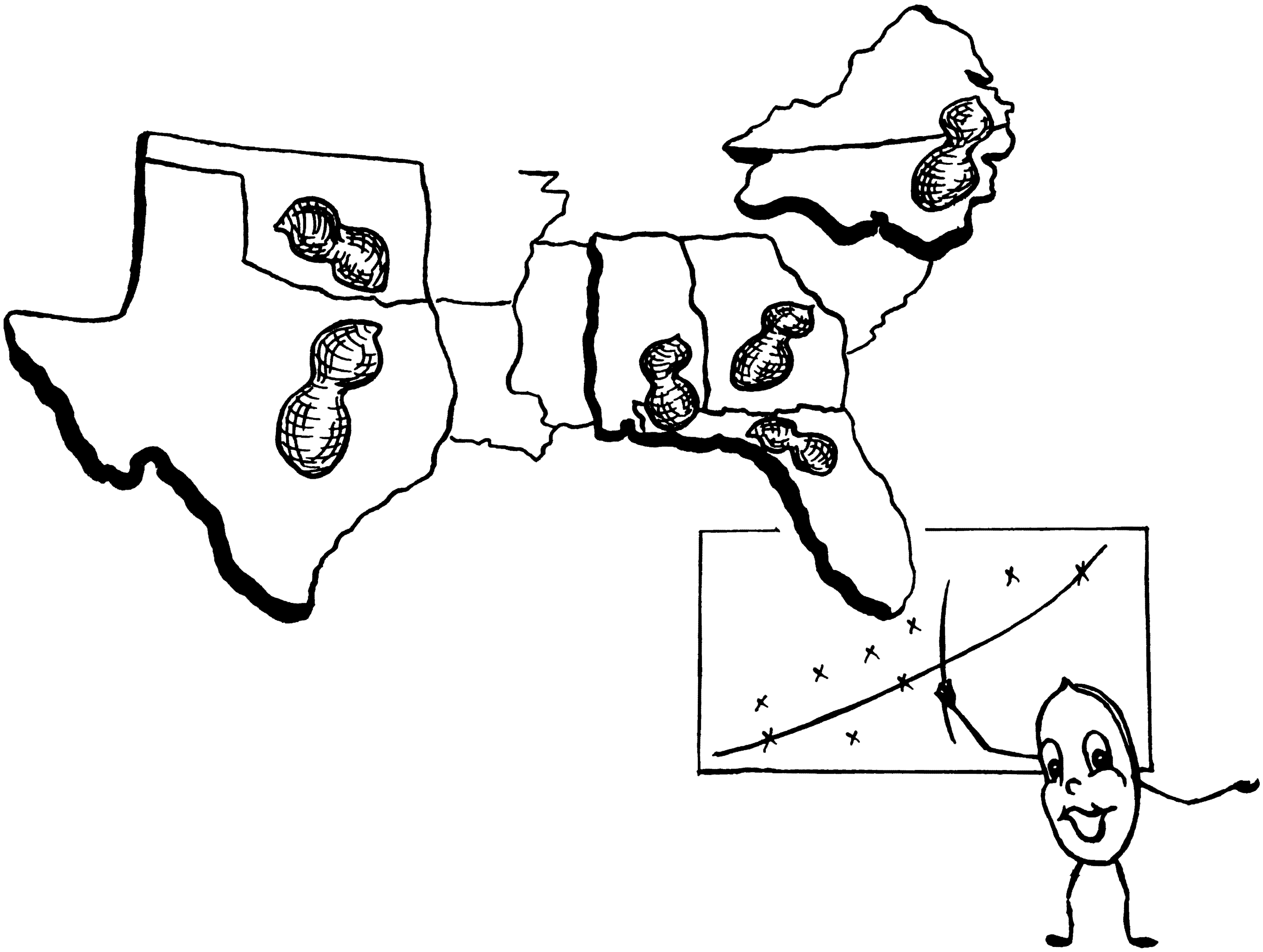
Response of Peanut Production to Technological Progress, Institutional Changes, and Economic Conditions

PART III

RESPONSE OF PEANUT PRODUCTION TO ECONOMIC CONDITIONS



Agricultural Experiment Station
Virginia Polytechnic Institute
Blacksburg, Virginia

Research Report No. 50

September, 1960

RESPONSE OF PEANUT PRODUCTION TO TECHNOLOGICAL PROGRESS, INSTITUTIONAL CHANGES, AND ECONOMIC CONDITIONS

Part III

Response of Peanut Production To Economic Conditions

by

D. Upton Livermore
Professor of Agricultural Economics

Agricultural Experiment Station
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Preface

This publication is one of three devoted to the topic "Response of Peanut Production to Technological Progress, Institutional Changes, and Economic Conditions." This Part III is a statistical analysis of the factors associated with acreage, yield, and production of peanuts in each of the seven major peanut-producing states. The results are summarized for the United States, and related to national supply and demand, and to current and prospective government surplus problems. For research workers and others who have need of it, a Data Supplement to Part III will be made available upon request. The Supplement includes a tabulation of all regression analyses, and all time series data used in the study, including the rainfall data.

Supply and demand for peanuts are heavily influenced by the march of technology and by legislative action. Their role in peanut production is described extensively in Part I and Part II, and their influence is taken into account in the analysis set forth in Part III.

Part I of the above general title is a descriptive study of the major technological factors of recent date believed to be influential in bringing about higher peanut yields per acre in the three geographic areas of peanut production: Virginia-Carolina; the Southeastern, composed of Georgia, Florida, and Alabama; and the Southwestern, composed of Texas and Oklahoma.

Part II is briefly descriptive of the institutional setting relevant to peanut production, but is primarily devoted to a legislative chronology since 1933, the year when government peanut programs were first introduced.

The study was conducted with funds from Regional Project SM-14, Agricultural Research Service, USDA, and the Virginia Agricultural Experiment Station. The three publications are based on a thesis submitted to Michigan State University, East Lansing, Michigan, in partial fulfilment of the requirements for a Master of Science Degree.

Acknowledgements

For first bringing this problem to my attention in all of its ramifications, I should like to credit William Bing, formerly chief, Program Analysis Branch, Oils and Peanut Division, Commodity Stabilization Service, USDA. The problem I have stated in Section I is essentially the problem as he outlined it to me back in 1954. Subsequent discussions with James E. Thigpen, A. T. Mace, and Joe F. Davis of the Oils and Peanut Division have been most helpful in keeping me abreast of the problem and current program results. They have provided much information, counsel, and relevant data.

For aid in planning and carrying out the over-all study, including the methodological approach, I have relied upon the advice and guidance of Dr. Glenn L. Johnson, professor of agricultural economics, Michigan State University. Additionally, his assistance in appraising the strengths and shortcomings of the results of the analysis was indispensable, for my training and experience in the field of econometrics is limited.

The statistical models were developed in consultation with Professor David C. Hurst, Statistics Department, V.P.I. His aid in appraising their relative usefulness is also gratefully acknowledged. It was at his insistence that I included the weather variables which were most helpful in the Southwest production area analysis.

All of the regression computations were performed by Dr. Rudolph Freund at the V.P.I. Computing Center, who also suggested several of the models attempted. Without such computational help, I would have been severely handicapped.

Dr. H. L. Dunton, Agronomy Department, V.P.I. was most helpful in the formulation of the weather hypothesis concerning the "critical" months.

The task of compiling the rainfall data fell to Mrs. Rennie Givens, whose assistance is gratefully acknowledged. Mrs. Gladys Weiler computed the residual data necessary for charting the regressions, and performed many other calculations. Mrs. Preston Newman prepared all of the charts and maps for photographic reduction. Their aid and careful attention to detail is much appreciated.

The thesis manuscript on which this bulletin is based was reviewed in detail by Dr. Glenn L. Johnson, and Dr. Harold Riley of Michigan State University; Professor Leo V. Blakely, Oklhaoma State University, Professor W. W. Harper, University of Georgia; and Professor Daniel D. Badger, and Dr. Harry M. Love, Virginia Polytechnic Institute. Their assistance and suggestions are deeply appreciated.

The prompt and generous assistance of the several state and federal statisticians in supplying me with the requisite historical time series data is greatly appreciated. The Virginia and North Carolina State Agricultural Conservation and Stabilization Offices also were most helpful in this regard.

To those who typed and assembled these pages, many thanks for their enduring patience.

The careful attention to editorial detail provided by Mr. R. D. Michael effected many improvements and is greatly appreciated.

To quote someone whose identity I am unable to recall, "From the gardens of others I have picked a bouquet of posies; nought but the string that binds them together is mine."

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Summary

The Response of Peanut Supplies to Technological Progress,

Institutional Changes, and Economic Conditions

A minimum national peanut acreage allotment of 1,610,000, as prescribed by Congress, became effective administratively in 1954 as a result of downward acreage adjustments since 1949. Meanwhile, peanut yields per acre have continued to increase steadily at a rate sufficient to create surplus supplies in most years in spite of greater total consumption requirements for an increasing population at a relatively stable per capita consumption rate. Since no further reductions in acreage allotments can be effected under present legislation, the question arises concerning the magnitude of prospective surplus supplies of peanuts, and related diversion costs, to be expected in the next few years, 1959-1965. In brief, will the combined effect of technology, institutional arrangements, and economic conditions stimulate yield increases such that, given fixed minimum acreage allotments, peanut production will equal or exceed the increase in consumption deriving from population increase?

Using ordinary least squares procedures, yields per acre for each of the seven major producing states have been estimated for the period 1909-1958, and projected to 1965 under specified assumptions, after making subjective adjustments to allow for recent technological progress. Yields per acre were significantly associated with technological change, price of peanuts, and acreage of peanuts. In the Southwest, yields per acre were also significantly associated with inches of rainfall in specified critical months of the growing season.

In most years, growers collectively underharvest their allotted acreage; however, attempts to associate underharvest with economic factors were unsuccessful. In the Southwest production area, however, inches of rainfall in specified critical months were significantly associated with underharvest.

Attempts to develop acreage estimating equations for years prior to 1949 were not successful. The changing economic structure of the industry, and problems of intercorrelation among the price and cost variables are believed to have obscured the measurement of the relationships. A qualified exception to this was found in the Southeast states for the period 1921-1940.

Annual production for the period 1959-1965 was projected by applying projected yields per acre to legal minimum state allotments which were subjectively adjusted for probable underharvest. Efforts to estimate peanut production directly by ordinary least squares procedures were unsuccessful.

Annual peanut supplies for the period 1959-1965 were estimated, taking into account imports and carry-in stocks. Comparative annual market demand requirements for all domestic uses and commercial export were estimated by two methods: (1) applying a subjectively determined per capita consumption rate of population data with non-consumption uses fixed, (2) applying a farmers stock demand equation developed by Oklahoma Experiment Station to projected data for price of peanuts, per capita disposable income, and marketing charges, with non-consumption factors fixed, such as seed, loss, and carry-in stocks.

Conclusions with respect to prospective surplus for the period 1959-1965 suggest that if per capita consumption does not increase above current levels, surplus production at about the current level of 200 million pounds will continue with some slight tendency to decline. The Oklahoma demand equation under the specified assumptions predicts increased per capita consumption of about one pound for the period 1959-1965; if this occurs, surplus production will disappear and some increase in allctted acreage and annual production will become necessary by 1963.

The study includes a detailed description of recent technological progress in each production area, Part I, Research Report No. 48, and a chronology of peanut legislation for each crop year since 1933, Part II, Research Report No. 49.

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THE RESPONSE OF PEANUT PRODUCTION TO ECONOMIC CONDITIONS

SECTION I

INTRODUCTION

The Problem

About six years ago it was noted with some concern that, if the then current rate of increase in peanut yields per acre were to continue, growers would be obliged to accept, more or less permanently, acreage allotment reductions representing the minimum permitted by law. Since 1949, when mandatory acreage allotments and marketing quotas were instituted by grower referendum, the national allotment had been reduced rather precipitately from 2,629,000 acres to the legal minimum of 1,610,000 in 1954.[1] It was also anticipated that, unless the minimum national allotment of 1,610,000 acres were to be reduced, a chronic annual surplus of peanuts would probably result. Per capita consumption showed little tendency to increase; accordingly, total consumption would be expected to increase only in proportion to the increase in population. The question then arose as to what rate of increase in peanut yields per acre, i.e. production, could be expected in the near future, and whether it would exceed the upward shift in demand represented by the rate of increase in population.

Interest also centered on the elasticity of demand. If acreage could be reduced no further, could per capita consumption be increased by price reduction? At that time, the Agricultural Adjustment Act of 1954 called for a change in the method of computing parity price,[2] beginning with the 1956 crop. The purpose of the general legislation was to achieve a "modernized" parity price which would take into account the relationship between prices received and paid by farmers not only during the selected base period but also during the most recent 10-year period. For some commodities, this meant an increase in parity price level; for others, a decrease. As applied to the parity price of peanuts this would effect, by means of annual 5% transitional reductions, a 20% reduction in the level

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[1]Commodity Stabilization Service, Compilation of Statutes, Handbook No. 158 (Washington: United States Department of Agriculture, 1959), p. 77.

[2]Harry W. Henderson, Price Programs, No. 135 (Washington: United States Government Printing Office, 1957) pp. 50-51.

of parity price of peanuts in its future relation to other prices. Up to that time (1954), with the sole exception of 1951 when support was 88%, peanut price had been supported at 90% of (old) parity.[3] The 1954 Act permitted support price to vary between 82.5 and 90% of parity for the 1955 crop and between 75 and 90% thereafter, depending upon specified percentage relationships of actual supply to a calculated "normal" supply.[4] This is termed the "sliding scale" legislation as provided in the Agricultural Act of 1949.[5] Accordingly, if supplies should become excessive, i.e., more than 100% of calculated normal, support price levels could be further reduced progressively from 90% of parity when supplies do not exceed 108% of normal, to a minimum of 75% of parity when supplies reach 130% of normal, or more, in accordance with a specified schedule. Such reductions could be applied first to the "transitional parity" during the 4 years necessary for effecting the annual 5% reductions, and then to "modernized" parity thereafter.

Demand has been shown to be quite inelastic.[6] A 1.0% change in the wholesale price, on the average, has been associated with a change of 0.3% in the opposite direction in per capita consumption of cleaned (in the shell) peanuts and 0.4 to 0.5% change in per capita consumption of shelled peanuts. A 1.0% change in disposable income, on the average, was found to be associated with a change of 0.6% in the same direction in per capita consumption of cleaned peanuts and 0.4 to 0.6% in that of shelled peanuts. The latter is the more significant relationship because the major part of the crop is sold as shelled peanuts.

In light of prospective peanut price support reductions, the one mandatory by change in the method of computing parity, and the other effective if excessive supplies occurred, the question arose as to the prospective supply-demand balance, given minimum acreage allotments held at a constant level. Since that time (1954), these price reductions gradually have been made effective, declining to 75% of modernized parity in 1959 as described in Part II of this study. This reflected a reduction in average farm price from 12.2¢ per pound in 1954 to 9.5¢ in 1959. The 1960 support level is 78% of parity. Kromer indicates[7] that lower prices to growers in recent years have not been reflected in the price of peanut products purchased by consumers. For example, he cites, the average retail price of peanut butter increased from 49¢ a pound in 1954 to about 56¢ in 1959, up 14%. Meanwhile, during the same period, prices to growers dropped 22%. These shifts, he suggests, "have had little effect on the per capita consumption rate."

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[3]Henderson, No. 135, pp. 57-58.

[4]Henderson, No. 135, p. 58.

[5]Commodity Stabilization Service, No. 158, pp. 128-135.

[6]Antoine Banna, Sidney Armore, and Richard J. Foote, Peanuts and Their Uses for Food, M. R. Report No. 16 (Washington: United States Department of Agriculture, 1952), pp. 3-4.

[7]George W. Kromer, "It Looks Like a Record Year for Peanut Consumption," Agricultural-Situation, Vol. 44, No. 5 (May, 1960), p. 4.

The elasticity of supply for peanuts is not known under the present economic and institutional structure of the industry. The reduction in support price in recent years has not had any observable effect on the supply forthcoming from the lower price levels. Yields per acre have continued their upward trend. Of course, it is not known what production would have been if support prices had not been reduced. It is often said that supply response is only partially reversible. This may be particularly true with respect to the amount of price reduction Congress is likely to provide under price support legislation because of conflicting policy goals; namely, those of achieving a supply-demand balance and, at the same time, maintaining a market price above equilibrium price.

Peanuts are not storable for more than a few months, as are grains, cotton, and tobacco, except for normal cold storage holdings in trade channels. Accordingly, government-owned supplies diverted from trade channels to maintain market price are crushed for peanut oil or sold for export, usually within the marketing year or soon thereafter. Prices for these uses are well below (perhaps 50% below) prices of peanuts for edible use in domestic consumption. Diversion for crushing and export, beginning in 1955, in millions of pounds farmers stock was 187, 269, 134, and 309. Estimated 1959 diversion is 280 million pounds and prospective diversion in 1960 is 240 million pounds. A loss of 3¢ to 5¢ per pound is sustained by Commodity Credit Corporation on diversion sales, depending upon the oil and export market and the support price.

Meanwhile, since 1955, per capita consumption shows the following pattern in pounds, kernel basis: 4.1, 4.3, 4.5, 4.4, and estimated 4.6 for 1959. These figures have the appearance of an upward trend, but may not be such because levels comparable to these were also obtained in the early 1950's. Since 1947, per capita consumption has varied between 4.1 and 4.5 pounds, a range not greatly different from that which prevailed in the 1930's. Higher levels have prevailed only during war years when peanuts substituted effectively for other foods in short supply. Relevant estimates regarding apparent United States supply and disposition beginning in 1954 are included in Table 1, as prepared by the Oils and Peanut Division, Commodity Stabilization Service, United States Department of Agriculture. The estimates for 1959 and 1960 take into consideration a demand elasticity[8] of -0.46 and an annual population increase of 1.7%. The figure pertinent to these considerations is "total commercial edible and crushing" disappearance. It will be noted that exports and imports (except for imports associated with the short crop of 1954) are negligible and offsetting; that commercial crushing for oil is relatively small within a

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[8] Sidney Reagan, Peanut Price Support Programs, 1933-1952, and Their Effect on Farm Income, (unpublished Doctoral Thesis, Harvard University, 1953, Chapter VI).

Table 1.--Peanuts: apparent United States supply and disposition, all types
(Farmers stock basis)

Item	1954	1955	1956	1957	1958	5 yr. average	Est. 1959	Est. 1960
	Year beginning August 1							
	- million pounds -							
A. Supply								
1. Beginning stocks								
a. Commercial	256.2	209.0	303.2	313.6	255.6	267.6	332	270
b. CCC	29.6	-	83.8	142.8	105.2	72.2	182	150
c. Total stocks	285.8	209.0	387.0	456.4	360.8	339.8	514	420
2. Production	1008.4	1548.0	1607.8	1436.0	1835.8	1487.2	1602	1652
3. Imports	187.4	2.6	6.0	2.4	2.0	40.0	2	2
4. Total supply	1481.6	1759.6	2000.8	1894.8	2198.6	1867.0	2118	2074
B. Disappearance								
1. Edible and related use								
a. Commercial edible	1019.4	987.4	1058.6	1112.8	1157.0	1067.0	1194[a]	1192[b]
b. Commercial crushing	88.2	71.4	90.6	158.2	101.4	102.0	102	102
c. Total commercial edible and crushing	1107.6	1058.8	1149.2	1271.0	1258.4	1169.0	1296	1294
d. Commercial export	.6	1.2	2.6	2.8	2.6	2.0	2	2
e. Seed, home use, fed and lost	137.8	124.4	122.2	122.6	119.8	125.4	122	122
f. Total edible and related use	1246.0	1184.4	1274.0	1396.4	1380.8	1296.4	1420	1418
2. CCC diversion								
a. Domestic crush	18.8	186.0	170.0	81.0	233.2			
b. Export	7.8	1.0	98.8	45.4	59.2			
c. Sec.32 and other uses	-	-	-	8.0	9.4			
d. Losses in storage	-	1.2	1.6	3.2	2.2			
e. Total diversion	26.6	188.2	270.4	137.6	304.0	185.2	280	238
3. Total disappearance	1272.6	1372.6	1544.4	1534.0	1684.8	1481.6	1698	1654
C. Ending stocks	209.0	387.0	456.4	360.8	513.8	385.4	420	420

a/ 7.34% increase over 5 year average because of change in price.
4.56% increase over 5 year average because of population change.
11.90% total increase over 5 year average.

b/ Allowance for population increase and increase in support level for 1960 crop.

Oils and Peanut Division, CSS
Program Analysis Branch
February 25, 1960

narrow range of variation since it is mainly a by-product of the shelling and manufacturing process; and that seed uses, etc., are practically constant. The figures of special interest are production, commercial edible and crushing use, and total diversion. For an understanding of the problem, these figures should be reviewed in light of the foregoing discussion and the descriptive material in Part II of this study. The magnitude of the diversion figure is a function of acreage and yield of peanuts, after deducting all requirements for other uses and making appropriate allowance for beginning and ending commercial stocks which are mainly those associated with the normal trade channel pipeline and are fairly constant from year to year at the beginning of the marketing season, August 1. The substance of this study centers on appraising the probable future magnitude of the quantity of peanuts which will be subject to diversion. In the process of doing so, the factors associated with acreage and yield of peanuts are explored in detail.

Purpose of the Study

There are four factors of production: land, capital, labor, and management. Of these, the peanut production control program exercises direct restrictions on one--land. Admittedly, if control of the use of land were fully exercised, production could be completely restricted. as observed elsewhere, this is not the policy. Accordingly, with a fixed minimum of land, growers are free to apply to this one factor additional units of other production factors and achieve additional production. The extent to which they may do this is thought to be associated with the relative profitability of such action.

The purpose of the peanut control program is to obtain for growers a price and income for peanuts greater than they would get under general equilibrium price conditions in a free market characterized by many sellers (growers) a relatively few buyers (shellers), and an inelastic demand. Since the market for the individual grower is perfectly elastic, he has nothing to gain by curtailing his own production and much to gain by increasing it if his price-cost relationship is favorable. Since the purpose of the peanut program is to provide a favorable price-cost relationship, his response has been to increase his production in the only way available to him--apply to his limited land greater quantities of capital, labor, and management per acre. The result is an increase in yield per acre and greater returns. Up to a point this is self-defeating in the aggregate because acreage has to be decreased to maintain supply-demand balance. At the point of minimum acreage allotments, it is no longer self-defeating unless price is reduced further in an effort to maintain supply-demand balance. When price is reduced to the specified minimum, it is no longer self-defeating unless further controls are instituted or the program is abandoned. Assuming the minimum price is a favorable one, growers will still seek ways to maximize returns by adding additional increments of other factors of production to the land factor. This condition now prevails--minimum price at a level presumed to be reasonably favorable and minimum acreage constitute the general policy.

The purpose of this study is to estimate the magnitude of total production response to be expected between 1959 and 1965 under assumptions of minimum support price and acreage as specified by current legislation; compare this estimate with prospective requirements for the same period; and thus, derive quantities to be diverted from normal trade channels by government action. In formulating these estimates, consideration has been given to variation of production conditions among the seven major producing states which make up the three main geographical areas of production.

Methodology

Subjective consideration has been given to the rate of technological progress in each of the three production areas in recent years, since this provides an appraisal of the additional increments of capital, labor, and management the grower has available to apply to the factor of fixed minimum of land, if it is profitable for him to do so as an individual. Part I of this study is devoted to this appraisal.

A limited statistical approach has been used to study the form of the relationships of peanut acreage, yield, and production with such factors as prices, costs, weather effect, and alternative crops. The next section has been devoted to a description of the analytical methods employed. This is amplified in a further section in which the variables are described. The models may be regarded as non-structural, semi- but indefinitely reduced, predictive equations.[9] Acceptable coefficients from this type of equation are regarded as reasonably reliable for prediction purposes; however, very little significance should be attached to the regression coefficients for individual variables.

The probability that intercorrelation exists among independent variables is recognized; the degree of intercorrelation has not been fully determined. Single linear equations have been fitted by least squares procedures to acreage, yield, and production models for each of the seven major peanut producing states.

The results of the analyses are presented for each of the three geographic production areas, one section for each. An additional section summarizes the production estimates for the nation, and proposes certain subjective adjustments for recent technology. Projected production is compared with projected requirements to the year 1965.

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[9]Memorandum from Glenn L. Johnson, Professor of Agricultural Economics, Michigan State University, April 15, 1960.

A final section sets forth a discussion of the short-comings of the statistical procedures employed, the difficulties encountered, and the manner in which the reliability of the parameter estimates may be affected.

SECTION II

INTRODUCTION TO STATISTICAL ESTIMATION OF PEANUT ACREAGE, YIELD, AND PRODUCTION

The peanut industry consists of three distinct geographical areas: Virginia-Carolina, Southeast, and Southwest. The division is more than geographical; the products are differentiated and the end-uses of the products differ in emphasis as pointed out in Part II. Accordingly, it seems appropriate to organize the discussion of acreage, yield, and production estimation around these three familiar areas with due regard for the analyses by states within each area.

This section will provide a general description of the statistical methodology and hypotheses used in constructing the acreage, yield, and production models which were, with some exceptions, applied to the data for each state in each area. The results of the statistical analysis will be discussed in detail in succeeding sections: one section on acreage, yield, and production for each of the three geographical areas (Sections IV, V, and VI), and one for the United States (Section VII) which summarizes the area estimates of production and considers certain subjective adjustments to the statistical estimates regarded as essential to allow for certain technological factors which are not taken into account in the statistical estimates. Following the statistical analyses, Section VIII will deal with problems of inter-correlation of the independent variables and other shortcomings which are generally characteristic of the statistical methodology used. Section VIII will also appraise the predictive power of the models.

This method of organizing the material is chosen in order to obviate, as much as possible, tedious repetition; and to provide an analysis centered on the three major divisions of the industry which are imbedded, by custom, in the thinking of growers, processors, end-users, program administrators, members of Congress, and scientists concerned with the industry. For some people, the estimates for a given area only are of particular importance; for others, comparative area estimates are meaningful; while for some the total picture, as well as its components, is of major concern.

A description of the variables employed in the analysis is included in Section III together with some observations concerning their selection, transformation, and lagging ; much of the description also constitutes an expansion on the statements of hypothesis contained herein, and should be taken into consideration therewith.

It is convenient at this point to make general reference to the graphic presentations included in succeeding sections since all of the charts are of the same general structure for depicting the regression relationships. Graphs other than these are regarded as self-explanatory. Accompanying the discussion of the analysis for each state are graphs[10] which show the relationships among the variables for regressions selected from the tables of analyses of variance. Graphs have been prepared for only the equations which are more useful or which are instructive for other reasons. The first graph in each figure shows by a solid line the actual value of the dependent variable as reported by the United States Department of Agriculture. The comparative broken line shows the value of the dependent variable as estimated from the like-numbered regression. The vertical difference between the actual and estimated value is the residual term of the equation. This is an estimate of the error or disturbance, and indicates the extent to which the equation failed to predict the actual value of the dependent variable. These residual differences are plotted at the top of the chart.

The second chart in each figure is the line of relationship between the dependent variable and the passage of time after the data have been adjusted for the influence of the other independent variables in the equation. The dots represent these adjusted data and the figure adjacent to the dot is the year for which the datum was estimated. In similar manner, other graphs in each figure give the relationship between the dependent variable and the specified independent variables. The slope of the line of relationship (partial regression line) indicates the nature of the relationship and the relative effectiveness of the coefficient of the specified independent variable.

Estimating Acreage

In view of the legislative chronology with respect to peanut acreage (Part II), it may be concluded from the outset that the usual economic factors which determine acreage in light of supply and demand conditions have been heavily influenced, since 1949, by legislative and administrative determinations. The terms supply and demand are here used in the sense of schedules of prices and quantities. While they are not "outlawed" as acreage determinants, the normal influence of these factors is modified by law. Such is the purpose of the legislation. Accordingly, no direct estimating equation for acreage has been attempted for years in which mandatory acreage allotments are in effect. The drastic acreage reductions accomplished during the past decade are clearly defined in the illustrative charts which accompany succeeding chapters.

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[10] Richard J. Foote, Analytical Tools for Studying Demand and Price Structure Handbook No. 146 (Washington: United States Department of Agriculture, 1958), pp. 174-175, 205-206.

As indicated in the chronology of legislation, Part II, acreage reductions have now reached the minimum allotments specified by Congress. At this level, production has been ample to meet demand at support prices--more than ample in most years. In a measure then, unless the current demand situation changes, and assuming continued yield trends which approximate those projected by this study, peanut acreage for the immediate future may be regarded as a known quantity with one exception. The exception is that growers may underharvest or overharvest their acreage allotments. The degree to which growers are able, or willing, to comply with given allotments is thought to be influenced by a special set of factors such that underharvest or overharvest may be subject to estimation.

