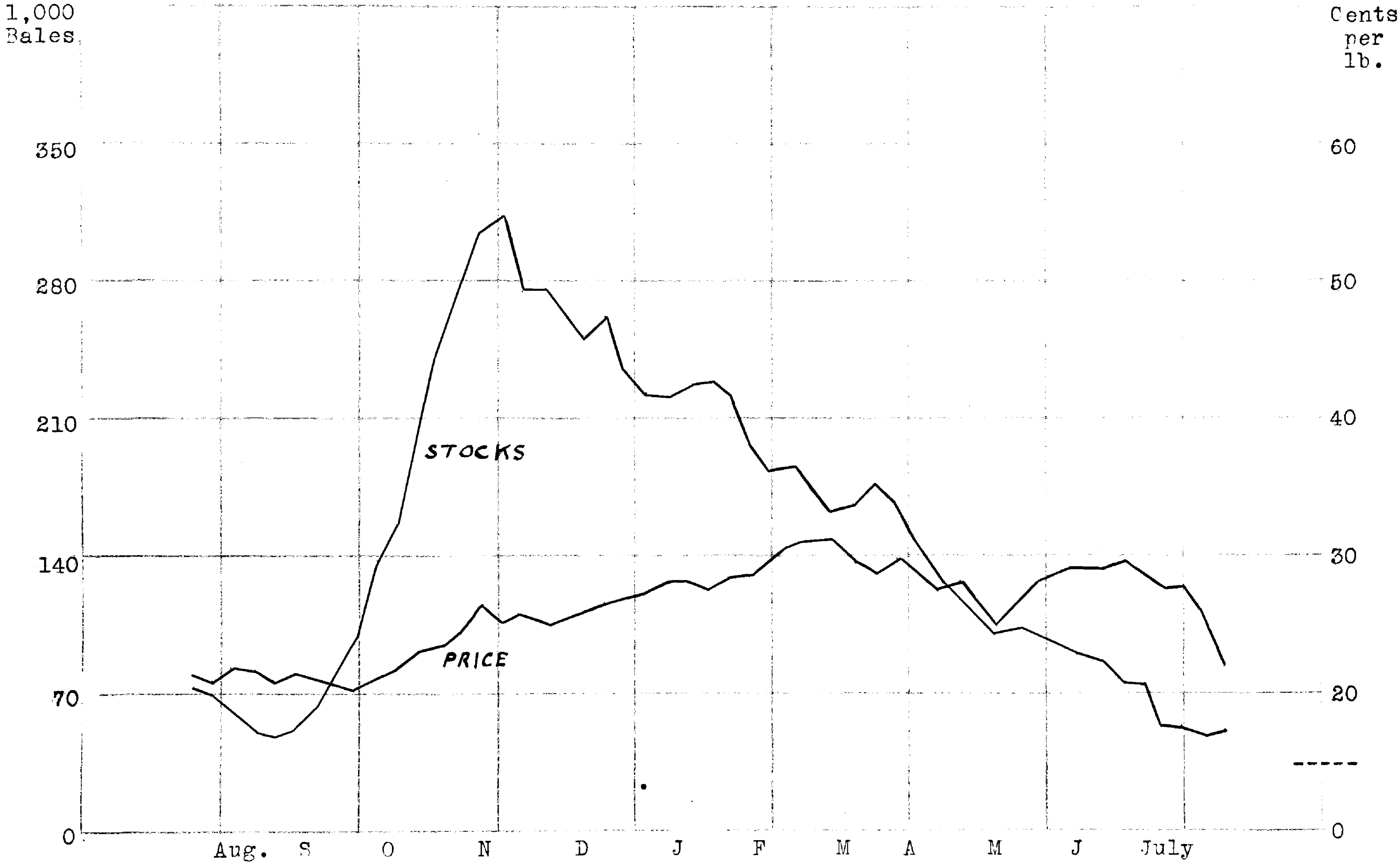
*Foreign Crops and Markets, Volume 13, Nov. 8, 1926, Number 19, page 624.
(1)Year beginning with August.
(2)Includes foreign cotton.
(3)Includes stocks on hand, ginnings, and imports.

Chart A. Stocks of Cotton and Middling Spot Quotations at New Orleans for the Season 1921--22*



*1923 Edition of Cotton Facts, pages 133 and 156.

Chart B. Stocks of Cotton and Middling Spot Quotations at New Orleans for the Season 1922--23*



*1923 Edition of Cotton Facts, pages 133 and 156.

Table D.
Relation Between Cotton Stocks and Spot Middling Prices at New Orleans, 1919-23*

Month	Expression of Relationship
September	-.066
October	.133
November	.129
December	.445
January	-.029

*Based on data in the 1923 Edition of Cotton Facts, pages 133 and 156. Expressions of relationship are calculated by the product-moment method. At the end of January, on an average, about 80 per cent. of the cotton crop has passed from the hands of producers into the channels of trade. It will be observed that flow to market bears no consistent relationship to price, once the size of the crop is known.

to be no consistency in the movements of prices in relation to market receipts, which indicates their fluctuations are due to factors other than mere quantity of cotton received for sale at any particular time. In 1919 and 1921 the cotton crop declined 620,000 and 5,486,000 bales in relation to the respective preceding years, and in each case there was an upward trend in prices during the season. In 1920 there was an increase of 2,019,000 bales over 1919, and there followed a sharp decline in prices after September. The largest cotton crop the United States has ever produced was in 1926, when the ginnings totaled 17,977,000 bales. During this season the prices declined very sharply, and they continued to decline until the probable short crop of 1927 became evident, after which there was a tendency upward. These facts point to the rather definite conclusion that cotton prices fluctuate inversely with the size of the cotton crop, rather than with the rate of flow to market. This same relationship applies to all the large cotton exchanges in the country, though in different degrees. New Orleans, for example, is an interior spot market located near the great cotton-producing centers, and there is often less of the speculative element involved in the prices here than at New York, which is primarily a futures market.

According to the quotations in Table A the increases in prices to producers in May over the preceding October have ranged from .1 of a cent a pound in 1923 to 5 cents in 1922, while decreases in May prices as compared with preceding October prices were as great as 12.8 cents in 1920, and as low as .1 of a cent in 1924. During the eighteen year period, 1909--26, prices in twelve years were higher in May than in October, and in six years they were lower. Omitting the war period, there were only eight years in which the May prices were higher than October prices. The United States Department of Agriculture has made studies of the cost of storing cotton, but these show average costs, and are, therefore, of little assistance to the individual producer in aiding him to decide upon the advisability of holding his crop off the market. In short-crop years, the prediction that prices will rise and continue to rise after October may be relied upon as unmistakably as any other economic fact, and in years of a heavy crop the price is just as surely to fall. These are two of the factors which will aid the producers and cooperative associations in arriving at a decision regarding the profitableness of holding. Another is the cost under the particular conditions, and this must be decided by each individual.

The holding of cotton for higher prices when the prices offered are sufficiently high in relation to supply and demand to allow a fair profit is not altogether economically sound, and it has often been indefensible. Any general movement to excessively increase domestic prices will ultimately lead to disaster. Under such condition the production of cotton in foreign countries would be stimulated, resulting in a restriction of markets for American cotton. This would in turn result in a still further depression of prices, since from three-fifths to two-thirds of our production is exported. Hence, an unwarranted holding of cotton, if it were to become widespread and general, would result in greater production in foreign countries, which would become our competitors for world markets, and there would be fewer buyers for our own cotton. A persistency in the movement would ultimately tend to encourage importation by American manufacturers.

Since most of the lint cotton produced in the United States passes into the world's channels of trade, and since, as stated, holding of cotton would be followed by a tendency for other countries to increase their production, and eventually defeat the purpose for which the holdings were made, no excessive gains are to be expected from such practices that are not wholly in harmony with the law of supply and demand. We know, of course, that supply and demand react upon prices for short periods, and that the cost of production is the main regulator of prices over a long period. The price regime involves also the concept that the cost of production determines to a large extent the prices of the future, and that costs of the past cannot become the regulator of present prices.

Cotton Markets

A cotton market is a place where two or more people meet to buy and sell cotton. The system of marketing begins in the small towns and at the country stores, where the cotton producers and the cotton dealers meet. The marketing function, so far as lint cotton is concerned, ends when the dealer makes his delivery to the spinner. Transactions in cotton trading are carried on by sales of actual cotton and by contracts for delivery at some future time. Actual cotton sold on the market is known in the channels of trade as "spot cotton", the market on which it is sold is known as a "spot market", and the price is referred to as a "spot quotation" or as a "spot price."

In the cotton-marketing regime there are several types of markets, and these may be classified according to location and functions in trading. First, there are the spot markets. Of these there are three kinds, the primary, the interior, and the large organized exchange. The difference between the last two named is not clearly defined in all cases. Primary markets are small towns, gins, and country stores where the baled cotton is first marketed and sold by producers. At many of these primary markets there is but one buyer, who does his own sampling and grading, and bids his price accordingly. At the larger markets, however, such as Troy, Alabama, there are often several buyers, and the bidding becomes more or less competitive. In the season of 1926 the writer personally visited primary spot markets in practically all of the cotton-producing states. At certain markets in Alabama, Georgia, and Texas the producers were literally forced to sell their cotton on the basis of grades established by the local dealer. At one market in Texas, and at another in Arkansas, three buyers, bidding on the same cotton, were offering a maximum of six cents per pound for what they classed as low middling, which is grade number 7. Farmers were not protesting against the price so much as they were against the method of grading, since they felt that Federal sampling and classing would have assured a higher price.

Interior spot markets, also known as central markets, are large towns and cities to which cotton is shipped from primary spot markets and sold by primary buyers to mills and to merchants operating on a large scale. These markets, of which Fort Worth, Memphis, Little Rick, Columbia, St. Louis, Macon, and Shreveport are typical examples, are usually points of assembling in large quantities for sampling, grading, compressing, and consigning to centers of consumption. They provide facilities for storage and are themselves markets for the sale and resale of cotton.

Future markets are located in New York and New Orleans, and their importance is indicated, not by the cotton received, but by the trading in future contracts. Dealers and manufacturers who wish to hedge a transaction buy their contracts on the future markets, and in this way protect themselves against a rise or fall in prices. The cotton exchange at New Orleans is both a spot market and a future market, while New York is primarily a future market. Liverpool is the most important foreign market dealing in American cotton. All cotton delivered on the New Orleans and New York future exchanges is now classified by the United States Department of Agriculture.

The cities along the Atlantic and Gulf Coasts, such as Savannah, Galveston, and Norfolk, where cotton is sold for export, are called "export markets". More than one-half of the American cotton crop is exported for consumption in foreign mills.[1] The leading countries to which the cotton is exported are as follows: United Kingdom, Germany, France, Italy, and Japan. During the year ending June 30th, 1926, our total exports of lint cotton amounted to 8,109,544 bales of 500 pounds each. (See Table XI) Of this quantity, the United Kingdom received 28.1%, Germany 20.4%, France 11.4%, Italy 9.2%, other European countries 12.6%, Japan 13.8%, and other countries 4.5%. Linters are exported mainly to Germany.[2]

On all the cotton exchanges in the United States, "American Middling", the standard short-staple grade, is the basis of price quotations for all short-staple cottons. Upland short-staple cotton constitutes about 92 per cent. of the total cotton crop of the United States and about 50 per cent. of the total world's crop.[3]

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(1) See Table X
(2) See 1926 U.S.D.A. Yearbook, page 1185, Table 498
(3) Miss E. Anderson, United States Dept. of Agri.

Monthly Spot Prices at New York and New Orleans

Spot quotations at all the cotton exchanges are based on Middling, which is grade 5. The differences in price between Middling and the other grades and the premiums for the longer staples vary from time to time because of special demands or the effects of seasonal weather factors upon the supply of the different grades and lengths of staple. Table XIV shows the spot prices for Middling cotton at New York for the years 1892-1927, inclusive, and at New Orleans for the years 1900-27, inclusive. The spot prices at New York are generally a little higher than at New Orleans because of the cost of transportation involved in moving cotton to the former. Fluctuations in price are due largely to the size of the crop, and, as will be observed, they have been quite varied. Average monthly spot prices during the World War rose to 35.09 cents per pound at New York in September of 1918 and to 33.22 cents at New Orleans in the same month and year. Prices during the World War period, however, were not as high as in the Civil War period, one reason being that production continued and there was always a good supply available, whereas in the earlier period very little cotton was produced, and almost none was available.

In the season of 1919-20 spot prices reached the highest level since the Civil War, surpassing by far the prices of any one year of the World War. In the latter part of the 1920-21 season prices declined to the pre-war level, but rose again in 1921-22, and continued at a high level until the fall of 1926, when they again receded to near the pre-war level.

Table XIV. Monthly Spot Quotations for Middling Upland Cotton at the New York Market, 1892---1927*

Year	Price in cents per pound			
	Jan.	Feb.	Mar.	Apr.
1892	7.56	7.23	6.79	7.08
1893	9.57	9.27	8.94	8.12
1894	8.06	7.89	7.60	7.59
1895	5.71	5.62	6.21	6.72
1896	8.27	8.07	7.75	7.94
1897	7.21	7.15	7.27	7.44
1898	5.92	6.17	6.19	6.28
1899	6.13	6.50	6.42	6.17
1900	7.87	8.69	9.77	9.80
1901	10.21	9.63	8.61	8.38
1902	8.31	8.62	9.08	9.39
1903	8.95	9.56	9.93	10.55
1904	14.35	14.82	15.93	14.32
1905	7.12	7.76	8.07	7.86
1906	11.93	11.19	11.37	11.72
1907	10.88	10.52	11.22	11.15
1908	11.88	11.55	11.05	10.10
1909	9.65	9.85	9.78	10.51
1910	14.90	14.72	15.02	15.09
1911	14.93	14.32	14.52	14.91
1912	9.53	10.32	10.72	11.19
1913	13.05	12.80	12.67	12.28
1914	12.72	12.83	13.27	13.23
1915	8.28	8.54	9.01	10.25
1916	12.33	11.73	11.90	12.05
1917	17.59	15.90	18.46	20.38
1918	32.26	31.76	33.74	31.85
1919	29.10	26.27	27.74	28.82
1920	39.26	38.77	41.20	42.30
1921	16.63	13.44	11.74	12.14
1922	17.94	17.90	18.32	18.06
1923	27.55	28.63	30.55	28.88
1924	34.19	31.88	28.39	30.30
1925	23.98	24.70	25.64	25.54
1926	20.84	20.60	19.35	19.13
1927	13.42	14.11	14.33	14.77

*Compiled from Weather and Crop Reports and from records of the U.S.D.A. See Table XVI. for yearly prices.

Table XIV. (Continued)

Year	Price in cents per pound			
	May	June	July	Aug.
1892	7.31	7.55	7.31	7.21
1893	7.78	7.89	8.03	7.59
1894	7.23	7.36	7.11	6.93
1895	6.99	7.22	7.04	7.57
1896	8.23	7.83	7.23	8.00
1897	7.72	7.75	7.94	8.00
1898	6.39	6.50	6.15	5.90
1899	6.34	6.25	6.14	6.23
1900	9.67	9.04	10.09	9.80
1901	8.15	8.41	8.57	8.24
1902	9.52	9.39	9.27	8.96
1903	11.47	12.12	12.62	12.75
1904	13.51	11.86	10.90	10.87
1905	8.20	8.89	10.99	10.90
1906	11.91	11.14	10.90	10.28
1907	11.98	12.95	13.05	13.36
1908	10.95	11.55	11.01	10.25
1909	11.35	11.40	12.80	12.76
1910	15.45	15.05	15.77	16.25
1911	15.85	15.64	14.01	12.34
1912	11.58	11.65	12.68	11.99
1913	11.99	12.16	12.25	12.16
1914	13.44	13.47	13.17	(1)
1915	9.81	9.68	9.22	9.41
1916	12.94	12.97	13.05	14.64
1917	20.74	25.33	26.30	25.49
1918	27.57	30.39	31.54	33.88
1919	30.58	32.96	35.33	32.10
1920	41.25	39.27	41.20	26.23
1921	12.84	12.00	12.41	13.79
1922	20.75	22.10	22.27	21.86
1923	27.20	28.52	26.26	25.20
1924	31.54	29.96	32.07	29.02
1925	23.41	24.13	24.68	23.72
1926	18.92	18.51	18.71	18.57
1927	16.04	16.85	17.99	20.04

(1) Cotton Exchange closed on account of the war.

Table XIV. (Continued)

Year	Price in cents per pound			
	Sept.	Oct.	Nov.	Dec.
1892	7.33	8.09	9.24	9.77
1893	8.19	8.33	8.17	7.91
1894	6.74	6.04	5.76	5.72
1895	7.41	9.00	8.66	8.36
1896	8.54	8.00	7.89	7.21
1897	7.08	6.33	5.88	5.90
1898	5.62	5.42	5.40	5.70
1899	6.60	7.31	7.62	7.66
1900	10.53	10.16	9.80	10.19
1901	8.39	8.42	7.95	8.47
1902	8.94	8.80	8.05	8.62
1903	11.84	9.70	11.18	13.01
1904	10.92	10.36	9.91	7.69
1905	10.84	10.39	11.49	12.15
1906	8.76	11.11	10.80	10.65
1907	12.54	11.55	11.80	11.96
1908	9.38	9.18	9.39	9.24
1909	13.29	13.90	14.70	15.30
1910	13.89	14.44	14.78	15.07
1911	11.28	9.65	9.42	9.46
1912	11.81	11.10	12.36	13.04
1913	13.46	14.05	13.70	12.99
1914	(1)	(1)	(2)	7.53
1915	10.83	12.37	11.89	12.33
1916	15.79	17.99	19.92	18.29
1917	23.05	28.02	29.78	30.74
1918	35.09	32.42	29.69	30.22
1919	30.60	34.98	39.40	39.19
1920	30.07	22.68	18.81	15.68
1921	19.95	19.63	18.01	18.30
1922	21.35	22.73	25.64	25.65
1923	29.06	30.06	34.73	35.92
1924	24.24	24.51	24.22	23.85
1925	23.79	21.77	20.94	20.06
1926	17.01	13.14	12.86	12.68
1927	21.93	20.96	20.22	19.58

(1) Cotton Exchange closed on account of the war.
(2) Cotton Exchange closed until November 16th.

Table XIV. Monthly Spot Quotations for Middling Upland Cotton at the New Orleans Market 1900----27*

Year	Price in cents per pound			
	Jan.	Feb.	Mar.	Apr.
1900	....	....	....	....
1901	9.52	9.20	8.49	8.15
1902	7.88	8.08	8.54	9.13
1903	8.66	9.36	9.73	10.05
1904	14.06	14.38	15.07	14.45
1905	6.83	7.45	7.45	7.39
1906	11.56	10.67	10.84	11.28
1907	10.46	10.49	10.83	10.79
1908	11.84	11.63	10.93	10.20
1909	9.34	9.42	9.39	10.03
1910	15.23	14.88	14.74	14.64
1911	14.95	14.62	14.54	14.70
1912	9.53	10.31	10.65	11.61
1913	12.58	12.51	12.45	12.44
1914	12.93	12.90	12.95	13.11
1915	7.87	8.01	8.34	9.43
1916	12.04	11.45	11.73	11.88
1917	17.33	17.14	17.94	19.51
1918	31.07	30.91	32.76	33.05
1919	28.84	26.97	26.84	26.70
1920	40.28	39.39	40.69	41.41
1921	14.53	12.85	11.08	11.17
1922	16.53	16.36	16.74	16.80
1923	27.51	28.78	30.43	28.42
1924	33.93	31.90	28.74	30.41
1925	23.66	24.61	25.52	24.52
1926	20.26	19.83	18.35	18.11
1927	13.17	13.82	14.11	14.42

*Yearbook of the U.S.D.A., 1923, page 809, Table 307, 1926, page 974, Table 251, and unpublished records of the Bureau of Agricultural Economics, U.S.D.A.

Table XIV. (Continued)

Year	Price in cents per pound			
	May	June	July	Aug.
1900	....	....	....	....
1901	7.69	8.05	8.33	8.28
1902	9.39	9.15	8.94	8.43
1903	11.14	12.71	13.02	12.70
1904	13.41	11.38	10.86	10.59
1905	7.90	8.87	10.61	10.48
1906	11.33	10.99	10.96	9.99
1907	11.85	12.81	12.89	13.13
1908	10.86	11.59	10.81	9.92
1909	10.59	11.04	12.13	12.28
1910	14.89	14.85	14.93	14.92
1911	15.48	15.26	14.30	11.96
1912	11.72	12.07	12.93	12.07
1913	12.29	12.44	12.34	12.02
1914	13.36	13.79	13.34	(1)
1915	9.04	9.12	8.71	8.94
1916	12.61	12.80	13.03	14.26
1917	20.06	24.18	25.41	25.07
1918	28.90	30.71	29.50	30.23
1919	29.22	32.09	33.93	31.38
1920	40.31	40.49	39.41	34.03
1921	11.80	11.03	11.49	12.78
1922	19.31	21.68	22.01	21.55
1923	26.63	28.61	25.73	24.22
1924	30.70	29.43	29.23	26.65
1925	23.54	24.07	24.05	23.07
1926	18.06	17.54	18.24	18.01
1927	15.68	16.46	17.63	19.36

(1) Market closed.

Table XIV. (Continued)

Year	(2)	Price in cents per pound			
		Sept.	Oct.	Nov.	Dec.
1900		10.39	9.57	9.48	9.50
1901		8.15	7.99	7.32	7.93
1902		8.43	8.22	7.82	8.14
1903		10.72	9.66	10.72	12.52
1904		10.54	9.80	9.50	7.48
1905		10.26	10.16	11.28	11.88
1906		9.24	10.76	10.39	10.53
1907		12.41	11.19	10.84	11.54
1908		9.11	8.92	8.97	8.78
1909		12.66	13.48	14.40	14.96
1910		13.49	14.21	14.50	14.85
1911		11.29	9.61	9.35	9.17
1912		11.37	10.95	12.15	12.81
1913		13.11	13.73	13.26	12.98
1914	(2)	8.42	7.02	7.43	7.18
1915		10.40	11.95	11.50	11.89
1916		15.27	17.24	19.45	18.34
1917		21.68	26.76	28.07	29.07
1918		33.22	31.18	29.75	29.44
1919		30.38	35.28	39.58	39.89
1920		27.48	20.95	17.65	14.59
1921		19.35	18.99	17.27	17.16
1922		20.74	22.05	25.34	25.48
1923		27.71	29.18	33.68	34.88
1924		22.79	23.48	23.95	23.66
1925		23.09	20.86	19.82	19.27
1926		16.14	12.68	12.52	12.22
1927		21.53	20.73	19.99	19.26

(2) No quotations prior to Sept. 23. Average for 7 days' business.

Secular Trend of Prices

With the exception of the World War period, and the years immediately following, cotton prices have risen gradually one year over another since 1866, and particularly since 1892. This tendency toward a uniform upward trend may be attributed mainly to the increased volume of money in circulation, which bears approximately the same ratio to production as production bears to demand for cotton.

Table XV shows the calculated ordinates of monthly trend of spot prices at New York for the period 1892-1912, inclusive. During these years the average of monthly prices was never above 10.0 cents nor below 9.0 cents. The lowest average of 9.39 cents was for the month of October, and the highest average of 9.97 cents was for July, constituting a difference of .58 cents.

Charts III to XIV show graphically the actual trend of monthly prices. Particular attention is called to the closeness of fit of the least squares line. The exact determination of the nature and extent of price movements is the first and most important procedure in the analysis of causal relatiosnhips between production and price.

Table XV. Ordinates of Secular Trend of Monthly Cotton Prices Computed by the Method of Least Squares.*

Year	Ordinates of Trend			
	Jan.	Feb.	Mar.	Apr.
1892	6.62	6.45	6.35	6.25
1893	6.91	6.75	6.68	6.59
1894	7.19	7.06	7.01	6.93
1895	7.48	7.36	7.33	7.26
1896	7.76	7.67	7.66	7.60
1897	8.05	7.98	7.99	7.94
1898	8.33	8.27	8.32	8.28
1899	8.62	8.58	8.65	8.62
1900	8.90	8.88	8.97	8.95
1901	9.19	9.19	9.30	9.29
1902	9.47	9.49	9.63	9.63
1903	9.76	9.79	9.96	9.97
1904	10.05	10.10	10.29	10.31
1905	10.33	10.40	10.61	10.64
1906	10.61	10.71	10.94	10.98
1907	10.90	11.01	11.27	11.32
1908	11.18	11.31	11.60	11.66
1909	11.47	11.62	11.93	12.00
1910	11.75	11.92	12.25	12.33
1911	12.04	12.23	12.58	12.67
1912	12.32	12.53	12.91	13.01

Mean of prices:
- Jan. 9.47 cents
- Feb. 9.49 cents
- Mar. 9.63 cents
- Apr. 9.63 cents

Monthly slope:
- Jan. .285 cents
- Feb. .304 cents
- Mar. .328 cents
- Apr. .328 cents.

*Based on New York spot quotations for middling cotton.