Prior to 1949, as described in the chronology, Part II, some price and payment incentives for voluntary compliance with acreage allotments were offered in some years, since 1933, by government programs. The result, insofar as effecting adjustments in acreage is concerned, was quite modest. The charts for the years in question show no marked break in the uptrend of acreage. The final adoption of mandatory allotments further justifies the conclusion that voluntary acreage allotments may be ignored as of little effect in any general analysis of forces affecting acreage prior to 1949. The isolated mandatory allotment year, 1941, may as well be ignored since the adjustment was relatively small and unsustained in succeeding years.

At no time in the history of peanut production have the economic factors associated with acreage determination been long undisturbed by strong exogenous forces. The forces include a rapid economic growth of the industry as it expanded to new territory from the "old" Virginia-North Carolina area. Powerful stimuli were provided by World War I, the "boll weevil adjustment" from cotton to peanuts, circa 1917, the "great depression" of the 1930's, World War II, and of course, the legislation referred to in the chronology. Any long-run analysis encounters these exceptions to the usual assumptions of economic investigation. Perhaps the term "unpredictable"[11] is well chosen, although these forces are not uniquely applicable to peanuts.

The effect of exogenous forces has not been the same in all areas. For example, acreage declined in the Virginia-North Carolina area during World War I, and responded less during World War II than in other areas. "Old timers" suggest that attractive alternatives, including high wages in the Norfolk area shipyards, may account for this departure from logical expectations suggested by high peanut prices during World War I. Opportunity costs for labor and management outran peanut price at this location.

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[11] W. C. Gregory, B. W. Smith and Yarborough, The Peanut--The Unpredictable Legume (Washington: National Fertilizer Assoc. 1950), title page.

Acreage Equations

The purpose of this phase of the analysis is to make a limited investigation of the degree to which peanut acreage is a function of price-cost relationships and of adjustments in the acreage of alternative crops. No useful estimating equation is visualized for the period 1949 to date, exclusive of certain possible under- or overharvested acreage in relation to acreage allotments discussed below. Equations for prior periods are presented as mainly of academic interest representing an inquiry into the nature of acreage relationships which might hold in similar manner at some future time should similar conditions prevail. These may be regarded as instructive but not directly useful for projection.

The general hypothesis regarding acreage is that it is determined largely by the following fundamental factors: (1) time which is indicative of factors which account for long run growth (or decline) of the industry; the extent to which certain factors of production, such as capital, have been substituted for land; and other influences not otherwise taken into account in the model (this may include certain factors normally associated with demand); (2) the profitability of production as determined by the relationship between prices received for peanuts and prices paid for production items, and the profitability of peanut production relative to that of the next best use for the same resources, i.e. opportunity costs.

Underharvest Equations

A special set of factors is thought to influence acreage harvested as compared to acreage allotted. These are: prices received, prices paid for production items, opportunity costs, rate of monetary penalty assessed by government for acreage in excess of allotments, and weather influence on abandonment of acreage or diversion to feed use such as "hogging off."

Enforcement of current acreage policy is accomplished through the exaction of penalties. A basic penalty rate per pound is assessed on the grower's production based on acreage harvested in excess of his allotment. For the period 1949-1955 the penalty rate was 50% of the support price; since then the rate has been 75%. The increase was designed to deter those growers who were finding it still profitable, because of high yields per acre, to produce excess peanuts after payment of the 50% penalty. In contrast to the voluntary acreage allotment programs in the 1930's, the mandatory allotment program has been effective in curtailing acreage. The first graph in each of the illustrative figures on acreage accompanying succeeding sections defines the relation between the acreage allotment and acreage picked and threshed, beginning in 1949, and designated on the graph as the "Marketing Quota Period." Inspection of these graphs for the seven states indicates a tendency for growers to pick and thresh an acreage less than the state allotment in most years. This differential between allotted and harvested acreage is a factor in determining production if it follows a pattern as a result of associated factors. It may also be a consideration at times in determining allotments for a particular level of production.

The purpose of this phase of the analysis is to appraise the factors thought to be associated in a significant way with the differential between acreage allotments and harvested acreage. The hypotheses are that underharvest will be encouraged by the penalty rate; that it will decrease under favorable price-cost relationships; that it will be encouraged by favorable hog prices in the Southeast; and that it may increase under unfavorable weather influence. These concepts, and the methodology employed, are similar in design to those used by Johnson[12] in his burley tobacco study. Comparable considerations were involved in the acreage planted model developed by Hathaway[13] in his study of the dry bean industry.

Interpretation of the expectations with respect to the signs of underharvest coefficients need not be (but sometimes is) confusing because a negative differential has been used in describing the dependent variable. The logical expectation is that as price increases, underharvest will decrease and become overharvest if not deterred by an offsetting change in the penalty rate. The underharvest data used as a dependent variable are derived by taking the state allotment as established by the United States Department of Agriculture and subtracting from it the acreage harvested. If the harvested acreage is less than the allotment, the difference was defined as underharvest and denoted as a negative figure. If the harvested acreage was more than the allotment, the difference was defined as overharvest and denoted as a positive figure. This results in being able to interpret the coefficients of price, penalty rate, or other factors in the usual way insofar as signs are concerned. Thus, a positive sign for the price coefficient denotes that as price increases underharvested acreage decreases to zero and then increases in the form of overharvested acreage. Similarly, as penalty rates increase, overharvested acreage will decline to zero and then increase negatively as underharvest. This is not likely to be a linear relationship beyond the penalty just necessary to discourage overharvest, but is so regarded for purposes of this study considering the range of the data. Similarly, the hog price relationship should be negative since underharvest is encouraged as hog price increases.

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[12]Glenn L. Johnson, Burley Tobacco Control Programs, Bulletin 580 (Lexington: Kentucky Agricultural Experiment Station, 1952), pp. 36-44.

[13]Dale E. Hathaway, The Effects of the Price Support Program on the Dry Bean Industry in Michigan, Technical Bulletin 250, (East Lansing: Agricultural Experiment Station, Michigan State College, 1955), pp. 20-28.

Regarding the other dependent variable data, i.e., the ratio of the acreage harvested to the peanut allotment, a ratio of 1.0 indicates neither under- nor overharvest; a ratio of less than 1.0 indicates underharvest; and of more than 1.0 overharvest. As price increases, the acreage harvested would be expected to increase; the ratio would increase, and therefore the logical sign of the coefficient is positive. Similarly, a negative sign for the penalty rate coefficient is indicated; as overharvest declines to the allotment, the ratio declines to 1.0 and then to less than 1.0 as underharvest occurs.

Inspection of the data indicates that it may take growers two or three years to complete the adjustment, a major one, from "all out" production conditions to one which is highly restrictive. For the grower, this involves crop rotation shifts and rather precise acreage measurements. These influences may obscure price-cost-penalty considerations, causing greater dispersion of the data in the early years of the adjustment. More important considerations which have influenced the differentials between harvested acreage and allotted acreage include (1) an undetermined number of 1-acre peanut farms which are included in harvested acreage estimates but which are exempt from the acreage allotment restrictions, (2) the provision for a two-price system in 1950 and 1951 under which acreage in excess of the peanut allotment was encouraged provided the peanuts were sold for crushing for oil, and (3) diversion of peanut allotment to the "soil bank." These and other considerations are discussed in more detail in the relevant sections.

Penalty rates fluctuate over a very narrow range. They are never low enough to permit much profitable non-compliance and exert no influence beyond the level just necessary to discourage non-compliance--i.e., if a 75% penalty is adequate, an 80% penalty can accomplish nothing additional. This appears to limit its usefulness as a variable helpful in explaining year to year variation. Furthermore, the penalty rate is directly related to price. The pricing method under the support program is "forward pricing"; hence, lagged values of price are not particularly applicable. There will doubtless come a time when underharvest can be explained if it exists to any appreciable degree; at present, the period of time for analysis is probably too brief to make analysis of economic influences feasible.

For the investigation of these hypotheses, regarding acreage and underharvest and related assumptions, a series of single linear equations was fitted to the data by ordinary least squares procedures. A description of the variables is set forth in Section III.

Estimating Yields per Acre

The estimation of yields per acre constitutes the hard core of this study. Prime interest centers on recent upward trends which, in some instances, have been little short of spectacular (for example, Oklahoma). An administered price during the past decade, as described in Part II chronology, has removed much of the risk and uncertainty usually associated with crop production returns to growers. The margin of profit has been such that the grower has every incentive to exploit fully the resources he is permitted to commit to production, including his highest level of managerial capacity. Since land is the only factor of production controlled and restricted by successive government programs, the grower is free to apply additional increments of management, labor (including his own as distinct from his managerial functions), and capital in the form of machinery, fertilizer, irrigation development, and the many other means implicit in the descriptive statement in Part I on technology. Since land is restricted, it may be safely assumed that the land employed will be that best adapted to production available to the grower. Under favorable price conditions, the optimum combination of resources probably exceeds the maximum permitted; hence, maximum yield per acre becomes the grower's goal. The additional (marginal) returns continue to exceed the added cost, and to constitute in many cases the most profitable allocation of resources among enterprises. It might be added parenthetically that price stability and ample supplies remove much risk and uncertainty otherwise encountered by millers.

The risk and uncertainty removed from growers and millers by government programs are not eliminated; instead, they are transferred to government in different forms. An under-realized estimate of a forthcoming crop in terms of permitted acreage and estimated yield disrupts the domestic peanut economy and may necessitate importation of peanuts--a "general welfare" course of action which incurs the wrath of growers but which is regarded as necessary to meet the normal needs of end-users and consumers at reasonable prices. Thus far, a situation of this kind has been generated only by generally adverse weather conditions, and seldom occurs. (See Chronology, Part II, mid-1950's). An over-realized estimate of forthcoming production results in excessive supplies which must be purchased by government at support price and sold at a discount for oil or export, an action which creates a loss for the Commodity Credit Corporation. In order to protect growers from undue restrictions, Congress has provided for minimum acreage allotments for the several states and the nation. As yields per acre have increased since 1949, acreage allotments have been administratively reduced to the Congressional minimum. Supplies have continued to exceed demand in most years. Accordingly, keen interest among policy-makers and administrators centers on future yields per acre as an indication of forthcoming production from minimum acreage allotments, and the relation of such production to expected supply requirements of the future. A similar interest on the part of growers may be safely assumed because excess supplies are price depressing under the provisions of the "sliding scale" legislation which relates actual supply to "normal" supply to determine a supply percentage (See Chronology, Part II). The supply percentage determines the percentage of parity at which price support may be offered. Again, Congress has specified that price support shall not be less than 75% of parity, a level which now prevails approximately as a result of imbalance in the supply-demand relationship in favor of excess supply.

Congress makes provision for determination of a national "normal" yield per acre--the average of the most recent five years adjusted subjectively for abnormal conditions. This normal yield applied to the national acreage allotment establishes the national marketing quota in pounds--a theoretical figure representing the national requirements for all uses of peanuts. In 1960, for example, the product of the normal yield and minimum national acreage allotment establishes a national quota in excess of what the requirements are actually expected to become; accordingly, realization of the normal yield automatically results in excess supply. The United States Department of Agriculture says[14] that the 1960 expected (real) requirements could be produced on 1,240,000 acres, or 370,000 less than the minimum acreage allotment of 1,610,000 acres required by Congress as a minimum, an indication that "normal" yields, as determined in accordance with the specifications of Congress, have exceeded expectations.

Inspection of the yield data for the seven states, as given in the Data Supplement to this bulletin, and in the illustrative charts which accompany succeeding sections readily reveal that peanut yields per acre are subject to considerable variation from year to year. It will be also observed that during the period of time considered, 1909-1958, a general linear upward trend in yields has occurred. The most rapid and consistent rate of increase has occurred in the Virginia-North Carolina area. Gains in recent years are mainly responsible for the more moderate long-run upward trend in the Southeast where there was little change until after World War II. In the subhumid Southwest, the long-run linear trend in Texas is slightly downward, but data for recent years show an increase. Only a moderate upward trend has occurred in Oklahoma until irrigation was introduced in the past decade.

The purpose of this analysis is to provide, by statistical methods, an explanation of the manner and extent to which various factors regarded as yield-generating give rise to year-to-year fluctuations and to the general level of yields per acre over the fifty years 1909-1958. This knowledge will be useful later in appraising forthcoming supplies under specified conditions.

The general hypothesis regarding yields per acre is that they are determined largely by the following fundamental factors:[15] (1) the

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[14]Agricultural Marketing Service, Fats and Oils Situation (Washington: United States Department of Agriculture, Nov. 1959), p. 42.

[15]Glenn L. Johnson, Burley Tobacco Control Programs, Bulletin 580 (Lexington: Kentucky Agricultural Experiment Stations, 1952), p. 45.

quality and treatment of soils both for the year in which peanuts are planted and throughout the rotation, (2) the selection of types and varieties of seed, particularly the introduction of improved varieties, (3) cultural practices during the growing season, including improved disease and insect control measures, and (4) the weather, more specifically the amount of rainfall received by the plants during the critical "pegging" season and during the weeks when the crop is maturing.

With the exception of the weather, it is assumed that the degree of influence of these factors is affected by the relative profitability of peanut production; in turn, profitability is influenced by prices received by growers for peanuts and prices paid by growers for the items used in producing peanuts. A further assumption is made that the quality and treatment of soils, and intensity of cultural practices is inversely associated with the quantity of land. Since growers have alternative uses for the resources they may commit to peanut production, it is also assumed that the relative profitability of alternative crops influences the allocation of certain specified non-weather factors which are regarded as generating peanut yields per acre.

Observed data from secondary sources have been used to investigate the extent to which prices, direct costs, opportunity costs, acreage, and weather may be associated with yields per acre. Other factors for which no observed data are available such as the introduction of improved seed varieties, better methods of disease and insect control, and modern farm power and equipment, are assumed to be reflected in the calculated time trend. These were discussed in Part I.

In order to investigate the hypothesis and related assumptions, a series of single linear equations was fitted to the data by ordinary least squares procedures.

Estimating Production

Production of peanuts is a function of acreage and yield per acre. As implied in previous discussion, the main purpose of this study is to find a reasonably reliable means of estimating future production. Consideration was given to the following methods:

a) Development of a system of structural equations after the manner of Foote,[16] Fox,[17] Johnson,[18] and Hathaway.[19]

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[16]Foote, Handbook No. 146, pp. 1-217.

[17]Karl A. Fox, Economic Analysis for Public Policy (Ames: The Iowa State College Press, 1958), pp. 1-288.

[18]Johnson, Bulletin 580, pp. 1-112.

[19]Hathaway, Technical Bulletin 250, pp. 1-71.

b) A single linear equation fitted to production data by ordinary least squares.

c) A single linear equation fitted by ordinary least squares for predicting yields per acre which in turn would be multiplied by the acreage allotment after either predicting or making allowance for under- or overharvested acreage.

Consideration of the quality of available data, the exogenous forces involved and the changing structure of the peanut industry resulted in the conclusion that adoption of method (a) would be impractical at this juncture in peanut production history. Ideally, this might be the soundest approach; it may become feasible in a few years if the economic structure of the industry remains unchanged long enough to provide an adequate number of observations. There is a possibility that such a system might be fitted for the years 1920-1940 in the Southeast area, using models described in Section VI. Even so, the application to present conditions would be debatable.

Method (b) was attempted but was not explored conclusively. The results are discussed in subsequent sections, but are not regarded as particularly useful for prediction purposes. The presentation serves the purpose of illustrating the effect of the exogenous forces at work and the changing structure of the peanut economy, as well as to provide a vehicle for descriptive information. The purpose of the analysis by method (b) was to obtain in one equation a direct estimate of production (by states). The models formulated were based on the hypothesis that growers plan their peanut production in accordance with their expectations regarding prices (or values) of peanuts relative to prices (or values) of competing crops, and related production costs. Relationships to rainfall variables were also investigated.

Since neither method (a) nor (b) seemed to meet the need, method (c) will be relied upon to estimate production beginning in 1949 when mandatory acreage allotments and marketing quotas were initiated, and to project production from 1959 to 1965. Considerations in selecting the period beginning in 1949 were:

1) It is of current interest and significance with regard to present and future policy formulation.

2) The economic structure of the peanut economy has been relatively uniform in that annual acreage and price data have been almost wholly determined by government.

3) The problem under study did not exist prior to this period.

4) It is possible to make quite reasonable assumptions about immediate future peanut price and acreage in light of the history of this period, although this does not imply complete confidence that alternative programs under consideration

will not be adopted which would materially affect the projections.

It is presumed that there are few econometric models that can take into consideration all of the factors involved and serve as a complete substitute for judgment. Accordingly, the production projections promulgated in succeeding sections are subject to certain subjective adjustments to allow for factors which are not believed to be reflected fully in the equations used. These are treated as encountered in the relevant discussion. Anticipating subsequent discussion, subjective upward adjustments in yields per acre for Virginia, North Carolina, and Georgia may be advisable to take into account new varieties introduced in the past few years. The effect of these varieties does not appear to be adequately reflected in the yield estimating equations for the 50-year period. Also, irrigation in Oklahoma has developed so rapidly and extensively in the past few years that a rather substantial adjustment seems indicated in order to make realistic projections for the immediate future.

The problem of what assumptions to make is a matter of interpretation of history, legislation, current administrative policy and attitude, the essential facts, and doubtless the bias of the person formulating the assumptions as a reflection of his thinking as to "what is," or "what ought to be." The future may be made to look bright or dim as points of view differ. Assumptions for the immediate future are closely related to the present situation. Acreage is based on minimum allotments and price at minimum support levels approximating 75% of parity. These are thought to represent current legislative and administrative policy, and reflect the present and prospective supply situation.

As to the merit of the statistical equations employed, an evaluation of their relative usefulness and shortcomings will be discussed generally in Section VIII. This will serve to obviate needless repetition from state to state and area to area. It would seem that problems of estimating endogenous variables from endogenous variables, and problems of intercorrelation, as they apply to this study, could best be appraised by the reader after review of the analyses discussed. Care has been taken to graph residuals and partial correlations as an aid in appraising the relative merits of the models considered and to help avoid the projection of accidental or historical situations which would be inappropriate. At the very least, the form of the relationships has been explored which is an essential prerequisite for the formulation of structural models for possible use in later studies.

SECTION III

DESCRIPTION OF VARIABLES AND TRANSFORMATIONS EMPLOYED IN THIS ANALYSIS

It seems desirable to devote one section to a discussion of the data used in this study as a means of providing in one place a convenient reference to the symbolism used in the subsequent statistical analysis. Additionally, since a mere listing of symbols and data fails to provide adequate information as to why certain variables were selected, or why they were used in a particular combination or transformation, some comment in this regard should be helpful in evaluating the results of yield, acreage, and production regressions discussed in the next sections. The description included here with respect to the use of time, prices received and paid, and rainfall constitutes an integral and necessary part of the statement of purposes and general hypotheses set forth in Section II. A listing of the data under consideration here is included in the Data Supplement to this bulletin for each of the seven states, or is included in tables accompanying relevant discussion. (The Data Supplement is distributed only upon request.)

Time (X_1)

The period of time selected for study includes the years 1909-1958. The unit of time is the crop year. In all states, peanuts are planted in the spring months. Harvest of the crop is completed during the late summer and fall months of the same year.

In the estimating equations for yields, no years have been omitted except as necessary for the use of lagged variables. It is recognized that during the 50-year period several changes in the economic and physical structure of the industry have occurred which might justify omission of certain time periods, or separate treatment of such time periods. However, with regard to the estimation of yields per acre, one of the purposes of the study is to take into account the effect of such events as wars, depressions, inflation, government intervention with respect to price and acreage adjustment, introduction of new varieties, improved methods of disease and insect control, improved and new cultural practices, and regional adjustments among production enterprises. For many of these events and innovations, no observed data are available for use in estimating the extent to which changes in yields are associated with them. Accordingly, time as a continuous variable has been employed to provide a composite, but not necessarily precise, measure of the long-run cumulative effect of phenomena not otherwise described by observed data.

Regarding certain estimates of acreage and production, three time periods have been selected. The first is the pre-marketing quota period, 1909-1948; the second is the marketing quota period, 1949-1958; and the third is an inter-war period, 1921-1940. For acreage estimates for Virginia and North Carolina, the last named period includes the several years prior to World War I. A definite structural change in the peanut economy occurred when mandatory acreage allotments became effective in 1949. This would also have been true for the year 1941 when marketing quotas were in effect; however, there seemed little to be gained by including this isolated year in the second time period, nor much advantage in omitting it from the first period. Prior to 1941, government intervention was mainly in the form of a voluntary price and acreage allotment program with less determinate effects. The nature of all such programs, since 1933, is described in Part II.

There remains the possibility of developing synthetic variables, or "dummy variables," consisting of arbitrary values and weights assigned to the introduction of such technological changes as new varieties, successful innovation of disease and insect control measures, or irrigation. However, it was decided that the difficulty of assigning such values in a meaningful way, considering the heterogeneity of soil and climatic conditions and varying responses to be expected in each of the seven states studied, would extend the cost and scope of the study beyond its original intent. In lieu of this, a descriptive bulletin on some of the more significant technological developments has been included as Part I of this study.

In summary, the use of the time variable may be regarded as a means of taking into account the combined influence of technological and institutional factors for which no observed data are available.

Yields (X_2)

The yield data for each state consist of the annual yield per acre as estimated by the United States Department of Agriculture. Attention was given to periodic revisions in such data and the latest revisions published, as of 1959, have been used; however, the several most recent years should be regarded as preliminary. For purposes of statistical estimation, these data are regarded as observed without error.

Peanut Price (X_3), Peanut Price Index (X_4), and Log of Peanut Price (X_5)

The seasonal average price received by peanut growers for the respective crop years, as published by the United States Department of Agriculture, was used in all estimating equations for all years. Attention was given to the use of revised data, but the most recent several years should be considered as preliminary. For purposes of statistical estimates, the data are regarded as observed without error. The symbol (X_4) was reserved for converting price to index form; however, this transformation of the price data was not used in the estimating equations. For certain estimating equations the price per pound was converted to its logarithm and in this form has been designated (X_5). The price received in a current year is influenced by the volume of the crop, the quality of the crop, and in recent years by the price support program. It is, therefore, generated within the economic structure of the peanut industry and would be regarded as an endogenous variable not independent of yield and production for the current year. To render the price variable independent of the influence of the current year's yield, acreage, or production when these are used as dependent variables, price has been used in a one-year lag relation to the dependent variable. Accordingly, "last year's" price has been used in relation to "this year's" value of the dependent variable. This conforms to the usual hypothesis that the peanut grower responds to an "expected price"--his expectation at planting time being that the price he will receive this year will approximate that which he received the preceding year. Intuitively, it may be reasoned that this is a greatly over-simplified measure of the decision-making process and does not conform to the real world. An attempt should be made to test the notion of the distributed lag.[20] Another shortcoming of the one-year lag approach is that, under support prices and marketing quota legislation, the support price for the forthcoming crop is announced well in advance of planting time. It may be reasoned, therefore, that the support price becomes the "expected" price as a minimum depending upon quality and expectations as to total supply. The level of support under marketing quotas has not varied greatly with the exception of the down-trend in the most recent three or four years; accordingly, in order to retain consistency in handling the data throughout the fifty-year period, a one-year lag of the seasonal average price was used.

The reason for the transformation of prices to their logarithms is described by Johnson.[21] It derives from the nature of the production function which is assumed to conform to the law of diminishing returns. Yields per acre, for example, would tend to increase at a decreasing rate as competitive entrepreneurs respond to price increases.

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[20]Marc Nerlove, Distributed Lags and Demand Analysis for Agriculture and Other Commodities, Agricultural Handbook No. 141, (Washington: U. S. Department of Agriculture, June 1958), pp. 1-277.

[21]Glenn L. Johnson, Burley Tobacco Control Programs, Bulletin 580 (Lexington: Kentucky Agricultural Experiment Station, 1952), pp. 45-46.

Index of Prices Paid for Items Used in Production (X_6) and the Index Squared (X_7)

One of the factors entering into the decision-making process is that of costs. Ideally, some observed variable or variables that would directly reflect the year-to-year change in cost of peanut production by states would be the most useful measure of grower's response to such changes. Unfortunately, no really satisfactory specific measure is available. Costs encountered in the production of peanuts are highly correlated with the costs associated with the production of all farm commodities. The United States index of the prices paid for items used in production (X_6), as published by the United States Department of Agriculture, was used as a measure of the relative change in the cost of producing peanuts. In the estimating equations, the square of the prices paid index (X_7), was usually employed to make allowance for the assumed nature of the production function,[22] thus, yields would be expected to decrease at an increasing rate as prices paid for items of production increase.

Composite Index of Costs (X_8), and Composite Index Squared (X_9)

In the allocation of limited resources to the production of a particular commodity there are two general types of costs to consider: (1) accounting costs which, for purposes of this study, are regarded as the prices paid for the actual quantities of the various factors used in producing the commodity, and (2) opportunity costs which may be thought of as the income which might have been earned if the same productive resources had been allocated to their next best use. The variable "prices paid for items used in production (X_7)," previously described, was used in an attempt to determine the manner in which changes in accounting costs are associated with changes in peanut yields per acre, or acreage harvested. Since no net income data for peanuts or other crops grown in association with peanuts in the rotation are available, the next best measure of opporutnity costs in an index of the prices of alternative or competing crops. The economic theory involved here is that, while accounting costs compared to revenue indicate the profit and degree of economic efficiency and profitability with respect to a particular commodity, they do not serve as a measure of the profit which might have been gained from alternative commodities which could have been produced with the resources. These would include land which is assumed not purchaseable for this comparison but which is, nevertheless, reallocatable between enterprises.

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[22] Johnson, Bulletin 580, p. 46.

The composite cost index was developed in an attempt to obtain in one series of data a blend of accounting costs and opportunity costs. The latter are represented by the prices of competing crops such that the manner in which changes in peanut yields, acreage, or production are associated with changes in these costs could be determined.

The decision to use this combination, and the manner in which it was effected, were arbitrary. One alternative would have been to use the prices of the alternative crops as separate variables. Aside from computational considerations and loss of degrees of freedom, it would appear that considerations other than price have been influential in effecting some of the shifts in acreage of crops which compete with peanuts. For example, it seems unlikely that the tremendous shift from cotton acreage in the Southeast was solely a matter of price considerations.[23] Another complication in measuring the response to opportunity costs is the matter of crop rotation. A response to relative price changes which might be logical pricewise might be restricted by the necessity of adherence to recommended or customary cultural practices. Without a considerable expansion and intensification of the study to consider in detail the nature and cause of shifts in acreage from one crop to another, it seemed advisable to try an aggregative composite cost index.

In Virginia and North Carolina, corn and cotton for the time period 1909-1958, and soybeans 1924-1958, were regarded as the principle competing crops. Their seasonal average prices were taken as a measure of opportunity costs. In computing the composite index, the relative importance of the prices of competing crops was considered by weighting them with the acreage of the respective crops. The relative importance of the direct (accounting) costs of producing peanuts, as measured by the United States Index of prices paid for items used in production, was weighted by the acreage of peanuts. Prices of competing crops were converted to indexes using the simple 1910-1914 average price equal to 100. One further adjustment was made: the opportunity costs (prices of competing crops) were lagged one year (in form t-1) while the prices paid index was not lagged (in form t). The composite cost index was then computed as the sum of the products of the prices paid index and peanut acreage, the price of corn index and corn acreage, and the price of cotton index and cotton acreage, and the price of soybean index and soybean acreage, all divided by the total acreage of peanuts, corn, cotton, and soybeans. This is based on the hypothesis that at planting time the grower considers the current level of the accounting costs of producing peanuts together with the expected prices (and therefore returns) that he could obtain by devoting resources to crops other than peanuts. He then makes a rational decision as to the most profitable combination of enterprises

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[23]Michael J. Brennan, Progress Report on Cotton Production Response ARS 43-72 (Washington: U. S. Department of Agriculture, 1958), pp. 3-4.

for the current year. The "expected prices" are regarded as those for the preceding year. It is not contended that this assumption is necessarily valid for little is known about the peanut grower's decision-making process. Neither can there be assurance that, assuming he does in fact consider the factors in approximately the manner described above, there are not other factors which enter into the process in an important way such as crop rotations, credit, soil type, and available labor which may cause non-response or considerable lag in his response to costs and alternative opportunities. Also, other methods of combining the several indexes might have been chosen.

In Virginia, the acreage used in weighting the price of corn was modified to include only acreage of corn in Crop Reporting District Number 9, the peanut producing area of the state. A similar modification was used in North Carolina by using corn acreage in Crop Reporting District Number 3 for the same reason. Since data in this form are not available prior to 1930 in Virginia and 1925 in North Carolina, arbitrary acreage weights were assigned for prior years in rough proportion to the total state acreage and census data. The main purpose of these modifications was two-fold: (1) to avoid excessive weights for corn price, and (2) to avoid the use of state corn acreage which had declined over the years in an amount disproportionate to change in corn acreage in the peanut production areas.

In all other states, state acreages were used in weighting the prices of competing crops as a measure of opportunity costs.

In summary, Table 1 gives the competing (alternative) crops selected for the seven states for purposes of deriving a composite index of direct production costs and opportunity costs.

Table 1.--Selection of crops which are regarded as competing with, or alternative to, peanuts in the seven major peanut producing states.

State	Crops
Virginia..................	corn, cotton, soybeans*
North Carolina............	corn, cotton, soybeans*
Georgia...................	corn, cotton
Florida...................	corn, cotton
Alabama...................	corn, cotton
Texas.....................	corn, cotton, sorghum**
Oklahoma..................	corn, cotton, sorghum**

*soybean data beginning in 1925
**sorghum data beginning in 1929

For use in the estimating equations, the square of the composite cost index (X_9) was used under the assumption that yields or acreage would decrease at an increasing rate as composite costs increased.[24]

Peanut Acreage (X_{10})

In the estimating of equations the peanut acreage data used is the "acreage of peanuts picked and threshed" as estimated by the United States Department of Agriculture.

In the Virginia-Carolina area, the acreage picked and threshed is substantially the same as acreage for "all purposes." Abandonment of acreage is normally small. Accordingly, acreage planted and acreage picked and threshed are substantially the same, particularly in recent years, although a small acreage is still hogged off in North Carolina.

In the Southeast area, the acreage grown for all purposes, including hogging-off, substantially exceeds the acreage picked and threshed although the differential has declined in recent years. A similar relationship holds in the Southwest area. Except for consideration given to the difference between acreage allotments and acreage picked and threshed, this study is concerned only with picked and threshed acreage.

Peanut Production (X_{11})

The data consist of the total number of pounds of peanuts picked and threshed annually, as estimated by the United States Department of Agriculture.

Value of Peanut Production (X_{12})

The annual peanut crop values used are those assigned by the United States Department of Agriculture.

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[24]Johnson, Bulletin 580, p. 46.

Value of Competing Crops (X_{13})

The annual crop values assigned by the United States Department of Agriculture to the competing (alternative) crops specified above under (X_9) were summed for the respective states.

Acreage of Competing Crops (X_{14})

Except as noted under (X_9) above, with regard to modifications in corn acreage in Virginia and North Carolina, the acreage used is the sum of the total acreages of the crops specified under (X_9) as estimated by the United States Department of Agriculture.

Rainfall in Critical Months (X_{15}, X_{16}, X_{17})

The same notation and subscripts (X_{15}, X_{16}, and X_{17}) have been used in all states to designate the critical months. A "critical month" is regarded as one in which the amount of rainfall received will "make or break" the crop. In the process of growth, the peanut plant goes through a stage referred to as "pegging". As the vine grows and spreads over the soil adjacent to the plant, "pegs" emerge from the vine and enter the soil. It is from these pegs that the peanut develops beneath the soil surface. Lack of adequate moisture during the pegging stage inhibits the process and lowers the yield. Agronomists in Virginia[25] have indicated that pegging occurs over a two-month period (July and August in Virginia and North Carolina) and that about four inches of rain per month, reasonably well distributed, would be the ideal norm. If pegging were inhibited in July by drought, however, a good yield might still result from adequate rainfall in August. Agronomists also indicate that relatively light rainfall in September would be ideal for maturing the crop; heavy rainfall in September is regarded as detrimental. Higgins and Bailey[26] say "observations indicate that lack of adequate soil moisture may be critical at three periods: at planting, when gynophores (pegs) are entering the soil, and during development of pods and seed. Too much rain at harvest time may favor losses--through seed sprouting, decay of gynophores, and decay of nuts."

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[25]Interviews with Dr. H. L. Dunton and M. P. Lacy, Agronomy Department, Virginia Polytechnic Institute, Blacksburg, Virginia.

[26]B. B. Higgins and Wallace K. Bailey, New Varieties and Selected Strains of Peanuts, Bulletin N. S. 11 (Athens: Georgia Agricultural Experiment Stations, 1955), p. 6.

Agronomists in other states were not contacted. The same general hypothesis was extended to each of the other six states, but modified for difference in growing season. Table 2 shows the critical months selected for the respective states.

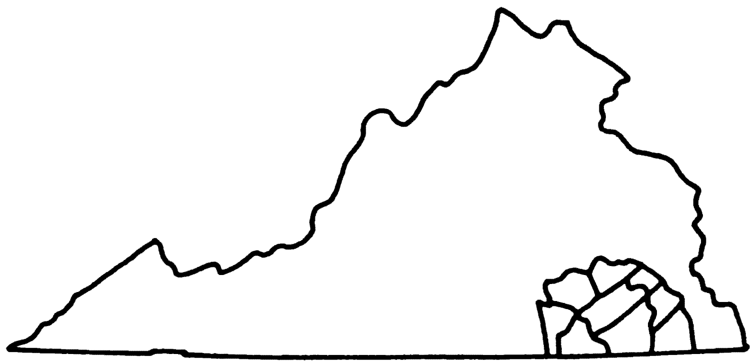
Table 2.--Months in which rainfall is deemed to be critical for normal growth and maturity of peanuts in seven major producing states.

State	Critical Months		
	X_{15}	X_{16}	X_{17}
Virginia	July	August	September
North Carolina	July	August	September
Georgia	June	July	August
Florida	June	July	August
Alabama	June	July	August
Texas	June	July	August
Oklahoma	July	August	September

In compiling the rainfall data for the respective months and states, the records of the Weather Bureau were consulted. Monthly total rainfall since 1909 was tabulated for all meteorological substations in all major peanut producing counties in the peanut producing area of each state insofar as the substation records contained a report for the desired month and year. Relatively few substations provided a continuous fifty-year record. Prior to 1930, less than half as many substation reports were available in some states as for the period since then. However, it is believed that enough substation reports were available in each of the early years to provide reasonably useful average rainfall data for the area for each month and year.

An arithmetic unweighted average of the inches of rainfall reported by all recording substations for each critical month and year for each state's peanut producing area was then calculated. These monthly averages are the observations designated as X_{15}, X_{16}, and X_{17}.

The substation rainfall data used are included in the Data Supplement to this Part III. The accompanying maps, Figures 1 through 7, designate: (1) the peanut producing areas of the seven major states, (2) the important peanut producing counties within each state, (3) the relative intensity of peanut production in the more important counties within each state as indicated by county acreage for 1957, and (4) the approximate location of each of the meteorological substations for which rainfall data were available for part or all of the 50-year period under study. An exception was necessary for Texas regarding location of substations on the map; instead, a list of substations by counties accompanies the map.



VIRGINIA PEANUT PRODUCTION AREA
PRINCIPAL COUNTIES
METEOROLOGICAL SUBSTATIONS

SUBSTATIONS

1. Capron
2. Emporia
3. Franklin
4. Holland
5. Hopewell
6. Ivor
7. Runnymeade, Surry
8. Smithfield
9. Suffolk, Lake Kilby
10. Surry
11. Sussex

Acreage of Peanuts 1957:

Total Acres in Counties Shown	-	105,340
Other Counties	-	660
Total State Acreage	-	106,000

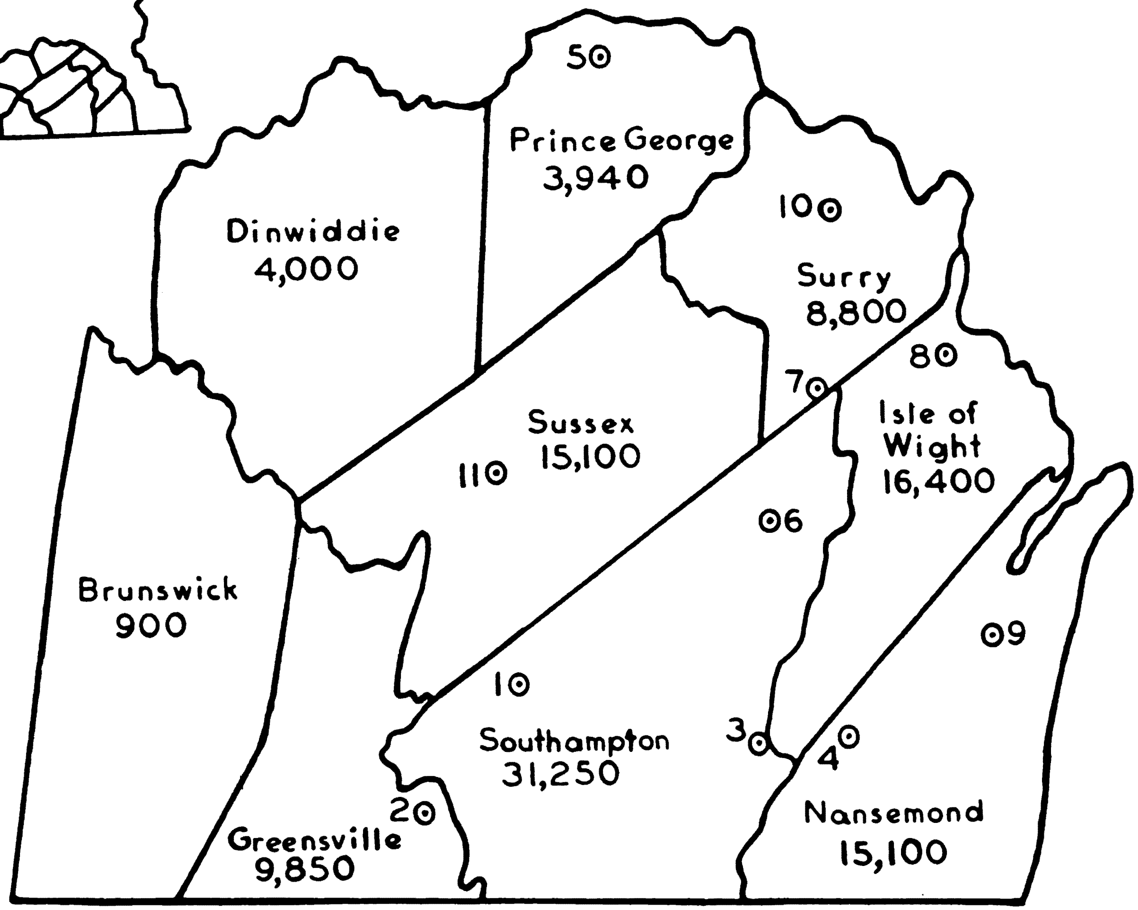
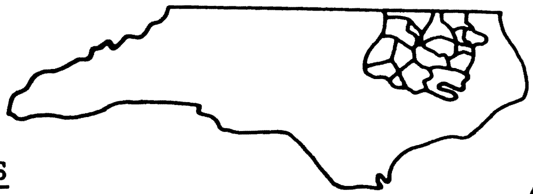
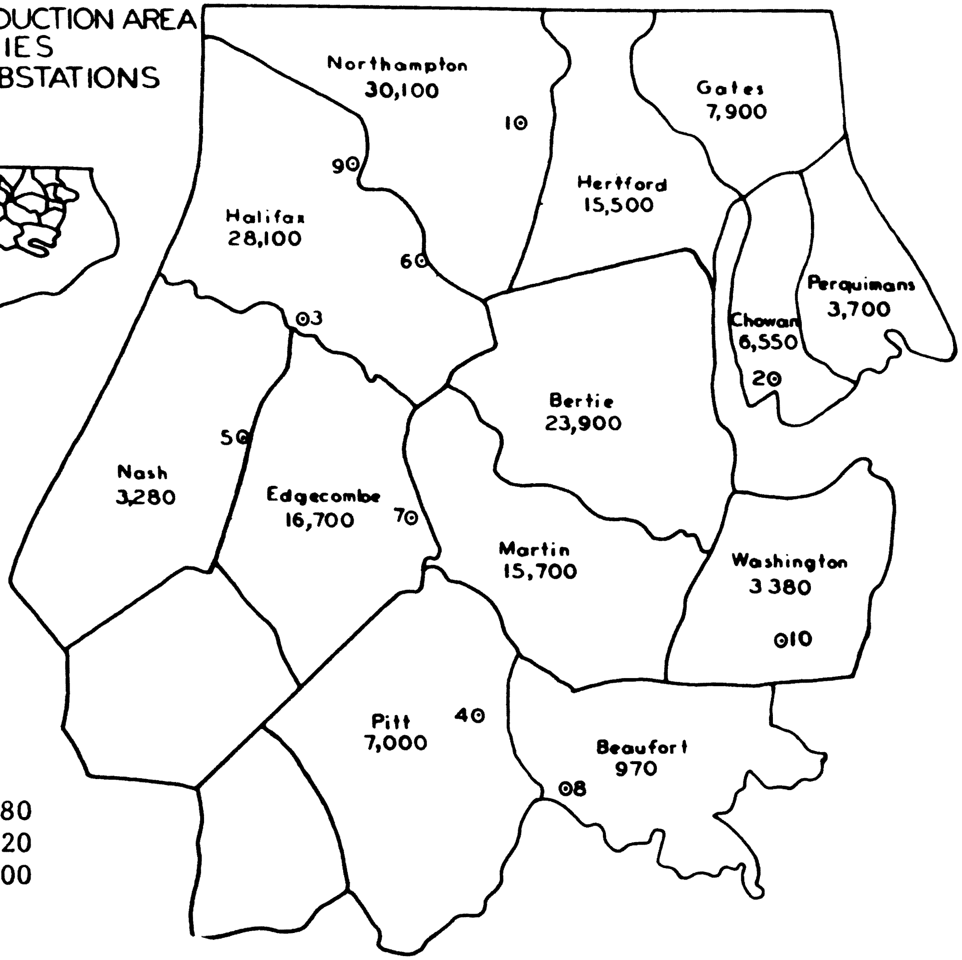


Figure 1.

NORTH CAROLINA PEANUT PRODUCTION AREA
PRINCIPAL COUNTIES
METEOROLOGICAL SUBSTATIONS





SUBSTATIONS

1. Eagletown
2. Edenton
3. Enfield
4. Greenville
5. Rocky Mount
6. Scotland Neck
7. Tarboro
8. Washington
9. Weldon
10. Wenona

Acreage of Peanuts 1957:

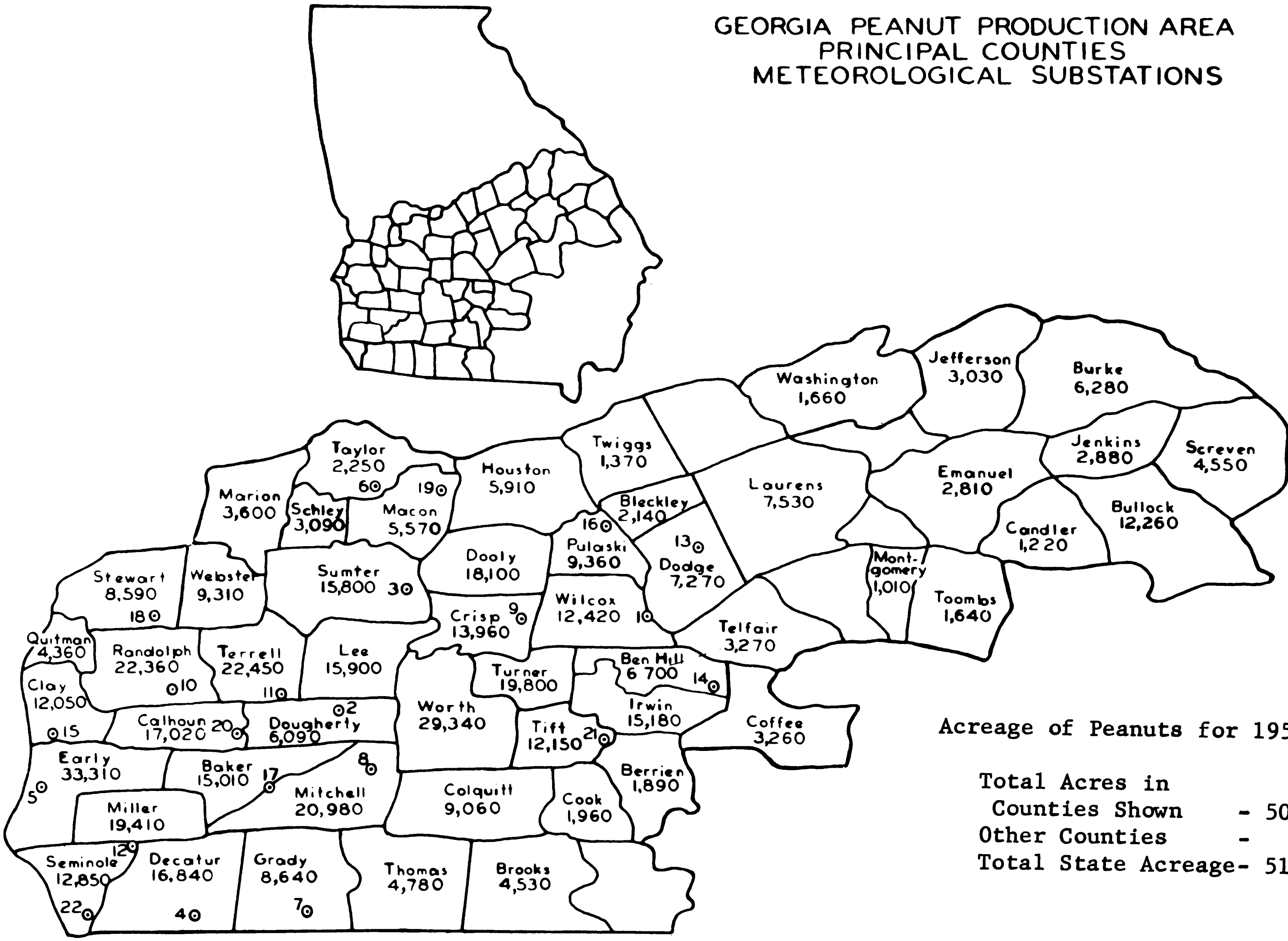
Total Acres in Counties Shown	-	162,780
Other Counties	-	18,220
Total State Acreage	-	181,000

Figure 2.

SUBSTATIONS

1. Abbeville
2. Albany
3. Americus
4. Bainbridge
5. Blakely
6. Butler
7. Cairo
8. Camilla
9. Cordele
10. Cuthbert
11. Dawson
12. Donalsonville
13. Eastman
14. Fitzgerald
15. Fort Gaines
16. Hawkinsville
17. Hoggards Mill
18. Lumpkin
19. Montezuma
20. Morgan
21. Tifton
22. Woodruff Dam

GEORGIA PEANUT PRODUCTION AREA
PRINCIPAL COUNTIES
METEOROLOGICAL SUBSTATIONS

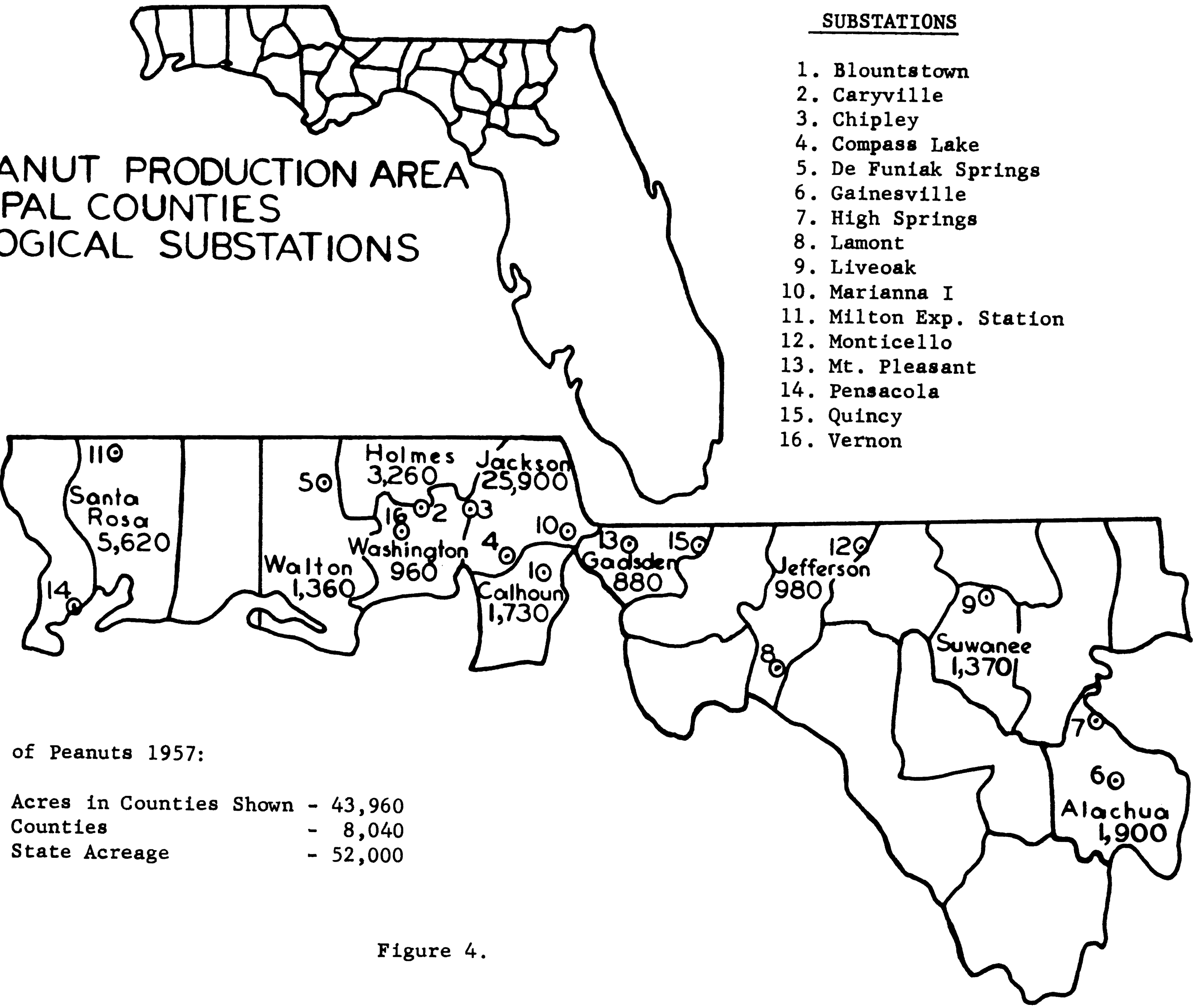


Acreage of Peanuts for 1957:

Total Acres in Counties Shown	- 502,800
Other Counties	- 7,200
Total State Acreage	- 510,000

Figure 3.

FLORIDA PEANUT PRODUCTION AREA
PRINCIPAL COUNTIES
METEOROLOGICAL SUBSTATIONS



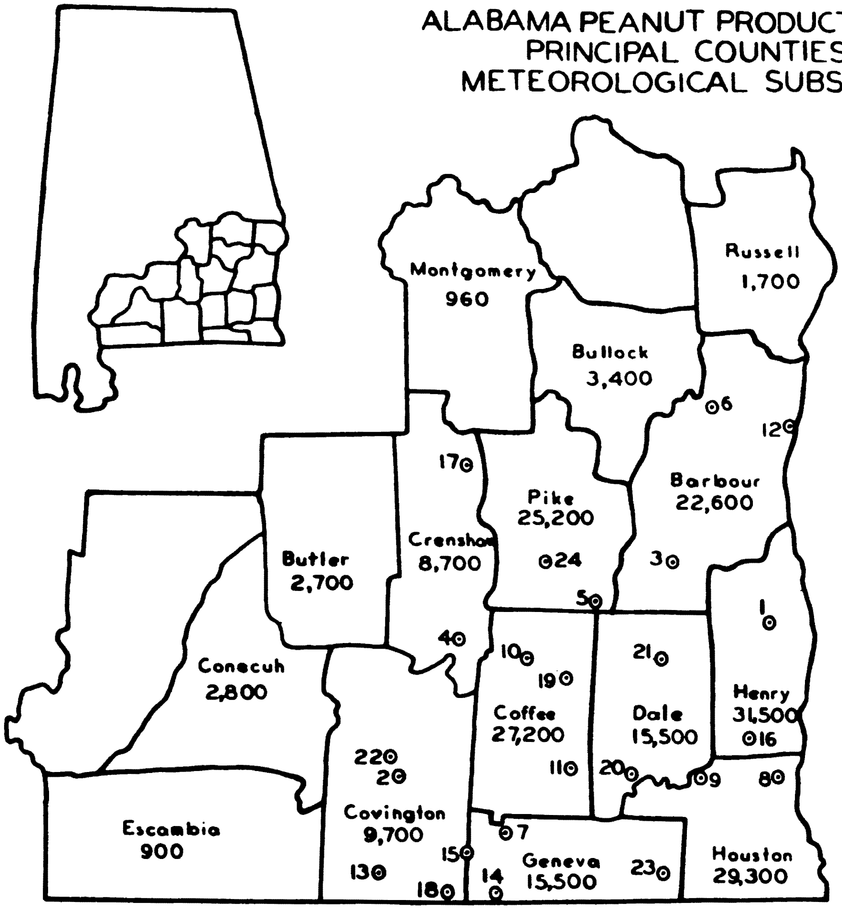
SUBSTATIONS

1. Blountstown
2. Caryville
3. Chipley
4. Compass Lake
5. De Funiak Springs
6. Gainesville
7. High Springs
8. Lamont
9. Liveoak
10. Marianna I
11. Milton Exp. Station
12. Monticello
13. Mt. Pleasant
14. Pensacola
15. Quincy
16. Vernon

Acreage of Peanuts 1957:

Total Acres in Counties Shown	- 43,960
Other Counties	- 8,040
Total State Acreage	- 52,000

Figure 4.



SUBSTATIONS

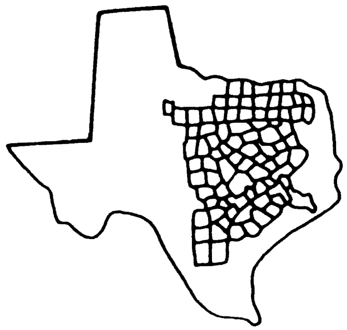
1. Abbeville
2. Andalusia
3. Blue Springs
4. Brantley
5. Brundidge
6. Clayton
7. Coffee Springs
8. Columbia
9. Dothan
10. Elba
11. Enterprise
12. Eufaula
13. Falco Open Pond Tower
14. Geneva
15. Green Bay
16. Headland
17. Highland Home
18. Lockhart
19. New Brockton
20. Newton
21. Ozark
22. River Falls
23. Slocomb
24. Troy

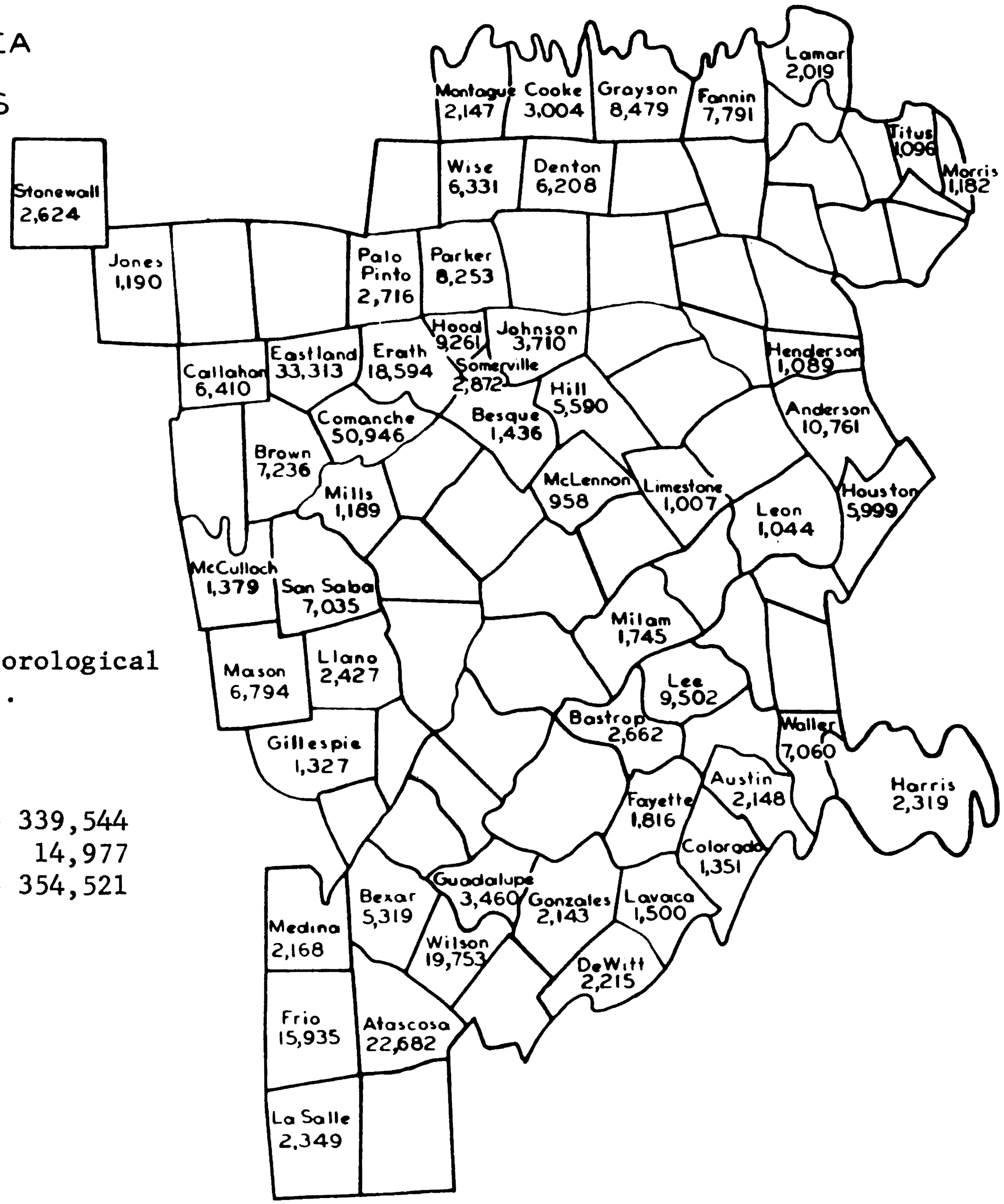
Acreage of Peanuts in 1957:

Total Acres in Counties Shown	-	197,260
Other Counties	-	7,740
Total State Acreage	-	205,000

Figure 5.