Table XV. (Continued)

Year	Ordinates of Trend			
	May	June	July	Aug.
1892	6.11	6.17	6.02	6.18
1893	6.49	6.54	6.42	6.54
1894	6.86	6.91	6.81	6.91
1895	7.24	7.28	7.21	7.27
1896	7.62	7.66	7.60	7.63
1897	7.99	8.03	8.00	8.00
1898	8.37	8.40	8.39	8.36
1899	8.75	8.77	8.79	8.72
1900	9.13	9.14	9.18	9.08
1901	9.50	9.51	9.58	9.45
1902	9.88	9.88	9.97	9.81
1903	10.26	10.25	10.37	10.17
1904	10.63	10.62	10.76	10.54
1905	11.01	10.99	11.16	10.90
1906	11.39	11.36	11.55	11.26
1907	11.77	11.74	11.95	11.63
1908	12.14	12.11	12.34	11.99
1909	12.52	12.48	12.74	12.35
1910	12.90	12.85	13.13	12.71
1911	13.27	12.22	13.53	13.08
1912	13.65	13.59	13.92	13.44

Mean of prices:

May	9.88	cents
June	9.88	cents
July	9.97	cents
Aug.	9.81	cents

Monthly slope:

May	.377	cents
June	.371	cents
July	.395	cents
Aug.	.363	cents

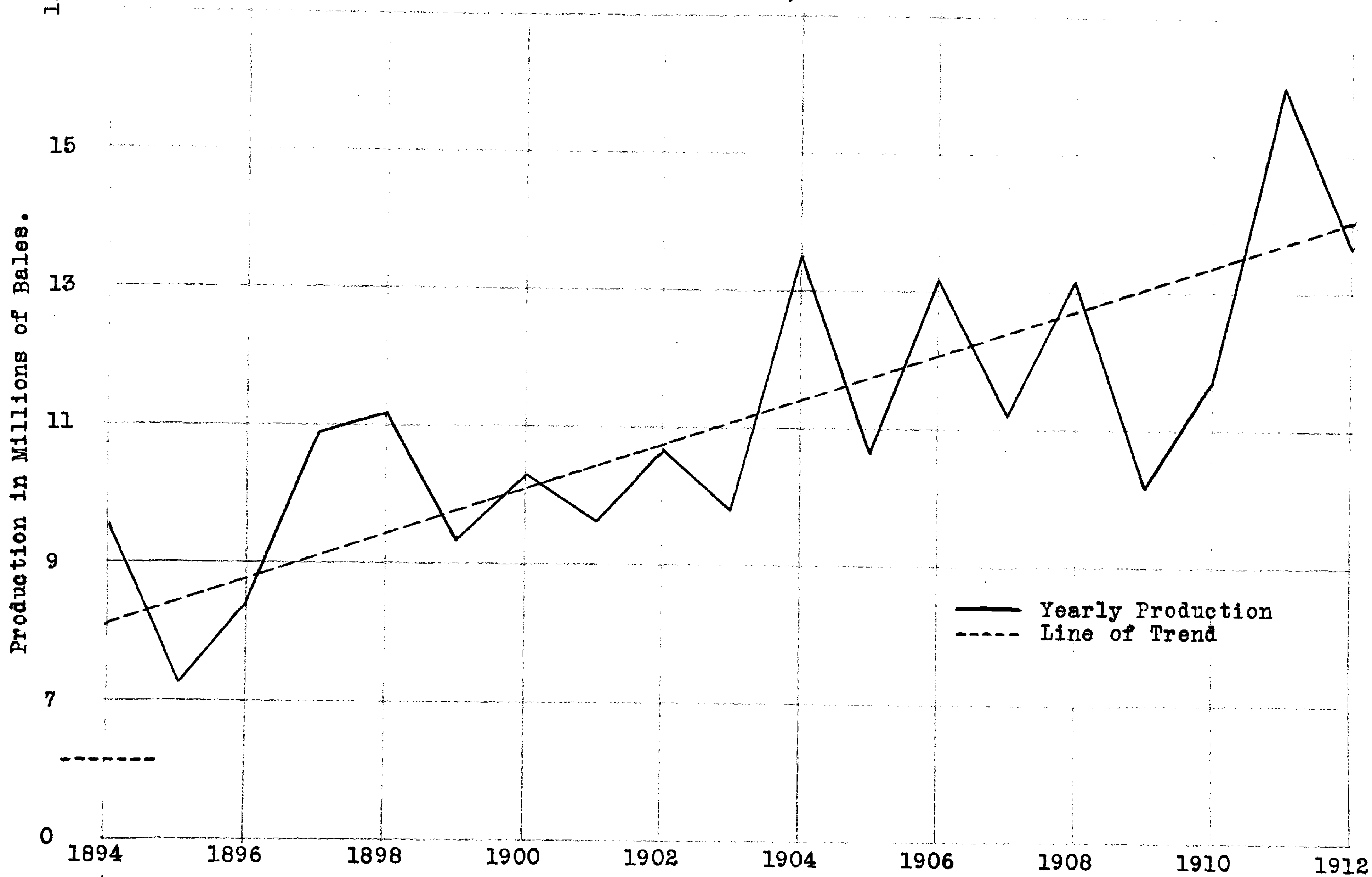
Table XV. (Continued)

Year	Ordinates of Trend			
	Sept.	Oct.	Nov.	Dec.
1892	6.50	6.66	5.34	6.49
1893	6.80	6.93	5.76	6.81
1894	7.11	7.21	6.18	7.13
1895	7.42	7.48	6.60	7.44
1896	7.73	7.75	7.02	7.76
1897	8.03	8.03	7.44	8.08
1898	8.34	8.30	7.86	8.40
1899	8.65	8.57	8.28	8.72
1900	8.95	8.84	8.70	9.03
1901	9.26	9.12	9.12	9.35
1902	9.57	9.39	9.54	9.67
1903	9.87	9.66	9.96	9.99
1904	10.18	9.94	10.38	10.31
1905	10.49	10.21	10.80	10.62
1906	10.80	10.48	11.22	10.94
1907	11.10	10.76	11.64	11.26
1908	11.41	11.03	12.06	11.58
1909	11.72	11.30	12.48	11.90
1910	12.02	11.57	12.90	12.21
1911	12.33	11.85	13.32	12.53
1912	12.64	12.12	13.74	12.85

Mean of prices:
- Sept. 9.57 cents
- Oct. 9.39 cents
- Nov. 9.54 cents
- Dec. 9.67 cents

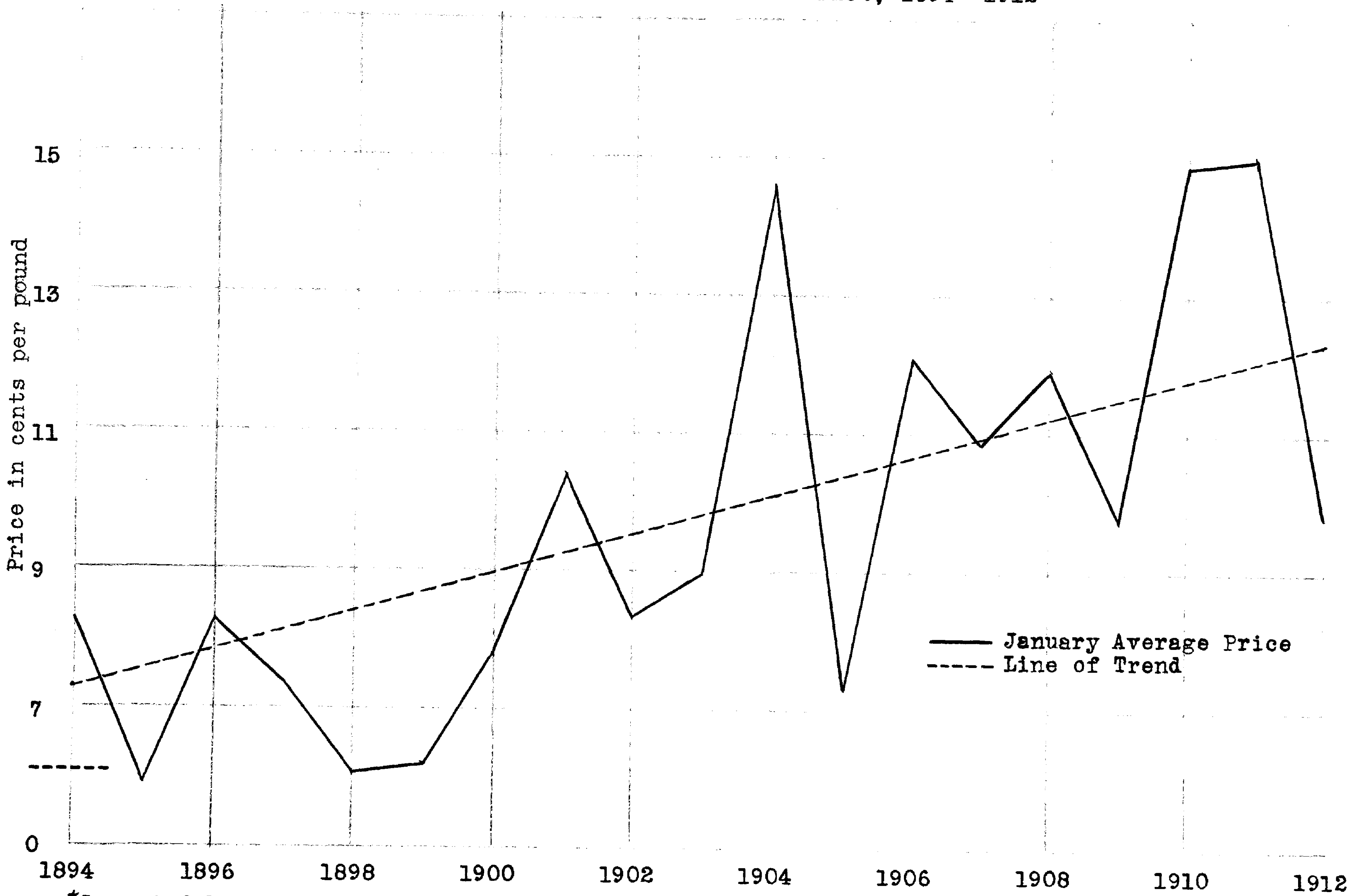
Monthly slope:
- Sept. .307 cents
- Oct. .273 cents
- Nov. .420 cents
- Dec. .318 cents.

Chart II. Straight Line Trend of Cotton Production in the United States, 1894--1912*



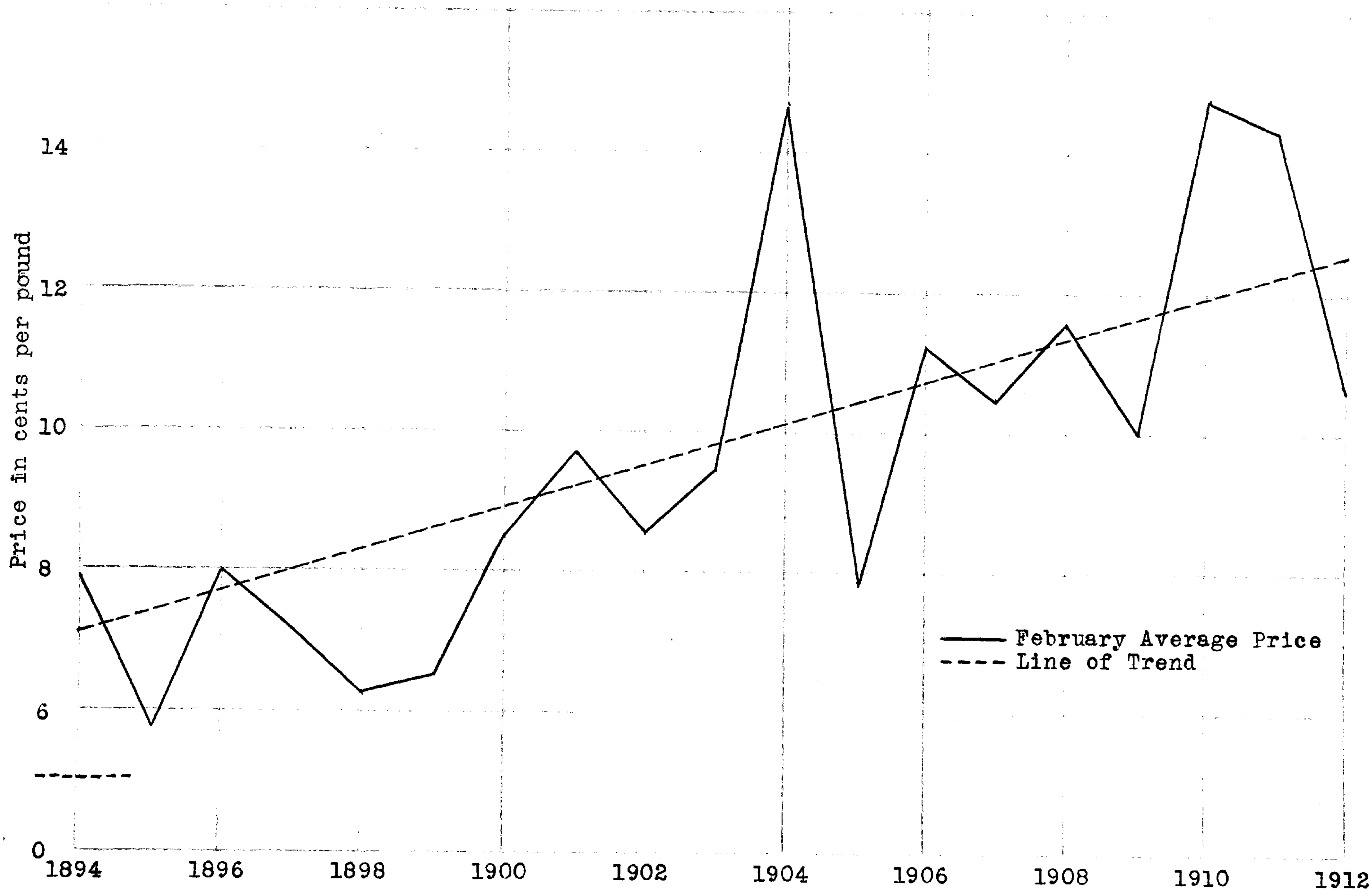
*Computed by the method of least squares.

Chart III. Straight Line Trend of January Spot Quotations for Middling Cotton at the New York Market, 1894--1912*



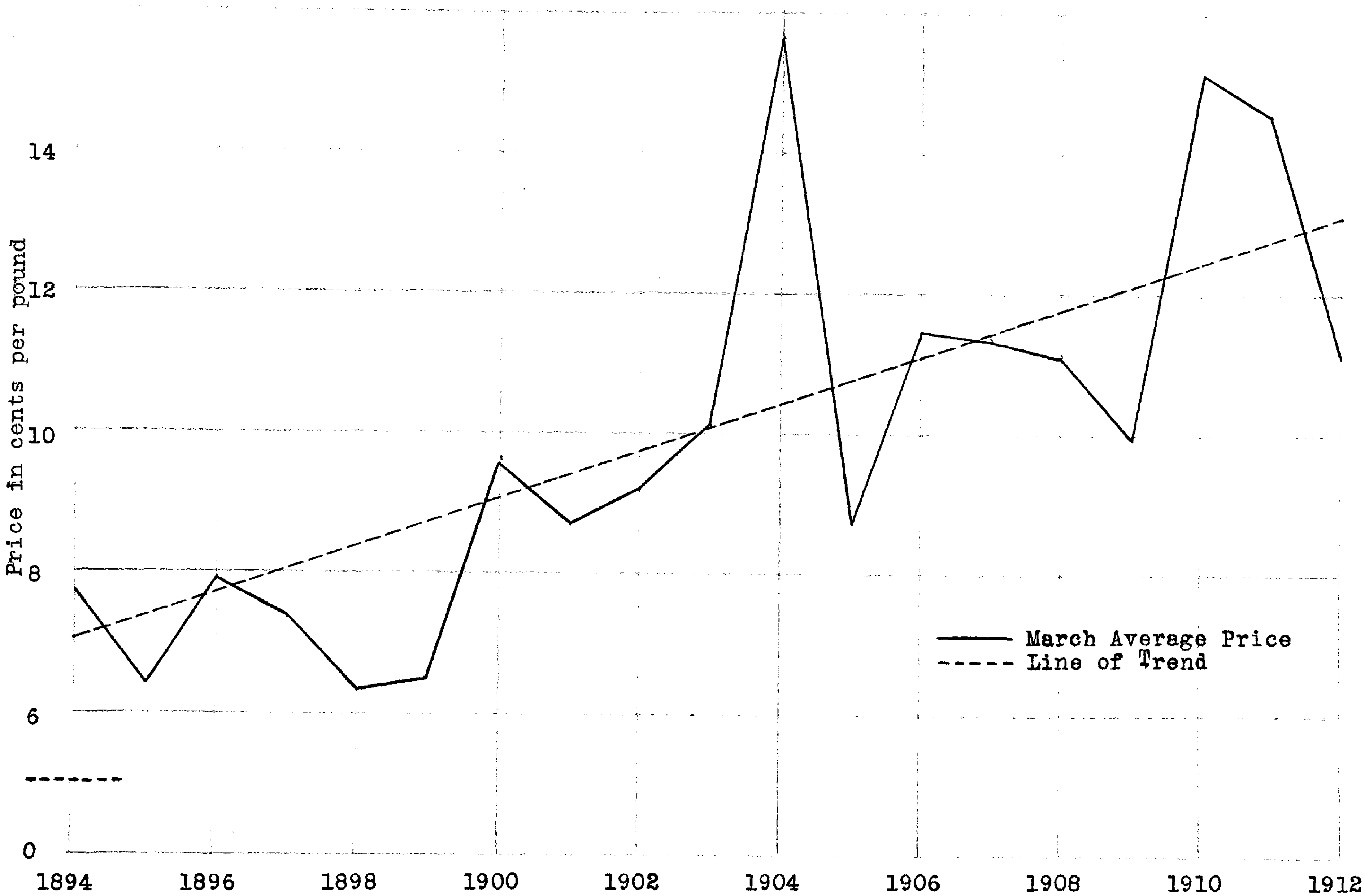
*Computed by the method of least squares.

Chart IV. Straight Line Trend of February Spot Quotations for Middling Cotton at the New York Market, 1894--1912*



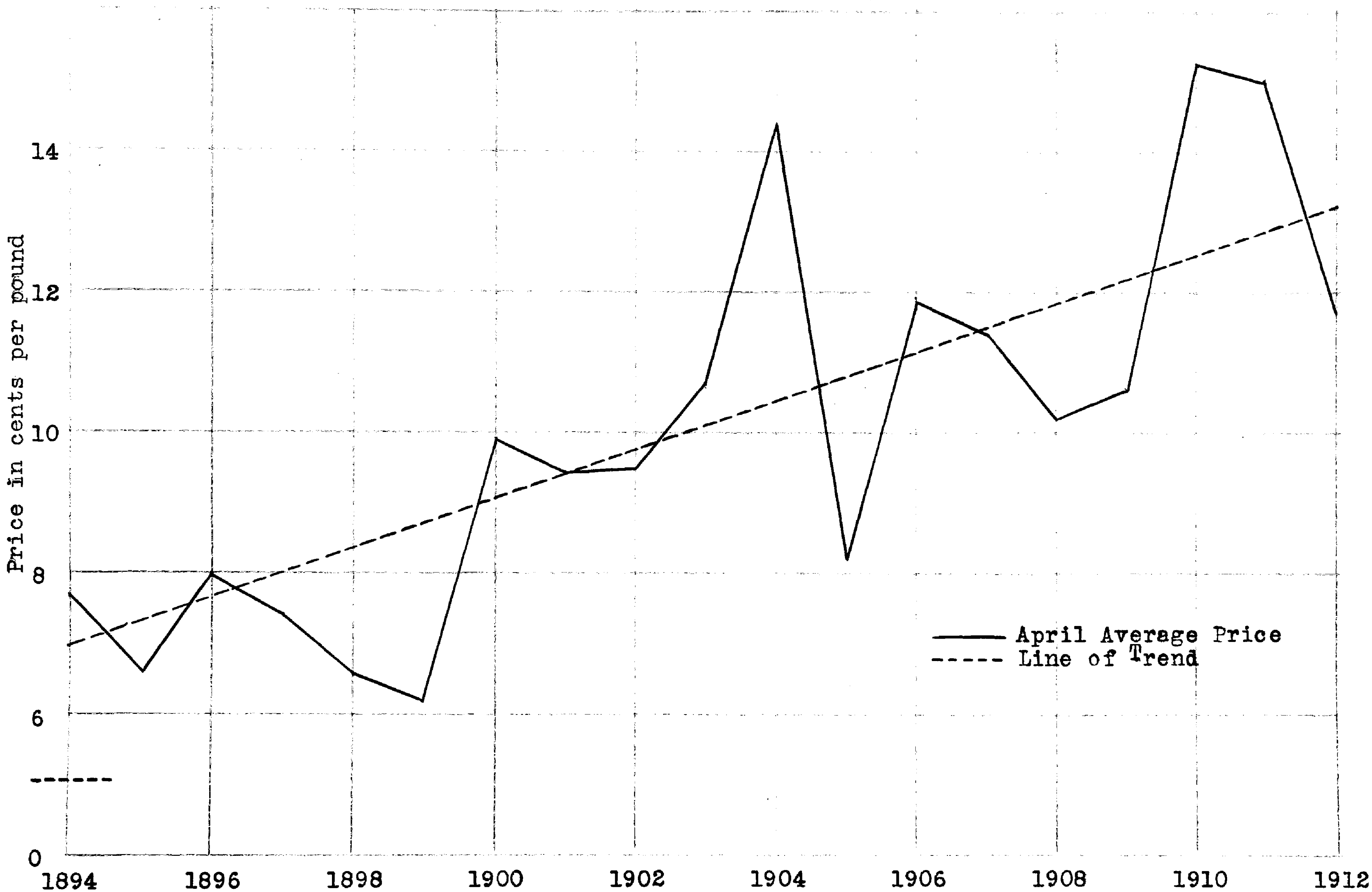
*Computed by the method of least squares.

Chart V. Straight Line Trend of March Spot Quotations for Middling Cotton at the New York Market, 1894--1912*



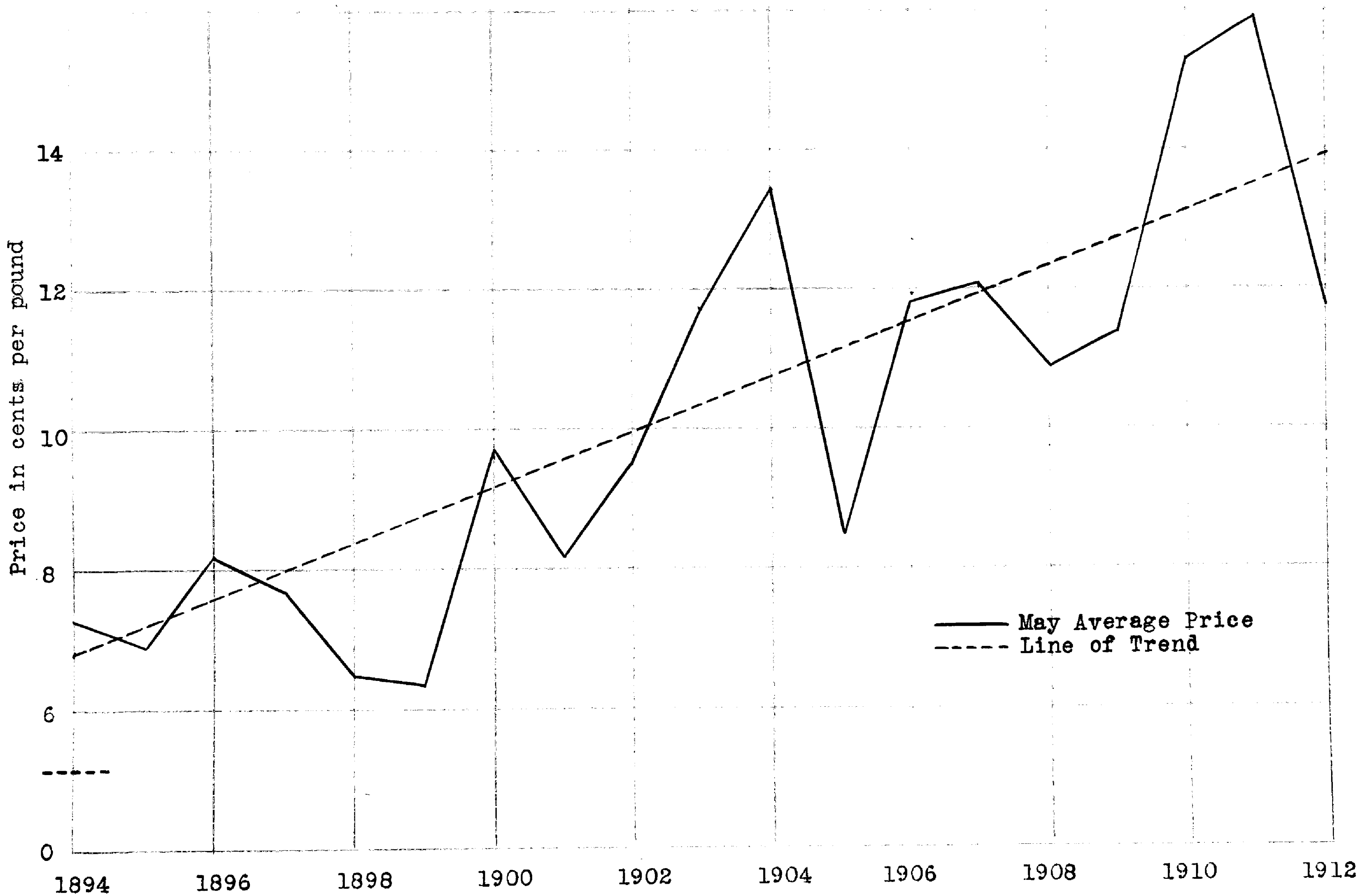
*Computed by the method of least squares

Chart VI. Straight Line Trend of April Spot Quotations for Middling Cotton at the New York Market, 1894-1912*



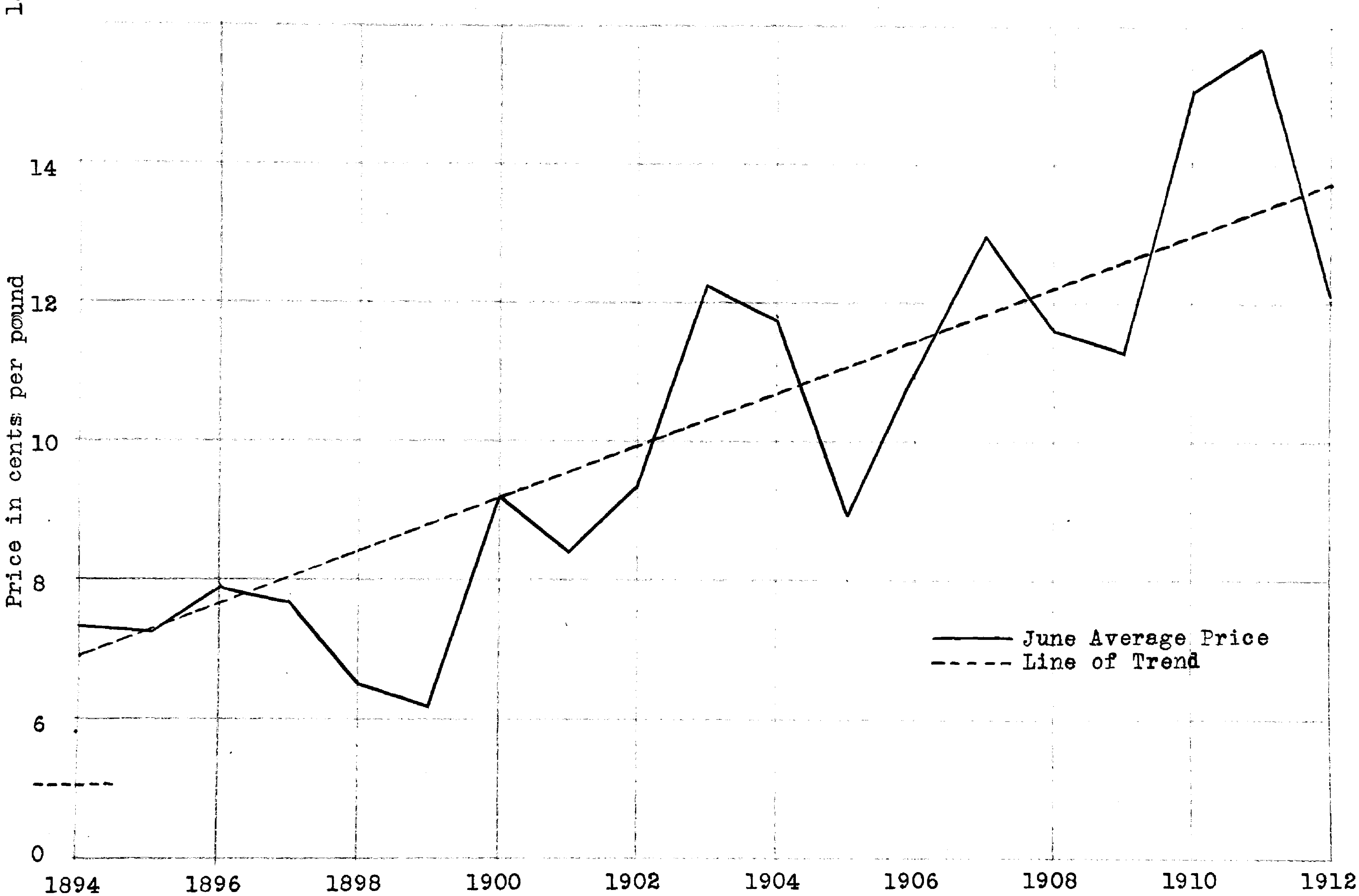
*Computed by the method of least squares.

Chart VII. Straight Line Trend of May Spot Quotations for Middling Cotton at the New York Market, 1894--1912*



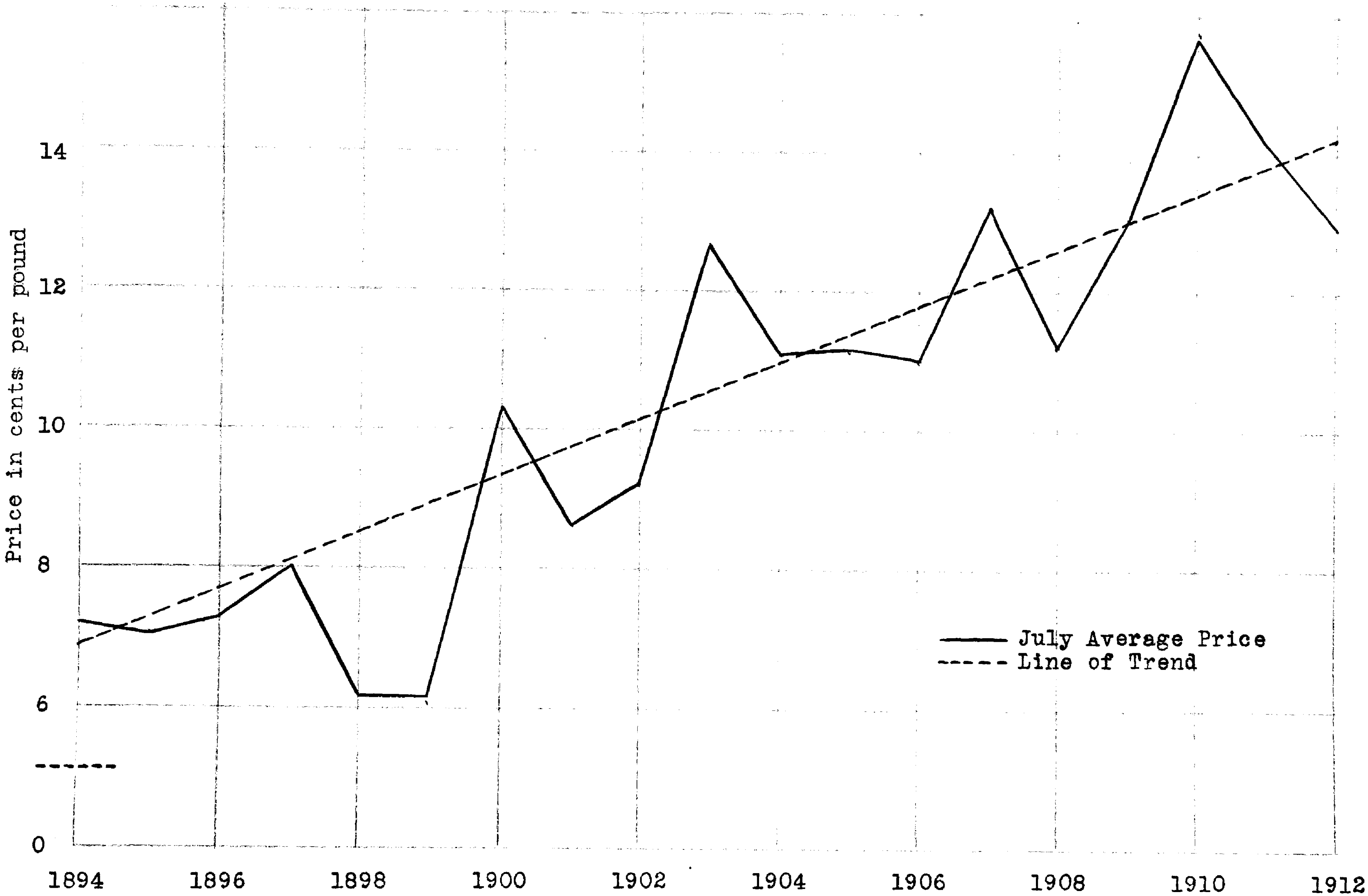
*Computed by the method of least squares.