TEXAS PEANUT PRODUCTION AREA
PRINCIPAL COUNTIES
METEOROLOGICAL SUBSTATIONS





See accompanying list of 134 meteorological substations by counties.

Acreage of Peanuts 1957:

Total Acres in Counties Shown	-	339,544
Other Counties	-	14,977
Total State Acreage	-	354,521

Figure 6.

TEXAS COUNTIES AND SUBSTATIONS

ANDERSON
- Long Lake

ATASCOSA
- Falls City
- Jourdanton
- Poteet

AUSTIN
- Sealy

BASTROP
- Jeddo
- Smithville

BEXAR
- Classens Ranch
- San Antonio
- Nursery

BLANCO
- Sandy

BOSQUE
- Clifton 9E
- Kopperl

BROWN
- Blanket
- Brownwood
- Byrds
- Health Farm
- Winchell

CALLAHAN
- Cross Plains
- McDonald Store
- Putnam

COLORADO
- Columbus

COMANCHE
- Comanche

COOKE
- Era
- Gainesville
- Muenster

DENTON
- Denton
- Lake Dallas
- Lewisville
- Little Elm
- Roanoke
- Sanger

DEWHITT
- Cuero
- Yorktown

EASTLAND
- Eastland
- Ranger
- Rising Star

ERATH
- Dublin
- Morgan Mill
- Stephenville

FANNIN
- Bonham
- Honey Grove
- Telephone
- Trenton

FAYETTE
- Flatonia
- LaGrange
- Schulenburg

FRIO
- Dilley
- Frio Town
- Pearsall

GILLESPIE
- Car Ranch
- Doss
- Fredericksburg
- Riley Ben Ranch

GONZALES
- Dryer
- Nixon
- Waelder

GRAYSON
- Denison Dam
- Sherman

GUADALUPE
- New Brounfels
- Seguin

HARRIS
- Clodine
- Cypress
- Houston Heights
- Tomball

HENDERSON
- Athens
- Trinidad

HILL
- Hillsboro
- Itasca
- Whitney Dam

HOOD
- Lipan

HOUSTON
- Crockett
- Grapeland
- Nogalus G S

JONES
- Hamlin
- Nugent
- Stamford
- Truby

LAMAR
- Arthur City
- Paris

LASALLE
- Cotulla
- Encinal
- Fowlerton

TEXAS COUNTIES AND SUBSTATIONS (Continued)

LAVACA
Halletsville
Provident City
Yoakum

LEE
Dime Box
Giddings

LEON
Buffalo
Centerville
Jewett

LIMESTONE
Mexia
Thornton

LLANO
Castell
Ligon Ranch
Llano
Moss Ranch

MASON
Capps Ranch
Martin Ranch
Mason
Miller Ranch
Pontotoc

MCCULLOCH
Brady
Fife
Johnson Ranch
Neal Ranch
Placid

MEDINA
Devine
Hondo

MILAM
Burlington
Cameron
Davilla

MILLS
Goldthwaite

MONTAGUE
Forestburg
Montague
Ringgold

PALO PINTO
Brazos
Mineral Wells
Palo Pinto
Strawn 8NNE

SAN SABA
Chappel
Flying V
Richland Springs
San Saba
Sloan

SOMERVILLE
Rainbow

STONEWALL
Aspermont

TITUS
Mt. Pleasant

WALLER
Hempstead
Waller

WILSON
Floresville

WISE
Boyd
Bridgeport
Decatur
Slidell

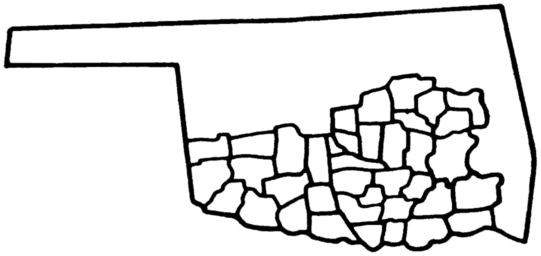
SUBSTATIONS

1. Anadarko
2. Ardmore
3. Atoka
4. Boswell
5. Bristow
6. Calvin
7. Caney
8. Chandler
9. Checotah
10. Chickasha
11. Comanche
12. Daisy
13. Dewar
14. Duncan
15. Durant
16. Elk City
17. Erick
18. Eufaula
19. Farris
20. Fort Cobb
21. Hanna
22. Haskell
23. Healdton
24. Heyburn Dam
25. Holdenville
26. Hugo
27. Kingston
28. Konawa
29. Lawton
30. Madill
31. Marietta
32. Marlow
33. McAlester
34. Meeker
35. Monavia
36. Ninnekah
37. Orr
38. Okmulgee
39. Pontotoc
40. Prague
41. Quinton
42. Sayre
43. Seminole
44. Shawnee
45. Spencerville
46. Tishomingo
47. Tribbey
48. Wetumka
49. Wewoka
50. Wichita Mt.
51. Yuba

Acreage of Peanuts for 1957:

Total Acres in Counties Shown	-	119,590
Other Counties	-	4,410
Total State Acreage	-	124,000

OKLAHOMA PEANUT PRODUCTION AREA
PRINCIPAL COUNTIES
METEOROLOGICAL SUBSTATIONS



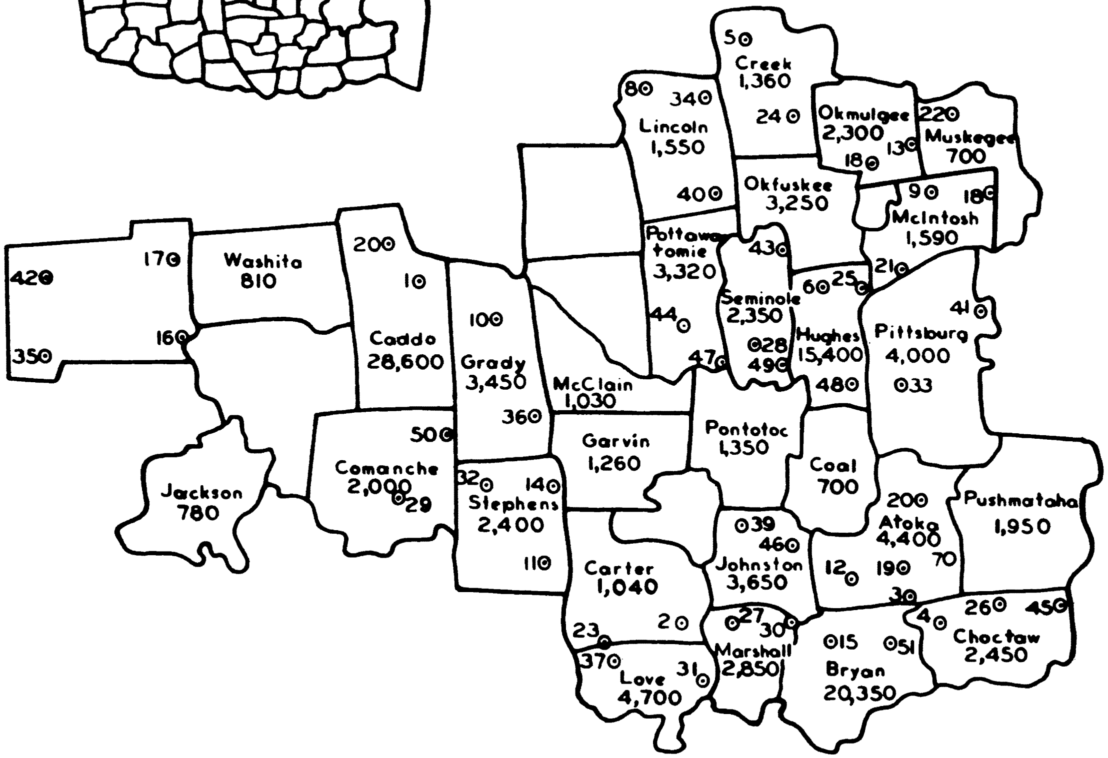


Figure 7.

Profitability Ratio (X_{18} and X_{19})

This series of data (X_{18}) consists of the ratio of the total value of the competing crops, described under (X_{13}) above, to the value of the peanut crop (X_{12}). The variable (X_{19}) is this ratio squared. It is difficult to assign a rational theoretical concept to the use of this ratio in terms of either costs or prices. The original notion was that, as peanut crop values increased relative to competing crop values, the ratio would decline at an increasing rate and possibly be associated with changes in peanut yields or acreage. As explained in the analysis, this variable did not prove to be useful.

Year (X_{20})

The symbol (X_{20}) was used to denote years 1909-1958. Year figures were used in some analyses as a measure of time.

Ratio of the Price of Peanuts to the Index of the Cost of Production Items (X_{21})

The title of this variable is largely self-explanatory. It is the price of peanuts per pound (X_3) divided by the index of the cost of production items (X_6) to obtain as one figure a variable in ratio form which would reflect the combined effect of prices paid and prices received. This variable was used in 1-year lagged form (t-1) to reflect the growers "expected" price-cost considerations.

Ratio of the Per Acre Value of Competing Crops to Index of Cost of Production Items (X_{22})

This is a ratio obtained by dividing the per acre value of competing crops (X_{24}) by the direct costs of production as represented by the index of the cost of production items (X_6). This ratio was lagged 1- year in the estimating equations on the hypothesis that the producer's expectations with regard to opportunities in the current year would be governed largely by his observations about such opportunities in the previous year.

Ratio of the Price of Peanuts to the Index of the Cost of Production Items (X_{23})

This is the same ratio as for (X_{21}). In certain regressions it was used in unlagged form and was designated as (X_{23}) to distinguish it from the lagged form.

Per Acre Value of Competing Crops (X_{24})

This is a machine computed value obtained by dividing the total value of competing crops (X_{13}) by the total acreage of competing crops (X_{14}).

Excess Penalty Rate (X_{25})

A penalty of 75% of the support price per pound is assessed by Government (50% for the period 1949-1956) against growers who fail to comply with the peanut program by planting acreage in excess of their farm allotments.

Acreage Allotment (X_{26})

National, state, county, and farm allotments are established under the peanut price support program. Only state allotments are used in this study.

Three-month Average Rainfall in Texas (X_{27})

This is the average of June (X_{15}), July (X_{16}), and August (X_{17}), rainfall for special use in estimating underharvested acreage in Texas.

Price of Hogs (X_{28})

This is the annual average price of hogs in Georgia and Alabama as published by the United States Department of Agriculture.

Underharvested Peanut Acreage (Y_1)

From the state acreage allotment is subtracted the acreage picked and threshed. If acreage picked and threshed is less than the allotment, the difference is regarded as a negative value; if not, a positive value.

Ratio of Peanut Acreage Picked and Threshed to Peanut Acreage Allotment (Y_2)

This is another means of expressing the relationship between the state acreage harvested and the state acreage allotment.

SECTION IV

ACREAGE, YIELD, AND PRODUCTION ESTIMATES

VIRGINIA-CAROLINA AREA

The variables used, as described in Section III, and the statistical models considered, are listed below in the relevant subsections for acreage, yield, and production estimates. The complete analysis of variance for each of these models bearing an equation number is given in tables in the Data Supplement to this bulletin, which will be made available on request.

Set forth below in both equation and graphic form are the coefficients and related values for selected models. For other models, only a brief description of the results is given; details may be found in the Supplement.

In the equations given, the figures in parentheses below the coefficients are the standard error values; one asterisk (*) denotes significance at the 5% probability level; two asterisks (**) denote significance at the 1% level. The symbol (R^2) refers to the value of the multiple correlation coefficient which ranges between zero and one; converted to percentage, it "suggests" the extent to which the several independent variables collectively "explain" the variation in the dependent variable. High values (.80 to 1.00) are not necessarily helpful, nor do low values (.30 to .60) necessarily render an analysis worthless.

Acreage Estimates

Virginia-Carolina Area

Variables Used and Models Considered:

X_1 ... Time
X_3 ... Price of peanuts
X_5 ... Log peanut price (t-1)
X_6 ... U. S. cost index
X_7 ... U. S. cost index squared
X_{10}... Peanut acreage (dependent)
X_{14}... Acreage of competing crops
X_{15}... July rainfall
X_{16}... August rainfall
X_{17}... September rainfall
X_{21}... Peanut price-cost ratio (t-1)
X_{22}... Per acre value-cost ratio competing crops (t-1)
X_{23}... Same as X_{21} but not lagged
X_{25}... Excess acreage penalty
X_{26}... State acreage allotment
Y_1 ... Underharvested peanut acreage (dependent)
Y_2 ... Ratio peanut acreage to acreage allotment (dependent)

Models Considered	Time Period	Data Supplement Reference: Table Number	Equation Numbers: Virginia	Equation Numbers: North Carolina
A. $X_{10}=f(X_5, X_7)$	1909-1958	1	140	240
B. $X_{10}=f(X_5, X_7)$	1909-1948	2	149	249
C. $X_{10}=f(X_5, X_7, X_{14})$	1909-1958	3	160	260
D. $X_{10}=f(X_5, X_7, X_{14})$	1909-1948	4	169	269
E. $X_{10}=f(X_5, X_7, X_{14t-1})$	1909-1948	5	167	267
F. $X_{10}=f(X_1, X_{21}, X_{22}, X_{23}, X_{15}, X_{16}, X_{17})$	1909-1958	6	163	263
G. $X_{10}=f(X_1, X_{21}, X_{22}, X_{23}, X_{15}, X_{16}, X_{17})$	1909-1948	6	164	264
H. $X_{10}=f(X_1, X_{21}, X_{22}, X_{23})$	1909-1948	6	166	266
I. $X_{10}=f(X_1, X_{21}, X_{22})$	1909-1917 1923-1940	7	166IW	266IW
J. $X_{10}=f(X_{26})$	1949-1958	none	(subjective)	
K. $Y_{11}=f(X_3, X_{25})$	1949-1958	8	9-1-1	9-2-1

Continued

Models Considered	Time Period	Data Supplement Reference: Table Number	Equation Numbers: Virginia	Equation Numbers: North Carolina
L. $Y_{12} = f(X_{3t-1}, X_{25})$	1949-1958	9	0-1-1	0-2-1
M. $Y_{13} = f(X_{21}, X_{25})$	1949-1958	10	2-1-1	2-2-1
N. $Y_{21} = f(X_3, X_{25})$	1949-1958	11	9-1-2	9-2-2
O. $Y_{22} = f(X_{3t-1}, X_{25})$	1949-1958	12	0-1-2	0-2-2
P. $Y_{23} = f(X_{21}, X_{25})$	1949-1958	13	2-1-2	2-2-2

Models A and B

These two initial exploratory models provided such low multiple correlation coefficients as to suggest omission of important variables, and wide dispersion of the data characteristic of the changing economic structure and exogenous forces affecting the industry. Omission of the mandatory allotment period in Model B effected some comparative improvement in favor of this explanation. It is quite to be expected that acreage response to price would be stifled by allotments. Such is the purpose of the program. During World War I, acreage declined when price increased, probably due to an employment alternative exogenous to the industry. No variable is included for this. At times, costs have increased along with prices; accordingly, some degree of intercorrelation is likely involved which reverses expected relationships. Both models were rejected.

Models C, D, and E

The addition of the acreage of competing crops increases the multiple correlation coefficient, particularly for Models D and E in which the mandatory allotment years are omitted. Of the six regressions, five bear statistically significant coefficients of logical sign for competing crop acreage suggesting a strong negative association between the acreage of peanuts and the acreage of specified competing crops. The use of this variable would bear further investigation if other difficulties mentioned under Models A and B above could be overcome. Reversal of signs from logical expectations is probably a result of including war years, and concomitant intercorrelation of the variables; however, this problem might not be completely overcome even if war years were to be omitted, as is the case in Model I below. The use of a time variable and price-cost ratio should probably be explored in a model containing acreage of competing crops. Since these models are inconclusive, they were rejected.

Models F and G

These models were tested to explore price-cost ratio relationship to acreage; the per acre value of competing crops in lieu of acreage; and to see if there exists any relationship between peanut acreage and rainfall. No weather effect was really anticipated in the Virginia-Carolina area where abandonment of acreage is negligible.

The comparatively low multiple correlation coefficients for Model F suggest a poor fit with the mandatory allotment period included, in manner similar to that experienced in Models A and C. Accordingly, Model F was rejected. Since there was no significant weather effect, Model G was also rejected. Other relationships are discussed below in connection with Model H.

Model H

In order to investigate more thoroughly the nature of these relationships, residuals and partial regression lines of relationship were computed for this model which is the same as Model G without the weather variables. These are presented graphically in Figures 1 and 2 for Virginia and North Carolina, respectively. The respective equations are:

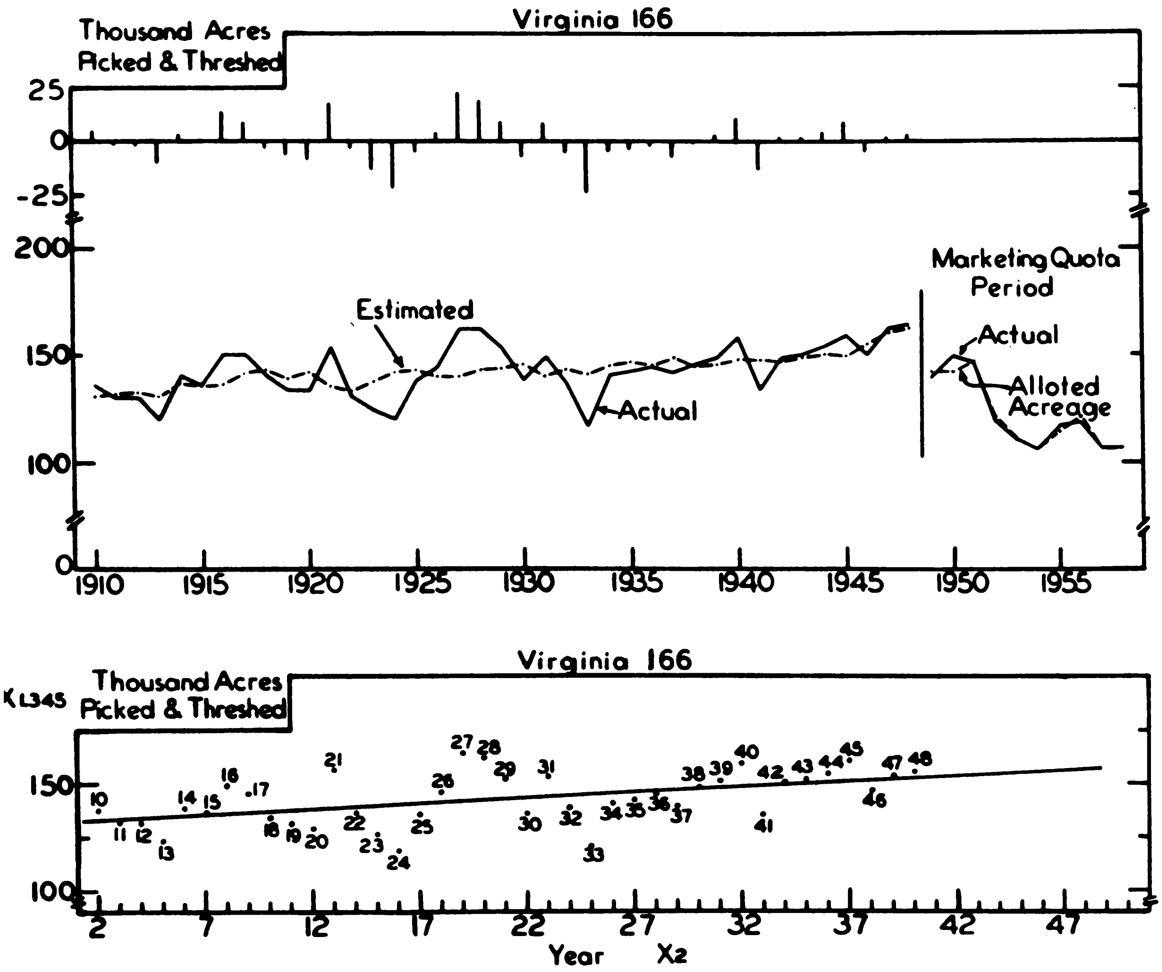
Virginia - 166 : $R^2 = .34$

$$X_{10} = 125.7262 + \underset{(0.1378)}{0.5030X_1^{**}} - \underset{(2.5585)}{0.9962X_{21}} + \underset{(0.4434)}{0.7674X_{22}} - \underset{(1.8293)}{1.2579X_{23}}$$

North Carolina - 266 : $R^2 = .85$

$$X_{10} \quad 117.4726 + \underset{(0.2867)}{4.4501X_1^{**}} + \underset{(6.6102)}{13.2486X_{21}} - \underset{(9.7624)}{18.3136X_{22}} - \underset{(4.1381)}{2.6896X_{23}}$$

Time is the only variable for the area with a significant coefficient. There is doubtless intercorrelation among the independent variables peanut price, costs and per acre value of competing crops as these tend to move together over time, particularly in war years. The behavior of acreage of competing crops in Model E suggests that perhaps acreage rather than price or value of competing crops might provide the more reliable coefficient. The acreage rotation of crops for corn, cotton, soybeans, and peanuts (not necessarily in this order) seems to suggest this possibility. Whether or not peanut acreage and acreage of competing crops are both associated with time has not been investigated. Total crop land use in the area has not changed greatly. For example, the decline in cotton in Virginia has been largely compensated by an increase in soybeans. If peanut acreage is associated with competing crops in some definite way in the rotation, as Models C, D, and E suggest, then perhaps



Virginia 166
Thousand Acres
Picked & Threshed
25
0
-25
200
150
100
0
Estimated
Actual
Marketing Quota
Period
Actual
Alloted
Acreage
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
Virginia 166
KL345
Thousand Acres
Picked & Threshed
150
100
2
7
12
17
22
27
32
37
42
47
Year
X2

Figure 1.

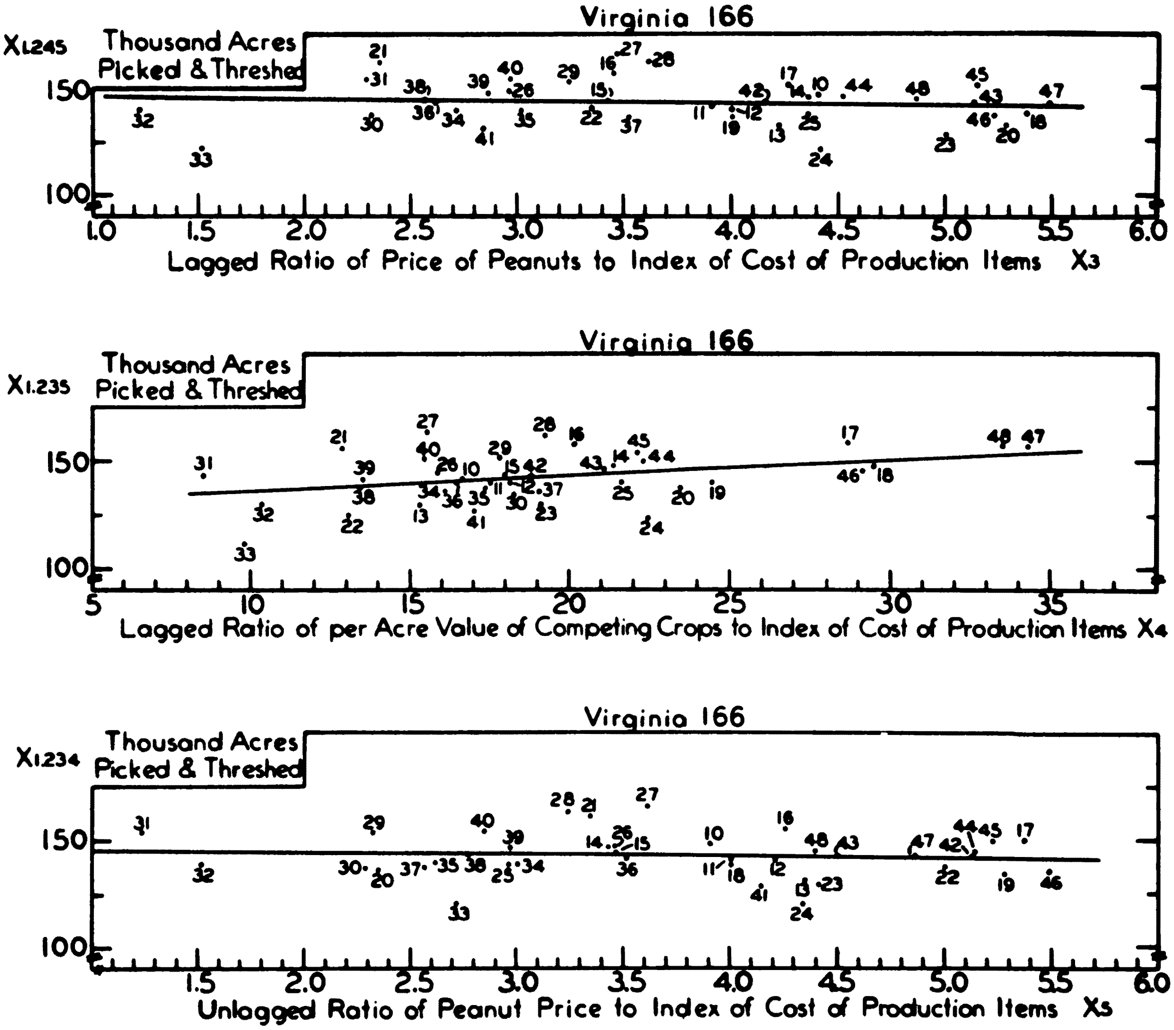
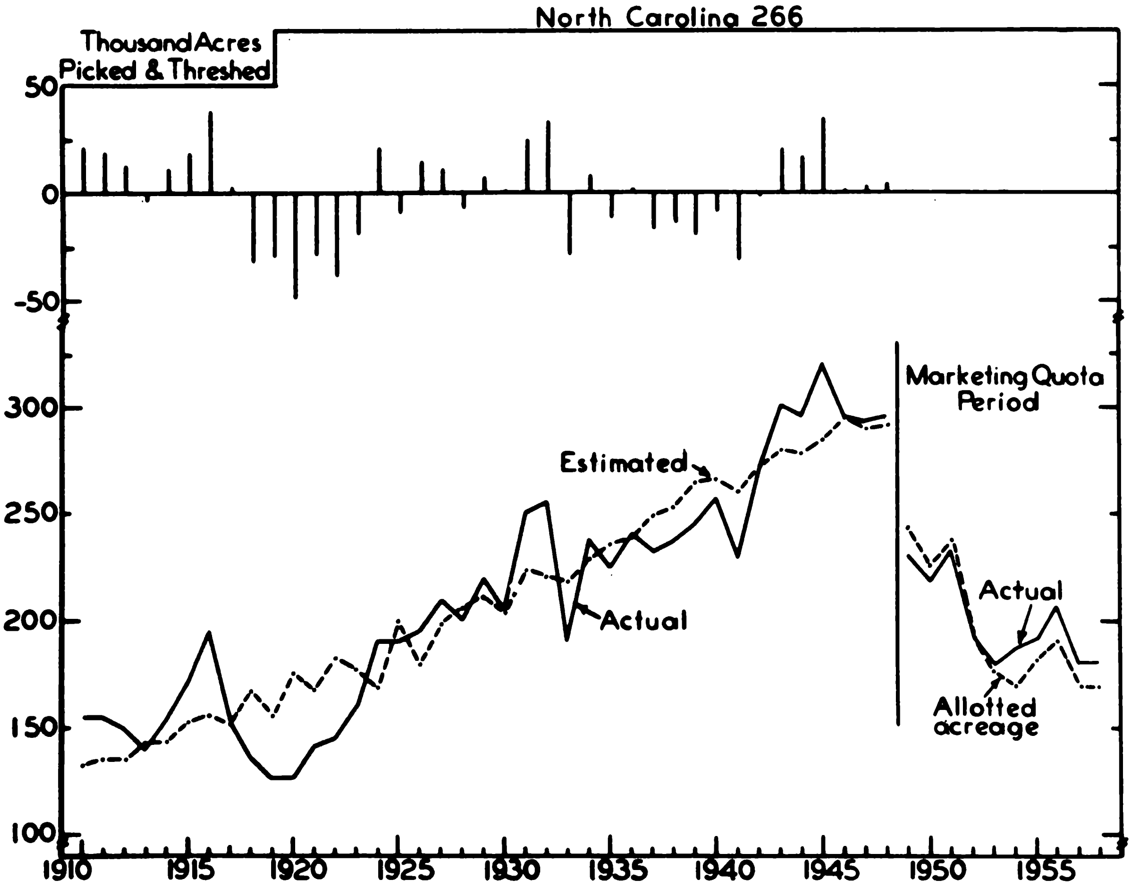