Chart VIII. Straight Line Trend of June Spot Quotations for Middling Cotton at the New York Market, 1894--1912*



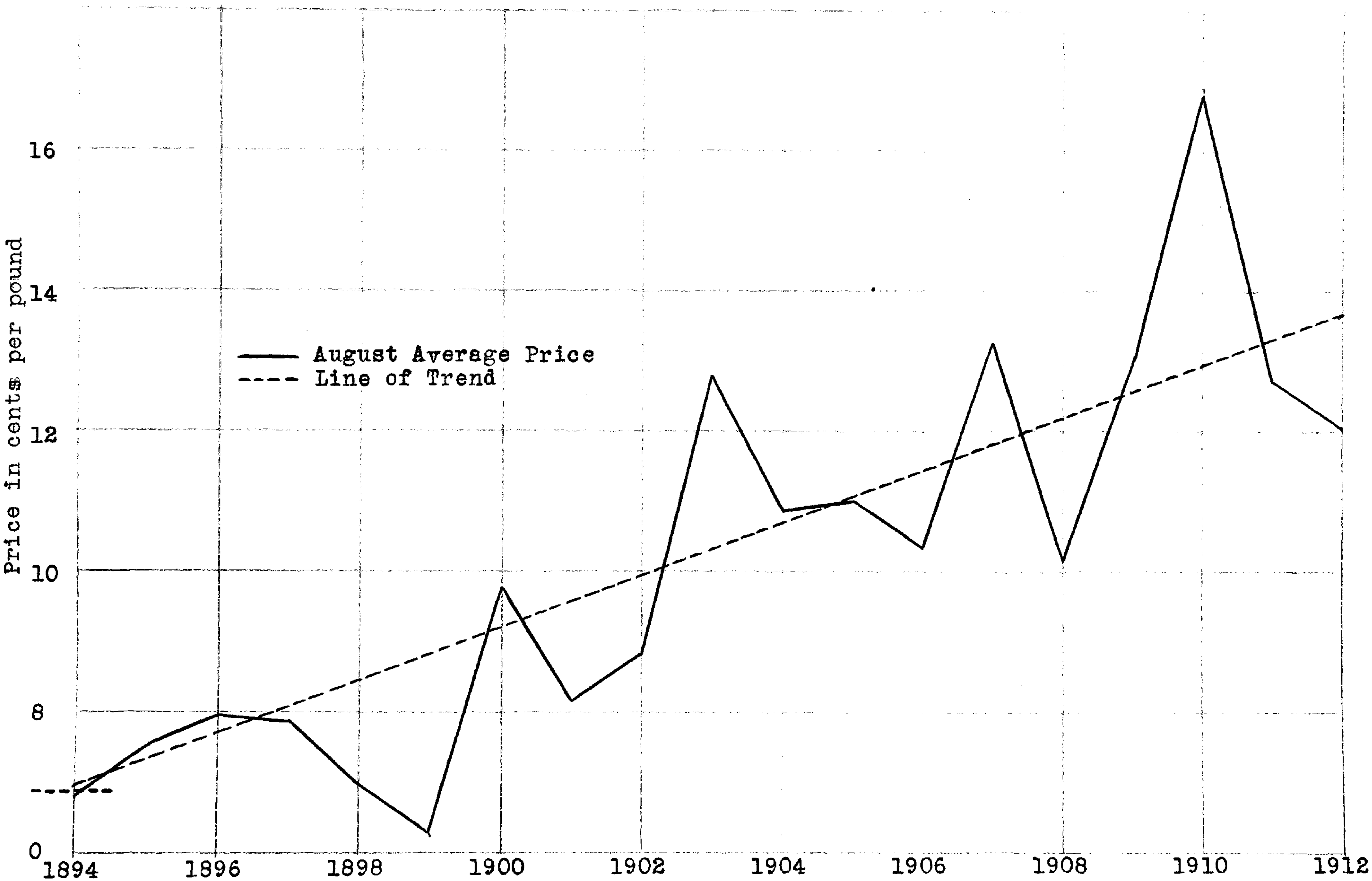
*Computed by the method of least squares.

Chart IX. Straight Line Trend of July Spot Quotations for Middling Cotton at the New York Market, 1894--1912*



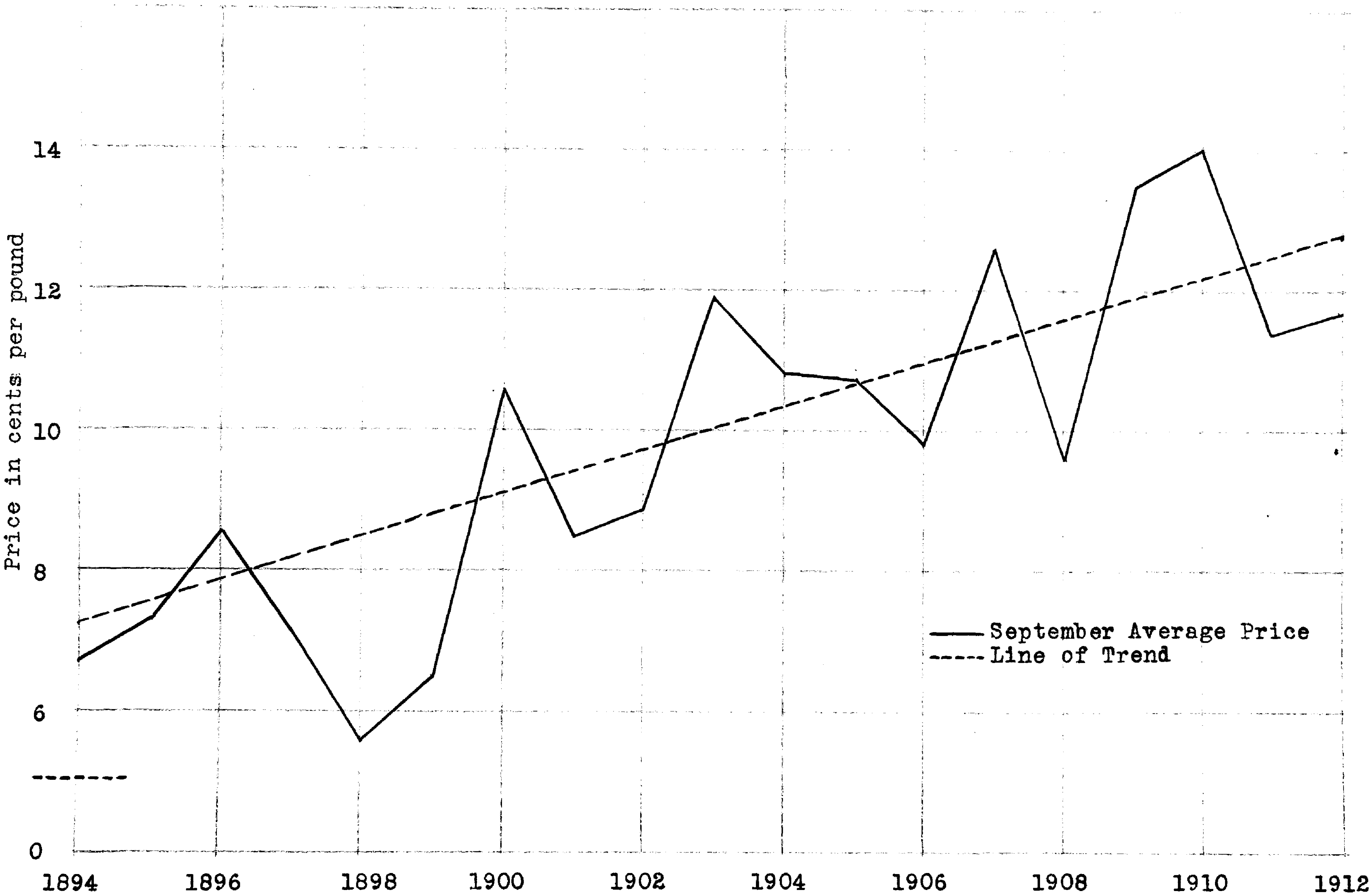
*Computed by the method of least squares.

Chart X. Straight Line Trend of August Spot Quotations for Middling Cotton at the New York Market, 1894--1912*



*Computed by the method of least squares.

Chart XI. Straight Line Trend of September Spot Quotations for Middling Cotton at the New York Market, 1894--1912*

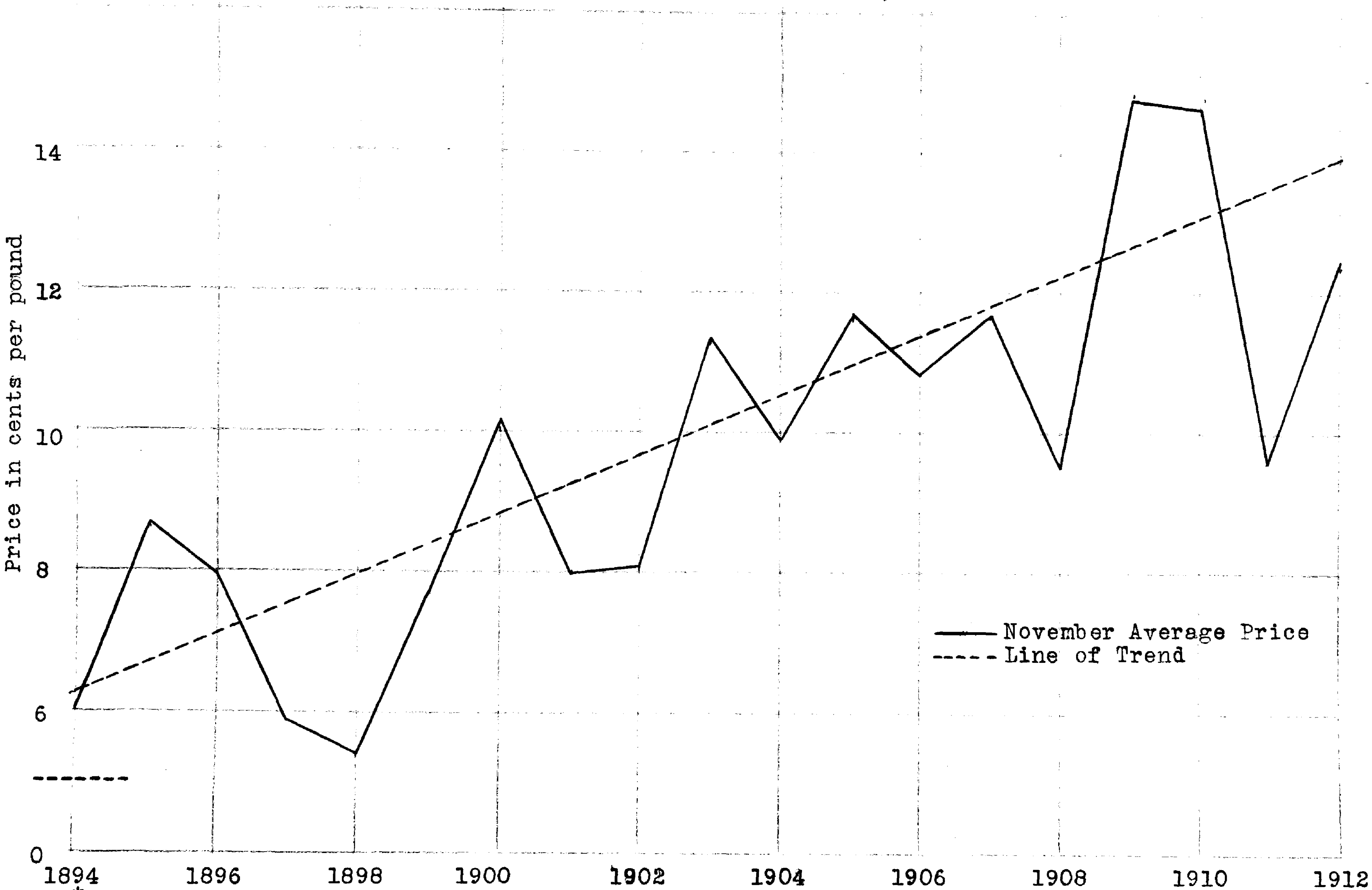


*Computed by the method of least squares.

Chart XII. Straight Line Trend of October Spot Quotations for Middling Cotton at the New York Market, 1894--1912*

*Computed by the method of least squares.

Chart XIII. Straight Line Trend of November Spot Quotations for Middling Cotton at the New York Market, 1894--1912*



*Computed by the method of least squares.

Chart XIV. Straight Line Trend of December Spot Quotations for Middling Cotton at the New York Market, 1894--1912*

*Computed by the method of least squares.

Yearly Spot Prices at New York, Liverpool and New Orleans

There is no consistent relationship between fluctuations in prices of American cotton at Liverpool and prices at the principal American markets. Table XVI shows the yearly average spot prices at New York, Liverpool, and New Orleans. Since 1900 the Liverpool prices at seven different times have reached a higher yearly average than the average of prices at the two American markets. It will be observed also that the margins in spot price changes bear no relation to changes at New York and New Orleans. The reasons for this lack of parity are quite complicated, but they center mainly around the fact that quotations for futures, upon which spots are based, at Liverpool do not fluctuate in sympathy with future quotations in America, and this situation is due to depressions in foreign markets, fluctuations in currency values, production changes in countries other than the United States, and increases or decreases in American production. The differences between spot quotations at New York and New Orleans are due to placement value, but differences in Liverpool prices over New York and New Orleans prices are due to conditions affecting the world's trade in cotton.

Table XVI. Yearly Average Price Per Pound for American Middling Cotton at Specified Markets, 1900--25*

Year	New York	Liverpool	New Orleans
	Cts. per lb.	Cts. per lb.	Cts. per lb.
1900	9.38	8.72	8.94
1901	8.73	8.07	8.40
1902	9.96	9.23	9.64
1903	12.84	11.73	12.49
1904	9.09	8.30	8.70
1905	11.30	10.05	10.97
1906	11.24	10.78	10.92
1907	11.53	10.46	11.41
1908	10.23	9.29	9.80
1909	14.66	13.28	14.33
1910	14.87	13.25	14.65
1911	10.85	10.29	10.85
1912	12.29	13.12	12.20
1913	13.21	14.20	13.12
1914	(1)	13.14	(1)
1915	11.98	11.55	11.68
1916	19.28	17.85	18.84
1917	29.68	32.24	28.96
1918	31.01	45.12	29.87
1919	38.29	36.28	38.21
1920	17.89	35.94	16.55
1921	18.92	15.02	17.92
1922	26.24	22.79	25.94
1923	31.11	31.37	30.33
1924	24.74	29.79	24.21
1925	20.53	25.54	19.71
1926 (2)	14.85	18.76	14.31

*Yearbook of the U.S.D.A., 1922, page 718, Table 233, 1924, page 759, Table 315, and page 756, Table 313, 1926, page 976, Table 254, page 974, Table 251, and page 975, Table 252, and unpublished records of the Bureau of Agricultural Economics, U.S.D.A.

(1) Market closed for three months.

(2) New York and New Orleans prices are averages of five months.

Standard Deviation of Monthly Spot Prices at New York

The standard deviation is a measure of the extent to which items deviate from their mean. In Table XVII are shown the standard deviation of monthly spot prices of cotton at the New York Market. The calculations are based on the percentage change of first differences. The magnitudes of these measures of dispersion decline from January to June, after which they increase. This indicates, to a certain extent, that there is a lower degree of causal relationship between production and price of cotton during the growing season than there is after the size of the crop is fairly accurately known. It is to be expected that deviations from the mean of prices for those months showing the greatest relationship to production will be greater than the deviations for those months showing a less degree of relationship, particularly since changes in production are not constant from year to year.

Table XVII. Standard Deviation of Monthly Cotton Prices at the New York Market, 1892--1912*

Month	Standard Deviation
January	32.53
February	27.90
March	27.92
April	25.26
May	22.41
June	17.47
July	20.00
August	22.00
September	23.87
October	23.71
November	26.07
December	32.20

*Computed from the square of the deviations from the mean of percentage changes.

Coefficients of Correlation Between Production and Price of Cotton

All coefficients of correlation between production and price of cotton are calculated by the percentage change of first difference method, with the exception of those in Table E, following Table XXIX. This method removes practically all the trend, which is an important analytical procedure in formulating estimating equations. In the calculations in Table E the Pearsonian method was used, since the sole aim is to show the general tendencies of price movements in relation to production since 1920.

Table XVIII shows the coefficients of correlation between production of cotton in the United States and yearly prices at New York, New Orleans, and Liverpool for different periods of time. Tables XIX to XXV, inclusive, show the results of analysis for the period 1893-1913 at New York; Tables XXVI to XXVIII, inclusive, show the results for the period 1900-13 at New York and New Orleans, and Table E shows the coefficients of correlation between production in the United States, India, and Egypt and prices at New York for the period 1920-27.

Particular attention is called to the differences in relationship between production and deflated prices and production and undeflated prices. Tables XXIII and XXIV bear out more fully the fallacies involved in attempting to remove from actual prices by deflation the changes in general price level. Cotton, itself, enters into the composite index number of the Bureau of Labor Statistics, but the changes in cotton prices from month to month do not bear the same relation to monthly price index numbers as the changes in index numbers bear to each other.

For each coefficient of correlation there is expressed the corresponding probable error, which means that if many similar samples were taken, half of the coefficients of correlation found would, on the average, if the differences between samples be due merely to random selection, fall within the range r plus or minus the probable error.

Table XVIII.
Coefficients of Correlation Between Cotton Production in the United States and Yearly Average Prices at Specified Markets*

Year	Market	Coefficient	Probable Error
Beginning with Jan. (1892-1912)	New York	-.568	.102
Beginning with Aug. (1892-1912)	New York	-.836	.045
Beginning with Aug. (1900-1913)	New York	-.812	.064
Beginning with Aug. (1900-1913)	New Orleans	-.820	.061
Beginning with Aug. (1900-1913)	Liverpool	-.759	.079

*Computed by the method of percentage change of first differences.

Note: All prices correlated are spot quotations for American middling cotton.

Table XIX.
Coefficients of Correlation Between Cotton Production in the United States and the Subsequent Prices of Cotton on the New York Market, 1892--1912*

Month	Coefficient of Correlation	Probable Error
January	-.857	.041
February	-.889	.032
March	-.831	.047
April	-.527	.109
May	-.699	.078
June	-.627	.093
July (1)	-.217	.146
August	-.309	.139
September	-.537	.108
October	-.685	.081
November	-.851	.041
December	-.871	.036

*Computed by the method of percentage change of first differences.

(1) July of the current harvest year.

Table XX.
Coefficients of Correlation Between Cotton Production in the United States and Monthly Deflated Cotton Prices, 1893--1913*

Month	Coefficient of Correlation	Probable Error
January	-.70	.07
February	-.79	.06
March	-.82	.05
April	-.76	.06
May	-.78	.06
June	-.60	.09
July (1)	-.22	.14
August (2)	-.31	.13
September	-.46	.12
October	-.60	.09
November	-.68	.08
December	-.75	.07

*Computed by the method of percentage change of first differences. Prices are spot quotations for middling cotton on the New York Market, and the index is of all commodities.
(1) July of the year following harvest.
(2) August of the current harvest year.

Table XXI.
Relation Between Cotton Production in the United States and January Deflated Cotton Prices Lagged One to Twelve Months, 1893--1913*

Lag	Coefficient of Correlation	Probable Error
One month Jan/Dec.	-.71	.07
Two months Jan/Nov.	-.69	.08
Three months Jan/Oct.	-.70	.08
Four months Jan/Sept.	-.73	.07
Five months Jan/Aug.	-.73	.07
Six months Jan/July	-.74	.07
Seven months Jan/June	-.73	.07
Eight months Jan/May	-.75	.06
Nine months Jan/April	-.75	.06
Ten months Jan/March	-.75	.06

(Continued on next page)

Eleven months Jan/Feb.	-.76	.06
Twelve months Jan/Jan.	-.75	.06

*Prices are spot quotations for middling cotton on the New York Market deflated with the B.L.S. index number of all commodities, 1913 as base. Coefficients of Correlation are computed by the method of percentage change of first differences.

Table XXII.
Coefficients of Correlation Between Cotton Production in the United States and Monthly Cotton Prices Deflated with Farm Products Indices, 1893--1913*

Month	Coefficient of Correlation	Probable Error
January	-.71	.08
February	-.78	.06
March	-.78	.06
April	-.78	.06
May	-.74	.06
June	-.59	.10
July (1)	-.41	.13
August (2)	-.32	.14
September	-.51	.11
October	-.62	.09
November	-.68	.08
December	-.74	.06

*Computed by the method of percentage change of first differences. Prices are spot quotations for middling cotton on the New York Market, and indices are expressed on a 1913 base.
(1) July of the year following harvest.
(2) August of the current harvest year.

Table XXIII.
Coefficients of Correlation Between Cotton Production in the United States and Subsequent Index Numbers of all Commodities, 1892-1913*

Month	Coefficient of Correlation	Probable Error
January	-.274	.140
February	-.167	.146
March	-.205	.144
April	-----	----
May	-----	----
June	.294 (1)	.138
July	.242 (1)	.142
August	-.495	.114
September	-----	----
October	-----	----
November	-.312	.135
December	-.244	.142

*Computed by the method of percentage change of first differences.

(1) Positive coefficient.

Table XXIV.
Coefficients of Correlation Between Yearly Index Numbers of all Commodities and the Subsequent Prices of Cotton, 1892--1913*

Month	Coefficient of Correlation	Probable Error
January	.551	.107
February	.567	.105
March	.360	.134
April	.363	.134
May	.305	.136
June	.482	.119
July	----	----
August	----	----
September	----	----
October	-.361 (1)	.134
November	----	----
December	-.301 (1)	.140

*Computed by the method of percentage change of first differences. Prices are spot quotations for middling cotton on the New York Market.

(1) Negative coefficient.

Table XXV.
Coefficients of Correlation Between December Cotton Prices and Preceding Index Numbers of all Commodities, 1892---1913*

Month	Coefficient of Correlation	Probable Error
November	----	----
October	----	----
September	----	----
August	.615	.094
July	.619	.095 (1)
June	.464	.121

*Computed by the method of percentage change of first differences. Prices are spot quotations for middling cotton at the New York Market.

(1) Probable error higher than for the month of August because the coefficient is computed from 19 pairs of items, whereas the August coefficient is computed from 20 pairs.

Table XXVI.
Coefficients of Correlation Between Cotton Production in the United States and Spot Quotations at the New York Market, 1900--13*

Month	Coefficient of Correlation	Probable Error
January	-.825	.061
February	-.836	.054
March	-.821	.061
April	-.591	.121
May	-.744	.084
June	-.481	.144
July (1)	-.496	.134
August (2)	-.525	.135
September	-.615	.116
October	-.542	.135
November	-.729	.088
December	-.868	.047

*Computed by the method of percentage change of first differences. Spot quotations are prices for middling cotton.

(1) July of the current harvest year.
(2) August of the current harvest year.

Table XXVII.
Coefficients of Correlation Between Cotton Production in the United States and Prices at the New Orleans Market, 1900--13*

Month	Coefficient of Correlation	Probable Error
January	-.892	.069
February	-.826	.060
March	-.818	.062
April	-.799	.067
May	-.554	.128
June	-.461	.135
July (1)	-.398	.162
August (2)	-.554	.128
September	-.545	.131
October	-.567	.127
November	-.733	.086
December	-.837	.056

*Computed by the method of percentage change of first differences. Prices are spot quotations for middling cotton.

(1) July of the current harvest year.
(2) August of the current harvest year.

Table XXVIII.
Coefficients of Correlation Between Cotton Production in the United States and Deflated Cotton Prices at the New York Market, 1900--13*

Month	Coefficient of Correlation	Probable Error
January	-.768	.077
February	-.815	.062
March	-.807	.065
April	-.809	.065
May	-.779	.073
June	-.602	.112
July (1)	-.373	.161
August (2)	-.557	.128
September	-.743	.084
October	-.503	.135
November	-.773	.073
December	-.902	.036

*Computed by the method of percentage change of first differences. Prices deflated with B.L.S. index number, 1890-99 base.

(1) July of the current harvest year.
(2) August of the current harvest year.

Table XXIX.
Coefficients of Correlation Between Monthly Prices of Cotton at New York and Total Cotton Production of the United States, India, and Egypt, 1900--13*

Month	Coefficient of Correlation	Probable Error
January	-.840	.055
February	-.825	.061
March	-.813	.064
April	-.591	.121
May	-.715	.091
June	-.357	.163
July (1)	-.597	.125
August	-.601	.119
September	-.663	.105
October	-.458	.148
November	-.674	.102
December	-.876	.044

*Computed by the method of percentage change of first differences. Prices are spot quotations for middling cotton.

(1) July of the current harvest year.

Table E.
Coefficients of Correlation Between Cotton Production in the United States and the Subsequent Prices of Cotton on the New York Market, 1920--27*

Month	Coefficient of Correlation	Probable Error
January	-.52	.18
February	-.49	.19
March	-.50	.19
April	-.49	.19
May	-.58	.17
June	-.60	.16
July	-.55	.18
August	-.50	.19
September	-.49	.19
October	-.51	.18
November	-.50	.19
December	-.52	.18

*Computed by the Pearsonian Method. Compare coefficients with similar coefficients in Table XIX. It will be noted that the same general relationships exist between production and subsequent monthly spot prices despite the abnormal economic conditions that have prevailed since the World War. The prices for the months of October, November, and December are for the current harvest year, while prices for all other months are for the year following the harvest year. In 1921 cotton production in the United States decreased 41 per cent. as compared with 1920, while prices for the crop year rose 5.4 per cent. In 1924 the cotton crop increased 71 per cent. over 1921, and the price for the crop year increased 31 per cent. over 1921. In calculating the above coefficients no correction has been made for the changes in the value of gold.

Predictive Formulas

The predictive formulas in Table XXX are developed from the equation y = Ay minus bAx plus bx, in which y is the percentage change in price, Ay the average of percentage change in price, x the percentage change in production, Ax the average of percentage change in production, and b the coefficient of regression of y on x, calculated by dividing the standard deviation of the y series by the standard deviation of the x series and then multiplying by the coefficient of correlation between x and y. The constant, Ay minus bAx, is determined by subtracting from the average of the y series the product of the coefficient of regression and the average of the x series. With the constant value determined, the estimate for any one month is made by adding to the constant the product of the coefficient of regression and the percentage change in x. The regression coefficient has a minus value because, normally, the y series moves in opposite direction from the x series.

Attention is called to the fact that for months in which the prices show the highest degree of relationship to current production the constant values are greatest.

Table XXX. Predictive Formulas.

Time	Formula
January	y = -1.379x plus 14.03
February	y = -1.252x plus 12.58
March	y = -1.182x plus 12.80
April	y = - .681x plus 4.79
May	y = - .864x plus 9.52
June	y = - .570x plus 6.75
July	y = - .210x plus 7.04
August	y = - .326x plus 5.10
September	y = - .545x plus 7.68
October	y = - .774x plus 8.26
November	y = - .941x plus 8.42
December	y = -1.409x plus 14.19
Year Beginning with August	y = - .901x plus 9.11

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In the above formulas the significance of the various factors is as follows: y = the percentage change in price: x = the percentage change in production: the numbers are constants.

Price Change Estimates

Tables XXXI to XLIII, inclusive, show the actual percentage changes in yearly and monthly spot prices of cotton and the changes as estimated by means of the dynamic laws of demand for cotton expressed in the predictive formulas in Table XXX. It will be seen that there is a tendency for the more nearly accurate estimates to be associated with the high constant values in the predictive formulas, which, themselves, tend to be associated with high minus values of regression. It is to be observed in this connection that the approach to accuracy tends to vary directly with the magnitude of the regression coefficient.

Table XLIV shows the average differences between actual and estimated changes in New York spot prices. In no case, it will be observed, is the error as great as 1 per cent., taking the period as a whole. The highest average per cent. of error occurs in July, the month for which prices and production show the lowest degree of negative relationship[1]. It necessarily follows that the lower degree of approach to accuracy in any estimate will be associated with a low degree of causal relationship between dependent and independent variables.

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[1] See Table XIX for coefficients of correlation from which regression coefficients were calculated.

Table XXXI.
The Actual Percentage Changes in Yearly Average Prices of Cotton and the Changes as Predicted.

Year	Actual Percentage Change	Predicted Percentage Change
1892-93		
1893-94	- 8.17	- 2.08
1894-95	-17.55	-14.69
1895-96	25.66	31.00
1896-97	- 4.48	- 8.10
1897-98	-16.55	-15.86
1898-99	-12.50	6.71
1899-00	49.28	23.08
1900-01	12.08	1.62
1901-02	- 6.62	15.60
1902-03	12.91	1.43
1903-04	30.06	15.79
1904-05	-29.57	-23.70
1905-06	25.19	28.31
1906-07	- 1.14	-13.87
1907-08	4.28	23.80
1908-09	-12.41	- 8.20
1909-10	43.40	31.10
1910-11	1.43	- 5.29
1911-12	-27.28	-22.82
1912-13	13.58	20.55

New York spot quotations for Middling cotton.

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Table XXXII.
The Actual Percentage Changes in January Cotton Prices and the Changes as Predicted

Year	Actual Percentage Change	Predicted Percentage Change
1893	26.40	42.00
1894	-15.70	- 3.29
1895	-27.90	-22.85
1896	44.80	48.11
1897	-12.80	-12.65
1898	-17.90	-24.67
1899	3.50	10.26
1900	28.30	37.08
1901	29.70	2.43
1902	-18.60	22.15
1903	7.70	- 2.31
1904	61.30	24.22
1905	-50.30	-36.82
1906	67.50	43.79
1907	- 8.80	-21.59
1908	9.10	36.80
1909	-18.70	-12.79
1910	53.30	48.11
1911	.20	- 8.32
1912	-36.10	-35.14

New York spot quotations for Middling cotton.

Table XXXIII.
The Actual Percentage Changes in February Cotton Prices and the Changes as Predicted.

Year	Actual Percentage Change	Predicted Percentage Change
1893	28.20	36.00
1894	-14.90	- 2.94
1895	-28.80	-20.46
1896	43.60	43.13
1897	-11.40	-11.33
1898	-13.70	-22.10
1899	5.30	9.20
1900	33.70	33.24
1901	10.80	2.19
1902	-10.50	20.22
1903	10.90	2.07
1904	55.00	21.72
1905	-47.60	-32.99
1906	44.20	39.25
1907	- 5.90	-19.35
1908	9.80	32.98
1909	-14.70	-11.46
1910	48.40	43.13
1911	- 2.70	- 7.45
1912	-27.90	-31.49

New York spot quotations for Middling cotton.

Table XXXIV.
The Actual Percentage Changes in March
Cotton Prices and the Changes as Predicted

Year	Actual Percentage Change	Predicted Percentage Change
1893	31.70	36.80
1894	-14.90	- 1.85
1895	-18.10	-18.40
1896	24.80	41.64
1897	- 6.30	- 9.77
1898	-14.90	-19.94
1899	3.70	9.61
1900	52.10	32.30
1901	-11.80	2.99
1902	5.40	20.01
1903	9.30	- 1.03
1904	60.40	21.43
1905	-48.11	-30.22
1906	40.90	37.98
1907	- 1.30	-17.34
1908	- 1.50	32.06
1909	-11.40	- 9.89
1910	53.50	41.64
1911	- 3.30	- 6.11
1912	-26.10	-28.80

New York spot quotations for Middling cotton.

Table XXXV.
The Actual Percentage Changes in April Cotton Prices and the Changes as Predicted

Year	Actual Percentage Change	Predicted Percentage Change
1893	14.60	18.62
1894	- 6.50	- 3.65
1895	-11.40	-13.19
1896	18.10	21.41
1897	- 6.30	- 8.21
1898	-15.60	-14.07
1899	- 1.70	2.95
1900	58.80	56.03
1901	-14.40	- .86
1902	12.00	8.94
1903	12.30	- 3.18
1904	35.70	9.76
1905	-45.10	-20.00
1906	49.10	39.39
1907	- 4.90	-12.58
1908	- 9.40	15.89
1909	4.00	- 8.28
1910	43.50	41.40
1911	- 1.10	- 6.11
1912	-24.90	-19.18

New York spot quotations for Middling cotton.

Table XXXVI.
The Actual Percentage Changes in May Cotton Prices and the Changes as Predicted

Year	Actual Percentage Change	Predicted Percentage Change
1893	6.40	27.06
1894	- 7.10	- 1.19
1895	- 3.30	-13.29
1896	17.10	30.60
1897	- 6.20	- 6.98
1898	-17.20	-14.41
1899	- 1.00	7.19
1900	52.50	23.72
1901	-15.70	2.35
1902	16.80	14.79
1903	20.40	- .59
1904	17.80	15.83
1905	-39.30	-21.83
1906	45.20	27.92
1907	1.00	-12.51
1908	- 8.60	23.60
1909	3.60	7.07
1910	36.20	30.60
1911	2.50	- 4.30
1912	-26.90	-20.08

New York spot quotations for Middling cotton.

Table XXXVII.
The Actual Percentage Changes in June Cotton Prices and the Changes as Predicted.

Year	Actual Percentage Change	Predicted Percentage Change
1893	4.50	18.32
1894	- 6.70	- .31
1895	- 1.90	- 8.29
1896	8.40	20.65
1897	- 1.00	- 4.13
1898	-16.40	- 9.04
1899	- 3.80	5.21
1900	44.60	36.16
1901	- 6.90	- 2.02
1902	11.60	10.23
1903	29.00	.08
1904	- 2.10	2.59
1905	-25.00	-14.00
1906	25.30	18.89
1907	16.20	- 7.79
1908	-10.80	16.04
1909	- 1.20	- 4.19
1910	32.00	20.66
1911	3.90	- 2.31
1912	-25.50	-13.31

New York spot quotations for Middling cotton.

Table XXXVIII.
The Actual Percentage Changes in July Cotton Prices and the Changes as Predicted.

Year	Actual Percentage Change	Predicted Percentage Change
1893	9.80	11.30
1894	-11.40	4.43
1895	- .90	1.50
1896	2.70	12.16
1897	9.80	3.03
1898	- 9.90	1.22
1899	- .10	6.57
1900	64.30	10.51
1901	-14.10	5.34
1902	8.10	8.32
1903	36.10	4.58
1904	-13.60	8.57
1905	.80	.60
1906	- .80	11.51
1907	19.70	1.68
1908	-15.60	10.46
1909	16.20	3.06
1910	23.20	12.16
1911	-11.10	3.68
1912	- 9.40	- .35

New York spot quotations for Middling cotton.

Table XXXIX.
The Actual Percentage Changes in August Cotton Prices and the Changes as Predicted

Year	Actual Percentage Changes	Predicted Percentage Change
1893	5.20	- .06
1894	- 8.70	- 3.51
1895	9.20	13.05
1896	5.60	11.33
1897	0.00	- 3.93
1898	-26.20	4.22
1899	5.60	10.48
1900	57.30	2.39
1901	-15.90	7.09
1902	8.70	1.29
1903	42.30	7.48
1904	-14.60	- 6.77
1905	.30	12.04
1906	- 5.70	- 3.21
1907	.80	10.41
1908	-23.20	- 1.16
1909	24.50	13.05
1910	27.30	- .11
1911	-24.10	- 6.38
1912	- 2.80	9.24

New York spot quotations for Middling cotton.

Table XL.
The Actual Percentage Changes in September Cotton Prices and the Changes as Predicted.

Year	Actual Percentage Change	Predicted Percentage Change
1893	11.70	.93
1894	-17.70	- 6.71
1895	9.90	20.97
1896	15.20	- 2.72
1897	-17.10	- 7.42
1898	-20.60	6.21
1899	17.40	16.67
1900	59.50	3.16
1901	-20.30	11.00
1902	6.50	1.31
1903	32.40	11.66
1904	- 7.70	-12.15
1905	-. .70	19.28
1906	- 9.90	- 6.21
1907	28.40	16.56
1908	-25.20	- 2.78
1909	41.60	20.98
1910	4.50	- 1.04
1911	-18.70	-11.50
1912	4.60	14.60

New York spot quotations for Middling cotton.

Table XLI.
The Actual Percentage Changes in October Cotton Prices and the Changes as Predicted.

Year	Actual Percentage Change	Predicted Percentage Change
1893	2.90	- 1.34
1894	-27.40	-12.17
1895	49.00	27.15
1896	-11.10	- 6.25
1897	-20.80	-13.18
1898	-14.30	6.17
1899	34.80	21.03
1900	25.80	1.84
1901	-15.10	12.98
1902	4.50	- .79
1903	10.20	13.91
1904	6.80	-19.91
1905	13.00	25.74
1906	6.90	-11.74
1907	.40	20.87
1908	-11.80	- 6.60
1909	51.40	27.15
1910	4.30	- 4.12
1911	-32.80	-18.98
1912	15.00	18.09

New York spot quotations for Middling cotton.

Table XLII.
The Actual Percentage Changes in November Cotton Prices and the Changes as Predicted.

Year	Actual Percentage Change	Predicted Percentage Change
1893	-11.50	- 3.24
1894	-29.20	-16.42
1895	15.60	31.38
1896	- 8.80	- 9.45
1897	-25.40	-17.65
1898	- 8.20	5.88
1899	33.70	23.95
1900	28.60	.61
1901	-18.80	14.16
1902	1.20	- 2.69
1903	38.80	15.29
1904	-11.30	-25.83
1905	15.90	28.46
1906	- 6.00	-15.57
1907	9.10	23.75
1908	-12.80	- 9.65
1909	57.50	31.38
1910	- .10	- 6.63
1911	-36.20	-14.70
1912	31.20	20.37

New York spot quotations for Middling cotton.

Table XLIII.
The Actual Percentage Changes in December Cotton Prices and the Changes as Predicted.

Year	Actual Percentage Change	Predicted Percentage Change
1893	-19.00	- 3.28
1894	-27.60	-13.01
1895	46.20	48.57
1896	-13.75	-12.72
1897	-18.15	-24.84
1898	- 3.39	10.39
1899	34.40	37.44
1900	33.00	2.50
1901	-16.90	22.78
1902	1.77	- 2.30
1903	50.93	24.48
1904	-40.82	-37.10
1905	58.00	44.19
1906	-12.35	-21.74
1907	12.30	37.16
1908	-22.78	-12.86
1909	65.60	48.56
1910	- 1.53	- 8.35
1911	-37.20	-35.41
1912	37.80	32.79

New York spot quotations for Middling cotton.

Table XLIV. Comparison of Averages of Actual and Predicted Percentage Changes in Cotton Prices*

Time	Average of Actual Changes (%)	Average of Predicted Changes (%)	Difference (plus or minus %)
Year beginning with August	4.08	4.22	.14
January	5.19	4.87	-.32
February	4.40	4.60	.20
March	4.86	5.06	.20
April	4.85	5.07	.22
May	4.62	4.65	.03
June	3.67	3.43	-.24
July	4.95	5.79	.84
August	3.28	3.84	.56
September	4.66	4.64	-.02
October	4.58	4.00	-.58
November	3.16	3.67	.51
December	6.33	6.87	.54

*Based on data for 19 years in tables XXXI to XLIII, inclusive, representing changes in spot quotations for middling cotton at the New York Market.

Graphic Presentation of Actual and Estimated Changes in Price

Charts XV to XXVII, inclusive, present more clearly the conception of estimates of price changes as influenced by size of crop. The actual percentage changes and the changes as estimated are plotted together, and the reader can readily see the degree of approach to accuracy. These changes are plotted in terms of percentages, since the coefficients of correlation were calculated by the percentage change of first difference method. They are, for that reason, the quantities in which we are most interested.

These charts show graphically the data presented in Tables XXXI to XLIII, inclusive. Here, again, will be observed the fact that the greatest degree of approach to accuracy of estimate is attained after the size of the crop is known. From planting time until the probable size of the subsequent crop is known there is less tendency for high or low prices to be associated with preceding low or high production. This is simply an example of the concept involved in the economic laws of supply, potential supply, and demand, and it illustrates the principle that for short periods of time prices are determined by factors other than elements of cost.

Chart XV.
The Actual Percentage Changes in Yearly Average Prices of Cotton, Year Beginning with August, and the Percentages as Predicted, 1894--1913.

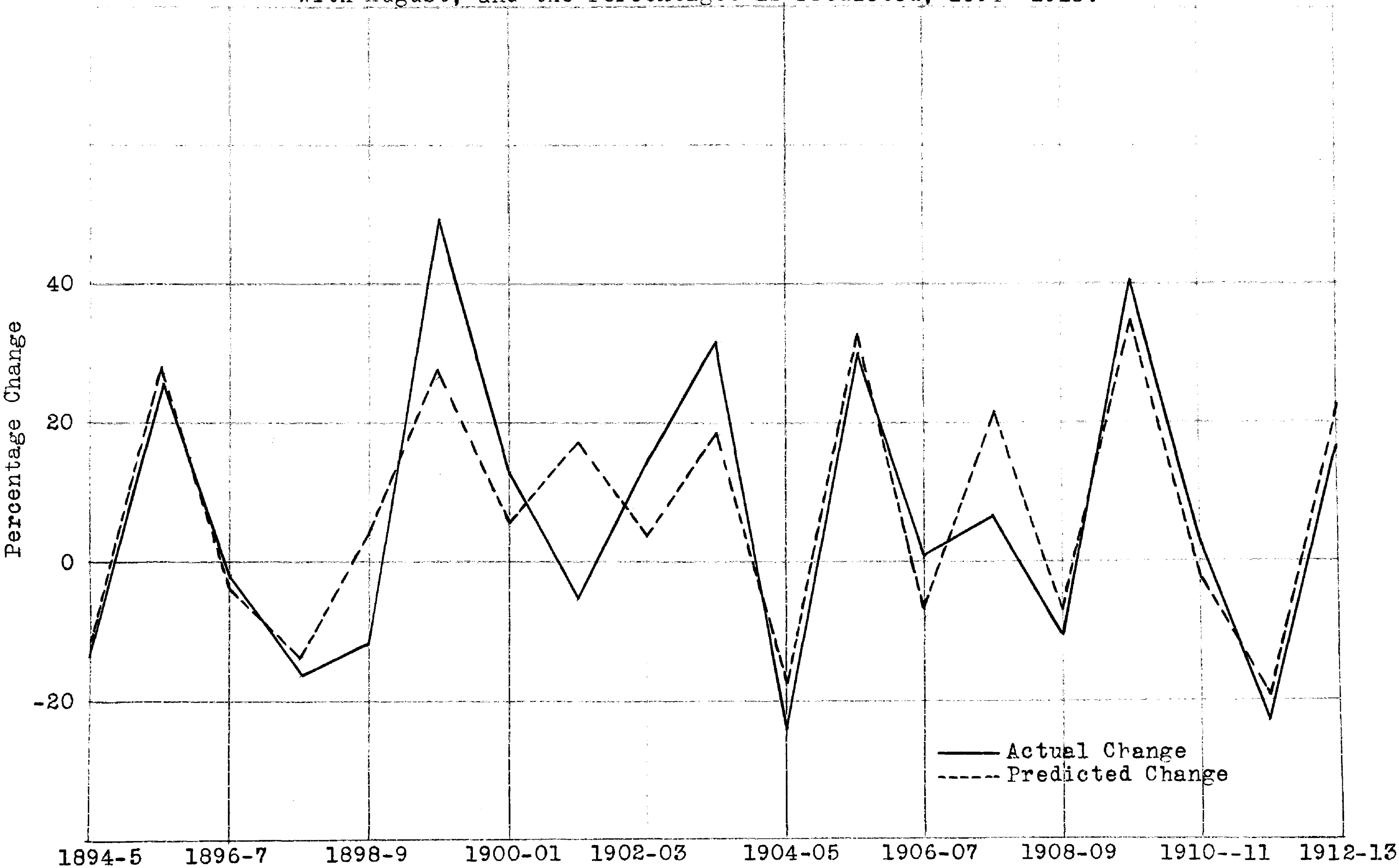


Chart XVI. The Actual Percentage Changes in January Prices of Cotton and the Percentages as Predicted, 1894--1912.

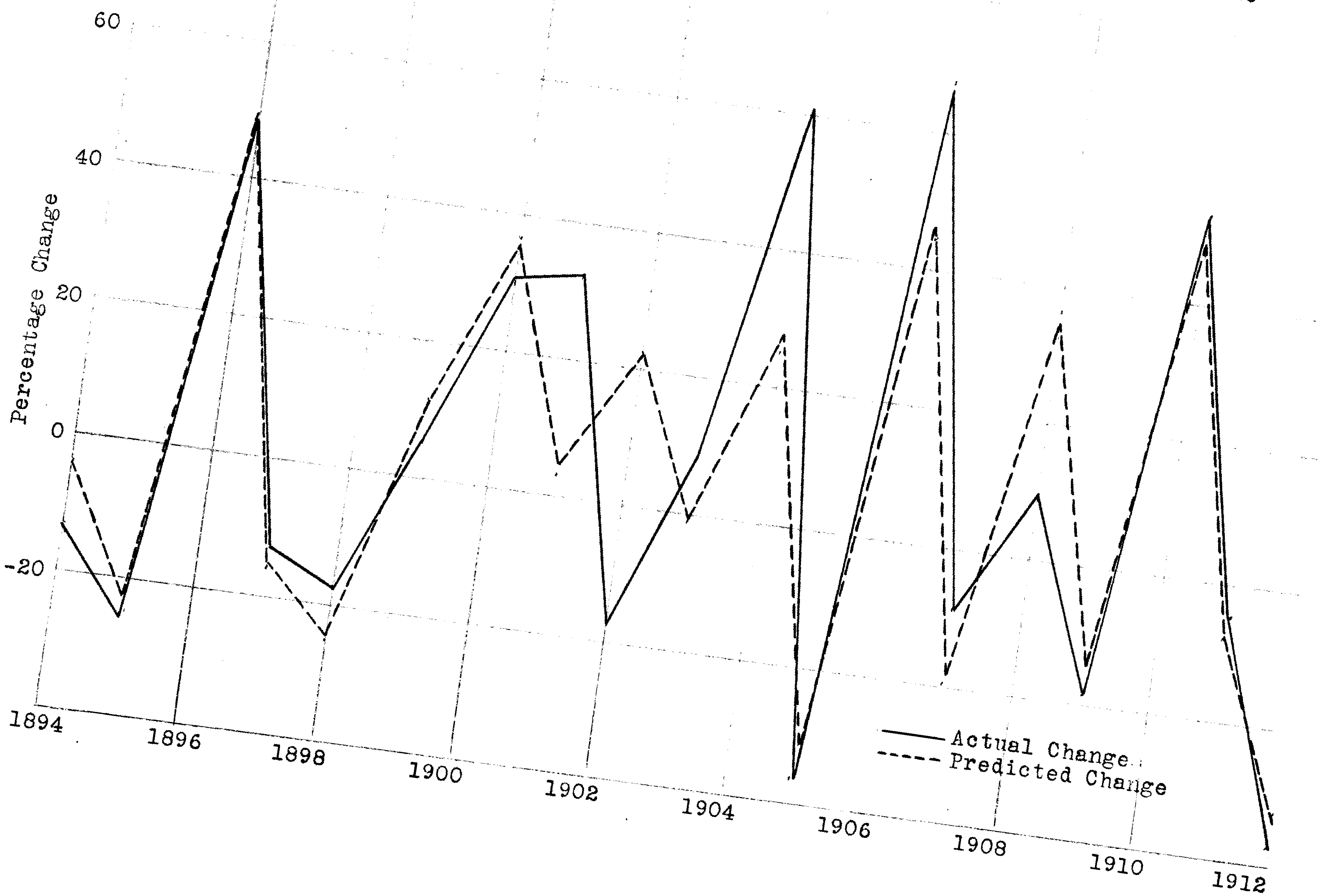


Chart XVII. The Actual Percentage Changes in February Prices of Cotton and the Percentages as Predicted, 1894--1912.

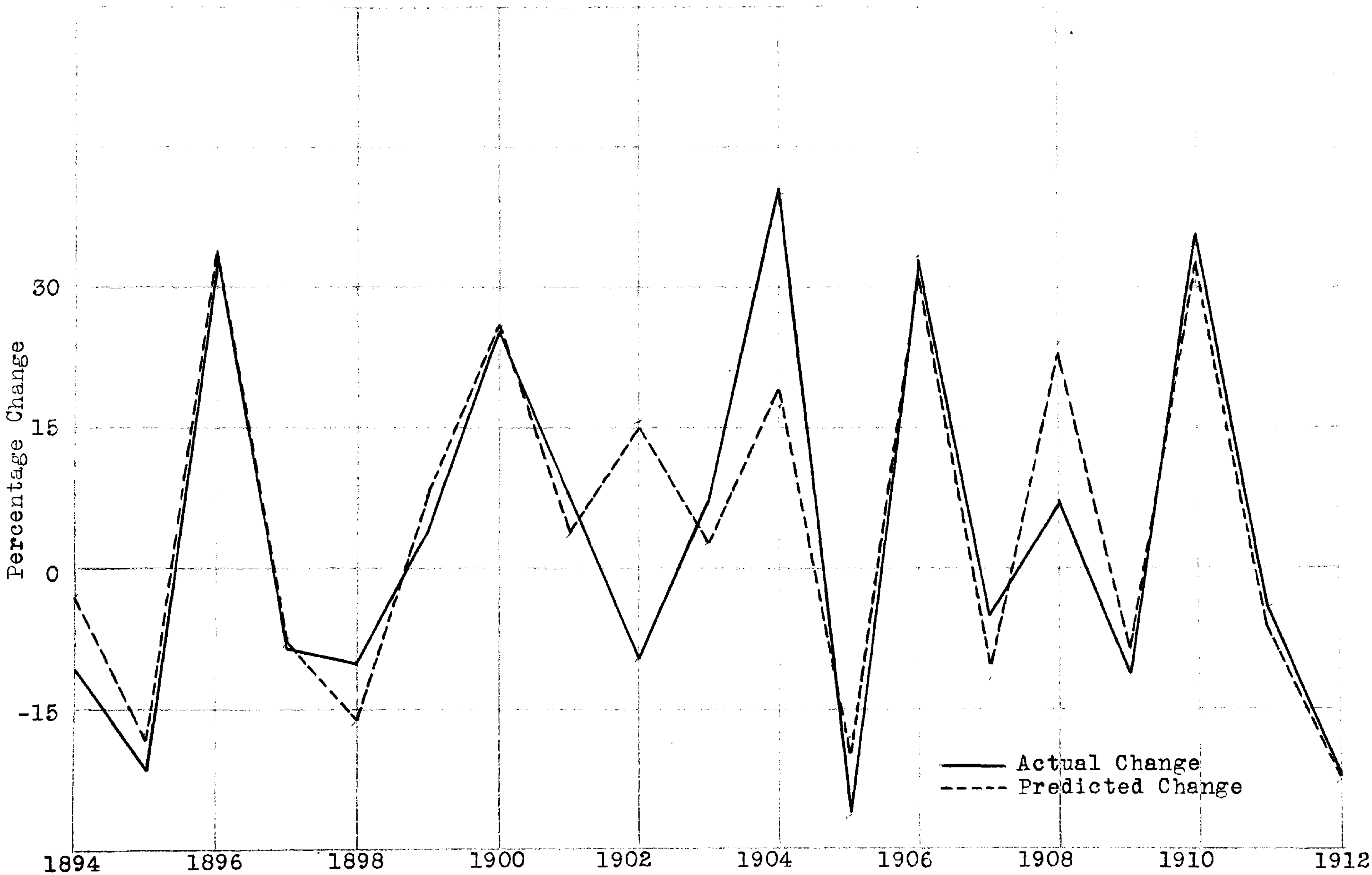


Chart XVIII. The Actual Percentage Changes in March Prices of Cotton and the Percentages as Predicted, 1894--1912

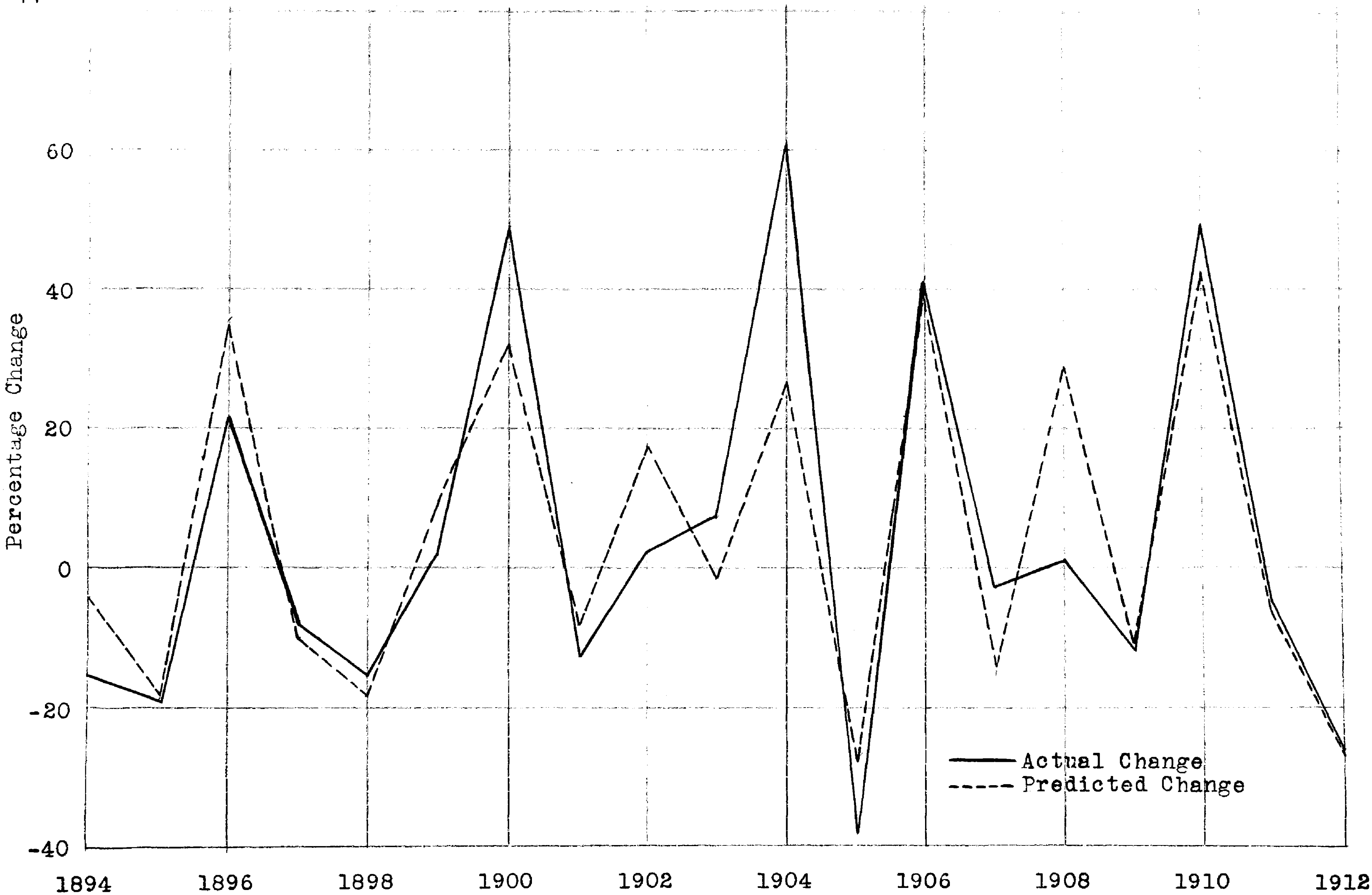


Chart XIX. The Actual Percentage Changes in April Prices of Cotton and the Percentages as Predicted, 1894--1912.