Figure 1. Continued


North Carolina 266
Thousand Acres Picked & Threshed
50
0
-50
300
250
200
150
100
Marketing Quota Period
Estimated
Actual
Actual
Allotted acreage
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

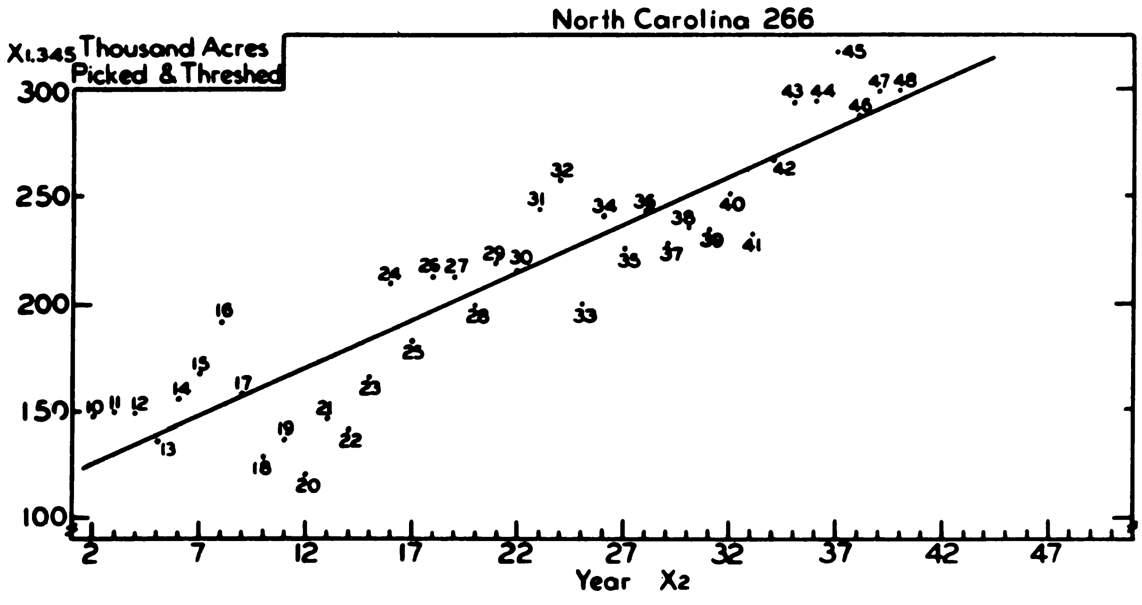

North Carolina 266
X1.345 Thousand Acres Picked & Threshed
300
250
200
150
100
2
7
12
17
22
27
32
37
42
47
Year X2

Figure 2.

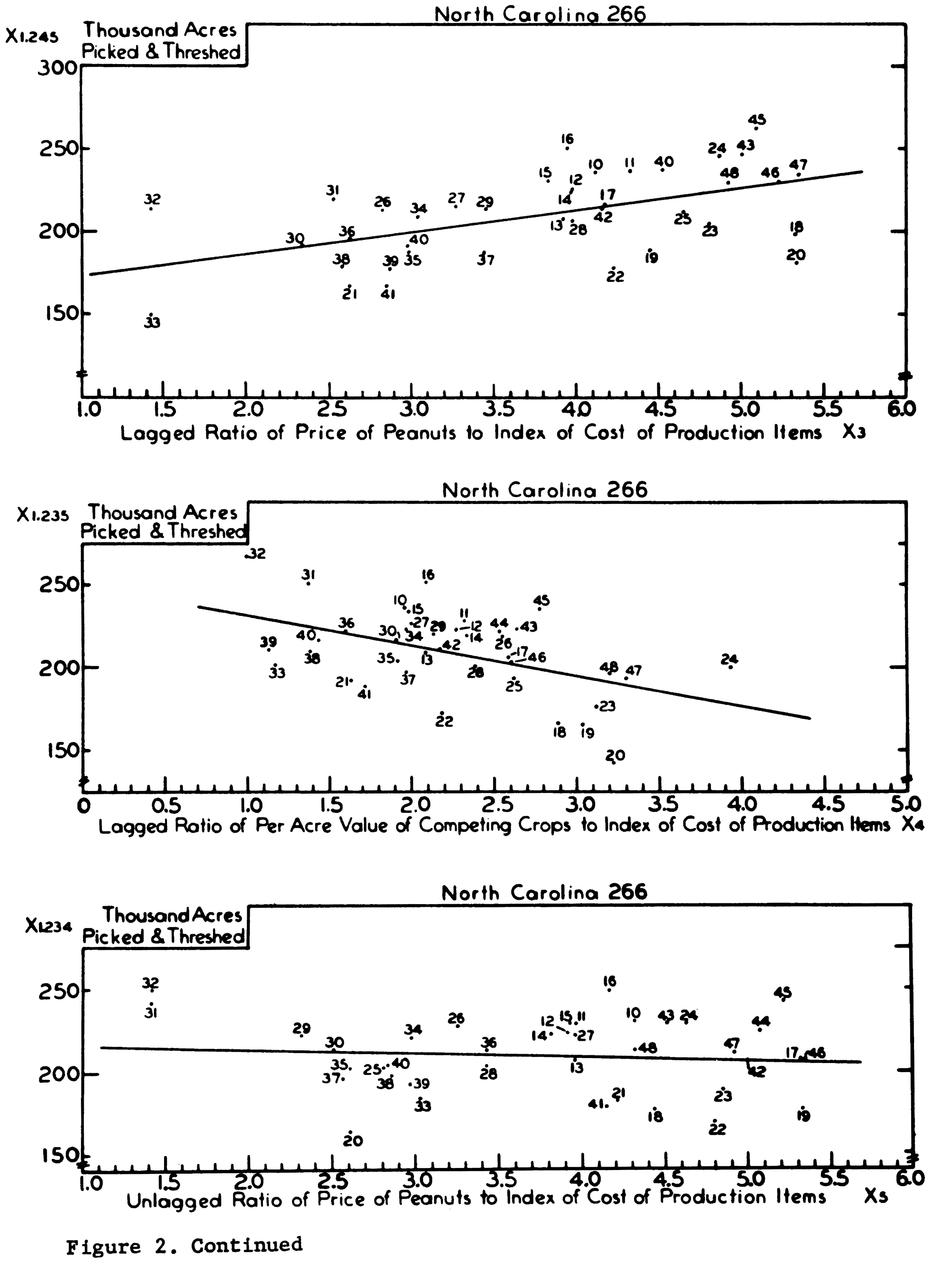


Figure 2. Continued

acreage of competing crops would have a more reliable coefficient than a competing crop value variable such as used in Model H.

Much of the magnitude of the residuals may be explained by World War I, the depression of the 1930's, World War II, and the single mandatory allotment year, 1941. Acreage behavior during World War I is contrary to the usual expectations suggesting that some exogenous factor, perhaps ship-yard wages, offered attractive alternatives to farm labor and perhaps farm operators. Competing crop acreage may have responded similarly, and thus been correlated with peanut acreage. It will be recalled that peanut production was largely a hand-operation at that time. The acreage response in World War II was comparatively less than in other production areas, as will be observed below. Considering the limitations of the statistical techniques employed, it is likely that the coefficient of time is overestimated with compensating underestimates of other coefficients. A more refined technique seems necessary to enhance the reliability of coefficients. The hypothesis that absolute and relative profitability of peanut production is associated with acreage can hardly be rejected, but the extent and manner of association is not demonstrated by these models.

Model I

This model is the same as Model H except for the time period and the omission of the unlagged price-cost ratio. It was thought that elimination of the war years might improve the measure of the relationships. The residuals are shown graphically in Figure 3 and represent no improvement in the coefficients. Since the major disturbances over the long-run period have been removed, this suggests that some other acreage models for the area should be explored.

Models J, K, L, M, N, O, and P

Inspection of the accompanying charts (Figures 1 and 2) reveal that the difference between the acreage allotment and acreage picked and threshed is small and random for Virginia, and is consistently an over-harvest in North Carolina in recent years. The differential data may be inspected in the relevant production estimate Tables 1 and 2 below. In the southeastern part of the North Carolina peanut production area, several (4 or 5) thousand acres are grown for hogging off; however, these are not included in the acreage picked and threshed estimate. There are, however, in the same section for the most part, but also elsewhere in the State, several thousand acres grown on what may be termed "1-acre farms." These peanuts are grown for home use as permitted by peanut legislation. This production is not included in the commercial acreage allotment for the state. However, the North Carolina Crop Reporting Service[27] does

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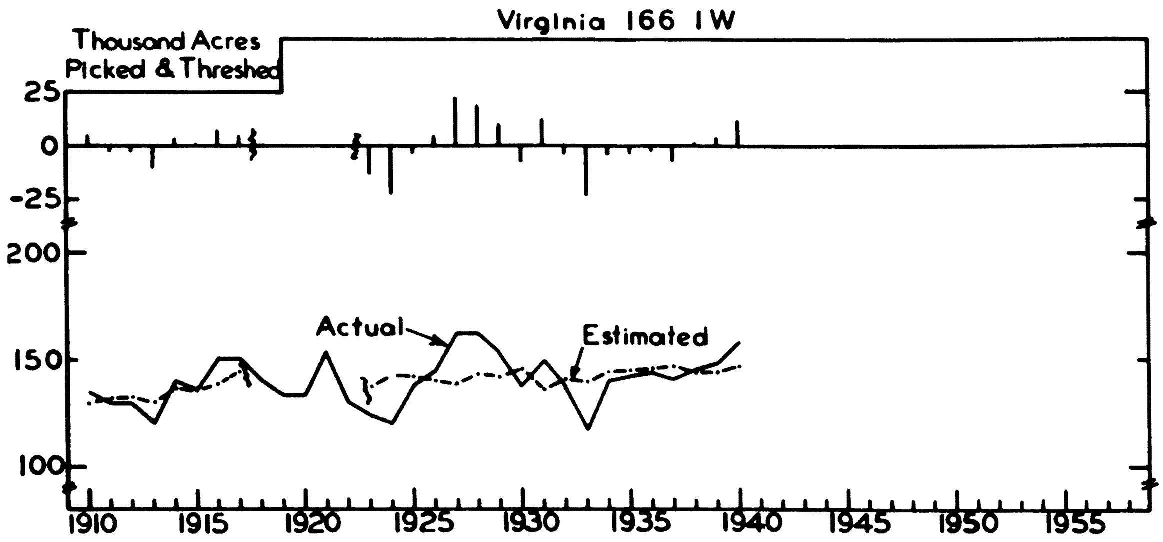
[27]Interview by telephone with Olas Wakefield, North Carolina Crop Reporting Staff, Raleigh, North Carolina, May 9, 1960.


Virginia 166 IW
Thousand Acres Picked & Threshed
25
0
-25
200
150
100
Actual
Estimated
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

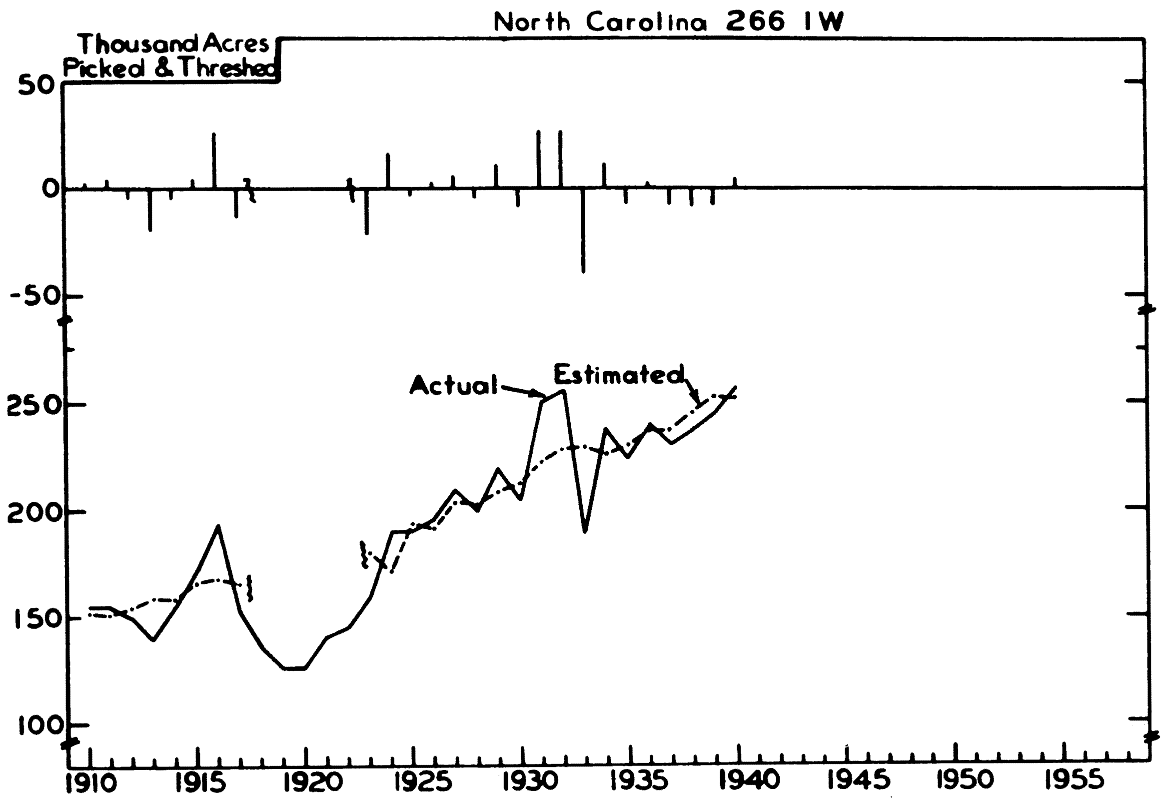

North Carolina 266 IW
Thousand Acres Picked & Threshed
50
0
-50
250
200
150
100
Actual
Estimated
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

Figure 3.

include this acreage in its determination of picked and threshed production and average yield. The Agricultural Stabilization and Conservation Committee, United States Department of Agriculture, Raleigh, North Carolina, advises that[28] as many as 6,774 1-acre farms were reported in 1956; of these 5,043 had their acreage measured. In other years, the number of reported farms ranged from 2,500 to 5,000. With regard to compliance with allotments on commercial farms, other reports[29] suggest that growers collectively harvest an acreage as close to their allotments as is reasonably possible. Another source of variation in over- or underharvest reported is suggested by the North Carolina Crop Estimates Staff, namely, that of "rounding off" the measurements such that small fractions are dropped. Even though such fractions are small (hundredths), it is believed that in total for 18,000 growers, a differential between measured and estimated acreage might amount to 500 acres from this source alone.[30]

A comparable situation exists in Virginia but lesser in extent because of a more compact production area composed of fewer growers and less acreage.

In light of the above considerations, the six Models K, L, M, N, O, and P were set aside in favor of Model J, which is merely to say that the best estimate of peanut acreage in the current and projected period is the peanut acreage allotment. It was not anticipated that Models K -- P would be helpful in the Virginia-Carolina area. Inspection of the data indicates that growers collectively plant and harvest an acreage equivalant to that permitted by the peanut program.

In Summary of This Section

It was decided that Model J would be used without adjustment for estimating acreage in Virginia, and that Model J would be satisfactory for estimating acreage in North Carolina after taking into account subjectively the consistent overharvest from 1-acre farms. Accordingly, 9,000 acres will be added to the North Carolina minimum allotment of 169,000 acres when estimates of production are considered in the relevant discussion below.

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[28]Letter from H. D. Godfrey, Administration Officer of the Agricultural Stabilization and Conservation Committee, May 23, 1958.

[29]Agricultural Stabilization and Conservation, 1956-59 Annual Reports for Virginia and 1959 Annual Report for North Carolina (Washington: United States Department of Agriculture, 1951-1960).

[30]Telephone interview with Mr. Wakefield.

Yield Estimates

Virginia-Carolina Area

Variables Used and Models Considered:

X_1... Time

X_1^2... Time squared

X_2... Peanut yield (dependent)

X_5... Log peanut price (t-1)

X_9... Composite cost squared

X_{10}... Peanut acreage

X_{15}... July rainfall

X_{16}... August rainfall

X_{17}... September rainfall

X_{19}... Profitability ratio

Models Considered Time Period - 1909-1958	Data Supplement Reference Table Number	Equation Numbers Virginia	North Carolina
A. $X_2 = f(X_1, X_5, X_{10})$	14	190	290
B. $X_2 = f(X_1, X_5, X_{10}, X_{16})$	14	100	200
C. $X_2 = f(X_1, X_1^2, X_5, X_{10}, X_{16})$	15	$100t^2$	---
D. $X_2 = f(X_1, X_5, X_9, X_{10})$	16	122	222
E. $X_2 = f(X_1, X_5, X_9, X_{10}, X_{15}, X_{16}, X_{17})$	17	121	221
F. $X_2 = f(X_1, X_1^2, X_5, X_{10}, X_{15}, X_{16}, X_{17})$	18	102	202
G. $X_2 = f(X_1, X_5, X_{10}, X_{19})$	19	132	232
H. $X_2 = f(X_1, X_5, X_{10}, X_{15}, X_{16}, X_{17}, X_{19})$	20	131	231

Model A

The coefficients obtained for this model are significant at the 1% or 5% probability levels except for price in North Carolina. The multiple correlation coefficients are reasonably satisfactory. The relationships are presented graphically in Figures 4 and 5. The respective equations are:

Virginia - 190 : $R^2 = .80$

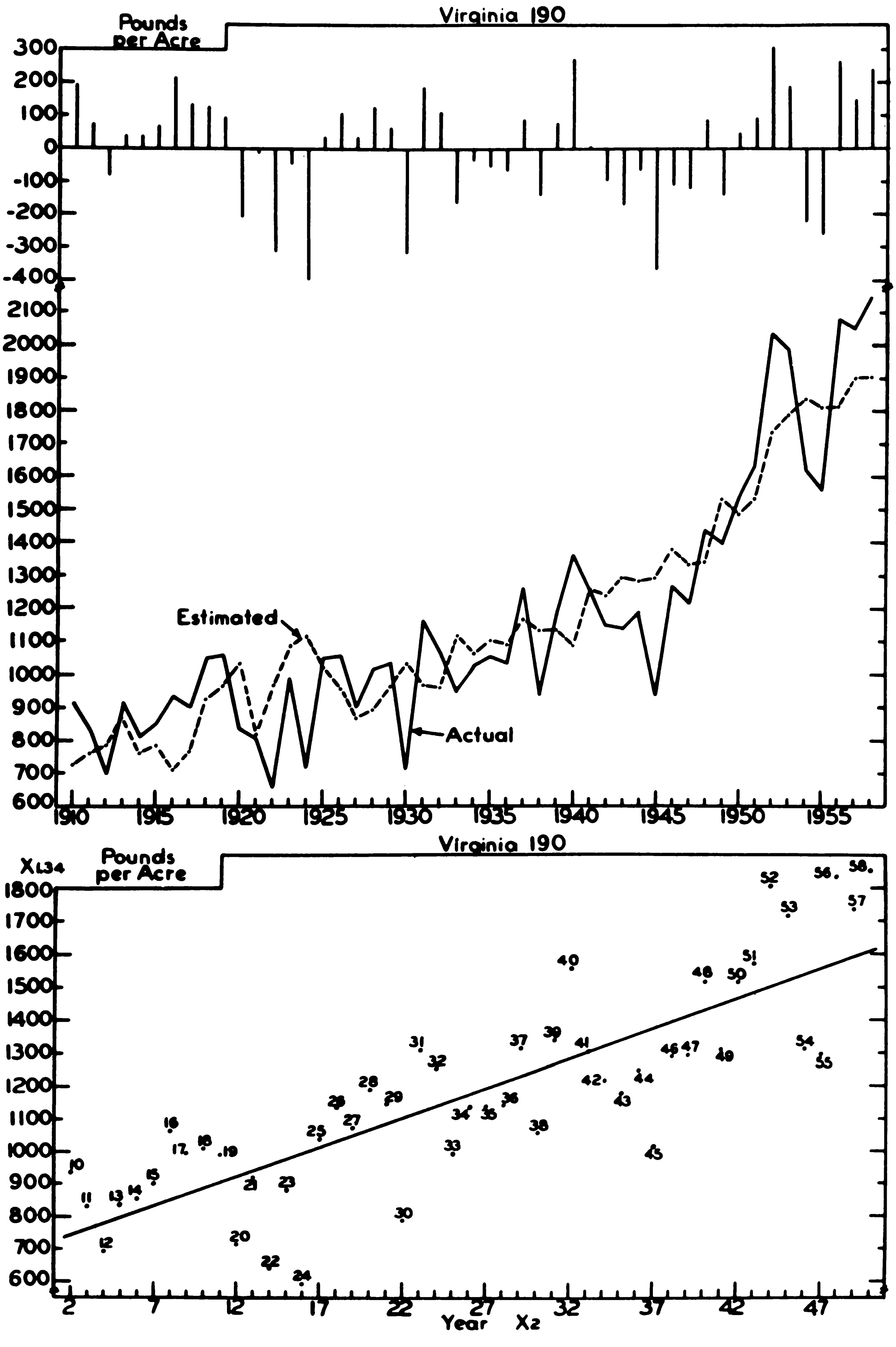
$$X_2 = 1,363.9670 + \underset{(2.1807)}{18.1213X_1^{**}} + \underset{(128.0588)}{312.3238X_{5(t-1)}^{*}} - \underset{(1.6745)}{6.4918X_{10}^{**}}$$

North Carolina - 290 : $R^2 = .68$

$$X_2 = 1182.4009 + \underset{(2.3845)}{18.2633X_1^{**}} - \underset{(118.1930)}{47.8456X_{5(t-1)}} - \underset{(0.5625)}{2.4303X_{10}^{**}}$$

The history of "good" and "bad" crop years has not been traced in detail, but general knowledge in recent years suggests that most of the large residuals are weather generated. If adequate observed data for weather effect could be developed, it could be most helpful in the determination of more reliable and useful coefficients for the economic variables. It will be recalled that, in Part I, reference was made to a comparative time lag in North Carolina regarding the achievement of higher yields in recent years. The charts appear to confirm this; and it may offer some explanation of the negative behavior of the coefficient of price in North Carolina. Inspection of the respective yield-price lines of relationship for the two states indicates that the period beginning about 1945 forms a unique configuration, differing from previous years, such that a positive line of relationship could probably be fitted with a much higher coefficient than that which obtains for the 49-year period. Since this configuration is applicable in both states, it suggests that the mean of this later period in North Carolina is comparatively lower than that which obtains in Virginia with respect to the pre-1945 period; this suggests an explanation of the negative yield-price relationship in North Carolina. Other than this, relationships appear no different than in Virginia where the price coefficient is significant. The special configuration of the yield-price relationship since 1945 appears to be the result of the contrasting drastic adjustments during the period: (1) The high acreage and low yields of World War II, followed by (2) the high yields and low acreage of the allotment period beginning in 1949. This is a situation which is not likely to be repeated in the near future; therefore, this period was not selected for special analysis. It would seem the better part of judgement not to project this situation into the future even though the coefficients of price might be highly significant.

The yield-acreage response conforms to general observation. The recent high yield--low acreage relationship, and the war time high



Virginia 190
Pounds per Acre
Estimated
Actual
Virginia 190
X_{L34}
Pounds per Acre
Year X_2

Figure 4.