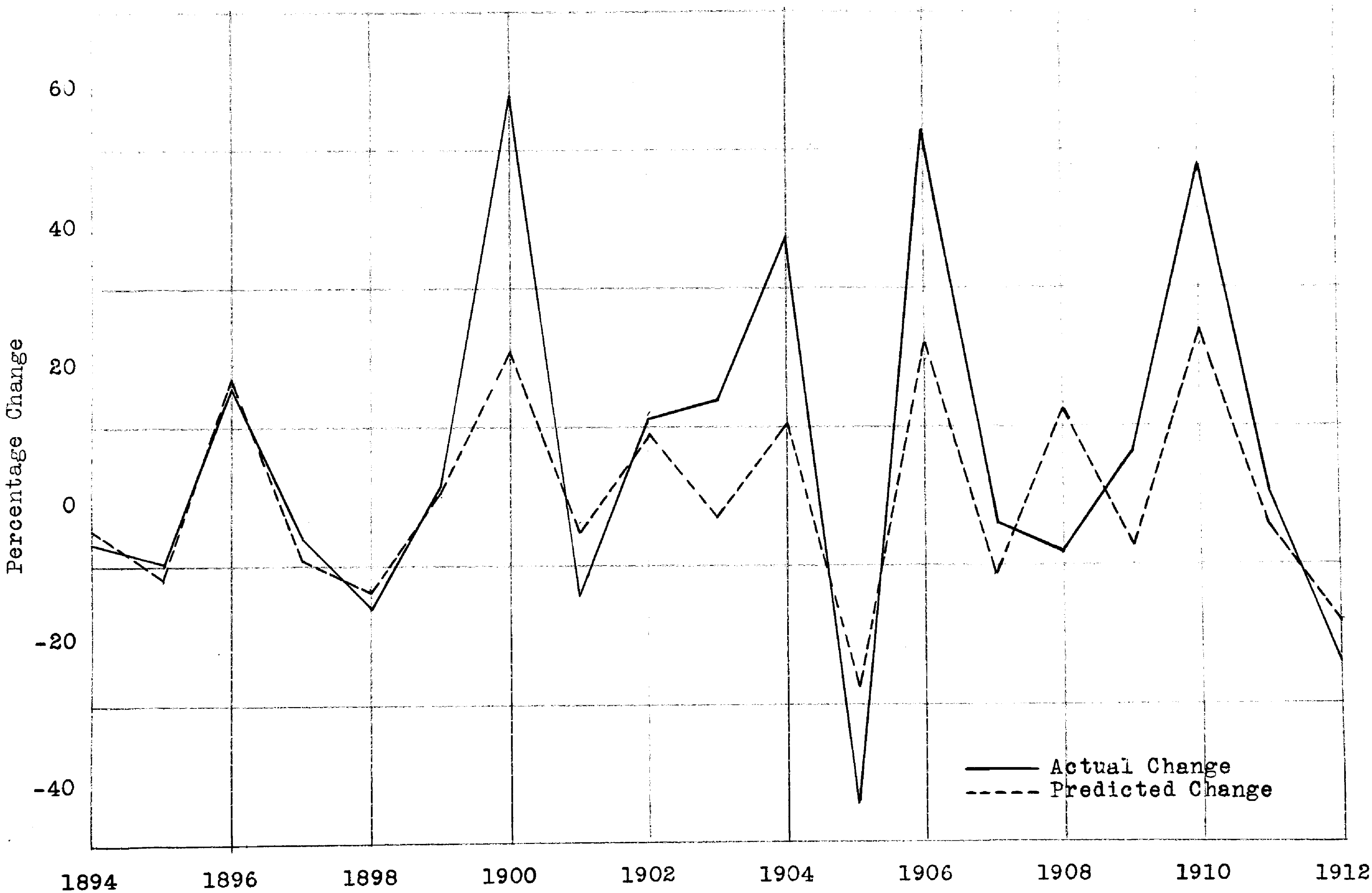


Chart XX. The Actual Percentage Changes in May Prices of Cotton and the Percentages as Predicted, 1894--1912.

Chart XXI. The Actual Percentage Changes in June Prices of Cotton and the Percentages as Predicted, 1894--1912.

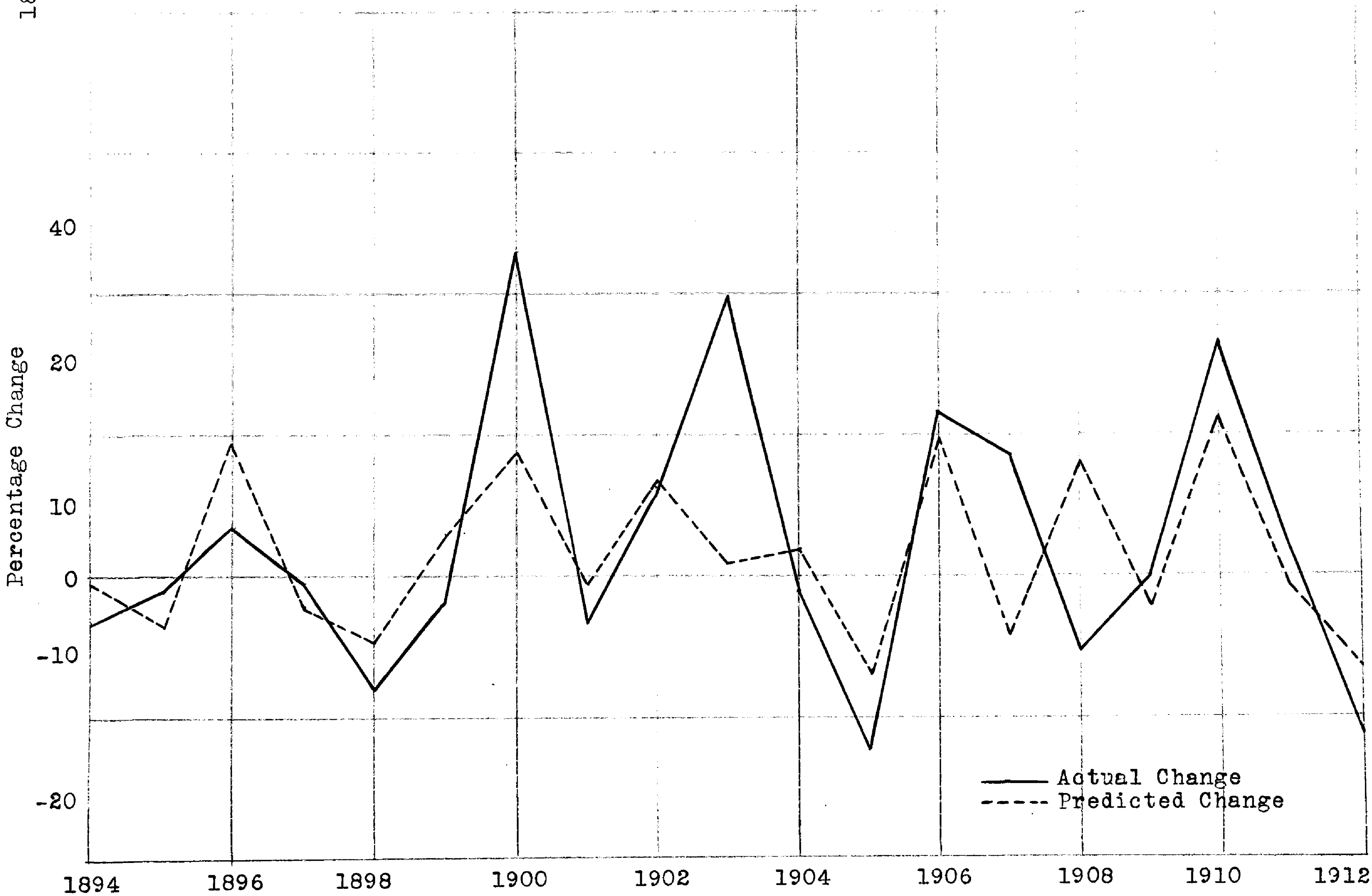


Chart XXII. The Actual Percentage Changes in July Prices of Cotton and the Percentages as Predicted, 1894--1912.

Chart XXIII. The Actual Percentage Changes in August Prices of Cotton and the Percentages as Predicted, 1894--1912.

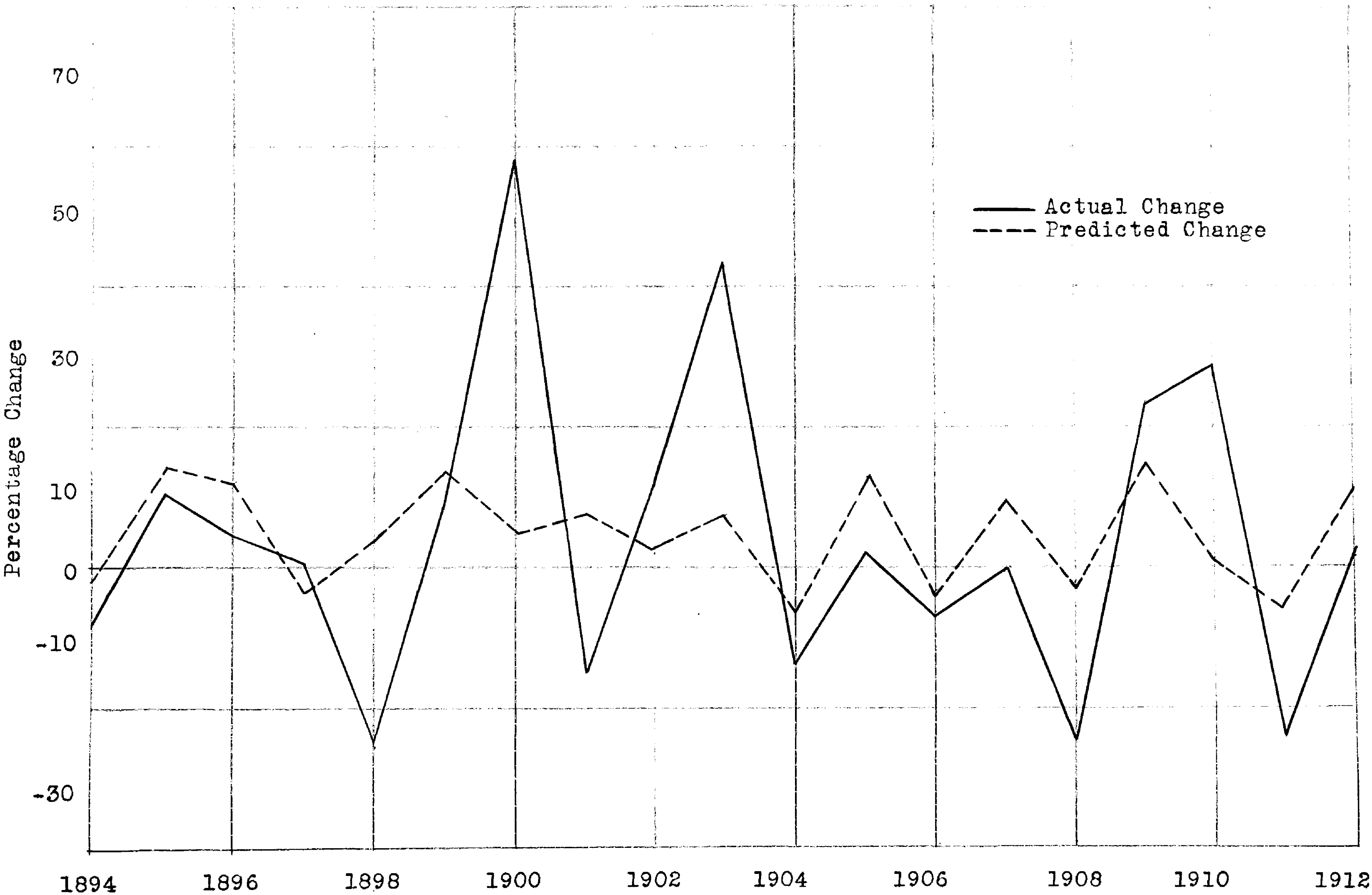


Chart XXIV. The Actual Percentage Changes in September Prices of Cotton and the Percentages as Predicted, 1894--1912.

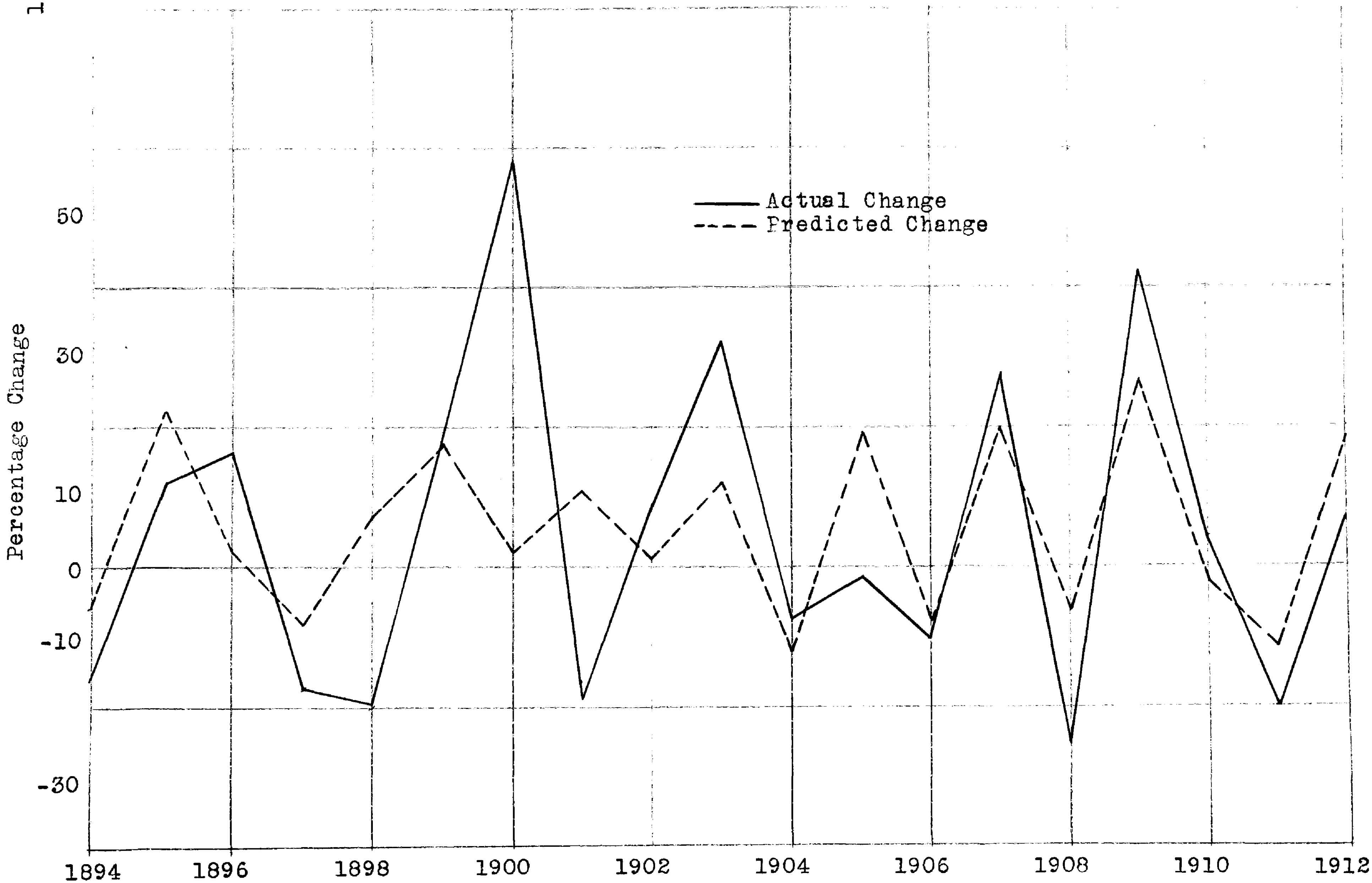


Chart XXV. The Actual Percentage Changes in October Prices of Cotton and the Percentages as Predicted, 1894--1912.

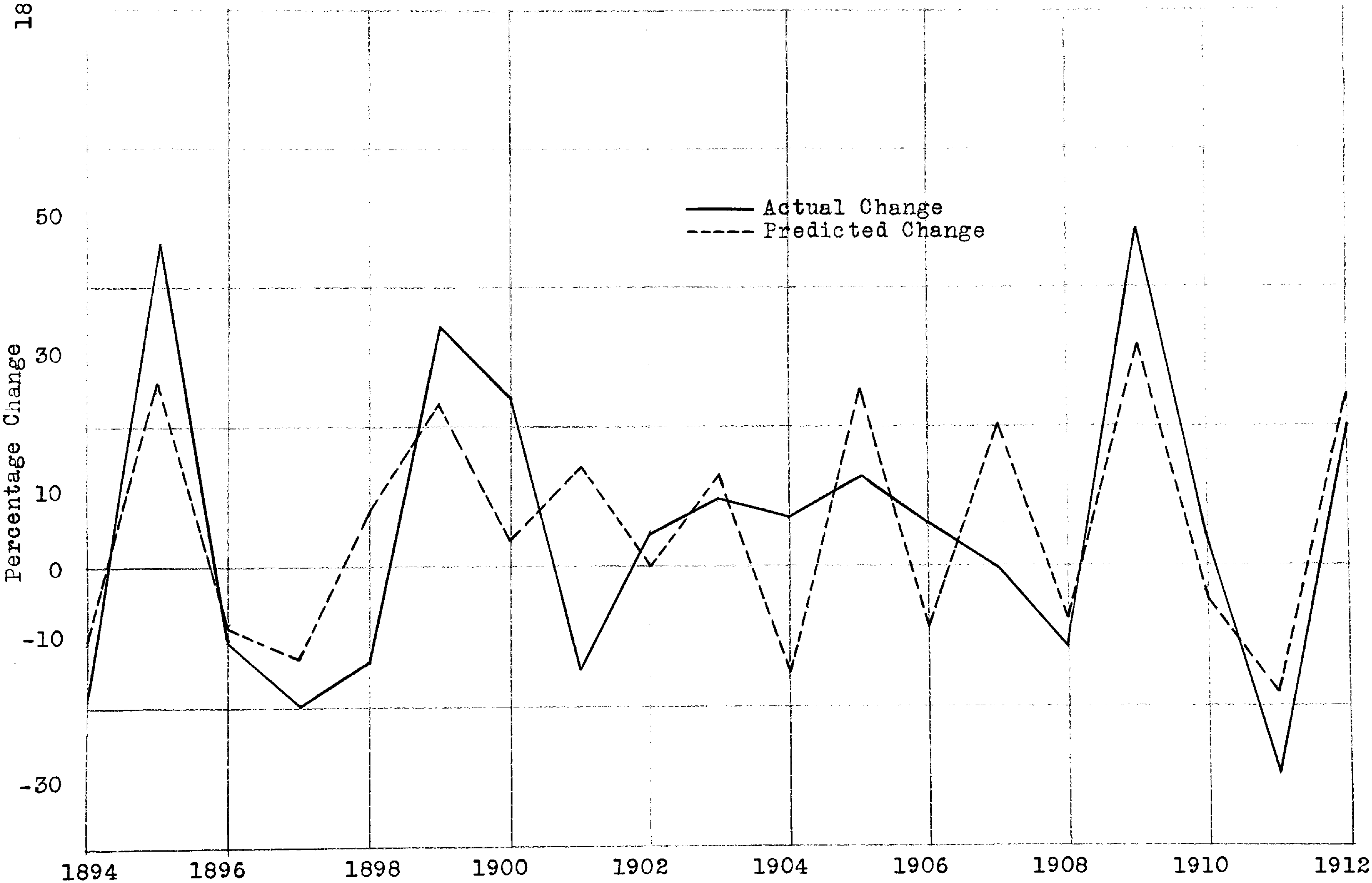


Chart XXVI. The Actual Percentage Changes in November Cotton Prices and the Percentages as Predicted, 1894--1912.

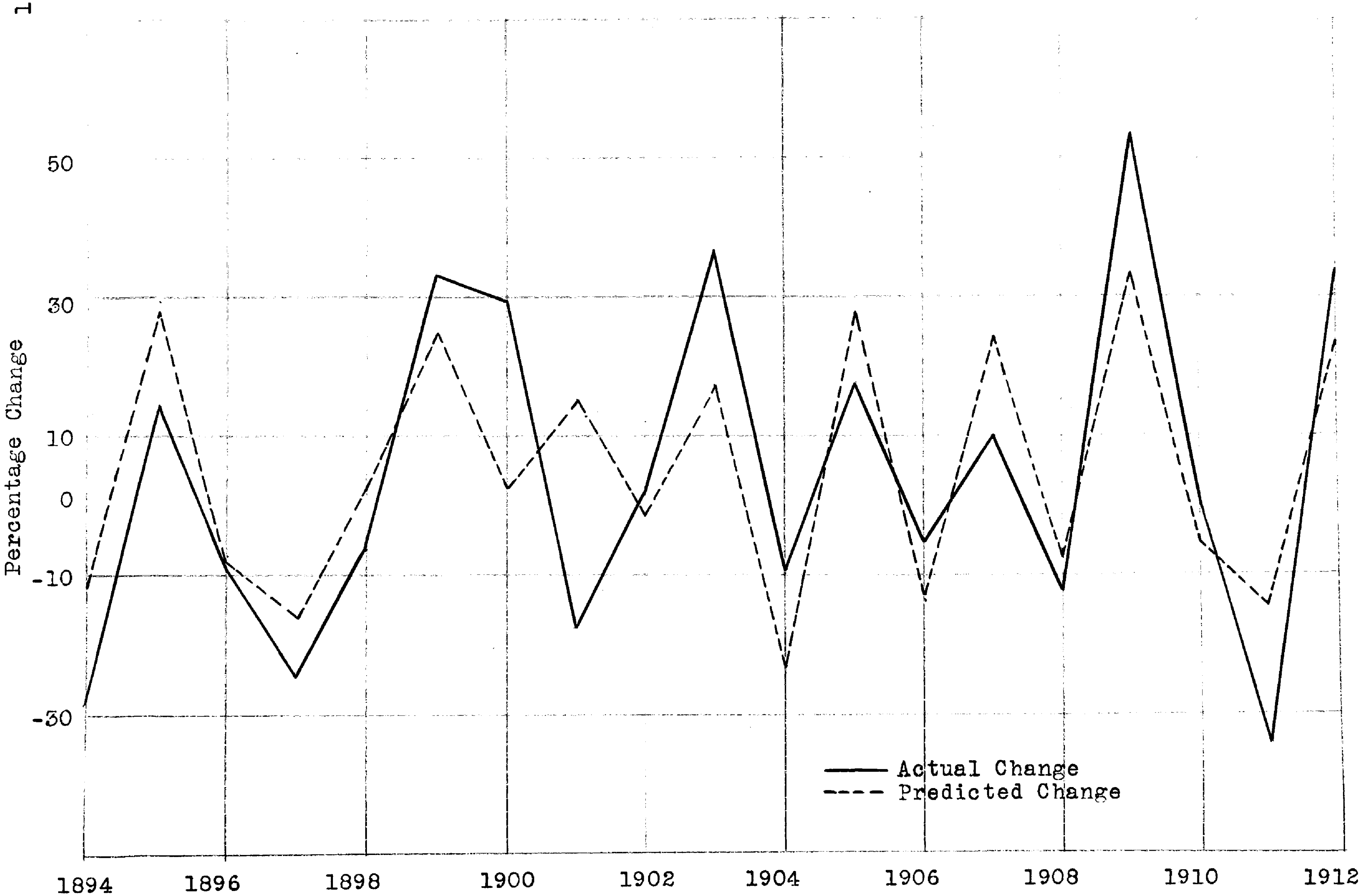
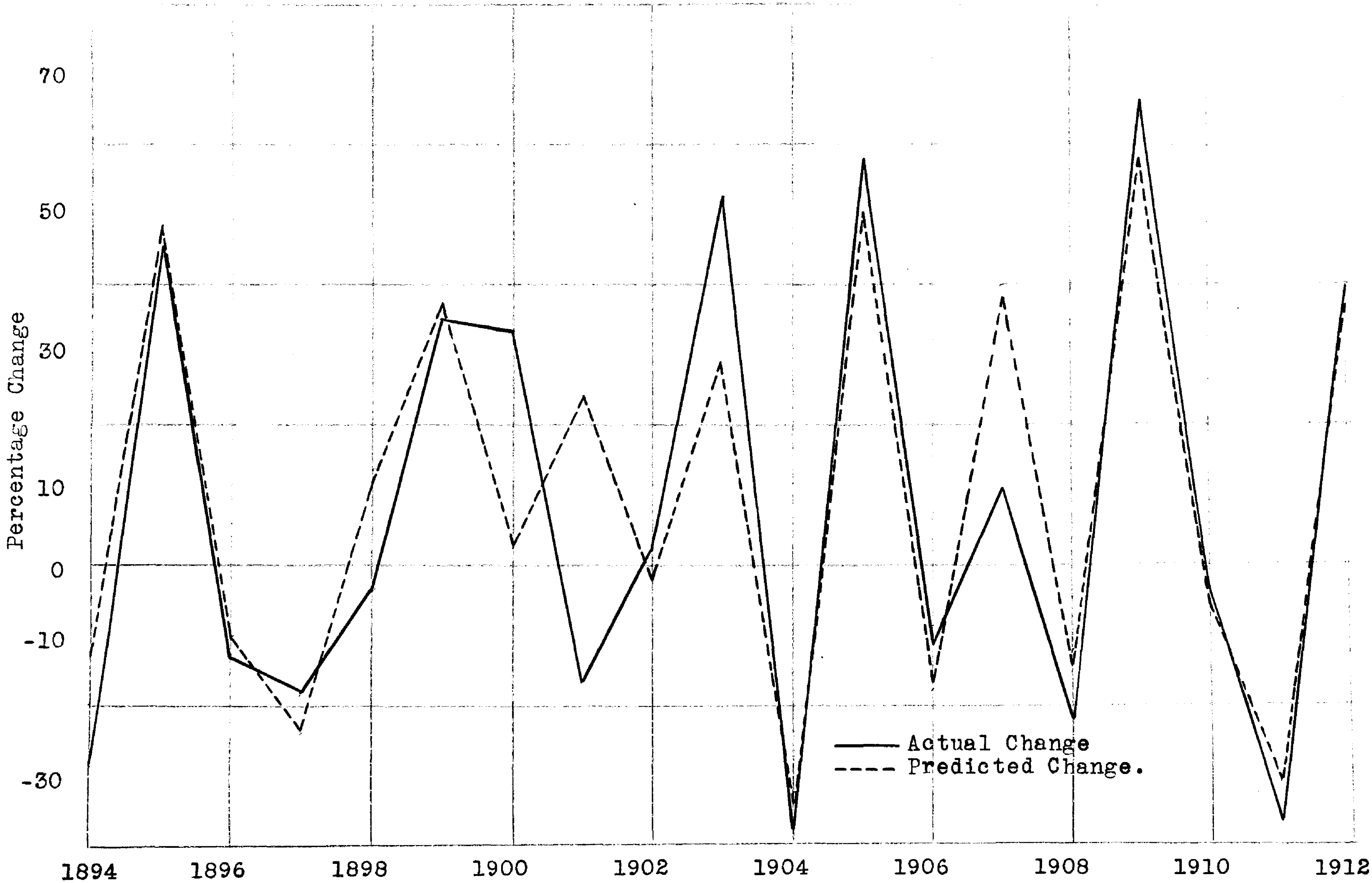


Chart XXVII. The Actual Percentage Changes in December Prices of Cotton and the Percentages as Predicted, 1894--1912.



Standard Errors of Estimate of Price Changes

The standard errors of estimate in Table XLV are expressions of the degree of accuracy of price change estimates as made by the predictive formulas in Table XXX. These measures have significance in that when a distance equal to the standard error is laid off on each side of the mean in a normal or only slightly skewed distribution about two-thirds of the estimates will be included.

The standard error is calculated by extracting the square root of the mean-square-deviations of estimated changes from actual changes. It is significant to note that the magnitudes of the standard errors of estimate in Table XLV are less than the standard deviations of actual changes in Table XVII, meaning that the estimated percentage changes deviate less from the actual changes than the actual changes deviate from their respective means. The reader will observe further that the difference between standard error and standard deviation diminishes from time of planting of the cotton crop to the time that the probable size of the current crop is indicated or known. This implies that there is likely to be less degree of accuracy in price predictions for the latter months of the harvest year, since potential current production, even as soon as the acreage planted is known to the cotton trade, exerts an influence upon price.

Table XLV.
The Standard Errors of Estimate of Monthly Cotton Prices, 1892-1912*

Month	Standard Error
January	16.71
February	13.77
March	15.63
April	17.60
May	14.44
June	14.22
July	18.54
August	21.82
September	19.52
October	16.09
November	18.00
December	22.13

*Computed from the differences between the actual and predicted percentage changes in cotton prices as shown in tables XXXI to XLIII, inclusive.

Factors Related to Cotton Prices

Cotton prices, being a component part of the composite index of general price level, are generally directly related to prices of other commodities. In the case of certain prices this direct relationship is particularly marked, especially with such commodities as are used for the same purposes as cotton, and those that reflect general business conditions as a whole.

Table XLVI shows the coefficients of correlation between monthly wool prices and the subsequent monthly prices of cotton. These expressions of relationship show that five to seven months after a rise or fall in the price of wool a corresponding rise or fall may be anticipated in the price of cotton. The same general degree of relationship prevails between silk prices and subsequent prices of cotton, the latter being lagged five to seven months. The reader, however, will not construe these associated relationships to mean there is an equal degree of causal relationship between the factors. The extent, if any, to which wool and silk are substituted for cotton involves the concept of consumer preference and effective demand, as well as the tendency toward increased consumption of rayon. As a matter of fact, the per capita consumption of all these materials---cotton--wool--silk--rayon---has tended to increase, and it would require a very detailed and comprehensive analysis of market conditions to determine the extent to which the demand for one is reflected in the price of another.

Table XLVII shows the coefficients of correlation between industrial stocks and the prices of cotton thirteen months later. These are expressions of relationship between one type of general business conditions and cotton prices, showing that a change in prices of industrial stocks is not evidenced to any great extent in cotton prices until about a year later. This is graphically shown in Chart XXVIII.

Other measures of general business conditions are reflected in bank clearings and pig iron production. Cotton prices tend to move simultaneously with the former, and with a lag of about seven months with the latter. Table XLVIII shows the coefficients of correlation between monthly pig iron production in the United States and monthly cotton prices. It will be observed that on an average the latter are associated with the former to approximately the same degree as with the prices of industrial stocks.

Table XLVI
Relation Between Monthly Wool Prices and the Subsequent Monthly Prices of Cotton, 1900-13*

Month	Coefficient of Correlation Between Wool Prices and the Subsequent Prices of Cotton	Number of Months lag
January	.55	7
February	.64	6
March	.72	5
April	.55	6
May	.70	7
June	.73	6
July	.66	4
August	.63	3
September	.70	2
October	.67	1
November	.48	0
December	.41	8

*Coefficients have been computed by the method of percentage change of first differences, and they are based on wool prices at the Boston Market as published in the 1924 U.S.D.A. Yearbook, page 958, Table 569, and deflated spot quotations for middling cotton at New York. In this analysis the coefficients of correlation between wool prices and the subsequent prices of cotton have been computed for each of the twelve months following the specified month, and it has been shown that a rise in cotton prices follows 5 to 7 months after a rise in wool prices. The relationship between silk prices and the subsequent prices of cotton, together with the lag in the latter, is approximately the same as in the case of wool prices. Aside from the influences involved in general business conditions there is probably little causal relationship between changes in cotton prices and prices of the so-called cotton substitutes.

Table XLVII
Relation Between Monthly Prices of Industrial Stocks and the Subsequent Monthly Prices of Cotton, 1900--13*

Month	Coefficient of Correlation with Cotton Prices Lagged Thirteen Months
January	.53
February	.58
March	.70
April	.68
May	.58
June	.31
July	.37
August	.52
September	.36
October	.41
November	.63
December	.66

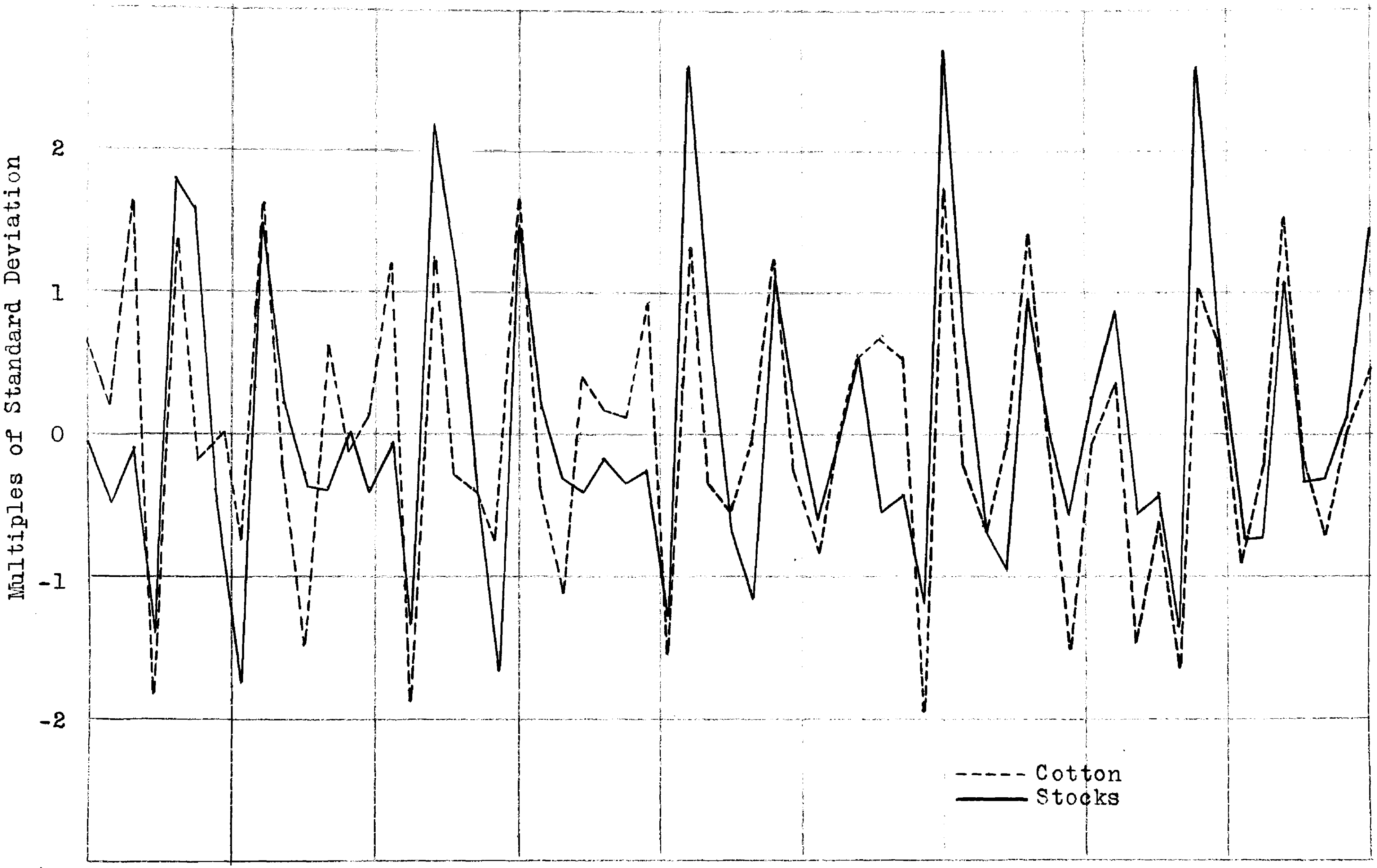
*Original prices of stocks taken from Harvard Review of Economic Statistics, Preliminary Volume Number I, 1924, page 167. Cotton prices are the deflated spot quotations for middling cotton at New York. The coefficients of correlation are computed by the method of percentage change of first differences. It will be seen that cotton prices tend to follow the stock market with a lag of approximately thirteen months. Higher coefficients of correlation than those above were obtained from different lags, but as an average a lag of thirteen months seems to show the highest relationship. Other measures of general business conditions are pig iron production and bank clearings. Cotton prices move with a lag of about seven months with the former, and almost simultaneously with the latter.

Table XLVIII.
Relation Between Monthly Pig Iron Production in the United States and the Subsequent Monthly Prices of Cotton, 1900--13*

Month	Coefficient of Correlation Between Pig Iron Production and Subsequent Cotton Prices	Number of Months Lag
January	.76	12
February	.74	8
March	.63	9
April	.59	8
May	.79	6
June	.73	12
July	.76	5
August	.75	6
September	.67	6
October	.51	8
November	.43	9
December	.80	12

*Original data on pig iron production furnished by the New York State Chamber of Commerce. Cotton prices correlated are deflated spot quotations for middling upland at New York. The coefficients of correlation, computed by the method of percentage change of first differences, show that cotton prices tend to follow pig iron production with a lag of approximately seven months on the average. That is, cotton prices tend toward a marked rise or fall in normal times about seven months after pig iron production increases or decreases. The number of months lag simply means that by such a method of correlating the highest degree of relationship can be expressed. It does not mean that the relationship is not in evidence before that time.

Chart XXVIII. Relation Between Prices of Industrial Stocks and the Subsequent Prices of Cotton, 1900-13*



*Plotted in terms of the multiples of standard deviation, with cotton lagged thirteen months. There is a tendency for cotton prices to move with the stock market about a year after the fluctuations in prices of stock. Another measure of general business conditions is pig iron production. Cotton prices tend to move with pig iron production with a lag of about seven months.

Cotton Acreage Harvested

Before attempting to measure the relationship existing between acreage of cotton harvested and prices prevailing prior to planting time it is necessary to reduce the factors to a common denominator. A satisfactory expression is the percentage change of first difference in terms of the multiples of standard deviation of each corresponding variable. Table XLIX shows the multiples of standard deviation of cotton acreage harvested in the United States for the years 1908-24, inclusive. These multiples are the expressions of the extent to which the percentage change in acreage of each individual year deviates from the mean of the percentage changes for the entire series of years, and they are calculated by dividing the standard deviation of percentage changes into each percentage change as expressed in terms of deviation from the mean.

The reduction of individual items in a series to terms of multiples of standard deviation is a very convenient procedure in analysis involving large numbers, since the ultimate calculations are greatly facilitated. It is a method by which the extent of changes in acreage as influenced by prices received for the preceding crop may be readily measured, inasmuch as changes in price and acreage are expressed in like terms.

Table XLIX.
Multiples of Standard Deviation of Cotton Acreage Harvested in the United States, 1907-24*

Year	Multiples of Standard Deviation
1907	
1908	.184
1909	- .771
1910	.313
1911	1.065
1912	- .800
1913	.710
1914	- .314
1915	- 1.936
1916	1.080
1917	- .613
1918	.505
1919	- 1.019
1920	.561
1921	- 1.964
1922	.723
1923	1.195
1924	1.084

*Based on original data in Table III and calculated from the deviations of percentage changes of first differences from their mean.

Acreage Value

The acreage of cotton planted and harvested in any one year is influenced somewhat by the acreage value of the lint of the preceding year as compared with acreage value of other crops. While cotton is the major cash crop of the South as a whole, southern farmers do have certain alternatives, and the extent to which the value of cotton per acre is less than the per acre value of crops that can be substituted is partly reflected in a decreased subsequent acreage of cotton planted. Likewise, the prediction that a relatively high acreage value of cotton will be followed by increased plantings is about as safe as any that can be made in the field of agriculture. Table L shows the December first farm value of cotton and the subsequent acreage of cotton harvested in the United States for the years 1882-1927, inclusive. It will be observed that there is a tendency toward direct relationship between the two series. A high value of lint tends to be associated with a relatively large acreage in the following year, and a low value tends to be associated with a relatively low acreage.

While there is a very marked direct relationship between December first farm value and subsequent acreage harvested, there is even greater evidence of relationship when acreage value on the basis of monthly spot quotations is compared with the extent of the next year's acreage. The December first farm value is not a true index to the returns actually received by the producer for his cotton crop, and the quotations as of the first of the month may not reflect the true market situation in regard to price. For example, a high or low value on December first would be reflected in a high or low value per acre, while prior to December first, when, on an average, about 53 per cent. of the current crop is marketed by farmers, the price of lint may have been very different from the price at the beginning of December. It is, therefore, quite proper to state that the tendency toward direct relationship is greater between acreage value of lint on the basis of spot prices for the months in which most of the cotton is sold and subsequent acreage of cotton harvested than the relationship between December first value and acreage.

In Table LI are shown the multiples of standard deviation of the value of cotton per acre as expressed on the basis of the average of New York and New Orleans spot quotations for Middling cotton (1). These multiples are calculated from the deviations of percentage changes of first differences from their mean. About 92 per cent. of the cotton crop of the United States is of the upland short-staple varieties, and the quotation for Middling, which is grade number 5, is considered by the cotton trade as a true index to the cotton price situation.

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(1) The trial and error method of analysis has shown that more satisfactory results can be obtained from the average of prices at the two markets than from the prices at either New York or New Orleans taken singly.

The multiples of standard deviation in Table LI, therefore, reflect very satisfactorily the acreage value of cotton in terms of spot prices, the changes in purchasing power of money being ignored.

A comparison of Tables XLIX and LI will show that in most cases the plus or minus values of the multiples of standard deviation of value per acre are associated with plus or minus values of acreage of cotton harvested, indicating a direct relationship between the two factors. In most cases where plus or minus values are not associated in the two series the product of the multiples of standard deviation approach a minimum, indicating again a tendency toward direct relationship.

Table L
Farm Value of Cotton Per Acre Based on December First Price and Acreage Subsequently Harvested, 1882-1927*

Year	Farm Value Per Acre December First	Acreage Harvested in Year Following Specified Year (000 omitted)
1882	$16.93	16,778
1883	14.96	17,440
1884	14.13	18,301
1885	13.76	18,455
1886	13.65	18,641
1887	15.61	19,059
1888	15.33	20,175
1889	13.64	19,512
1890	16.06	19,059
1891	12.99	15,911
1892	17.42	19,525
1893	10.50	23,688
1894	8.96	20,185
1895	11.82	23,273
1896	12.30	24,320
1897	12.20	24,967
1898	12.63	24,327
1899	13.41	24,933
1900	18.58	26,774
1901	12.48	27,175
1902	14.85	27,052
1903	19.10	31,215
1904	19.33	27,110
1905	21.02	31,374
1906	20.26	29,660
1907	19,39	32,444
1908	17.73	30,938
1909	22.55	32,403
1910	25.32	36,045
1911	19.08	34,283
1912	23.83	37,089
1913	23.26	36,832
1914	14.91	31,412

(See next page)

Table L. (Continued)

Year	Farm Value Per Acre December First	Acreage Harvested in Year Following Specified Year (000 omitted)
1915	$20.10	34,985
1916	32.08	33,841
1917	46.28	36,008
1918	46.20	33,566
1919	60.62	35,878
1920	26.02	30,509
1921	21.11	33,036
1922	35.03	37,123
1923	42.34	41,360
1924	37.26	46,053
1925	30.90	47,087
1926	20.87	40,168
1927	31.20	

*Value for the years 1882-1908, inclusive, tabulated and calculated from data in Yearbook of the U.S.D.A., 1919, page 590, Table 125. Value for years 1909-27, inclusive, tabulated from records of the U.S.D.A. Acreage figures are taken from Table II of this report. There is a high degree of relationship between acre value of the crop and acreage of cotton subsequently harvested, but a coefficient of correlation calculated from such relationship is not as satisfactory in formulating a predictive equation as the coefficient of correlation between deflated average spot prices at the New York and New Orleans Markets for certain months. There are several reasons for this, chief among which are the following: a high value per acre might be due to a high yield and consequent low price per pound, and a low value per acre might be the result of a low yield per acre and a price which is not correspondingly high. Then, on the technical side, the mean of percentage changes of first differences of deflated prices is less than the mean of undeflated prices, and undeflated prices are necessarily used in calculating the values per acre.

Table LI.
Multiples of Standard Deviation of the Value of Cotton Per Acre on the Basis of the Average of New York and New Orleans Middling Spot Quotations for Various Series of Months, 1906-23*

Year	Multiples of Standard Deviation		
	Sept., Oct., Nov., Dec.	Oct., Nov., Dec., Jan., Feb.	Sept., Oct., Nov., Dec., Jan., Feb., Mar.
1906			
1907	- .345	- .518	- .362
1908	- .807	- .701	- .722
1909	.511	.493	.455
1910	.202	.192	.150
1911	- .891	- .948	- .791
1912	.107	.096	.052
1913	- .028	.147	- .095
1914	-1.584	-1.586	-1.391
1915	.649	.860	.428
1916	1.193	.953	1.024
1917	1.744	1.940	2.035
1918	.277	.016	- .007
1919	.317	.429	.481
1920	-1.601	-1.694	-1.737
1921	-1.687	-1.462	-1.474
1922	1.325	1.292	1.624
1923	.621	.491	.331

*Based on data in Tables II, V, and XIV, and calculated from the deviations of percentage changes of first differences from their mean.

Table LI. (Continued)

Year	Multiples of Standard Deviation		
	Nov., Dec., Jan., Feb.	Oct., Nov., Dec.	Nov., Dec., Jan.
1906			
1907	- .457	- .539	- .446
1908	- .642	- .728	- .666
1909	.479	.549	.548
1910	- .032	.076	.001
1911	- .913	-1.038	- .993
1912	.309	.268	.420
1913	- .254	- .108	- .341
1914	-1.225	-1.553	-1.291
1915	.399	.761	.534
1916	.847	1.085	.960
1917	1.836	1.616	1.704
1918	- .467	- .123	- .373
1919	.832	.562	.781
1920	-1.979	-1.871	-1.946
1921	- .946	-1.345	-1.054
1922	1.892	1.422	1.795
1923	.319	.525	.367

Table LI. (Continued)

Year	Multiples of Standard Deviation	
	Nov., Dec.	Dec., Jan.
1906		
1907	- .424	- .399
1908	1.875	- .579
1909	-1.263	.359
1910	.036	- .056
1911	- .927	- .776
1912	.439	.197
1913	- .246	- .398
1914	-1.272	-1.021
1915	.608	.205
1916	.955	.567
1917	.448	2.133
1918	- .220	- .658
1919	.676	.878
1920	-1.795	-1.918
1921	-1.006	- .741
1922	1.584	2.038
1923	.501	.171

Undeflated Average Prices

In order to perfect the expressions of relationship between cotton prices and acreage of cotton subsequently harvested it is necessary to carry the analysis further than the calculations of per acre values on the basis of average monthly spot prices. While, as a normal sequence, an increased planting is subsequent to a high acreage value of lint, it is not always the case. In the years 1906, 1908, 1911, and 1920, for example, the value of lint cotton per acre on the basis of September, October, November, and December Middling spot prices, the months during which about two-thirds of the total cotton crop is marketed by producers, was relatively high, and yet there was a decrease in the acreage of each subsequent year. The high values in these years were due to high yields, which were followed by low prices. The latter, though compensated by high yields, were the factors influencing the farmer's decision to plant cotton, and the value per acre was of secondary importance. In the case of a low yield the value per acre on the basis of the average of September, October, November, and December spot prices and price per pound for the season are both relatively high, as in 1922 and 1923, and, for convenience, the subsequent increase in acreage planted and harvested may be considered as having been encouraged by the total returns received by the producer for his crop. As a fact, however, in economic analysis the price per pound is regarded as the determining psychological factor, since a high or low price tends in a greater degree to be followed by increased or decreased plantings than does a high or low value of lint per acre. In one case the low price per pound, despite the relatively high value per acre, is obviously the influencing factor, and in the case of the high price per pound the value per acre may be considered as an associated factor, just as the high value which is associated with low price per pound and high yield per acre.

In Table LII are the calculated multiples of standard deviation of average New York and New Orleans spot quotations for Middling cotton expressed in terms of the deviations of percentage changes of first differences from their mean. They are, therefore, directly comparable with multiples of standard deviation of acreage in Table XLIX. With these prices the relationship to acreage of cotton subsequently harvested is more pronounced than the relationship between value and acreage, as shown in Tables XLIX, L, and LI. There is a stronger tendency for plus and minus values in Table LII to be associated with plus and minus values in Table XLIX, and the tendency for the products of multiples of standard deviation with unlike signs of the two series to approach a minimum is greater than in the case of the products of similar expressions of acreage and value per acre. This indicates a greater relationship over a period of time between price of cotton per pound and acreage of the following year than between value of cotton per acre and subsequent acreage.

Table LII.
Multiples of Standard Deviation of the Average of Monthly New York and New Orleans Spot Quotations for Middling Cotton, 1906-23*

Year	Multiples of Standard Deviation		
	November	December	January
1906			
1907	- .361	- .119	- .087
1908	- .939	- .978	- .882
1909	1.306	1.355	1.118
1910	- .462	- .595	- .405
1911	-1.531	-1.357	-1.309
1912	.449	.622	.500
1913	- .168	- .364	- .383
1914	-1.773	-1.496	-1.333
1915	1.177	1.269	.921
1916	1.574	.930	.731
1917	.937	1.235	1.854
1918	- .381	- .390	- .601
1919	.618	.450	.575
1920	-1.312	-1.964	-1.946
1921	- .559	.055	- .109
1922	.865	.747	1.151
1923	.558	.602	.227

*Based on data in Table XIV, and calculated from the deviations of percentage changes of first differences from their mean.

Table LII. (Continued)

Year	Multiples of Standard Deviation	
	February	March
1906		
1907	- .128	- .373
1908	- .832	- .669
1909	1.215	.978
1910	- .424	- .425
1911	-1.168	-1.008
1912	.303	.066
1913	- .301	- .251
1914	-1.368	-1.190
1915	.800	.533
1916	.873	.940
1917	.490	1.634
1918	- .760	- .809
1919	.964	.845
1920	-2.249	-2.105
1921	.521	.932
1922	1.590	1.422
1923	.472	- .516

Farm Products Index Numbers

The selection of an index number for price deflation is one of the most difficult problems confronting the economic analyst. So many indices have been published from time to time by different agencies that it is only by the method of trial and error that one can arrive at a satisfactory conclusion regarding the proper one to use in measuring the relationship between the prices of specific farm products and the acreage of the particular crop subsequently planted and harvested. The aim should be to choose that index which when used to deflate prices will give the most nearly accurate comparison of the price of the commodity in question with other commodities entering into the composite expression of price level. The index number which seems best in meeting these requirements to show the relationship between cotton prices and acreage of cotton planted and harvested in the subsequent year is the one published by the Bureau of Labor Statistics, computed on a 1913 base, and made by weighting the commodity prices for the years by quantities marketed in the census year 1919.

Table LIII shows the Farm Products Index Number for the years 1906-26, inclusive, as published by the Bureau of Labor Statistics in "Index Numbers of Wholesale Prices, by Years and Months, 1890 to August, 1926". These indices are constructed from the prices of Middling cotton, grains, livestock and poultry, beans, eggs, fruit, hay, hops, milk, peanuts, seeds, tobacco, vegetables, and wool, and a study of them indicates that they are at least as nearly representative of farm products in regard to their relationships to acreages of the various crops subsequently planted as any other index number. A further study of the numbers as published by the Bureau of Labor Statistics for the years since 1890 shows that farm products fluctuated below the level of all commodities from 1890 to 1908, rising slightly above all commodities in 1909 and 1910. In 1911 they closely paralleled the prices of all commodities, and in 1916, with the marked increase in the general level of prices, farm products lagged behind all commodities, recovering in the latter part of the year, and exceeding the prices of all commodities in 1917, 1918, and 1919. From 1920 to 1924 farm products prices fell below the prices of all commodities. In 1925 they reached the level of all commodities, but fell below them in 1926. This movement of the prices of farm products in relation to the prices of all commodities is fairly representative of the actual trend of agriculture, and it constitutes the basis for the selection of the index number in Table LIII for cotton price deflation.

Table LIII.
Index Numbers of Farm Products Prices
1906--26*

Year	Number
1906	80.3
1907	86.7
1908	86.5
1909	97.0
1910	103.2
1911	93.0
1912	101.3
1913	100.0
1914	102.6
1915	103.9
1916	122.8
1917	189.6
1918	218.5
1919	230.8
1920	217.9
1921	123.7
1922	133.3
1923	141.1
1924	143.4
1925	158.1
1926	151.8

* "Index Numbers of Wholesale Prices, by Years and Months, 1890 to August, 1926", Bureau of Labor Statistics, pages 4 to 8.

Deflated Average Prices

The analysis of causal relationship existing between cotton prices and acreage of cotton subsequently planted and harvested involves not only the measurement of cause and effect between absolute prices and acreage, but also the determination of the extent to which relative prices are reflected in subsequent plantings. It is not always sufficient to merely express the degree of causal association between series of absolute quantities, since the dependent variable is often influenced more by the independent when the latter is expressed in terms which are relative to the common denominator of which it is a component part. Cotton prices in absolute terms are directly associated with acreage of cotton planted in the subsequent year, and there is a high degree of positive correlation between the two factors. There is, however, a tendency toward even greater relationship when prices are expressed in terms that are relative to the composite index number of farm products prices, of which cotton prices are an integral part.

Tables LIV and LV show the multiples of standard deviation of average New York and New Orleans spot quotations for Middling cotton deflated with the Bureau of Labor Statistics Index Number of farm products. These multiples are expressions in terms of the standard deviation of the extent to which the percentage changes of first differences in cotton prices deviate from their mean after they have been changed from absolute quantities to terms that are relative to the general composite price of which they are a part. There are certain alternatives in agriculture,and the extent to which one crop is substituted for another is dependent, in many cases, upon the relative prices received for the various commodities. A very striking illustration of relative prices and substitution may be drawn from the agricultural history of the San Benito Valley in the State of Texas, where the pineapple industry was forced to yield its position of importance to citrus and early vegetables.

A study of the multiples of standard deviation in Tables XLIX, LIV, and LV will show the general tendency toward direct relationships between prices of cotton and subsequent acreage, and a minute study will show these relationships to be greater than in the case of undeflated prices. Attention is called particularly to the fact that there is a higher degree of relationship earlier in the season between deflated prices and acreage than between undeflated prices and acreage. This indicates a decisive response on the part of the farmer to changing conditions in the price regime and a tendency, so far as alternatives can be substituted, toward modification of cropping systems in accordance with relative values of farm products.

Table LIV.
Multiples of Standard Deviation of the Average of New York and New Orleans Deflated Spot Quotations for Middling Cotton, 1906-23*

Year	Multiples of Standard Deviation		
	September	October	November
1906			
1907	.609	- .343	- .408
1908	- 1.805	- .880	- .757
1909	.738	.886	.986
1910	- .442	- .301	- .460
1911	- .889	-1.073	-1.118
1912	- .770	- .066	.315
1913	.350	.652	.060
1914	- 2.352	-1.891	-1.646
1915	.745	2.066	1.312
1916	.711	.494	.994
1917	- .801	- .219	.425
1918	1.049	- .219	- .608
1919	- 1.228	.343	.496
1920	- .392	-1.596	-1.818
1921	.366	1.575	1.837
1922	- .483	.006	.745
1923	.876	.568	.525

*Based on data in Table XIV, deflated with B.L.S. index number of farm products prices, 1913 base, and calculated from the deviations of percentage changes of first differences from their mean.

Table LIV. (Continued)

Year	Multiples of Standard Deviation		
	December	January	February
1906			
1907	- .115	- .215	- .301
1908	- .901	- .803	- .700
1909	1.367	.852	.622
1910	- .399	- .465	- .501
1911	- 1.155	- 1.072	- .797
1912	.682	.361	.012
1913	- .117	- .244	- .224
1914	- 1.580	- 1.332	- 1.196
1915	1.766	1.054	.632
1916	.687	.305	.207
1917	- .006	.198	.262
1918	- .601	- .841	- .918
1919	.610	.540	.627
1920	- 2.032	- 1.878	- 1.854
1921	.148	2.318	2.850
1922	.868	1.037	1.051
1923	.778	.184	.226

Table LV.
Multiples of Standard Deviation of the Average of New York and New Orleans Deflated Spot Quotations for Middling Cotton for Various Series of Months, 1906-23*

Year	Sept., Oct., Nov., Dec.	Oct., Nov., Dec., Jan., Feb.	Nov., Dec., Jan., Feb.
1906			
1907	- .125	- .318	- .288
1908	-1.041	- .887	- .787
1909	1.123	.972	.866
1910	- .388	- .374	- .477
1911	-1.134	-1.112	-1.027
1912	.139	.092	.278
1913	.254	.374	- .167
1914	-1.926	-1.787	-1.407
1915	1.678	1.729	1.075
1916	.829	.547	.474
1917	- .299	- .132	- .025
1918	- .246	- .444	- .766
1919	-1.035	.153	.518
1920	- .810	-1.655	-1.861
1921	1.811	1.937	2.366
1922	.408	.356	.870
1923	.763	.549	.359

*Based on original data in Table XIV, deflated with B.L.S. index number of farm products prices, 1913 base, and calculated from the deviations of percentage changes of first differences from their mean.

Table LV. (Continued)

Year	Multiples of Standard Deviation	
	Nov., Dec., Jan.	Jan., Feb.
1906		
1907	- .279	- .258
1908	- .807	- .745
1909	.910	.733
1910	- .460	- .481
1911	-1.084	- .924
1912	.888	.174
1913	- .544	- .230
1914	-1.442	-1.258
1915	1.190	.823
1916	.537	.267
1917	- .131	.231
1918	- .692	- .877
1919	.448	.584
1920	-1.803	-1.861
1921	2.127	2.563
1922	.758	1.051
1923	.381	.210

Coefficients of Correlation Between Cotton Prices and Acreage of Cotton Subsequently Harvested

On the basis of the multiples of standard deviation in Tables XLIX, LI, LII, LIV, and LV, coefficients of correlation were calculated to show the extent of relationship between cotton prices and acreage of cotton harvested in the subsequent crop years. These coefficients are divided into four groups, each of which will be briefly discussed.

In Table LVI are shown the results of calculations involving the relationship between acreage value of cotton lint and subsequent cotton acreage harvested. There is, as will be seen, a significant degree of positive correlation between the two factors, indicating the general tendency for cotton plantings to vary directly with the acreage value of lint produced in the preceding crop year.

The coefficients of correlation between undeflated prices and acreage are shown in Table LVII. The highest degree of relationship exists between February prices and acreage of the ensuing year. While the prices for the months immediately following the beginning of harvest are related in considerable degree to acreage, the greatest relationships occur between prices prevailing at the time planting season approaches and acreage subsequently planted. This would seem to involve a psychological concept as well as an economic principle, in that there is a tendency for the farmer's intention to plant to be influenced by the prices being paid for cotton at the beginning of the planting season, regardless of what may actually have been received for the cotton produced in the preceding year.