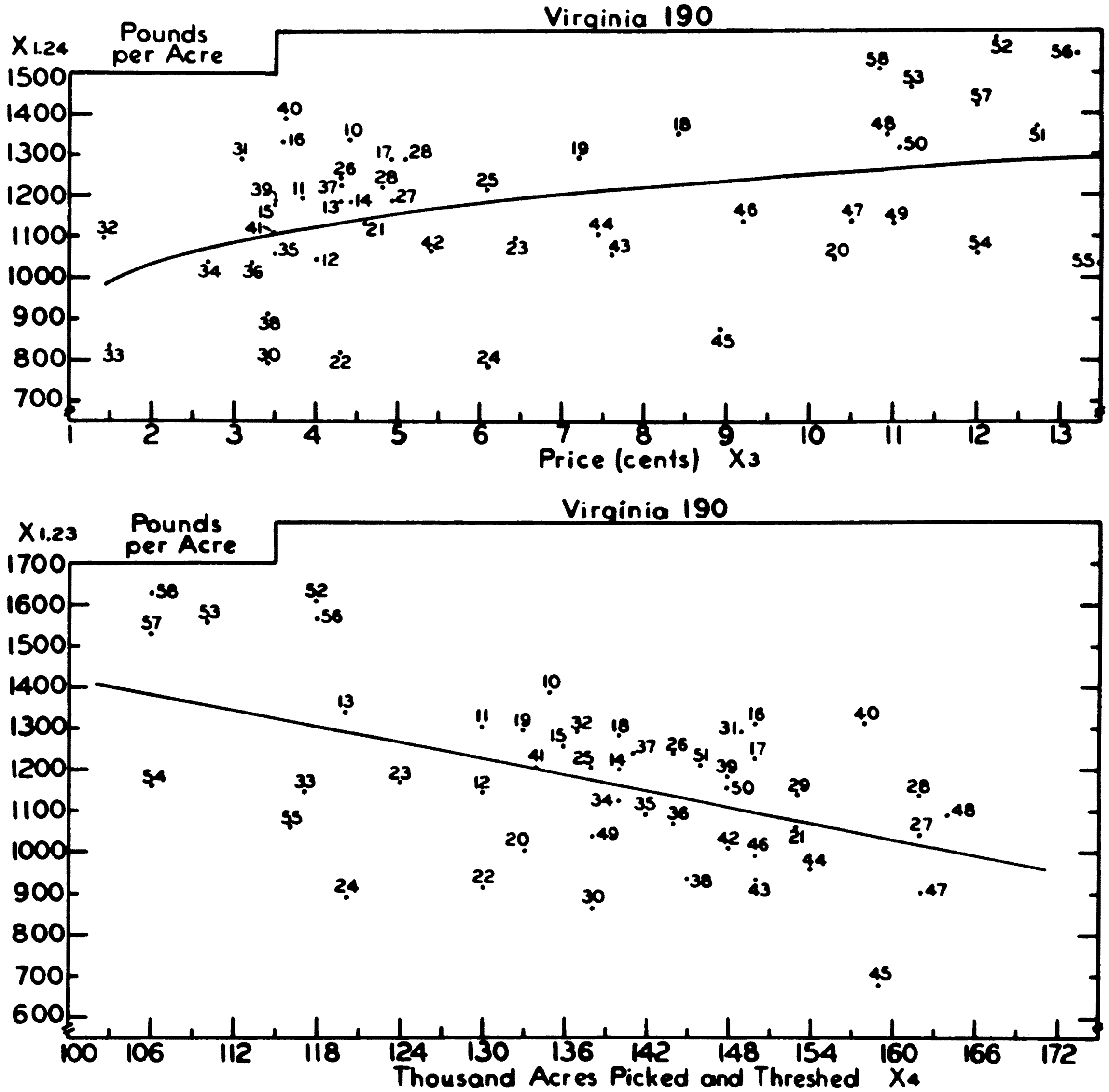
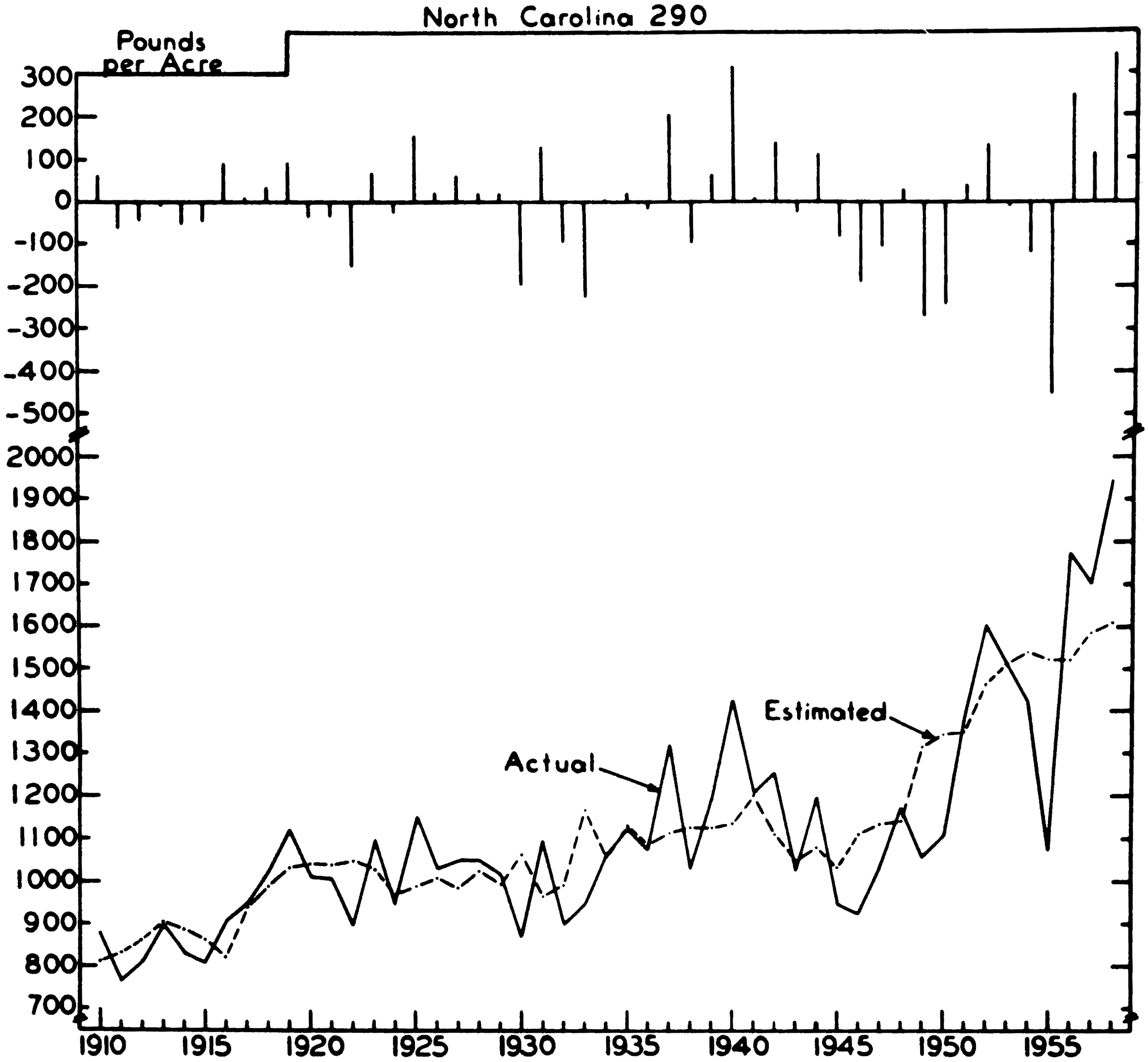


Figure 4. Continued


North Carolina 290
Pounds per Acre
300
200
100
0
-100
-200
-300
-400
-500
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
Estimated
Actual
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

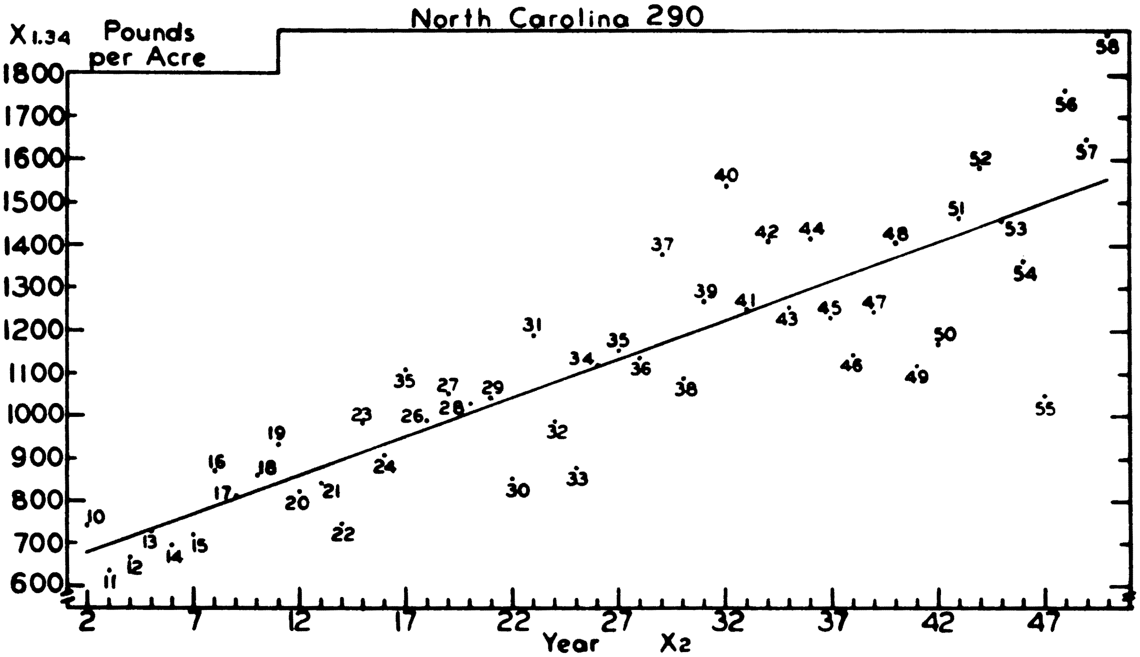
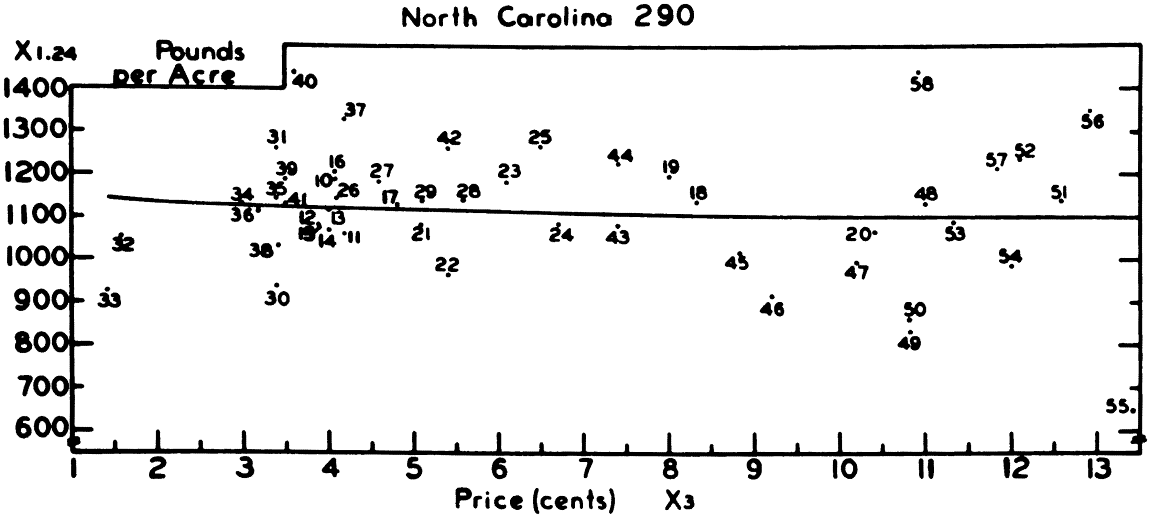

North Carolina 290
X1.34
Pounds per Acre
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
2
7
12
17
22
27
32
37
42
47
Year
X2

Figure 5.



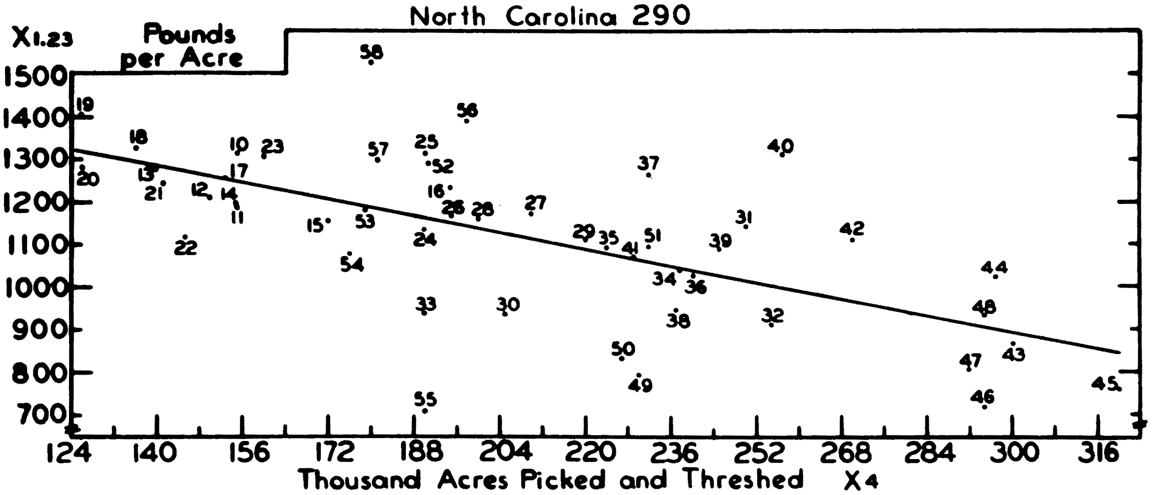


Figure 5. Continued

acreage--low yield relationships are clearly evident in the charts for both states, but less pronounced in North Carolina. It may be observed that removal of these two periods from the model would likely result in a non-significant acreage coefficient. Yield is probably not greatly affected by small changes in acreage; this is logical since it is unlikely that there is any abrupt line of demarcation between well adapted and less adapted soils, nor between the degree of intensity with which other factors of production are combined with slightly differing quantities of land.

The yield-time relationship is highly significant. As a measure of technology, this "squares" with the observations reviewed in Part I. The "strength" of this variable sometimes leads the production scientist to observe that "price doesn't seem to make any difference", while the economist adheres to the view that price makes all the difference. Taken literally, the coefficients of Model A appear to favor the view of the production scientist particularly in North Carolina where price is not significantly associated with yields, suggesting that farmers will produce peanuts regardless of price, an obvious absurdity in view of their interest in price legislation. The problem is doubtless one of intercorrelation of price and technology suggesting that the price coefficient is underestimated with compensating overestimation of the time coefficient.

Model B

August rainfall failed to enter the equation with a significant coefficient; however, the positive relationship hypothesized is given some support.

Model C

In Virginia, the quadratic of time was also added to test the seeming curvilinearity of the data. The variable was significant at the 1% level and the multiple correlation coefficient was increased. No other coefficient was significant. These relationships are shown graphically in Figure 6. The equation is:

Virginia - 100t^2 : R^2 = .85

$$X_2 = 1{,}247.5831 - \underset{(9.1579)}{12.7440X_1} + \underset{(0.1924)}{0.6462X_1^{2**}} + \underset{(143.3575)}{34.4330X_{5t-1}} - \underset{(1.8591)}{2.8486X_{10}} + \underset{(8.2661)}{11.4840X_{16}}$$

This suggests a rather high degree of intercorrelation such that the coefficient of time tends to be overestimated with compensating underestimation of the other variables. Subjectively, it seems advisable to reject

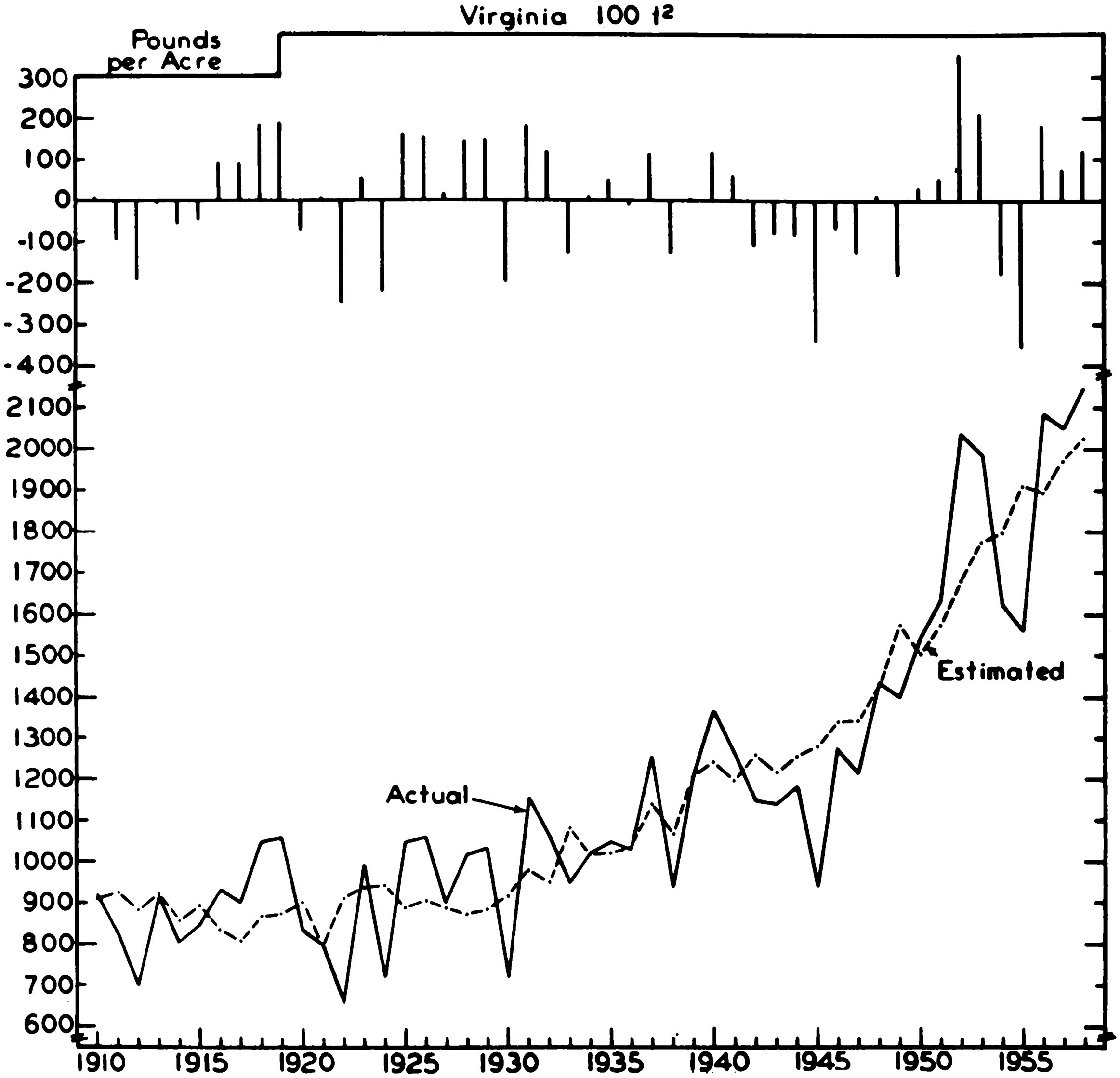
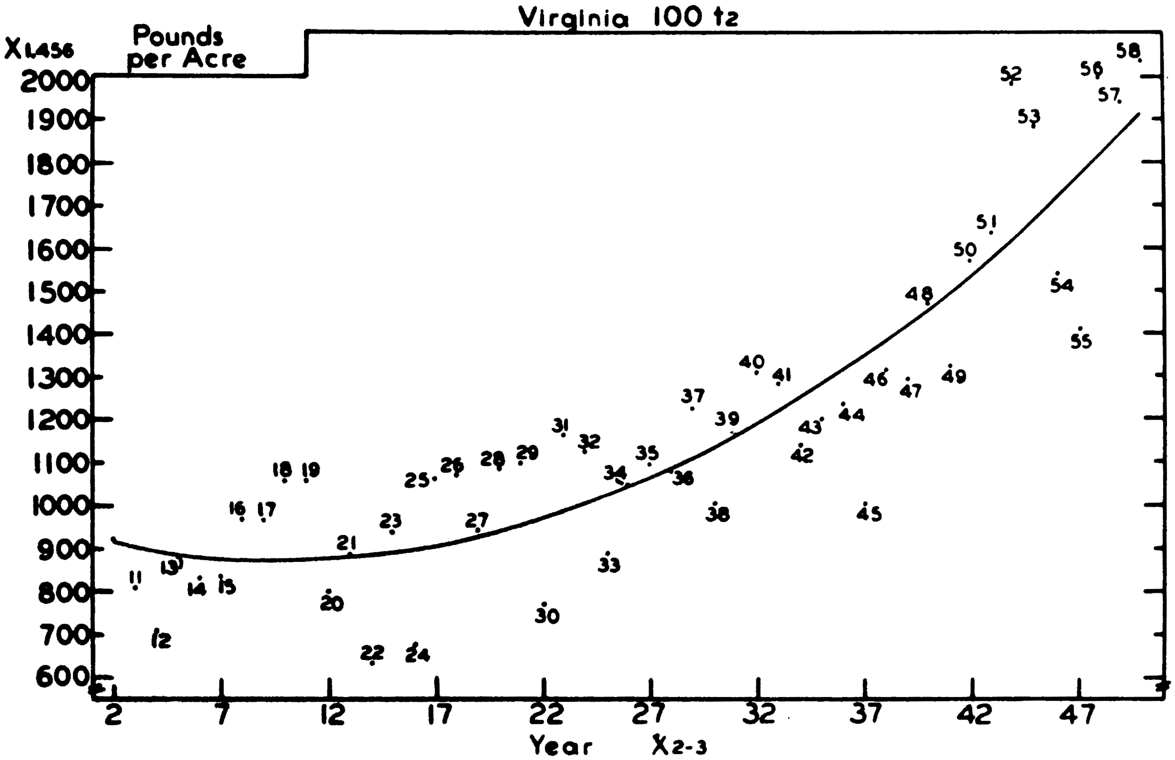

Virginia 100 t²
Pounds per Acre
300
200
100
0
-100
-200
-300
-400
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
Actual
Estimated
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

Figure 6.



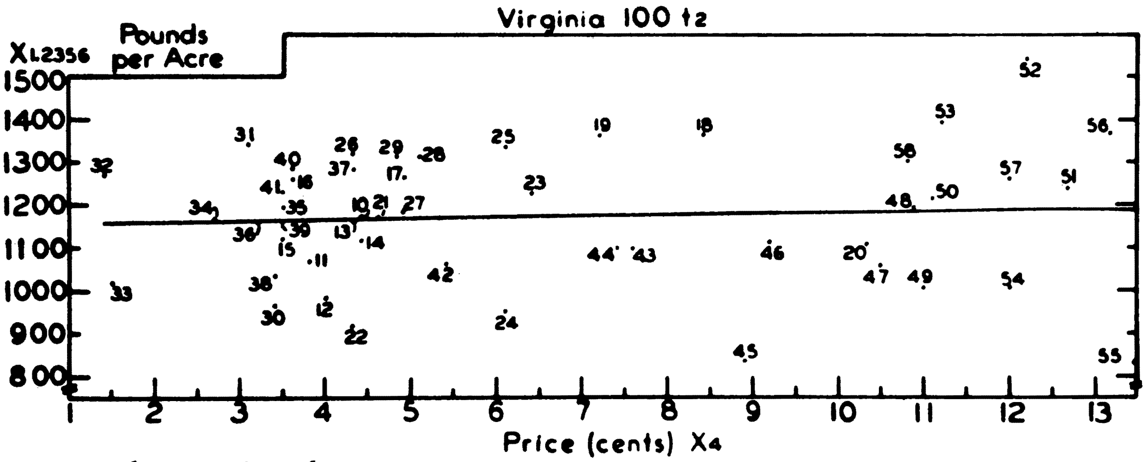
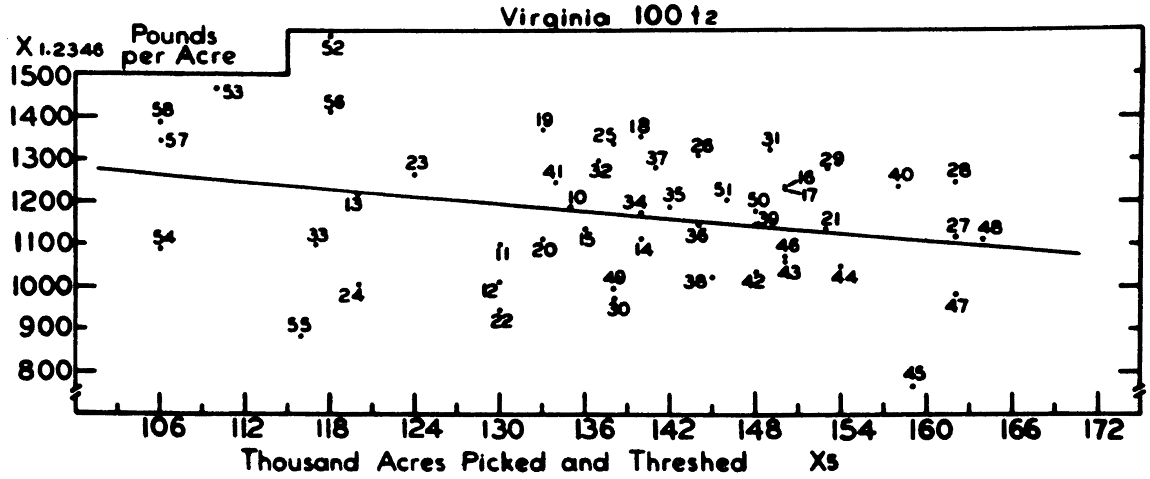


Figure 6. Continued



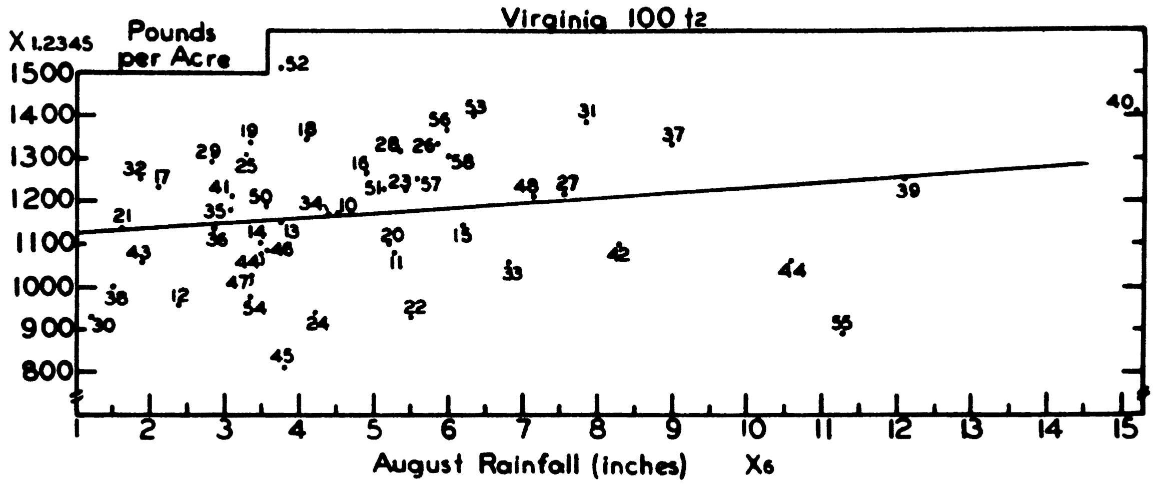


Figure 6. Continued

this model because its relative effectiveness appears to arise from the special conditions prevailing since 1940: (1) The high acreage, low yield situation during World War II followed by (2) the exact opposite situation beginning in 1949. Repetition of this special set of conditions in the near future seems unlikely; therefore, a quadratic projection would appear unwarranted in this production area.

Model D

The variable, composite cost, was added to the variables in Model A, but in neither state was the coefficient significant. Price also was not significant in this model. Again, this may be a problem of intercorrelation since composite cost includes the prices of competing crops which, over much of the time period, probably move together with peanut prices. Direct costs, also included, would likely move similarly. It will be recalled that no special case is made that the composite cost index is adequately conceived in its construction. It might be worthwhile to try a model with separate variables for direct costs and opportunity costs.

Model E

The addition of the three rainfall variables effected a slight improvement but it was not significant. The signs of the rainfall coefficients are of interest in light of further investigation possibilities. The August and September relationships conform to the hypotheses, but for some reason July rainfall is negatively associated with yield in contrast to expectations; the equivalent month, June, in the Southeast is of the same sign suggesting that rainfall is in some way yield depressing in the first critical month in the humid areas. This might be associated with excessive grass, weeds, or plant growth; some observers postulate that tall plant growth might inhibit "pegging". Possibly the negative sign arises from intercorrelation among the rainfall variables. If so, the relationship is consistent among five states. The yield-rainfall relationship suggests that a considerable variation about the mean inches of rain throughout the season does not measurably affect peanut yields in the humid area. Small rainfall effects could be easily obscured by uncorrelated effects of insects and disease, or lack of them. Serious droughts, or heavy hurricane rainfall, both of which are damaging, do not occur often enough, even in a long time-period, to influence the size of the coefficient. A quite different response will be observed later in the subhumid Southwest. A more refined, possibly weighted, measure of weather effect for the humid area remains to be developed.

Model F

The test for curvilinearity conducted with Model C was expanded to the general case with this model. The response in Virginia was about the same as for Model C, but no response to quadratic time was obtained for North Carolina. This seems to be a further confirmation of the time-lag associated with technology in North Carolina, as previously mentioned in Part I on technology.

Models G and H

The performance of the "profitability ratio" proved to be peculiar and unsatisfactory. These and all other models discussed later, which contain it, were rejected.

In Summary of This Section

Model A was selected as the most useful of the group for projecting yields in the Virginia-Carolina area.

Production Estimates

Virginia-Carolina Area

Variables Used and Models Considered:

X_1 ... Time
X_1^2 ... Time squared
X_3 ... Peanut price (t-1)
X_{11}... Peanut production (dependent)
X_{12}... Value of peanuts (t-1)
X_{13}... Value of competing crops (t-1)
X_{14}... Acreage of competing crops (t-1)
X_{15} ... July rainfall
X_{15}^2... July rainfall squared
X_{16} ... August rainfall
X_{16}^2 ... August rainfall squared
X_{17} ... September rainfall
X_{17}^2... September rainfall squared
X_{24}... Per acre value competing crops (t-1)

Models Considered	Time Period	Data Supplement Reference: Table Number	Equation Numbers: Virginia	North Carolina
A. $X_{11}=f(X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17})$......	1909-1958	21	111	211
B. $X_{11}=f(X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17})$......	1909-1948	22	119	219
C. $X_{11}=f(X_1, X_1^2, X_3, X_{24}, X_{15}, X_{16}, X_{17}, X_{15}^2, X_{16}^2, X_{17}^2)$...........	1909-1958	23	103	203
D. $X_{11}=f(X_1, X_1^2, X_3, X_{24}, X_{15}, X_{16}, X_{17}, X_{15}^2, X_{16}^2, X_{17}^2)$...........	1909-1948	24	104	204

Models A and B

The concept employed in formulating these exploratory models was based on the hypothesis that the grower may consider the relative crop values of peanuts and competing crops the preceding year, evaluate his current prospective income in light of the previous year's experience, and produce peanuts accordingly in the current year. The rainfall variables were included to determine their association, if any, with the resulting production. Other than to fit the model to the two time periods, this set of variables was not explored further. The use of a time variable was not introduced, for example, nor were other combinations or time periods attempted. The significant competing crop relationships, as in the acreage models, seem to confirm the notion that herein lies a useful variable worth exploring in additional models. There may be a degree of intercorrelation between peanut and competing crop values, and between value and acreage of competing crops. Inclusion of war years tends to distort normal relationships. A significant response to August rainfall in Virginia was obtained, but the relationship failed to hold in North Carolina. The signs of the rainfall coefficients were quite consistent with those obtained for yield regressions on rainfall.