Table LVIII shows the correlations being monthly deflated prices and acreage. These coefficients are the expressions of relationship on the basis of prices that have been reduced to terms which are relative to the composite expression of farm products prices. The highest degree of relationship exists between December prices and acreage, indicating that at the end of December the relationship between prices and acreage of cotton to be subsequently planted can be fairly accurately measured and a close estimate obtained of the extent of acreage. There is a greater per cent. of the cotton crop marketed by farmers in either October or November than in December, but there is a tendency for the greater relationships to be associated with December prices because by the end of the month about two-thirds of the crop ordinarily has been disposed of by producers, and spot prices during the months immediately following harvest are not as reflective of the cotton price regime as are prices after the size of the crop is more nearly definitely known to the cotton trade. This is because prices are largely dependent upon the size of the cotton crop

Table LIX shows the coefficients of correlation between average prices for various series of months and acreage of cotton subsequently planted and harvested. In a way these coefficients are tributary to those in Table LVIII, since the degree of relationship between production and price immediately following the beginning of harvest tend to be offset by the more direct relationships between production and price after the former is more nearly definitely known. This is an important factor because the extent to which production and price of the current harvest year are related will tend to be reflected in the acreage planted and harvested in the next crop year. Any factor which diminishes the expression of relationship between production and prices will likewise tend to diminish indirectly the relationship between price and acreage.

Table LVI.

Coefficients of Correlation Between the Value of Cotton per Acre on the Basis of the Average of New York and New Orleans Middling Spot Quotations for Various Series of Months and the Acreage of Cotton Subsequently Harvested in the United States, 1906-23*

Series of Months	Coefficient	Probable Error
Sept., Oct., Nov., Dec.	.57	.11
Oct., Nov., Dec., Jan., Feb.	.62	.10
Sept., Oct., Nov., Dec., Jan., Feb., Mar.	.59	.11
Nov., Dec., Jan., Feb.	.68	.09
Oct., Nov., Dec.	.66	.09
Nov., Dec., Jan.	.68	.09
Nov., Dec.	.46	.13
Dec., Jan.	.66	.09

*Based on original data in Tables II, V, and XIV, and calculated from the deviations of percentage changes of first differences from their mean. Between December first farm value and acreage subsequently harvested there is a correlation of .68, and between yield per acre and subsequent acreage the correlation is -.45

Table LVII.
Coefficients of Correlation Between Average of Monthly Spot Quotations for Middling Cotton at New York and New Orleans and Acreage of Cotton Subsequently Harvested in the United States, 1906-23*

Month	Coefficient	Probable Error
November	.64	.09
December	.74	.06
January	.73	.08
February	.80	.05
March	.68	.09

*Based on original data in Tables III and XIV, and calculated from the deviations of percentage changes of first differences from their mean.

Table LVIII.
Coefficients of Correlation Between Deflated Average Spot Quotations for Middling Cotton at New York and New Orleans and Acreage of Cotton Subsequently Harvested in the United States, 1906-23*

Month	Coefficient	Probable Error
September	.32	.15
October	.73	.08
November	.76	.07
December	.80	.05
January	.77	.07
February	.73	.08

*Based on original data in Tables III, XIV, and LIII, and calculated from the deviations of percentage changes of first differences from their mean.

Table LIX.
Coefficients of Correlation Between the Average of Deflated Spot Quotations for Middling Cotton at New York and New Orleans for Various Series of Months and the Acreage of Cotton Subsequently Harvested in the United States, 1906-23*

Series of Months	Coefficient	Probable Error
September October November December	.73	.08
October November December January February	.73	.08
November December January February	.76	.07
November December January	.77	.07
January February	.75	.07

*Based on original data in Tables III, XIV, and LIII, and calculated from the deviations of percentage changes of first differences from their mean.

Acreage Estimates

The making of acreage estimates involves the calculation of regression of acreage on price, which varies in magnitude with the coefficient of correlation. A high value of the latter is associated with a relatively high value of regression, indicating the possibility of more nearly accurate estimates than could be made from a low coefficient of correlation and a correspondingly low regression coefficient. This merely involves the concept that deviations of actual acreages from the estimated acreages tend to a minimum as the size of the numerical expression of regression increases in magnitude.

In Table LX are shown the actual percentage changes in acreage of cotton harvested in the years 1908-24, inclusive, and the percentage changes as estimated from the expression of relationship between December deflated spot quotations for Middling cotton at New York and New Orleans and the acreage of cotton harvested in the subsequent crop year. It will be seen that for the period as a whole the estimated percentage changes and actual percentage changes are identical, indicating that over a series of years the December prices may be relied upon as a basis for estimating percentage changes in subsequent acreages.

In Table LXI the actual acreages and the acreages as estimated from the estimated percentage changes in Table LX are compared. On the whole the estimated acreage was 4.97 per cent.

less than actual acreage. This close approximation is significant, since a difference as great as 2,000,000 acres is equivalent to only about three-fifths of a million bales of lint. When it is realized that these estimates are made before the cotton crop is planted, and one year prior to the report on final ginnings, their degree of accuracy assumes even greater significance.

Another way of making acreage estimates is by the "ratio method". These are made on the assumption that the size of the current year's crop is reflected in price, which in turn is reflected in acreage planted and harvested. The estimate for any one year is made by multiplying the production ratio by the acreage ratio. For the twenty-seven year period, 1901-27, inclusive, as shown in Table LXII, the acreage as estimated was 2.63 per cent. less than the actual acreage harvested in the subsequent crop year. This difference of 2.63 per cent. in acreage estimates is equivalent to only 2.37 per cent. of the total production as measured by the average for the period 1901-27, inclusive.

Chart XXIX shows graphically the actual and estimated percentage changes in cotton acreage harvested for the years 1919-24 as expressed in terms of multiples of standard deviation. This Chart is based on data in Table LX. The estimated changes, as will be observed, deviate only slightly from actual.

Table LX.
The Actual Percentage Changes in Cotton Acreage Harvested in the United States and the Changes as Estimated, 1908-24*

Year	Actual Percentage Change	Estimated Percentage Change
1908	3.62	1.21
1909	- 4.64	- 4.33
1910	4.74	11.69
1911	11.24	- .78
1912	- 4.89	- 6.13
1913	8.18	6.85
1914	- .69	1.21
1915	-14.72	- 9.13
1916	11.37	14.52
1917	- 3.27	6.89
1918	6.40	1.99
1919	- 6.78	- 2.22
1920	6.89	6.35
1921	-14.96	-12.33
1922	8.28	3.08
1923	12.37	8.17
1924	11.41	7.53
Average	2.03	2.03

*Estimates are made on the basis of relationship between the average of New York and New Orleans December spot quotations for Middling cotton, deflated with B.L.S. index number of farm products prices, 1913 base, and subsequent acreage of cotton harvested. In making the estimates the following formula was used: y = Ay minus bAx plus bx, in which y is the percentage change in acreage, Ay the average of the percentage change in acreage, x the percentage change in price, Ax the average of percentage change in price, and b the coefficient of regression of acreage on price, determined by dividing the standard deviation of the acreage series by the standard deviation of the price series and then multiplying by the coefficient of correlation between price and acreage subsequently harvested.

Table LXI.
The Actual Acreage of Cotton Harvested in the United States and the Acreage as Estimated, 1908-24*

Year	Actual Acreage (000 omitted)	Estimated Acreage (000 omitted)
1908	32,444	31,690
1909	30,938	31,039
1910	32,403	34,554
1911	36,045	32,150
1912	34,283	33,835
1913	37,089	36,631
1914	36,832	37,537
1915	31,412	33,469
1916	34,985	35,973
1917	33,841	37,395
1918	36,008	34,514
1919	33,566	35,208
1920	35,878	35,697
1921	30,509	31,454
1922	33,036	31,449
1923	37,123	35,735
1924	41,360	39,918
Average	36,415	34,603

*Estimates are made on the basis of relationship between the average of New York and New Orleans December spot quotations for Middling cotton, deflated with B.L.S. index number of farm products prices, and subsequent acreage of cotton harvested. On an average the acreage as estimated was 4.97 per cent. less than the actual acreage. Slight variations are negligible, since a difference as great as 2,000,000 acres is equivalent to only approximately three-fifths of a million bales of lint. These facts are noteworthy when it is realized that estimates of harvested acreage are made one year in advance.

Table LXII.
Production and Acreage Ratios of Cotton
Harvested in the United States, 1900-27*

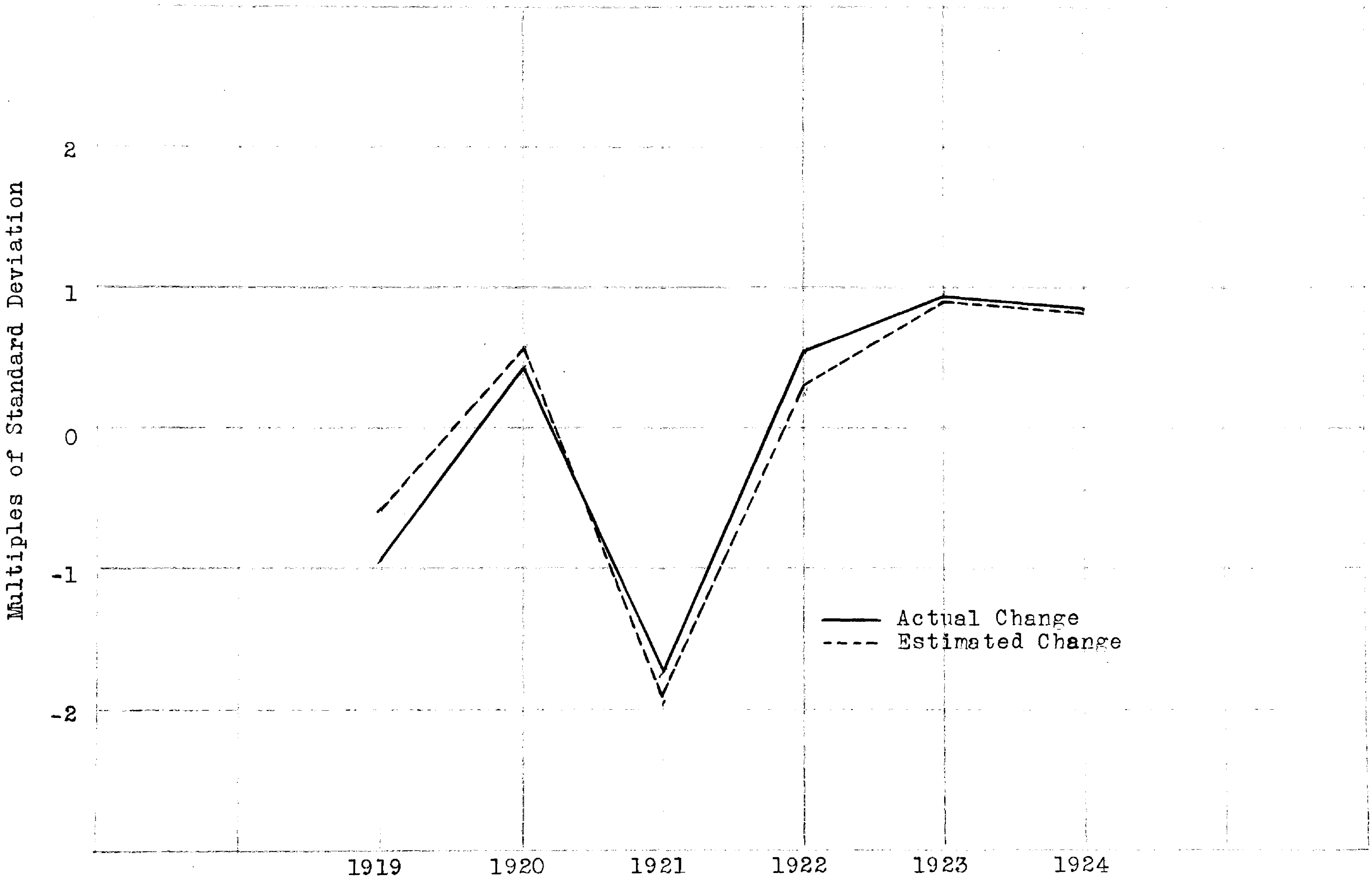
Year	Production Ratio (per cent. five year average ending with specified year is of specified year)	Acreage Ratio (per cent. acreage of specified year is of acreage of preceding year)
1900	88.8	102.5
1901	97.8	107.4
1902	90.8	101.5
1903	98.4	99.5
1904	77.3	115.4
1905	100.4	86.8
1906	81.8	115.7
1907	97.9	94.5
1908	85.4	109.4
1909	112.9	95.4
1910	99.3	104.7
1911	77.0	111.2
1912	91.3	95.1
1913	89.0	108.2
1914	81.9	99.3
1915	116.0	85.3
1916	113.7	111.4
1917	113.3	96.7
1918	108.2	106.4
1919	113.9	93.2
1920	94.9	106.9
1921	152.4	85.0
1922	119.3	108.3
1923	108.1	112.4
1924	82.5	111.4
1925	73.0	111.3
1926	69.5	102.2
1927	98.4	85.3

(See following page)

Table LXII. (Continued)

*The estimate of acreage for any subsequent year is made by multiplying the acreage of the specified year by the product of the production and acreage ratios. For the twenty-seven year period, 1901-27, inclusive, the total actual acreage harvested was 921,420,000, an average of 34,126,000 acres per year. For the same period the total estimated acreage harvested was 896,637,000, an average of 33,209,000 acres per year. The difference is 917,000, meaning that the acreage as estimated was 2.63 per cent. less than the actual acreage harvested one year hence. At 152 pounds per acre, which is both the ordinate of the line of least squares and the yield per acre for the year 1927, the difference of 917,000 acres represents 291,598 bales of 478 pounds, or 2.37 per cent. of the total cotton crop as measured by the average production for the years 1901-27, inclusive. In other words, knowing the acreage and production of cotton for any specified year, it was possible to estimate by the ratio method, one year in advance, within 2.63 per cent. of the acreage harvested during the subsequent year, and within 2.37 per cent. of the production of cotton for the same subsequent year.

Chart XXIX. The Actual Percentage Changes in Cotton Acreage Harvested in the United States and the Changes as Estimated, 1919--24*



*Plotted in terms of multiples of standard deviation.

Yield of Lint Cotton Per Acre

In the analysis involving determination of relationships between various weather factors and yield of lint cotton per acre two representative counties in North Carolina, Wake and Cumberland, were selected. These counties are situated in different parts of the cotton area of the State, and are considered as being representative of the status of cotton production in the two areas.

Table LXIII shows the yield per acre of lint cotton in the counties of Wake and Cumberland. During the twenty-three year period, 1904-26, inclusive, the yields of Wake County were above the State yields in seven different years, and were the same as the State yields in one year, 1909, when the yield for both County and State was 210 pounds. During the same twenty-three year period the yields of Cumberland County were above the State yields in twelve different years. These facts indicate that during these years there was a decided tendency for Wake County yields to fall below State yields, and a slight tendency for Cumberland County yields to exceed the yields of the State as a whole.

A further analysis of the data in Table LXIII shows that during the years 1904-27, inclusive, the trend of Wake County yields was upward at the rate of 4.3 pounds per year, while the yearly trend of yields in Cumberland County was upward at the rate of only 1.2 pounds (1). These differences in trend of yields

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(1) Ordinate of the straight line of least squares.

illustrate a further dissimilarity in the status of cotton production in the two counties, which, together with the relative magnitudes of yields as compared with those of all the counties taken collectively, has significance in that the aim has been in this study to select areas of production which are unlike in acreage yields.

Table LXIII.
Yield of Lint Cotton Per Acre in
Specified Counties of North Carolina, 1904--27*

Year	Yield per Acre in Pounds	
	Wake County	Cumberland County
1904	165	255
1905	165	200
1906	183	157
1907	178	197
1908	194	320
1909	210	230
1910	250	210
1911	285	350
1912	200	320
1913	235	285
1914	275	320
1915	205	250
1916	200	175
1917	200	180
1918	200	265
1919	218	290
1920	274	288
1921	249	250
1922	342	350
1923	298	325
1924	219	184
1925	322	301
1926	286	265
1927	214	178

*Compiled from records of the North Carolina State Department of Agriculture at Raleigh. There seems to be some question regarding the yields of Cumberland County for the years 1922 and 1923. Records of the Department of Agriculture of the State show different figures, and it has been impossible to determine which are the correct ones. In this study the yields of 350 pounds and 325 pounds respectively have been used, since a survey in the County reveals the fact that yields in those years were abnormally high. The Department of Agriculture reports these yields, as well as 274 and 262 pounds for the respective years.

Weather Factors

The weather data used in this study were tabulated from the official records of the United States Weather Bureau at Raleigh, North Carolina. Daily numerical expressions of sunshine, precipitation, and temperature were compiled and summated by monthly, semi-monthly, and weekly periods. The totals of the various factors for different ranges of time were then correlated with subsequent yields of lint cotton per acre.

Table LXIV shows the relative weights of May, June, and July precipitation and mean temperature for Cumberland County as calculated by the method of determinants from secular trend residuals. The concept involved in these calculations is that the numerical expressions of relative importance represent the extent to which each of the six factors, taken collectively, is related to yields per acre. Table LXV shows the relative weights of May, June, July, and August precipitation, mean, maximum, and minimum temperature, and sunshine for Cumberland County. These weights, like those in Table LXIV, show the relative importance of the various factors when the entire group is considered together, and they involve the principle that secular trend residuals of various weather conditions are associated in varying degrees with the current season's production of cotton. This is evidenced by the tendency for the summation of the products of weights and residuals to equal the residuals of yield per acre.

In calculating the relationships between weather factors and yield of cotton in Wake County and at the North Carolina Agricultural Experiment Station the actual data were used instead of relative weights. For convenience, however, the actual numerical expressions of the various factors were reduced to multiples of standard deviation in terms of deviation of percentage changes of first differences from their mean. These multiples were then correlated with similar expressions of yield of lint cotton. This method of reducing actual data to multiples of standard deviation has the advantages of reducing numerical magnitudes and of removing most of the trend from the series correlated.

Table LXIV.
Relative Weights of Six Weather Factors When Correlated With Subsequent Yield of Cotton Per Acre in Cumberland County, N.C., 1904-24*

Weather Factor	Weight
May Precipitation (A)	-16.84
June Precipitation (B)	- .37
July Precipitation (C)	- 4.64
May Mean Temperature (E)	9.30
June Mean Temperature (F)	13.20
July Mean Temperature (G)	17.07

*The equations for determining the weights of the various factors are formulated and solved by the method of determinants.

Table LXV.
Relative Weights of Twenty Weather Factors When Correlated With Subsequent Yields of Cotton Per Acre in Cumberland County, N.C., 1904-24*

Weather Factor	Weight
May Precipitation (A)	- .60
June Precipitation (B)	- 4.50
July Precipitation (C)	- 3.29
August Precipitation (D)	6.85
May Mean Temperature (E)	6.75
June Mean Temperature (F)	7.45
July Mean Temperature (G)	12.40
August Mean Temperature (H)	.13
May Mean Maximum Temperature (I)	4.13
June Mean Maximum Temperature (J)	8.40
July Mean Maximum Temperature (K)	6.26
August Mean Maximum Temperature (L)	4.63
May Mean Minimum Temperature (M)	3.00
June Mean Minimum Temperature (N)	3.59
July Mean Minimum Temperature (O)	2.61
August Mean Minimum Temperature (P)	4.79
May Per Cent. Possible Sunshine (Q)	.63
June Per Cent. Possible Sunshine (R)	.70
July Per Cent. Possible Sunshine (S)	.75
August Per Cent. Possible Sunshine (T)	.36

*The equations for determining the weights of the various factors are formulated and solved by the method of determinants.

Measures of Correlation

Weather Factors and Yield of Lint Cotton at the North Carolina Experiment Station.

It is obvious, of course, that there must be some relation between weather factors and subsequent yield of cotton. Taking all conditions collectively, some react favorable, some unfavorably, and some show no relationship at all. An attempt has been made to show the degree of correlation between various factors for different periods of time and the final yield of cotton lint. In the calculation of these expressions of correlation, each factor has been taken separately, and the degrees of relationship are shown on that basis.

Tables LXVI to LXX, inclusive, show the expressions of relationship between precipitation, sunshine, and temperature and yield of cotton on experimental plots at the North Carolina Agricultural Experiment Station. It will be observed that for certain well-defined periods there is a very high degree of relationship between weather and yield, while for other periods the relationship is negligible. Between precipitation for the months of July and August and subsequent yield of lint, as shown in Table LXVI, there is a correlation of .96, while for shorter periods the coefficients of correlation range from .46 to .86. It is interesting to observe the high degree of relationship between precipitation for weekly periods and yield. In Table LXVII there will be seen a coefficient of correlation as high as .81 between sunshine for the week of June 25th to July 1st and subsequent yield. Similar coefficients calculated for the fourteen day period, June 25th to July 8th, and for the seven day period, July 2nd to July 8th, indicate that a high percentage of sunshine during these periods is favorable to high production. In this connection the reader will observe in Table LXVI that for the same fourteen day period there is a high degree of relationship between precipitation and yield, indicating further that bountiful rainfall followed by a high percentage of sunshine from June 25th to July 8th is favorable to growth of plant and yield of lint. The calculated expressions of relationship between temperature and yield are shown in Tables LXVIII, LXIX, and LXX. There are varying degrees of association between temperature and subsequent yield, and in interpreting them the reader is to understand that they are based on conditions which, in analysis, must be assumed to be more or less static, or to have undergone compensating changes.

Tables LXIX and LXX show an appreciable degree of positive relationship between high temperatures and yield from June 25th to July 1st, and in Tables LXVI and LXVII it will be observed that when bountiful rainfall and a high percentage of sunshine are associated directly with temperature during this period there is a tendency toward an associated subsequent high yield of cotton. A further study of Tables LXVI, LXIX, and LXX will show that there is a tendency for precipitation and temperature in late July and early August to be conducive to lint growth.

There are many variations in degree of association between single weather factors and yield of cotton, as well as almost innumerable multiple relationships. The question of forecasting cotton production resolves itself into the problem of determining the extent of variation in response to weather conditions, time of planting, ravages of pests, and cultural practices, and this can best be done by the par method, which takes into consideration those conditions not subject to accurate numerical measurement.

Table LXVI.
Relation Between Total Precipitation During Different Periods of the Growing Season and Yield of Lint Cotton on Experimental Plots at the North Carolina Experiment Station, 1910-17*

Period	Relationship	
	Direction	Expression
May	minus	r = .69
June	minus	negligible
July	plus	r = .76
August	plus	r = .46
May - June - July	minus	negligible
July - August	plus	r = .96
June 25 - July 1	plus	negligible
June 18 - June 24	minus	negligible
June 25 - July 8	plus	r = .76
July 2 - July 8	plus	r = .73
July 9 - July 15	minus	negligible
July 9 - July 22	plus	negligible
July 16 - July 22	minus	negligible
July 20 - July 26	plus	r = .86
July 23 - July 29	plus	negligible
July 23 - August 5	plus	r = .80

(Continued on next page)

Table LXVI. (Continued)

Period	Relationship	
	Direction	Expression
August 6 - August 12	plus	negligible
August 13 - August 19	plus	negligible
August 20 - August 26	minus	negligible
August 27 - September 2	plus	negligible

*In calculating the degree of relationship, all factors except precipitation have been ignored. Hence, in interpreting the expressions it is to be understood that other factors in conjunction might react either favorably or unfavorably on subsequent yield.

Table LXVII.
Relation Between Per Cent. of Possible Sunshine During Different Periods of the Growing Season and Yield of Cotton on Experimental Plots at the North Carolina Experiment Station, 1910-17*

Period	Relationship	
	Direction	Expression
May	plus	negligible
June	plus	negligible
July	plus	negligible
August	minus	negligible
June 18 - June 24	minus	negligible
June 25 - July 1	plus	r = .81
June 25 - July 8	plus	r = .75
July 2 - July 8	plus	r = .75
July 9 - July 15	minus	negligible
July 9 - July 22	plus	negligible
July 16 - July 22	plus	negligible
July 23 - July 29	minus	r = .61
July 23 - August 5	minus	r = .70
July 30 - August 5	minus	negligible
August 6 - August 12	minus	negligible
August 13 - August 19	plus	negligible

(Continued on next page)

Table LXVII. (Continued)

Period	Relationship	
	Direction	Expression
August 20 - August 26	minus	negligible
August 27 - September 2	minus	negligible

*In calculating the degree of relationship, all factors except sunshine have been ignored. Hence, in interpreting the expressions it is to be understood that other factors in conjunction might react either favorably or unfavorably on subsequent yield.

Table LXVIII.
Relation Between Mean Temperature During Different Periods of the Growing Season and Yield of Lint Cotton on Experimental Plots at the North Carolina Experiment Station, 1910-17*

Period	Relationship	
	Direction	Expression
May	plus	negligible
June	plus	r = .50
July	plus	negligible
August	minus	negligible
June 18 - June 24	plus	r = .76
June 25 - July 8	minus	r = .53
July 9 - July 15	plus	r = .53
July 16 - July 22	minus	negligible
July 23 - August 5	plus	negligible
August 6 - August 12	plus	r = .72
August 13 - August 19	minus	negligible
August 20 - August 26	minus	r = .50
August 27 - September 2	minus	negligible

*In calculating the degree of relationship, all factors except mean temperature have been ignored. Hence, in interpreting the expressions it is to be understood that other factors in conjunction might react either favorably or unfavorably on subsequent yield.

Table LXIX.
Relation Between Minimum Temperature During Different Periods of the Growing Season and Yield of Lint Cotton on Experimental Plots at the North Carolina Experiment Station, 1910-17*

Period	Relationship	
	Direction	Expression
June	plus	r = .57
July	plus	negligible
August	plus	negligible
June 18 - June 24	plus	r = .85
June 25 - July 8	plus	r = .51
July 9 - July 15	plus	r = .52
July 9 - July 22	minus	negligible
July 23 - August 5	plus	r = .38
July 30 - August 5	plus	negligible
August 6 - August 12	plus	r = .81
August 13 - August 19	plus	negligible
August 20 - August 26	plus	negligible
August 27 - September 2	minus	negligible

*In calculating the degree of relationship, all factors except minimum temperature have been ignored. Hence, in interpreting the expressions it is to be understood that other factors in conjunction might react either favorably or unfavorably on subsequent yield.

Table LXX.
Relation Between Maximum Temperature During Different Periods of the Growing Season and Yield of Lint Cotton on Experimental Plots at the North Carolina Experiment Station, 1910-17*

Period	Relationship	
	Direction	Expression
May	plus	negligible
June	plus	negligible
July	plus	negligible
August	minus	negligible
June 18 - June 24	plus	r = .71
June 25 - July 1	minus	negligible
June 25 - July 8	plus	r = .70
July 2 - July 8	plus	r = .56
July 9 - July 22	plus	negligible
July 16 - July 22	plus	negligible
July 23 - July 29	minus	negligible
July 23 - August 5	plus	negligible
July 30 - August 5	plus	negligible
August 6 - August 12	plus	r = .61
August 13 - August 19	minus	negligible
August 20 - August 26	minus	negligible
August 27 - September 2	minus	negligible

*In calculating the degree of relationship, all factors except minimum temperature have been ignored. Hence, in interpreting the expressions it is to be understood that other factors in conjunction might react either favorably or unfavorably on subsequent yield.

Weather Factors and Yield of Cotton in Wake County, North Carolina.

The results of analysis showing relationship between weather factors and yield of lint cotton in Wake County, North Carolina, are given in Tables LXXI to LXXVI, inclusive. Expressions of relationship between mean temperature and yield and maximum temperature and yield are shown for two periods, 1900-17 and 1900-24. In the case of precipitation and minimum temperature all analysis apply to the shorter period, 1900-17. These tables are self-explanatory, and it will be observed that there are varying degrees of relationship between the different factors and subsequent yield. Bountiful rainfall and high maximum temperature during the first half of July tend to be favorable to yield, while during the latter half of the month excessively high temperatures when associated with high precipitation react unfavorably. This latter tendency is probably due to the detrimental effects of high temperatures coming immediately after heavy rainfall. High temperature and rainfall when associated during the second and third weeks of August tend to be favorable to yield of lint. This relationship, as well as in the case of the first half of July, is due mainly, perhaps, to frequent showers of light rainfall. A heavy, dashing rain when followed immediately by excessively high temperature is particularly detrimental to cotton at certain periods, and it is such conditions as these which the par method of estimates takes into consideration, but which cannot be measured by regression.

The expressions of relationship in Tables LXXI to LXXVI are given to impress the reader with the fact that even though there must necessarily be some causal association between weather factors and yield of cotton,there are at the same time innumerable counteracting climatic influences and certain reversals in response which cannot be measured in rigid mathematical equations. In calculating multiple regression there is a tendency for positive relationship between precipitation and yield to be offset by both excessively low and high temperatures. At the same time, positive correlation between certain other factors and yield for one period may be offset by a reversal of response during another period. An illustration of this condition may be drawn from the relationship between July precipitation and subsequent yield of lint in Cumberland County, where from 1908 to 1915 there was a tendency for high rainfall to be followed by low yields, and from 1916 to 1924 the tendency was for rainfall and yield to be directly associated. A similar illustration may be taken from the data representing Wake County. From 1907 to 1924 there was a direct correlation between precipitation and yield for the period of August 6th to August 19th, inclusive, taking the series of years as a whole, but for individual years a high precipitation and a high yield were not always directly associated. On the contrary, there was much inverse relationship. In 1904, for example, the rainfall for the period was about one and one-half inches, and the yield of lint that year was 165 pounds per acre, while in 1905 a precipitation of six and one-half inches was followed by an ultimate yield of 165 pounds, just as in 1904. Similar conditions occurred in 1915, 1918, and 1919, when in the former year a precipitation of less than two-tenths of an inch was followed by a yield of 205 pounds of lint per acre, while a precipitation of one and seven-tenths inches in 1918 was associated with a yield of 200 pounds, and in 1919 the low precipitation of six-tenths of an inch was followed by the high yield of 218 pounds per acre. These examples are presented to show how the effects of specific weather factors are counteracted by other factors, with the result that multiple coefficients of correlation cannot be used as satisfactorily as condition pars for the basis of making production estimates.

Table LXXI.
Relation Between Total Precipitation During Different Periods of the Growing Season and Yield of Lint Cotton Per Acre in Wake County, N.C., 1900-17*

Period	Relationship	
	Direction	Expression
June 4 - June 24	minus	r = .37
June 4 - July 1	minus	negligible
June 25 - July 2	minus	negligible
June 11 - July 5	minus	r = .27
June 18 - July 1	minus	negligible
June 25 - July 29	plus	r = .38
June 25 - August 5	plus	negligible
July 2 - July 8	minus	negligible
July 2 - July 10	plus	r = .57
July 2 - July 22	plus	r = .35
July 2 - July 29	plus	r = .41
July 2 - August 5	plus	r = .43
July 9 - July 15	minus	negligible
July 9 - July 22	plus	r = .32
July 9 - August 5	minus	r = .35
July 9 July 29	plus	negligible
July 16 - July 22	minus	r = .37
July 16 - July 29	minus	r = .34

(Continued on next page)

Table LXXI. (Continued)

Period	Relationship	
	Direction	Expression
July 23 - July 29	plus	negligible
July 16 - August 5	plus	negligible
July 23 - August 12	plus	negligible
July 16 - August 12	plus	negligible
July 30 - August 5	plus	negligible
July 23 - August 5	plus	r = .32
July 23 - August 19	plus	negligible
July 30 - August 12	minus	negligible
July 30 - August 19	plus	negligible
August 6 - August 12	plus	negligible
August 13 - August 19	plus	r = .30
August 20 - August 26	minus	negligible
August 27 - September2	plus	r = .36

*Factors other than precipitation ignored.

Table LXXII.
Relation Between Mean Temperature During Different Periods of the Growing Season and Yield of Lint Cotton Per Acre in Wake County, N.C., 1900-17*

Period	Relationship	
	Direction	Expression
June 25 - July 2	plus	r = .60
July 2 - July 8	plus	negligible
July 9 - July 15	plus	negligible
July 16 - July 22	minus	negligible
July 23 - July 29	plus	negligible
July 30 - August 5	minus	negligible
July (month of)	minus	r = .45
August 6 - August 12	plus	r = .41
August 13 - August 19	plus	r = .46
August 20 - August 26	minus	r = .35
August 27 - September 2	minus	negligible

*Factors other than mean temperature ignored.

Table LXXIII.
Relation Between Mean Temperature During Different Periods of the Growing Season and Yield of Lint Cotton Per Acre in Wake County, N.C., 1900-24*

Period	Relationship	
	Direction	Expression
June 25 - July 1	plus	r = .31
July (month of)	minus	negligible
July 2 - July 8	plus	negligible
July 9 - July 15	plus	negligible
July 16 - July 22	minus	negligible
July 23 - July 29	plus	negligible
July 30 - August 5	minus	negligible
August 6 - August 12	minus	negligible
August 13 - August 19	plus	r = .34
August 20 - August 26	plus	negligible
August 27 - September 2	plus	r = .41

*Factors other than mean temperature ignored.

Table LXXIV.
Relation Between Minimum Temperature During Different Periods of the Growing Season and Yield of Lint Cotton Per Acre in Wake County, N.C., 1900-17*

Period	Relationship	
	Direction	Expression
June 25 - July 1	plus	r = .52
July 2 - July 8	minus	negligible
July 9 - July 15	minus	negligible
July 16 - July 22	minus	negligible
July 23 - July 29	minus	negligible
July 30 - August 5	minus	negligible
August 6 - August 12	plus	r = .43
August 13 - August 19	plus	negligible
August 19 - August 26	minus	negligible
August 27 - September 2	plus	negligible

*Factors other than minimum temperature ignored.

Table LXXV.
Relation Between Maximum Temperature During Different Periods of the Growing Season and Yield of Lint Cotton Per Acre in Wake County, N.C., 1900-17*

Period	Relationship	
	Direction	Expression
June 25 - July 2	plus	r = .68
July 2 - July 8	plus	negligible
July 9 - July 15	plus	negligible
July 16 - July 22	minus	negligible
July 23- July 29	plus	negligible
July 30 - August 5	minus	negligible
August 6 - August 12	plus	negligible
August 13 - August 19	plus	negligible
August 20 - August 26	minus	negligible
August 27 - September 2	plus	negligible

*Factors other than maximum temperature ignored.

Table LXXVI.
Relation Between Maximum Temperature During Different Periods of the Growing Season and Yield of Lint Cotton Per Acre in Wake County, N.C., 1900-24*

Period	Relationship	
	Direction	Expression
June 25 - July 1	plus	r = .41
July 2 - July 8	plus	negligible
July 9 - July 15	plus	negligible
July 16 - July 22	minus	negligible
July 23 - July 29	minus	negligible
July 30 - August 5	minus	r = .30
August 6 - August 12	minus	negligible
August 13 - August 19	plus	negligible
August 20 - August 26	minus	negligible
August 27 - September 2	minus	r = .33

*Factors other than maximum temperature ignored.

Weather Factors and Yield of Cotton in Cumberland County, North Carolina.

While there are high degrees of relationship between single weather factors and yield of cotton, it would ordinarily seem likely that the combined effect of a number of them affords a more satisfactory basis for calculating the causal association between weather and yield. One of the reasons for this presumption is because of the compensating tendencies among variations in climatic conditions. The shedding of squares caused by excessive rainfall may be compensated by conditions which tend to reduce excessive vegetative growth, thus tending to favor the production of lint, while the effects of insufficient rainfall during the period of formation of bolls may be offset by high temperature and rainfall later in the season. It is difficult, of course, to procure a measure of all weather factors which can be incorporated in a rigid mathematical equation for predictive purposes. Some climatic conditions do not lend themselves to numerical measurement, and these are often the ones which offset the favorable and unfavorable effects of those which can be accurately measured. This accounts for many of the short-time reversals in yield response, and it implies the practicability of production estimates on the basis of condition pars.

Table LXXVII shows the measures of alienation between actual yields of cotton in Cumberland County and the yields as estimated from the combined effects of various weather factors at different periods of the growing season. The estimates of least-square straight line residuals of yield per acre are made by multiplying the relative weights of various weather factors as shown in Tables LXIV and LXV by the least-square line residuals of the corresponding weather factor and then summating. The total algebraic sum of the products thus obtained is the estimated straight line residuals of yield per acre. As a measure of alienation between actual and estimated yields the standard error of estimated residuals is divided by the standard deviation of the actual residuals to obtain the numerical expression which shows the relative magnitude of the extent to which the actual and estimated yield residuals deviate from their respective bases. In the case of the standard deviation the mean of the straight line residuals is taken as the base from which deviations are measured, while the standard error is based on the deviations of actual residuals from estimated residuals. The extent to which the standard error approaches the size of the standard deviation is an indication of the degree of alienation between actual and estimated yields, while the extent to which it tends to a minimum is indicative of a greater degree of approach to absolute accuracy in estimates.

Table LXXVII.
The Standard Error of Estimate of Least-Square Residuals of Yield and the Measure of Alienation Between Actual and Estimated Residuals of Yield of Cotton Per Acre in Cumberland County, North Carolina, 1904-24*

Factors Correlated	Standard Deviation of Actual Residuals	Standard Error of Estimated Residuals	Measure of Alienation
Six weather factors and yield. (ABCEFG.X)	57.60	47.50	.82
Twenty weather factors and yield. (ABCDEFGHIJKLM NOPQRST.X)	57.60	55.30	.96

*Based on data in Tables LXIII, LXIV, and LXV. The estimates of residuals of yield per acre are made by multiplying the residuals of the weather factors by their respective weights and then summating. The product thus obtained is the estimated residual of the line of least-squares representing the trend of cotton yields per acre. The standard error is calculated by extracting the root-mean-square of the deviations of the actual residuals of the least-square line of yield from the estimated residuals of the least-square line of yield. The measure of alienation is calculated by dividing the standard error by the standard deviation.

Planting Dates

Cotton planting begins usually from the middle to the last of March in extreme southern Texas and northern Florida, about April first in the Black Waxy Prairie of Texas, in central Louisiana, central Alabama, and central Georgia, and about April twenty-first along the northern margin of the Cotton Belt. Planting is general during the month of April, and it usually ends by May twenty-first [1]. Table LXXVIII shows the mean dates when planting begins, becomes general, and ends in the important cotton-producing States. On an average the plantings of eight States, Texas, Georgia, Alabama, Oklahoma, Mississippi, Arkansas, South Carolina, and North Carolina comprise about 95 per cent. of the total cotton acreage of the entire Country[2]. The harvested production of these eight States constitutes approximately 91 per cent. of the total ginnings of all States [3]. These facts are of great potential assistance to the reporters of the United States Department of Agriculture, or any other agency engaged in making forecasts of the current year's crop. When the acreage of the various States is known, together with the percentage of the total ginnings the acreage ordinarily represents, there is possibility of still further perfecting the forecasts of production on the basis of condition pars.

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(1) Reported by Miss Elna Anderson, Bureau of Agricultural Economics, United States Department of Agriculture.
(2) Based on total acreage for the years 1912-26, inclusive.
(3) Based on total production of lint cotton for the years 1912-26, inclusive.

Table LXXVIII.
Mean Dates When Planting of Cotton Begins, Becomes General, and Ends*

State	Planting Time		
	Beginning	General	Ending
Texas	March 29	April 13	May 9
Oklahoma	April 18	May 2	May 24
Mississippi	April 5	April 21	May 11
Arkansas	April 15	April 28	May 13
Alabama	April 8	April 20	May 11
Georgia	April 5	April 21	May 12
North Carolina	April 19	May 1	May 16
South Carolina	April 5	April 22	May 12
Louisiana	March 29	April 21	May 7
Tennessee	April 21	May 2	May 16
Missouri	April 25	May 4	May 14
Florida	March 16	March 28	April 20

*Yearbook of the U.S.D.A., 1922, page 989, Table 530. The States are arranged in descending order of total production for 1926. Planting dates for California, Arizona, New Mexico, and Virginia, which in volume of total production for 1926 follow Missouri in the order named, are not reported. The early ascertainment of acreage planted, which differs but slightly from acreage ultimately harvested, is indespensable in estimating current production by the par method.

Monthly Harvestings

In knowing from month to month the percentage of the total cotton crop that is ordinarily harvested by a certain date the cotton trade is enabled to estimate to a fairly accurate degree the size of the current year's crop before the final ginnings report is issued by the Government. This is of particular interest to those who have cotton to sell as well as those who are buying, since they are in a position to predict the most probable trend of prices in the ensuing months. Table LXXIX shows the percentage of the crop that is harvested, on an average, during each month of the year. At the end of September about 45 per cent. of the crop has been harvested, 79 per cent. at the end of October, and approximately 95 per cent. at the end of November. There are conditions, of course, which tend to modify these percentages, but it is not likely that changes from normal are often so marked throughout the United States as to alter greatly the averages given. Hence, if at the end of October 10,000,000 bales have been harvested, it is fairly safe to conclude that this number represents 79 per cent. of the total production, and if the harvestings at the end of November total 12,000,000 bales it will not be far from accurate to state that this figure is equal to about 95 per cent. of the year's crop. The early ascertainment of actual harvestings and ginnings is important to the cotton trade, and when the size of the crop is fairly accurately known the trend of subsequent monthly prices and the next year's acreage can be predicted to a considerable degree.

Table LXXIX.
Percentage of the Cotton Crop of the United States Harvested Monthly*

Month	Percentage Harvested
January-April	.4
May	
June	
July	1.4
August	11.5
September	31.6
October	34.4
November	16.0
December	4.7
Total	100.0

*Yearbook of the U.S.D.A., page 988, Table 529. The above table shows what proportion of the cotton crop is usually harvested each month. Two factors tend to modify these percentages in any given year. In some years the harvest period comes somewhat earlier or later than normal. Also, if the crop is larger than usual in its northern section and smaller than usual in its southern section, or vice versa, the effect is to modify the percentage of the total crop which is harvested in a particular month. However, it is not likely that such changes from normal are often so marked throughout the United States as to alter greatly the averages here given. By knowing as early in the season as possible the percentage of crop ginned the estimates of current production, subsequent monthly prices, and the following year's acreage and production have greater significance.

Ratio Estimates of Total Production

The yield of cotton per acre most likely to occur in any year is the normal, the average for a period of years preceding any specified year. By calculating a moving average from year to year for a period of sufficient length to allow abnormal trends to be smoothed out it is possible to determine the most probable yield per acre of the current or following year. In Table LXXX are the calculated yield and acre ratios for the years 1900-27, inclusive, and the actual and estimated total production. The yield ratio is obtained by dividing the nine-year average of yield ending with the year preceding the specified year by the yield of the preceding year. This gives the most probable yield ratio for the current year. The acreage ratio is the product obtained by dividing the current year's acreage by the acreage of the preceding year. The product of the yield and acreage ratios and the total production of the preceding year represents the most probable production of the current year. As will be seen in Table LXXX the actual and estimated production tend to be equal. The greatest discrepancies occur in 1921 and 1922, when the yields per acre were abnormally low. In spite of this, however, the total estimated production of 353,723,000 bales for the entire twenty-eight year period was only 3.3 per cent. greater that the total actual production of 342,238,000 bales. The yearly average difference between estimated and actual production was only 410,000 bales. For the twenty-one year period, 1900-20, inclusive, the degree of approach to accuracy is even greater than that for the period of twenty-eight years. The total estimated production for this period was 261,799,000 bales, as compared with a total actual production of 253,898,000 bales. This means that the estimated production for the entire period was only 3.1 per cent. greater than the actual production, constituting a yearly average difference of 376,000 bales between estimated and actual.

The degree of approach to absolute accuracy of production estimated by this method is of considerable significance because the estimate for the current year is made as soon as the extent of plantings is known. Therefore, the indications are that as soon as the Department of Agriculture issues its report on acreage in the Spring it is possible to predict, on an average, within less than a half million bales the current year's production. This prediction assumes even greater significance when one realizes that it is made before the growing season scarcely begins.

In connection with estimates of production it is interesting to recall the percentage changes in acreage as estimated on the basis of relationship between deflated December spot prices and subsequent acreage of cotton harvested. Table LX shows that over a period of years the averages of percentage changes in actual and estimated acreage are identical. This indicates that on the basis of relationship between December prices and subsequent acreage the most probable production of the following year can be fairly accurately determined before any of the cotton is planted, since over a period of years the estimated acreage is approximately the same as the actual acreage. Hence, the production for the crop year following current quotations for December tends to be equal to the sum obtained by multiplying the product of the acreage and production ratios as calculated in Table LXXX by the acreage as estimated at the end of December. On an average this gives, one year in advance of the Government report on final ginnings, an estimate of the following year's crop that approaches in a very high degree the total actual production. The Recapitulation following Table LXXXII shows the exact measurement of the degree of accuracy.

Table LXXX.
Estimate of Cotton Production in the United States by the Ratio Method, 1900-28*

Year	Yield per acre(1) for year preceding specified year (lbs)	Average yield(2) per acre for nine year period ending with year preceding specified year (lbs)	Yield Ratio (per cent. nine year av. is of yield for year preceding specified year)
1900	183.8	196.9	107.1
1901	194.4	192.2	98.9
1902	170.0	188.3	110.8
1903	187.3	188.8	100.8
1904	174.3	186.9	107.2
1905	205.9	190.7	92.6
1906	186.6	191.7	102.7
1907	202.5	190.7	94.2
1908	179.1	187.4	104.6
1909	194.9	188.3	96.6
1910	154.3	184.0	119.2
1911	170.7	184.0	107.8
1912	207.7	186.9	90.0
1913	190.9	188.3	98.6
1914	182.0	185.9	102.1
1915	209.2	188.3	90.0
1916	170.3	185.5	108.9
1917	156.6	182.6	116.6
1918	159.7	178.8	112.0
1919	159.6	178.8	112.0
1920	161.5	177.8	110.1
1921	178.4	174.5	97.8
1922	124.5	167.8	134.8
1923	141.2	163.5	115.8
1924	130.6	153.9	117.8
1925	157.4	152.5	96.9
1926	167.2	154.4	92.3
1927	182.5	157.7	86.4

(1) Yearbook of the U.S.D.A., 1919, page 590, Table 125, and 1926, page 962, Table 235.

(2) Based on data in Table II.

Table LXXX. (Continued)

Acreage ratio (per cent. current year's acreage is of preceding year)	Production of preceding year in thousands of bales (3)	Actual production in thousands of bales for current year (3)	Estimated production in thousands of bales (production of preceding year times the product of the yield and acre ratios)
102.5	9,345	10,123	10,257
107.4	10,123	9,510	10,752
101.5	9,510	10,631	10,696
99.5	10,631	9,851	10,661
115.4	9,851	13,438	12,187
86.8	13,438	10,575	10,800
115.7	10,575	13,274	12,566
94.5	13,274	11,107	11,816
109.4	11,107	13,242	12,710
95.4	13,242	10,005	12,202
104.7	10,005	11,609	12,486
111.2	11,609	15,693	13,916
95.1	15,693	13,703	13,431
108.2	13,703	14,156	14,618
99.3	14,156	16,135	14,352
85.3	16,135	11,192	12,386
111.4	11,192	11,450	13,576
96.7	11,450	11,302	12,909
106.4	11,302	12,041	13,468
93.2	12,041	11,421	12,568
106.9	11,421	13,440	13,442
85.0	13,440	7,954	11,172
108.3	7,954	9,755	11,611
112.4	9,755	10,140	12,696
111.4	10,140	13,628	13,307
111.3	13,628	16,104	14,698
102.2	16,104	17,977	15,191
85.3	17,977	12,782	13,249

(3) Yearbook of the U.S.D.A., 1919, page 590, Table 125, and 1926, page 962, Table 235.

Table LXXX. (Continued)

*The total actual production in thousands of bales for the twenty-eight years was 342,238. The total estimated production in thousands of bales for the same period was 353,723. The estimated production exceeded the actual production by 11,485,000 bales, constituting an average of 410,000 bales per year. For the entire period the estimated production exceeded the actual production by 3.3 per cent. As will be observed in Table II, the per acre yields in 1921, 1922, and 1923 were abnormally low. In spite of this, however, the error involved in the estimates is almost negligible. For the period 1900-20, inclusive, the error involved in the estimates is even more negligible, as the following figures will show. The total actual production for the twenty-one year period, expressed in thousands of bales, was 253,898. The total estimated production in thousands of bales for the same period was 261,799. The estimated production exceeded the actual production by 7,901,000 bales, which was an average of 376,000 bales per year. For the entire twenty-one year period the estimated production exceeded the actual production by 3.1 per cent.

Par Estimates of Production

The making of production estimates on the basis of condition of the crop at intervals during the growing season is more satisfactory and approaches a greater degree of absolute accuracy than estimates made by rigid equations formulated from numerical expressions of relationship between weather factors and yield. The condition par takes into account the ravages of boll-weevil, storm damage, influences due to early and late plantings, improvements in cultural practices, and countless other factors which do not readily lend themselves to exact numerical measurement.

In Table LXXXI are shown the actual ginnings for the years 1915-27, inclusive, and the production as estimated on the basis of July, August, September, and October condition pars. For the period of thirteen years as a whole the degree of error is practically negligible. The July estimates were 1.51 per cent. above actual, August estimates .16 per cent. above, September estimates 1.94 per cent. below, and October estimates 2.04 per cent.below actual. These very close approaches to absolute accuracy constitute exceedingly striking illustrations of the efficient work that is being done by the Department of Agriculture. The wisdom of estimating cotton production by the par method may be further exemplified by the innumerable differences in weather conditions over the Cotton Belt, which cannot be incorporated into a predictive equation. The Bureau of Crop Estimates with its force of reporters in the cotton-producing states is able to determine fairly accurately from the condition of the crop the most probable yield per acre for the season.

Table LXXXI.
Actual Cotton Production in the United States and Estimates for the Various Months, 1915-27*

Year	Production in thousands of bales				
	July Estimate	August Estimate	September Estimate	October Estimate	Actual
1915	12,381	11,876	11,697	10,950	11,192
1916	14,266	12,916	11,800	11,637	11,450
1917	11,633	11,949	12,499	12,047	11,302
1918	15,327	13,619	11,137	11,818	12,041
1919	10,986	11,016	11,230	10,696	11,421
1920	11,450	12,519	12,783	12,123	13,440
1921	8,433	8,203	7,037	6,537	7,954
1922	11,065	11,449	10,575	10,135	9,755
1923	11,412	11,517	10,788	11,015	10,140
1924	12,351	12,787	12,499	12,816	13,628
1925	13,566	13,740	14,759	15,386	16,104
1926	15,621	15,166	16,627	17,918	17,977
1927	13,492	12,692	12,678	12,842	12,782
Average	12,430	12,265	12,007	11,994	12,245

*Tabulated from unpublished records of the United States Department of Agriculture. On an average the July estimates have been 1.51 per cent. above the actual, the August estimates .16 per cent. above, the September estimates 1.94 per cent below, and the October estimates 2.04 per cent. below.

Relation Between Actual and Estimated Production

To further illustrate the degree of accuracy of par estimates of production numerical expressions were calculated to show the relationship between estimated and actual ginnings. The footnote to Table LXXXII shows these relationships in terms of coefficients of correlation calculated by the sum-product method. These high degrees of associated relationships considered in connection with estimated and actual production as shown in Table LXXXI point to the rather definite conclusion that the present forecasting methods as employed by the United States Department of Agriculture are to be commended quite highly for their degree of approach to absolute accuracy.

Charts XXX to XXXIII, inclusive, show graphically the relation between actual production of cotton and the production as estimated on the basis of July, August, September, and October condition pars. The data are plotted in terms of multiples of standard deviation, and the two series are, therefore, directly comparable (1). It will be observed that estimated production tends in a very high degree to be the same as the actual production.

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(1) The multiples of standard deviation are calculated from the deviations of percentage changes from the mean of percentage changes of first differences.

Table LXXXII.
Relation Between Total Actual Production of Cotton and Production as Estimated from Condition of the Crop, 1915-27*

Year	Per Cent. Estimated Production is of Actual			
	July	August	September	October
1915	117.6	106.1	104.5	97.8
1916	124.6	112.8	103.0	101.6
1917	102.9	105.7	110.6	106.6
1918	127.3	113.1	92.5	98.1
1919	96.2	96.5	98.3	93.7
1920	85.2	93.1	95.1	90.2
1921	106.0	103.1	88.5	82.2
1922	113.4	117.4	108.4	103.9
1923	112.5	113.6	106.4	108.6
1924	90.6	93.8	91.7	94.0
1925	84.2	85.3	91.6	95.5
1926	86.9	84.4	92.5	99.7
1927	105.6	99.3	99.2	100.5
Total	101.8	100.2	98.1	97.9

*The coefficients of correlation, calculated by the sum-product method, between actual production and production as estimated from condition of the crop for the various months are as follows: July estimated production and actual production, .711: August estimated production and actual production, .891: September estimated production and actual production, .948: October estimated production and actual production, .962.

Chart XXX. Comparison of the Actual Production of Cotton in the United States and the Production as Estimated by the July Par, 1918-27*

*Plotted in terms of multiples of standard deviation.

Chart XXXI. Comparison of the Actual Production of Cotton in the United States and the Production as Estimated by the August Par, 1918-27*

*Plotted in terms of multiples of standard deviation.

Chart XXXII. Comparison of the Actual Production of Cotton in the United States and the Production as Estimated by the September Par, 1918-27*

*Plotted in terms of multiples of standard deviation.

Chart XXXIII. Comparison of the Actual Production of Cotton in the United States and the Production as Estimated by the October Par, 1918-27*

*Plotted in terms of multiples of standard deviation.

Recapitulation

As shown in Tables LX and LXI, it is possible to estimate with a considerable degree of approach to accuracy, several months prior to planting time, the acreage of cotton that is most likely to be harvested in the subsequent crop year. These estimates are based on the relationship between average December deflated spot quotations for Middling cotton at New York and New Orleans and the acreage of cotton actually harvested by farmers in the following crop year, affording a fairly accurate estimate of the size of the ensuing acreage several months before the planting season begins. Carrying the analysis further, it is possible to obtain at the end of December an estimate of the final ginnings one year in advance, before any of the cotton crop is planted and before the Government issues any report on acreage. By dividing the acreages as estimated in Table LXI by the acreage actually harvested in the preceding year a product is obtained which expresses the ratio of estimated acreage for any subsequent crop year to the acreage of the preceding year. The product of the acreage ratio and the yield ratio as calculated in Table LXXX (1), multiplied by the harvested acreage of the preceding crop year is the estimated production of the following year, and the production most likely to be reported in the Government's final estimate of ginnings one year later. The total actual production for the

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(1) The yield ratio is calculated by computing the percentage that the average yield of the nine year period, ending with the year preceding the year for which estimates are to be made, is of the average yield for the preceding crop year.

years 1908-24, inclusive, was 206,266 thousands of bales, and the production as estimated at the end of December was 222,557 thousands of bales. The yearly average difference between estimated and actual production was 923,000 bales, meaning that for each ensuing year the crop as estimated on the basis of December spot prices was, on the average, 923,000 bales greater than the actual. For the years 1900-20, inclusive, the estimated production exceeded the actual by a yearly average of 632,000 bales, and for the two year period, 1923-24, the estimated production was 648,000 bales greater than the average of actual production. The high degree of approach to absolute accuracy in production estimates assumes greater significance when it is realized that they are made several months before the planting season begins in the South, and approximately one year in advance of the report on final ginnings as issued by the United States Department of Agriculture. On this basis, the cotton trade is enabled, one year in advance, to make a fairly accurate estimate of the total production of cotton that is most likely to result from the acreage as estimated at the end of December.

Conclusions.

I. There is, normally, a high degree of inverse relationship between current production of cotton in the United States and subsequent monthly prices of lint at American markets.

II. The relationship between domestic production of cotton and prices at American markets is greater than the relationship between domestic production and prices of American cotton at Liverpool.

III. The relationship between world production of cotton and prices in the United States and at Liverpool is no greater than the relationship between domestic production and domestic prices.

IV. There is inverse correlation between exports and prices, and the multiple relationship between carry-over, current production, and exports is not appreciably greater than the simple correlation between domestic production and prices.

V. The relationship between consumption of cotton in the United States and prices of lint at American markets is inverse, indicating that prices are determined primarily by production, rather than by consumption.

VI. Price predictions can be fairly accurately made on the basis of relationship between production and undeflated spot prices.

VII. Intentions to plant are influenced to a great extent by prices paid for the current crop.

VIII. Acreage planted varies directly with price, and the most satisfactory correlations for predictive purposes are those existing between deflated spot prices and subsequent acreage.

IX. The deflated December spot prices for Middling cotton serve as the best basis for acreage predictions.

X. Acreage predictions can be fairly accurately made several months before the planting season begins, and from these predictions a fair estimate of the following year's crop can be obtained twelve months prior to the Government's final report on ginnings.

XI. Yield predictions can be made with a higher degree of approach to accuracy by the ratio method than on the basis of weather factors.

XII. Predictions of yield on the basis of condition pars are more satisfactory than those made from numerical measurement of climatic conditions.

Literature Cited

(1) Moore, H.L. Forecasting the Yield and the Price of Cotton.

(2) Smith, B.B. Forecasting the Acreage of Cotton.

(3) Smith, B.B. Relation Between Weather Conditions and Yield of Cotton in Louisiana.

(4) Smith, B.B. Factors Affecting the Price of Cotton.