It is believed these results are inconclusive without further investigation; accordingly, the models were rejected.

Models C and D

These exploratory models were designed to take into account the curvilinear aspect of the entire production period with the introduction of the time squared variable; test the response of production to price and per acre value of competing crops, and determine the linear and quadratic association with rainfall, if any. It was assumed, of course, that production would be positively related to price; that per acre value of competing crops would be negatively associated with production; and that the same production-rainfall relationship would hold as was hypothesized for yields.

Considering the history of peanut production which includes two major wars, a major depression, a major inflation, and the intervention of a major governmental program, it would be expecting a rather unusual degree of "cooperation" from a single linear regression coefficient for it to deal adequately with all of these exogenous forces. There are also several possibilities of intercorrelation because production of peanuts is not really a single dependent variable but rather the product of two variables, yield and acreage.

In light of the above considerations, Models C and D are not considered acceptable for production estimates. Model C has been graphed for purposes of illustration, and the production estimates derived from it are included below, in Tables 1 and 2,only for illustration and comparative purposes. The residuals are presented in Figures 7 and 8. The respective equations are:[31]

---

[31]Inadvertently, the deciamls in some variables were not correctly coded for electronic computer purposes; consequently, the coefficients and related data could not be completely uncoded until X_{11} values were determined. Accordingly, the coefficient and standard error values are relative rather than actual values.

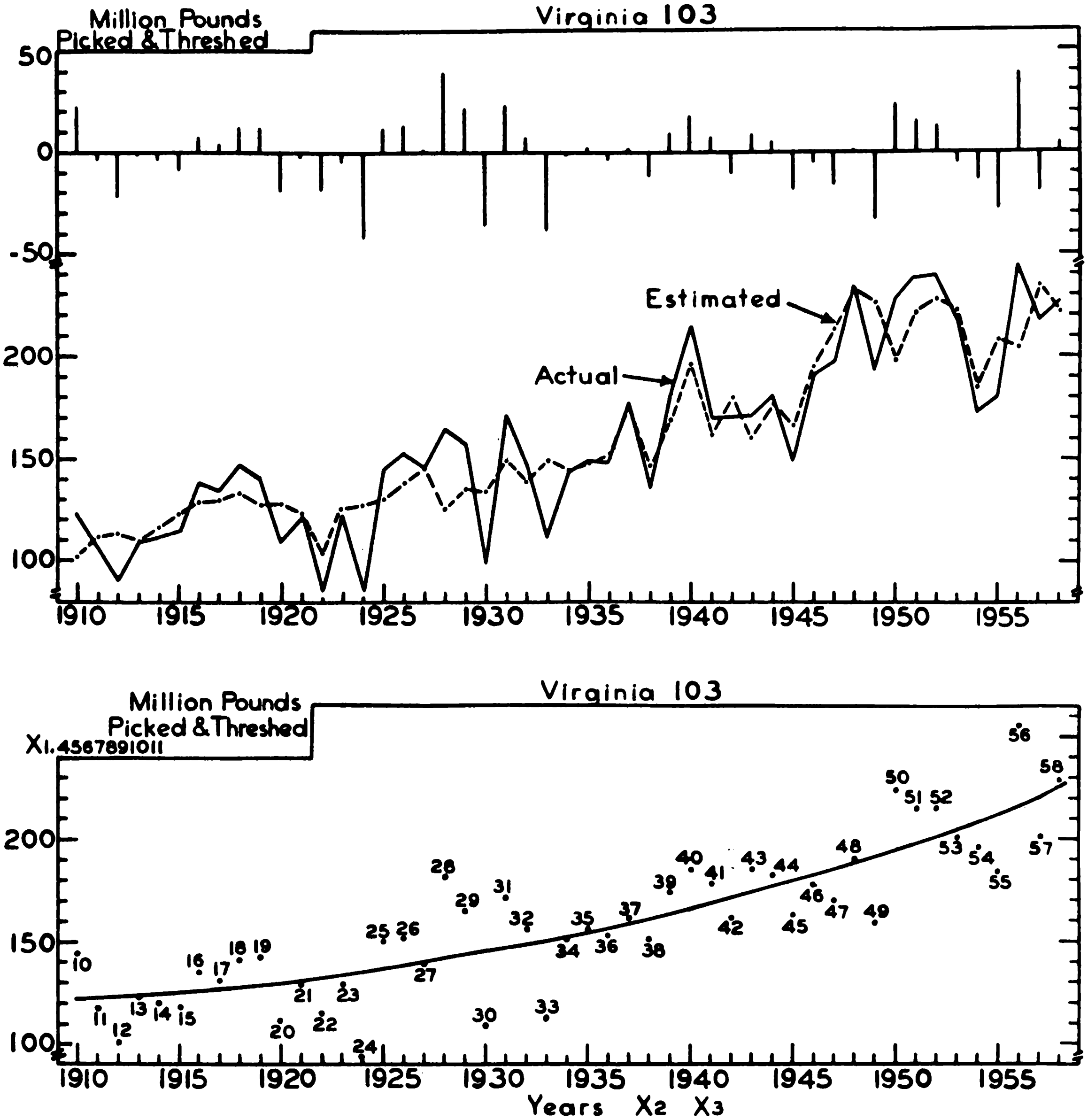

Million Pounds
Picked & Threshed
Virginia 103
50
0
-50
200
150
100
Estimated
Actual
1910 1915 1920 1925 1930 1935 1940 1945 1950 1955
Million Pounds
Picked & Threshed
X1.4567891011
Virginia 103
200
150
100
1910 1915 1920 1925 1930 1935 1940 1945 1950 1955
Years X2 X3

Figure 7.

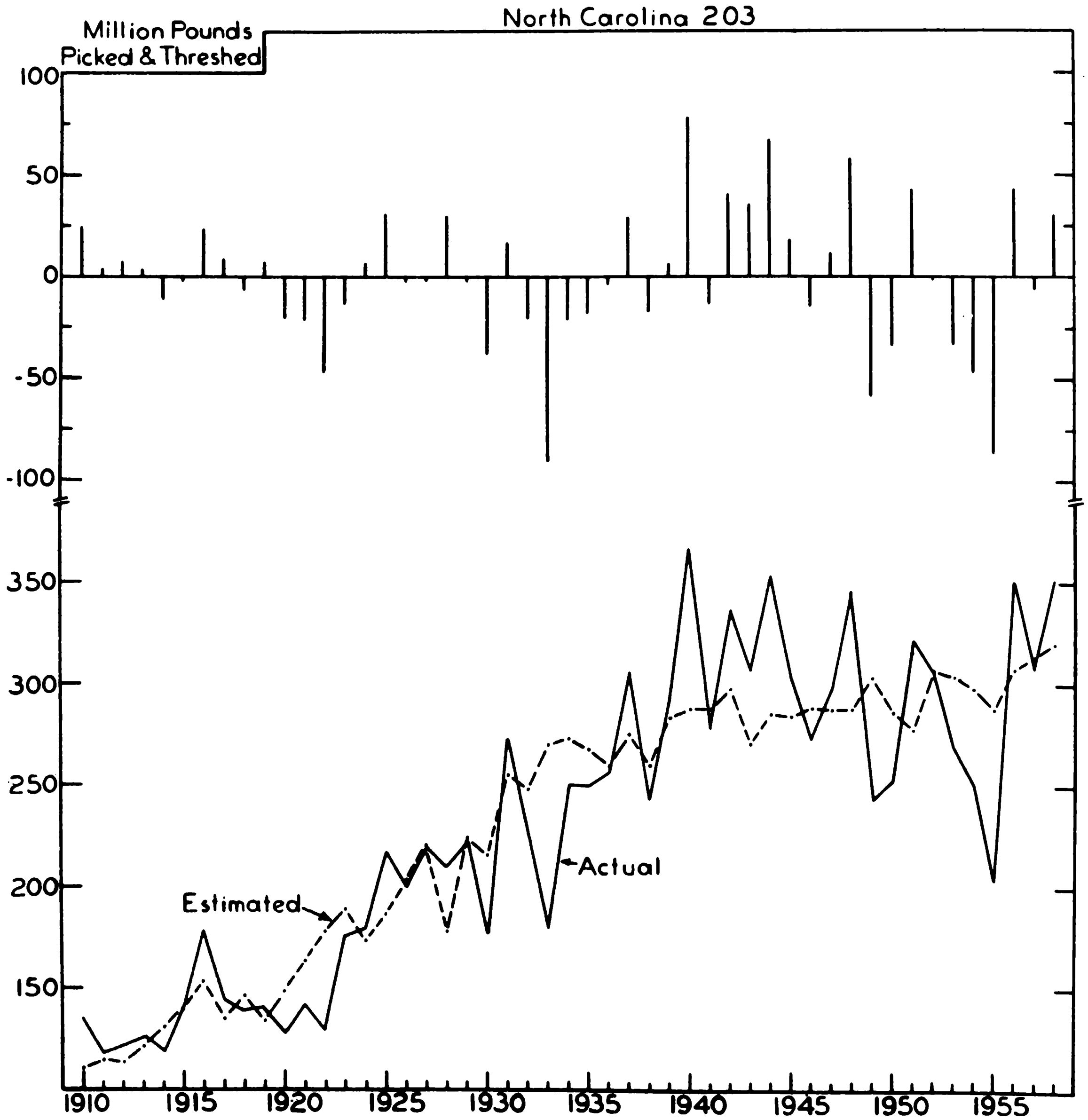

North Carolina 203
Million Pounds
Picked & Threshed
100
50
0
-50
-100
350
300
250
200
150
Estimated
Actual
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

Figure 8.

Virginia - 103 : $R^2 = .82$

$$X_{11} = 757.7822 - \underset{(14.9380)}{2.2445X_1} + \underset{(0.2401)}{0.3438X_1^2} - \underset{(31.7307)}{70.1123X^{*}_{3t-1}} + \underset{(4.9498)}{16.6656X^{**}_{24}}$$

$$+ \underset{(52.3782)}{6.7820X_{15}} + \underset{(39.3577)}{23.2649X_{16}} + \underset{(64.9100)}{117.0916X_{17}} - \underset{(3.9857)}{0.6634X_{15}^2} + \underset{(2.6411)}{0.5519X_{16}^2}$$

$$- \underset{(7.2923)}{13.0403X_{17}^2}$$

North Carolina - 203 : $R^2 = .79$

$$X_{11} = -46.2157 + \underset{(33.7227)}{82.3393X_1^{*}} - \underset{(0.5640)}{0.4318X_1^2} - \underset{(74.5293)}{60.9651X_{3t-1}} + \underset{(111.5810)}{13.1558X_{24}}$$

$$+ \underset{(138.4689)}{42.8201X_{15}} + \underset{(108.9728)}{85.1210X_{16}} + \underset{(80.0564)}{67.8546X_{17}} - \underset{(9.8467)}{3.5818_{15}^2} - \underset{(8.1802)}{4.9697X_{16}^2}$$

$$- \underset{(6.2441)}{6.3688X_{17}^2}$$

The principal objection to Model C is the high level of the production projections derived from it. These probably stem from the influence of wartime production included in the model. Secondary objections include illogical signs. A comparison of Model C with Model D suggests that the reversal of expected signs is associated with inclusion of the war years. Although all price and value coefficients in North Carolina are nonsignificant, logical signs are obtained when the mandatory allotment period is omitted in Model D. In similar manner, the significance of "wrong" signs in Virginia is reduced. Presumably, the normal response of production to price is stifled to some extent in these control years. Such is the purpose of the program. Meanwhile, prices and costs have been increasing, so intercorrelation may be affecting the expected relationships. In spite of this variety of shortcomings, the residuals are not as great as might be expected, especially in Virginia, after making allowance for weather effect. The partial regression data does little to encourage further investigation of these models even in time periods when exogenous forces are not as influential, 1920-1940 for example.

Projections to 1965

In the acreage estimate subsection of this section, it was concluded that, for purposes of projection to 1965, the acreage allotment (Model J) would be the most valid estimate of future acreage in the Virginia-Carolina area, subject to adjustment for 1-acre farms in North Carolina. Similarly, in the yield subsection, it was decided that Model A (yield regressions 190 and 290 for Virginia and North Carolina, respectively) would be the most useful estimating equations for projecting yield. Applying acreage to these yields, actual and estimated production have been considered for the mandatory allotment period 1949 to 1958, and projected for the period 1959-1965. The accompanying Tables 1 and 2 set forth the essential information comparatively, along with production estimates derived from production Model C.

Projections were made under the following assumptions for Virginia and North Carolina, respectively:

Yield-allotment equations:

1) price, 10.5 cents; 10.5 cents
2) acreage, 106,000; 169,000 plus 9,000 acres for 1-acre farms

Production equations:

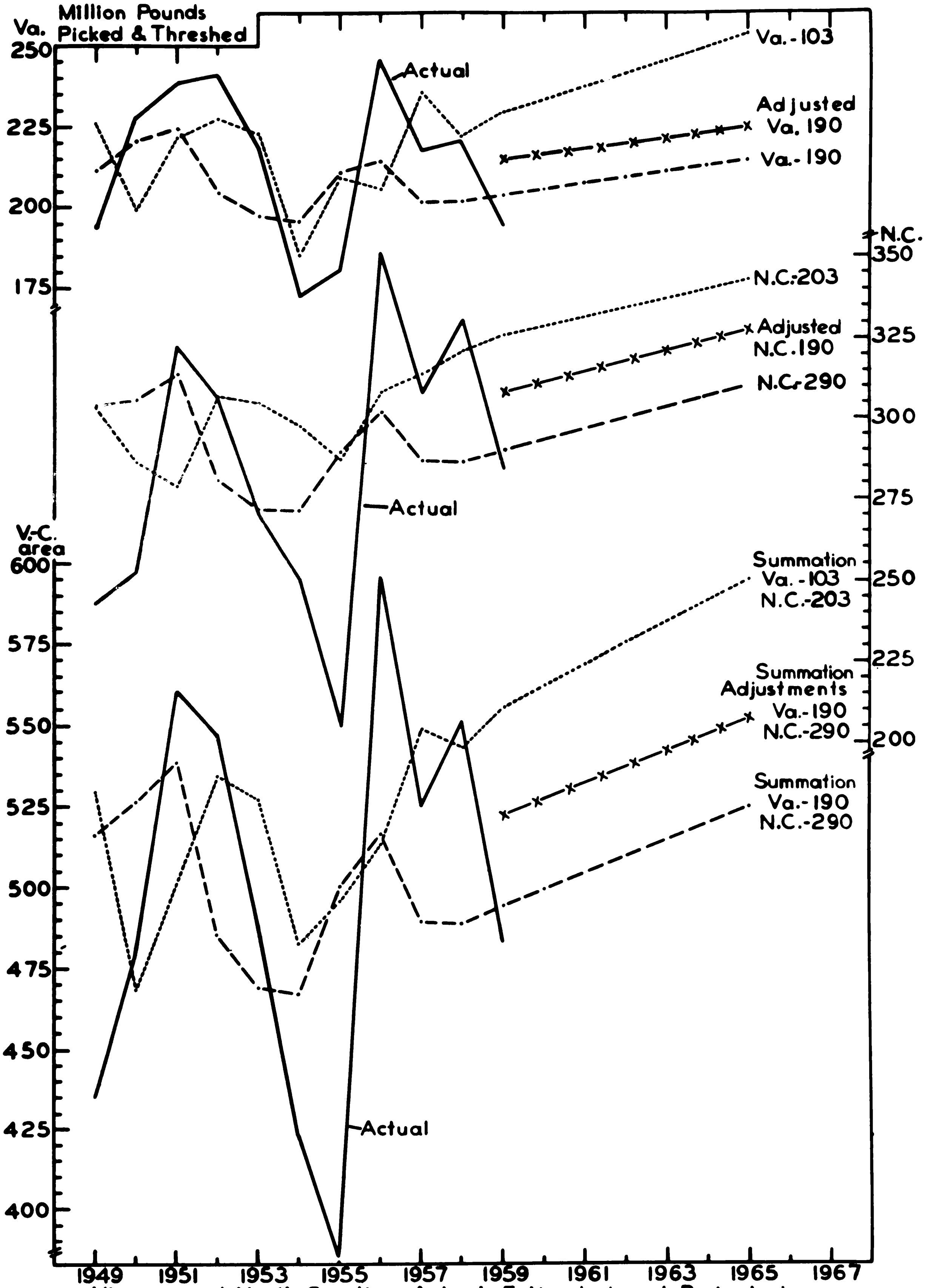
1) price, 10.5 cents; 10.5 cents
2) 1954-58 average per acre value of competing crops $51.64; $55.66
3) mean July total rainfall, 5.5 inches; 6.0 inches
4) mean August total rainfall, 5.1 inches; 5.00 inches
5) mean September total rainfall, 3.8 inches; 4.5 inches

The above indicated values were assumed constant for the period with only time increasing, (1910 = 2 for yield regressions, and 1910 = 10 for production regressions).

Comparative production data are depicted graphically in Figure 9, for each state and for the Virginia-Carolina area. In viewing these data it should be kept in mind that not until 1957 did acreage and price decline to the levels stated in the assumptions. The production equations Virginia-103 and North Carolina-203, which are represented by a dotted line, project to the future a reflection of all past influences. As a matter of judgement, this injects a considerable (upward) bias. While future production might conceivably be as high, it would not likely become so for the same reasons; therefore, the production equation projections are not regarded as valid future estimates.

The production from allotted acreage in Virginia, and allotted acreage as adjusted for 1-acre farms in North Carolina, using the yields per acre from the specified predicting equations, is represented by the broken line in Figure 9. For comparison, the actual production for each state and for the area is included in Figure 9 as a solid line, period 1949 to date, 1959.

Certain adjustments in the level of yield per acre in the area appear desirable. These adjustments and a summary of production data for the area will be presented in the summary section on national production. The effect of such adjustments on production in this area is represented by the "adjustment" line in Figure 9 for the projected period 1959-1965.



Virginia and North Carolina: Actual, Estimated, and Projected Peanut Production from Specified Equations

Figure 9.

Table 1.--Production of Peanuts in Virginia: actual and estimated, 1949-1958; and projected, 1959-1965, using specified yield and production equations under assumptions of price, 10.5 cents; acreage, 106,000; 1954-1958 average per acre value of specified competing crops; and 49-year mean total rainfall in July, August and September.

Year	Acreage			Yield		Production						
							Yield regression Va. - 190[a]			Production regression Va. - 103[b]		
	Actual A	Allotted A'	Under Harvest	Actual Y	Va.-190 estimated $\hat{Y}$	Actual P=AY	Estimated $\hat{P}=A\hat{Y}$	Residual $P-\hat{P}$	Per-cent $\hat{P}/P$	Estimated $\hat{P}$	Residual $P-\hat{P}$	Per-cent $\hat{P}/P$
				Pounds	Pounds	Thousand Pounds	Thousand Pounds			Thousand Pounds	Thousand Pounds	
1949...	138,000	141,444	-3,444	1,400	1,536	193,200	211,968	-18,768	110	225,965	-32,765	117
1950...	148,000	141,108	6,892	1,540	1,491	227,920	220,668	7,252	97	199,102	28,818	87
1951...	146,000	147,481	-1,481	1,630	1,540	237,980	224,840	13,140	95	221,753	16,227	93
1952...	118,000	121,217	-3,217	2,040	1,735	240,720	204,730	35,990	85	227,399	13,321	95
1953...	110,000	110,366	- 366	1,990	1,793	218,900	197,230	21,670	90	222,617	- 3,717	102
1954...	106,000	106,072	- 72	1,625	1,846	172,250	195,676	-23,426	114	185,058	-12,808	107
1955...	116,000	113,569	2,432	1,560	1,816	180,960	210,656	-29,696	116	208,573	-27,613	115
1956...	118,000	120,802	-2,802	2,080	1,818	245,440	214,524	30,916	87	205,519	39,921	84
1957...	106,000	105,840	160	2,050	1,901	217,300	201,506	15,794	93	235,324	-18,024	108
1958...	105,000[c]	105,885	- 885	2,100[c]	1,905	220,500[c]	201,930	18,570	92	222,300	- 1,800	101
1959[d]...	(105,000)	(105,750)	- 750	(1,850)	1,919	(194,250)	203,414	(- 9,164)	(101)	229,700	(-35,450)	(118)
1960...		106,000[e]			1,937		205,322			233,500		
1961...		106,000			1,955		207,230			237,500		
1962...		106,000			1,973		209,138			241,500		
1963...		106,000			1,991		211,046			245,500		
1964...		106,000			2,010		213,060			249,700		
1965...		106,000			2,028		214,968			253,900		

[a] See Supplement, Table 14, for coefficients. Also page 52

[b] See Supplement, Table 23, for coefficients. Also page 67

[c] Revised.

[d] Data included in the regression coefficients ended with 1958. Figures in parenthesis are preliminary for 1959.

[e] Used to project production for 1959-1965.

Table 2.--Production of peanuts in North Carolina: actual and estimated, 1949-1958; and projected, 1959-1965, using specified yield and production equations under assumptions of price, 10.5 cents; acreage 178,000; 1954-1958 average per acre value of specified competing crops; and 49-year mean total rainfall in July, August, and September.

Year	Acreage			Yield		Production						
							Yield regression N.C.-290[a]			Production regression N.C.-203[b]		
	Actual A	Allotted A'	Under harvest	Actual Y	N.C-290 estimated $\hat{Y}$	Actual $P=AY$	Estimated $\hat{P}=A\hat{Y}$	Residual $P-\hat{P}$	Percent $\hat{P}/P$	Estimated $\hat{P}$	Residual $P-\hat{P}$	Percent $\hat{P}/P$
				Pounds	Pounds	Thousand Pounds	Thousand Pounds	Thousand Pounds		Thousand Pounds	Thousand Pounds	
1949...	230,000	243,444	-13,444	1,055	1,323	242,600	304,290	-61,690	125	303,972	-61,372	125
1950...	227,000	225,702	1,298	1,110	1,348	252,000	305,996	-53,996	121	286,988	-34,988	114
1951...	232,000	238,890	- 6,890	1,390	1,351	322,500	313,432	9,068	97	278,678	43,822	86
1952...	191,000	193,605	- 2,605	1,605	1,470	306,600	280,770	25,830	92	306,759	-159	100
1953...	179,000	176,686	2,314	1,510	1,519	270,300	271,901	- 1,601	101	304,401	-34,101	113
1954...	176,000	169,662	6,338	1,425	1,543	250,800	271,568	-20,768	108	297,420	-46,620	119
1955...	190,000	181,673	8,327	1,075	1,525	204,200	289,750	-85,550	142	287,122	-82,922	141
1956...	198,000	191,914	6,086	1,775	1,525	351,400	301,950	49,450	86	307,813	43,587	88
1957...	181,000	169,235	11,765	1,700	1,586	307,700	287,066	20,634	93	313,325	- 5,625	102
1958...	178,000	169,379	8,621	1,860[c]	1,608	331,080[c]	286,224	44,856	87	320,583	10,497	97
1959[d]..	(178,000)	178,000[e]		(1,600)	1,632	(284,800)	290,496	(5,696)	102	325,428	(40,628)	114
1960...		178,000			1,651		293,878			328,523		
1961...		178,000			1,669		297,082			331,532		
1962...		178,000			1,687		300,286			334,455		
1963...		178,000			1,705		303,490			337,291		
1964...		178,000			1,724		306,872			340,041		
1965...		178,000			1,742		310,076			342,705		

[a] See Supplement, Table 14, for coefficients. Also page 52

[b] See Supplement, Table 23, for coefficients. Also page 67

[c] Revised.

[d] Data included in the regression coefficients ended with 1958. Figures in parenthesis are preliminary for 1959.

[e] A 9,000 acre upward adjustment has been made in the minimum allotment for the years 1959-1965 to provide for production from "1-acre" farms. Used to project production for 1959-1965.

SECTION V

ACREAGE, YIELD, AND PRODUCTION ESTIMATES

SOUTHEAST AREA

The procedures used for reporting the analysis for the Southeast area are the same as those set forth at the beginning of Section IV with respect to symbols used and equations selected.

Acreage Estimates

Southeast Area

Variables Used and Models Considered:

X_1 ... Time
X_3 ... Price of peanuts
X_5 ... Log peanut price (t-1)
X_6 ... U. S. cost index
X_7 ... U. S. cost index (squared)
X_{10}... Peanut acreage (dependent)
X_{14}... Acreage of competing crops
X_{15}... July rainfall
X_{16}... August rainfall
X_{17}... September rainfall
X_{21} ... Peanut price (X_3) deflated by cost (X_6); (t-1)
X_{22} ... Per acre value-cost ratio competing crops
X_{23} ... Same as X_{21} but not lagged
X_{25} ... Excess acreage penalty
X_{26} ... State acreage allotment
Y_1 ... Under harvested peanut acreage (dependent)
Y_2 ... Ratio peanut acreage to acreage allotment (dependent)

Models Considered	Time Period	Data Supplement Reference: Table Number	Equation Numbers: Georgia	Florida	Alabama
A. $X_{10}=f(X_5, X_7)$	1909-1958	1	340	440	540
B. $X_{10}=f(X_5, X_7)$	1909-1948	2	349	449	549
C. $X_{10}=f(X_5, X_7, X_{14})$	1909-1948	3	360	460	560
D. $X_{10}=f(X_5, X_7, X_{14})$	1909-1948	4	369	469	569
E. $X_{10}=f(X_5, X_7, X_{14t-1})$	1909-1948	5	367	467	567
F. $X_{10}=f(X_1, X_{21}, X_{22}, X_{23}, X_{15}, X_{16}, X_{17})$	1909-1958	6	363	463	563
G. $X_{10}=f(X_1, X_{21}, X_{22}, X_{23}, X_{15}, X_{16}, X_{17})$	1909-1948	6	364	464	564
H. $X_{10}=f(X_1, X_{21}, X_{22}, X_{23})$	1909-1948	6	366	466	566
I. $X_{10}=f(X_1, X_{21}, X_{22})$	1921-1940	7	366IW	466IW	566IW
J. $X_{10}=f(X_{26})$	1949-1958	none		(subjective)	
K. $Y_{11}=f(X_3, X_{25})$	1949-1958	8	9-3-1	9-4-1	9-5-1
L. $Y_{12}=f(X_{3t-1}, X_{25})$	1949-1958	9	0-3-1	0-4-1	0-5-1
M. $Y_{13}=f(X_{21}, X_{25})$	1949-1958	10	2-3-1	2-4-1	2-5-1
N. $Y_{21}=f(X_3, X_{25})$	1949-1958	11	9-3-2	9-4-2	9-5-2
O. $Y_{22}=f(X_{3t-1}, X_{25})$	1949-1958	12	0-3-2	0-4-2	0-5-2
P. $Y_{23}=f(X_{21}, X_{25})$	1949-1958	13	2-3-2	2-4-2	2-5-2

Models A and B

Low multiple correlation coefficients and illogical signs in Model A suggest omission of important variables and wide dispersion of the data characteristic of the changing economic structure and the exogenous forces affecting the industry. Model B appears to fit a little better as a result of dropping the mandatory allotment period. The inference may be drawn from the data illustrated below for Model H that including the war years is the principle cause of illogical signs for price and cost coefficients. The mandatory allotment period included in Model A would, of course, stifle the normal response to price in line with the purposes of the control program. Both models were rejected.

Models C, D, and E

Acreage of competing crops enters the equation with highly significant coefficients, except in Florida for Models C and E. The signs of the added variable are consistently logical, but are illogical for price and cost in all but two of the six regressions. This general reversal of signs is probably associated with the same configuration of the data as is illustrated below for Models H and I. If so, it arises mainly from including the war years in these models. The tremendous upsurge of acreage in wartime is accompanied by increasing cost and increasing price, along with some increase in cotton and corn acreage. When all factors move together in one general direction, illogical relationships are to be expected. The relationship between peanut acreage and competing crops appears to warrant further investigation in an interwar time period such as is used in Model I below.

Models F and G

These models were designed to explore price-cost ratio relationships to acreage; the per acre value of competing crops in lieu of the acreage variable; and to determine the effect of rainfall, if any. It was thought that there might be a weather effect in this area as abandonment or diversion to "hogging off" is of more frequent occurence than in the Virginia-Carolina area. Although behavior of rainfall coefficients is usually quite consistent among different models and in contiguous state areas, judging by experience with yield regressions, the response in these models is inconsistent, suggesting that the true relationships are obscured by the exogenous forces acting upon the other variables. Weather effect might be more accurately appraised if included in Models I described below for the interwar time period. Accordingly, Models F and G were rejected.

Model H

In order to explore more thoroughly the nature of these relationships, the residuals and partial regression lines of relationship were computed for this model which is the same as Model G without the rainfall variables. The model is presented graphically in Figures 1, 2, and 3 for Georgia Florida, and Alabama, respectively. The equations are:

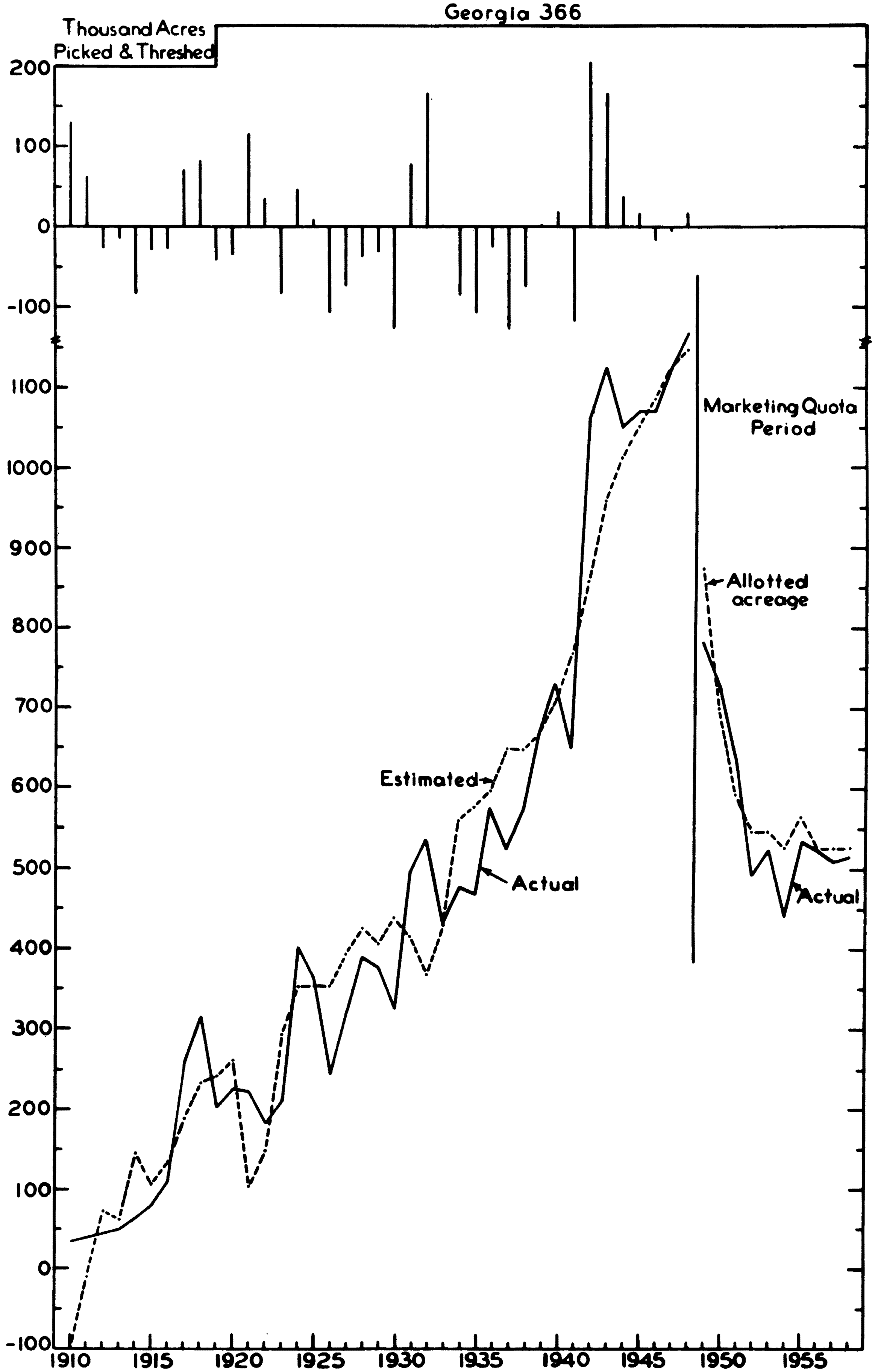

Georgia 366
Thousand Acres
Picked & Threshed
200
100
0
-100
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
Marketing Quota
Period
Allotted
acreage
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Figure 1.

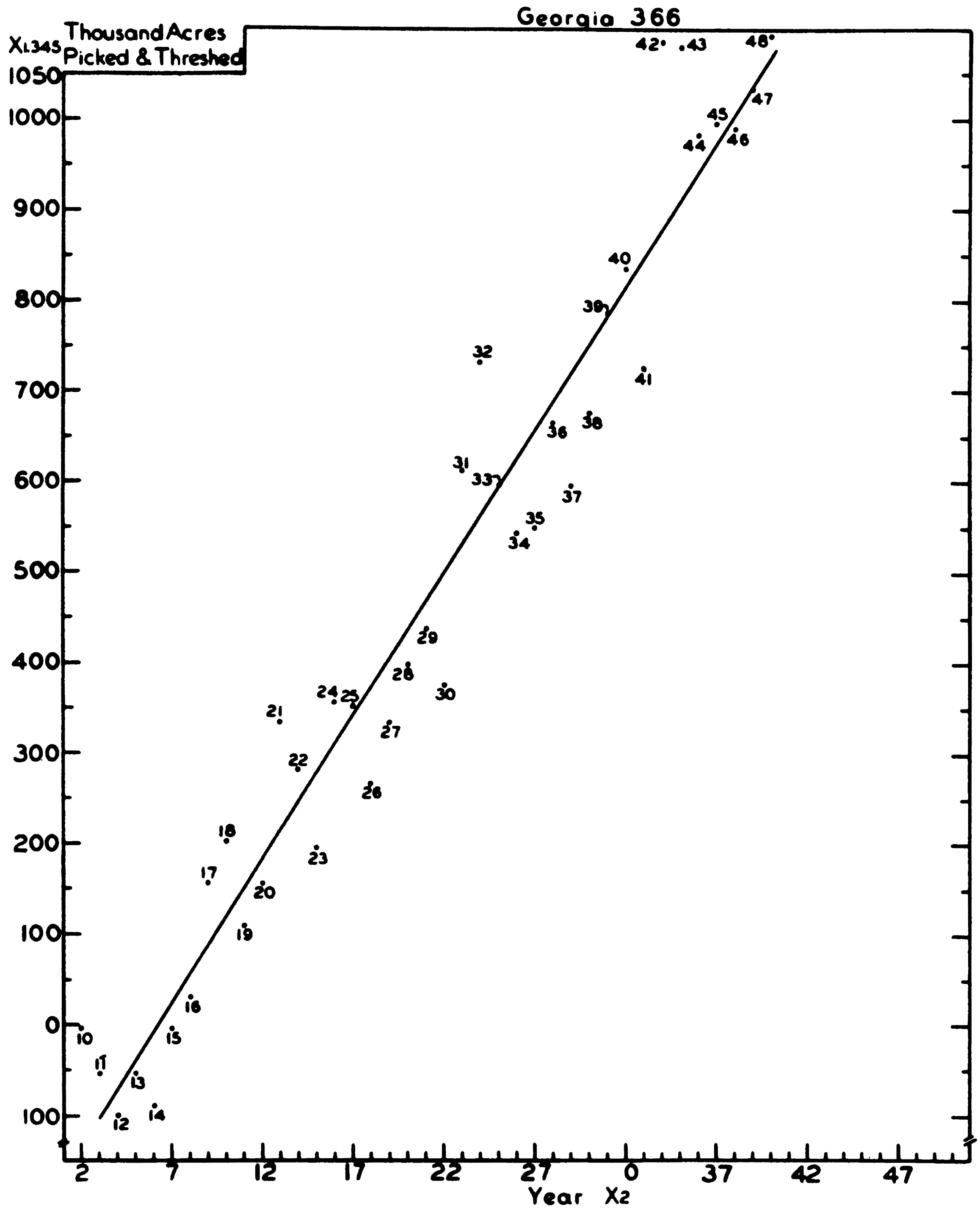
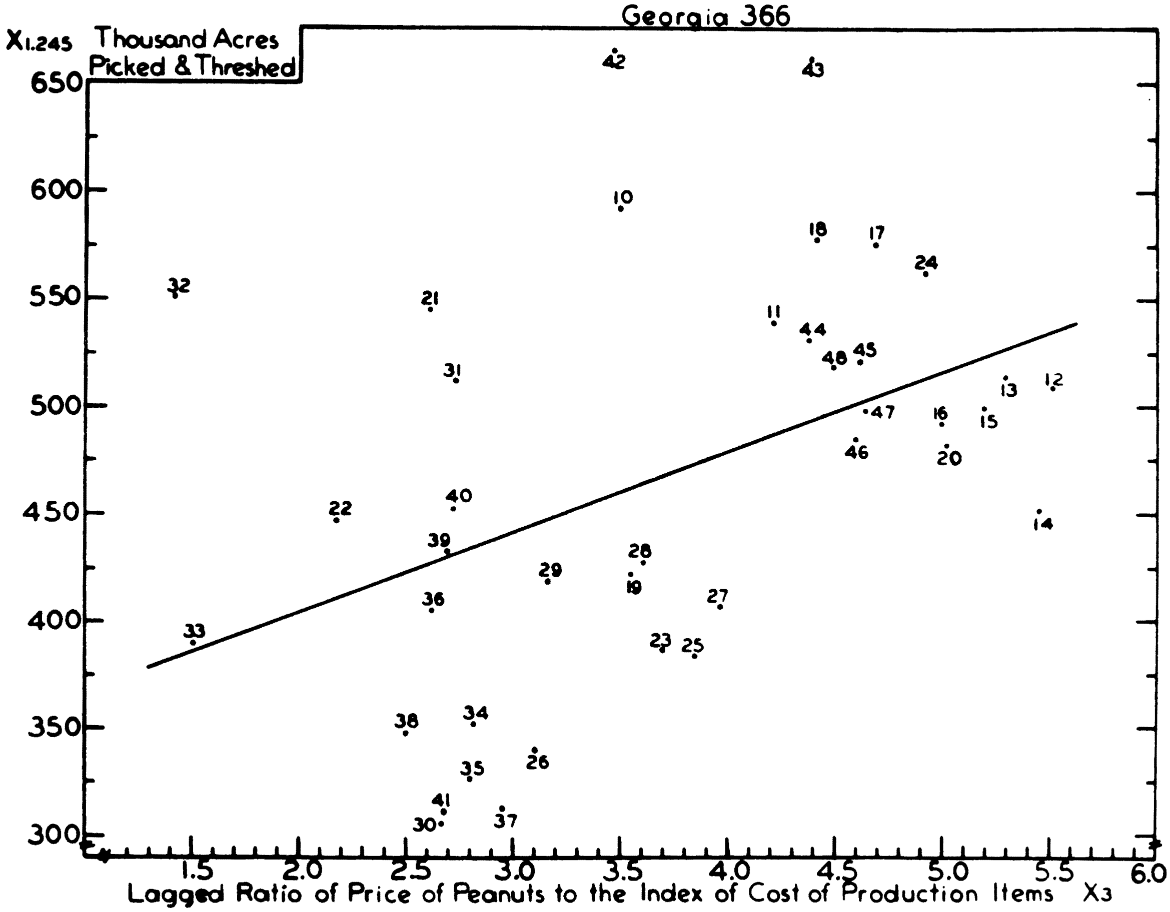


Figure 1. Continued



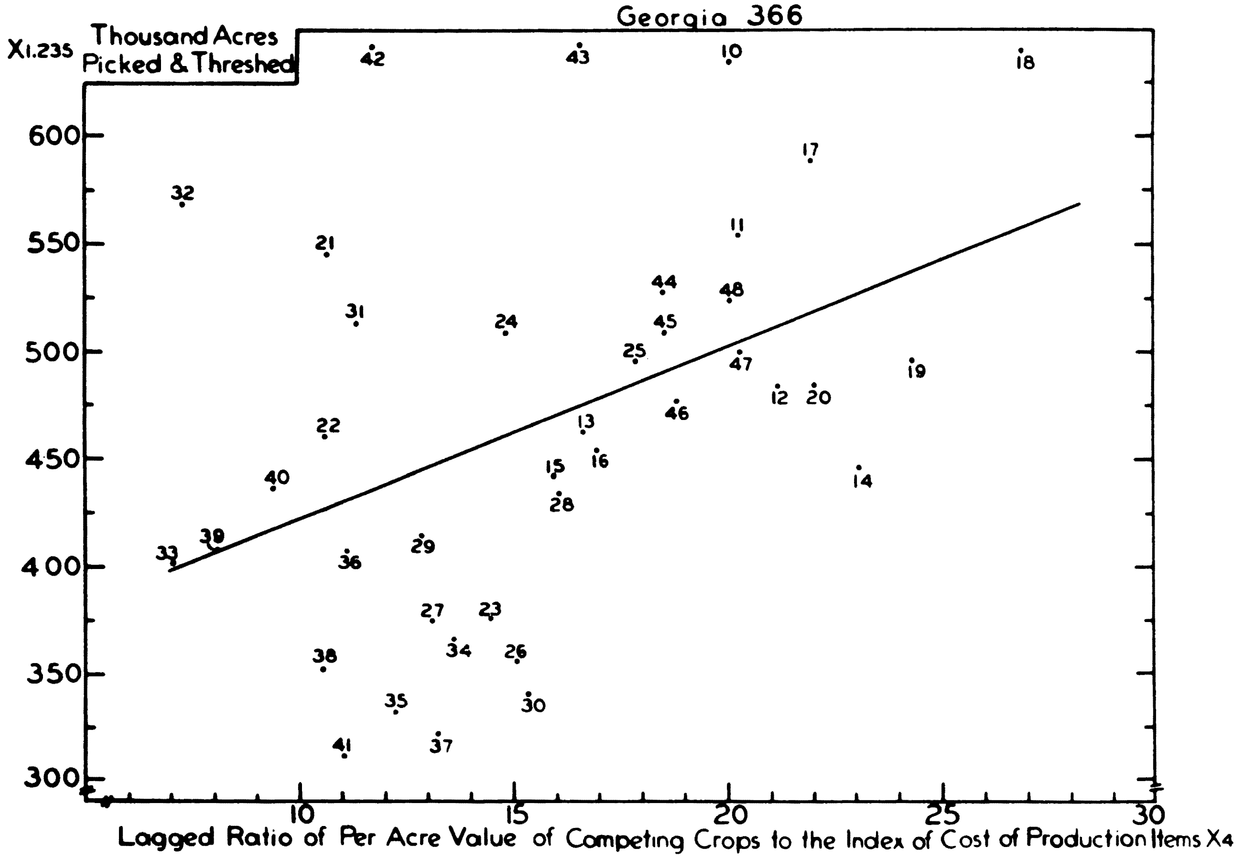


Figure 1. Continued

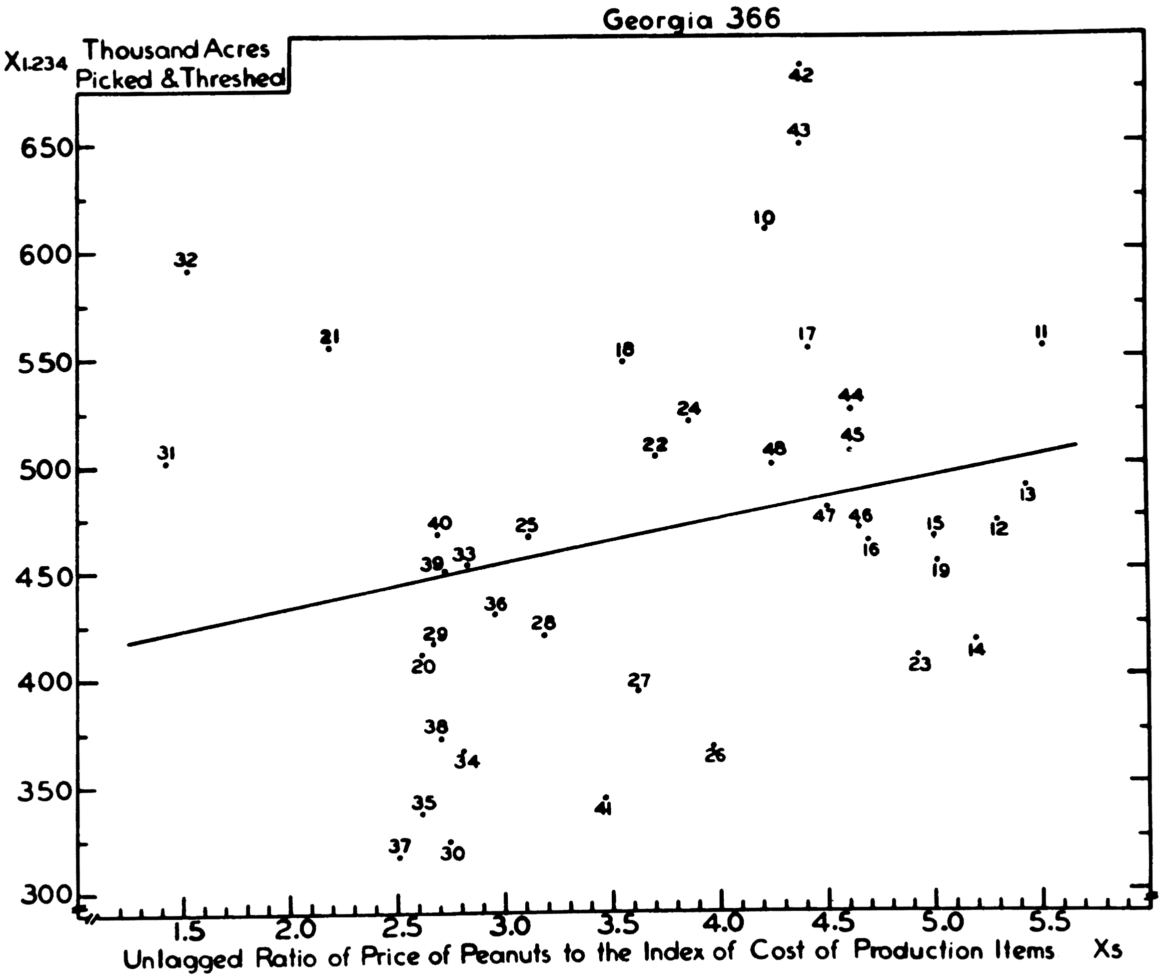


Figure 1. Continued

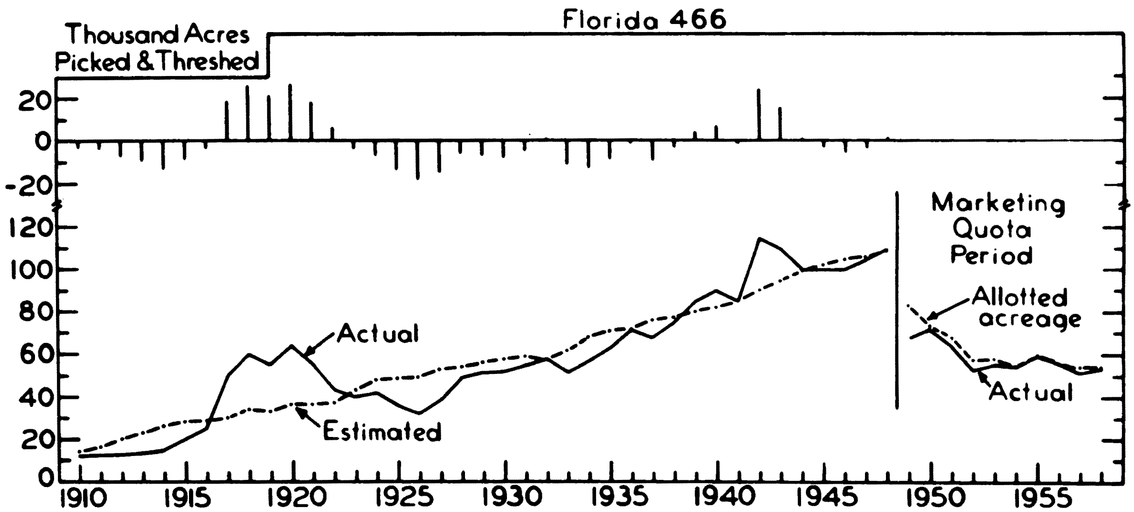


Figure 2.

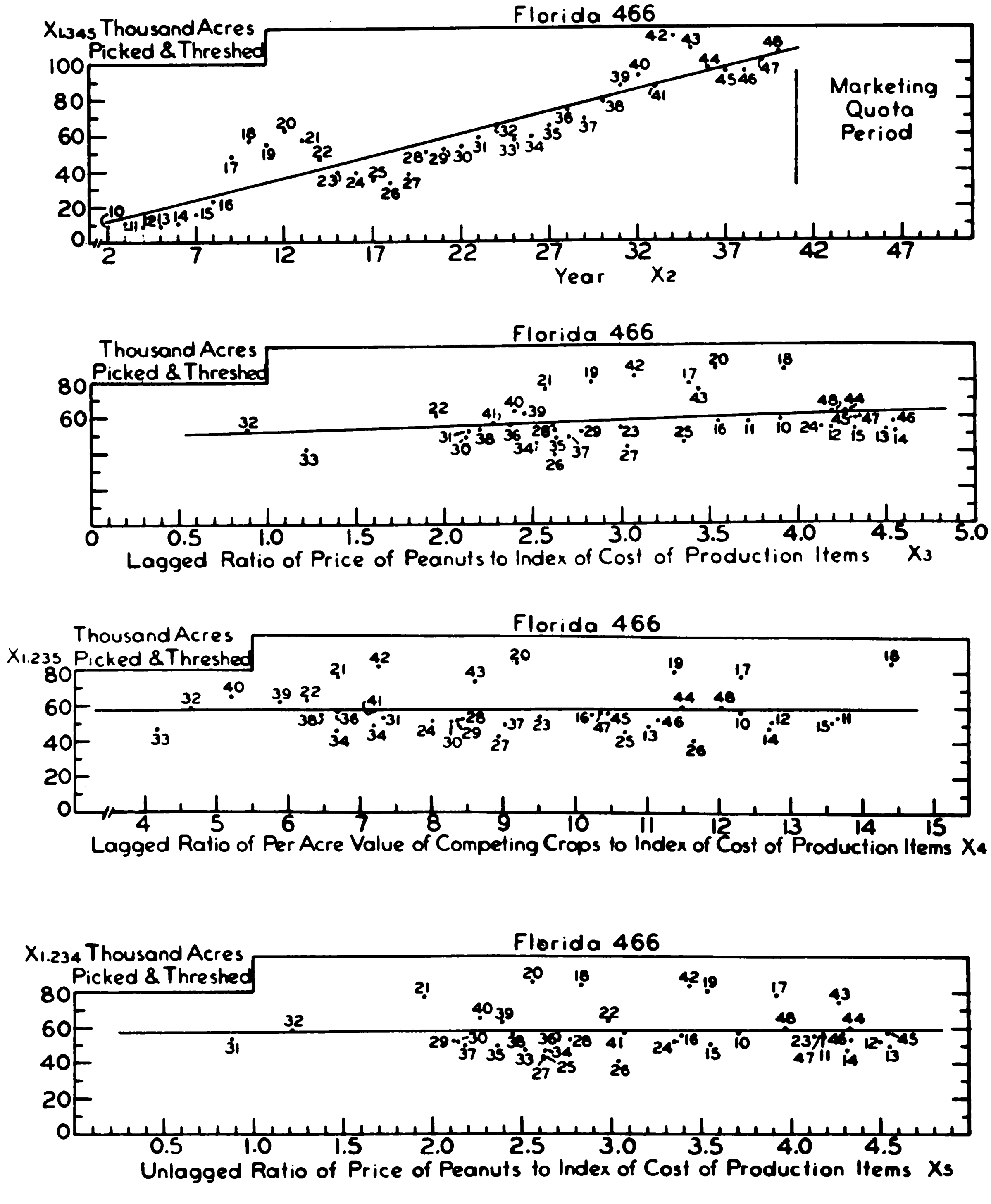
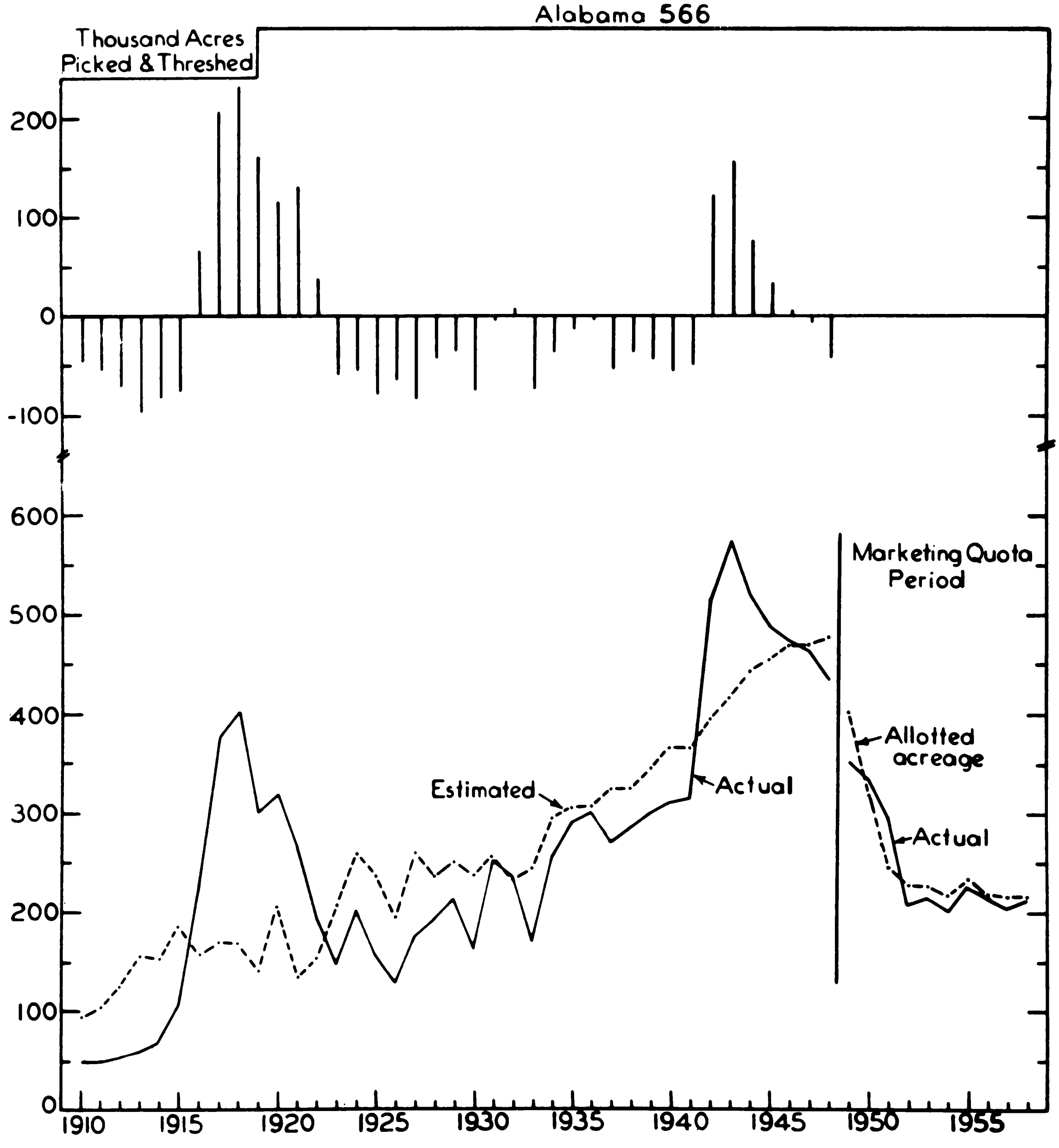


Figure 2. Continued


Alabama 566
Thousand Acres
Picked & Threshed
200
100
0
-100
600
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400
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200
100
0
Marketing Quota
Period
Allotted
acreage
Estimated
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1910
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Figure 3.

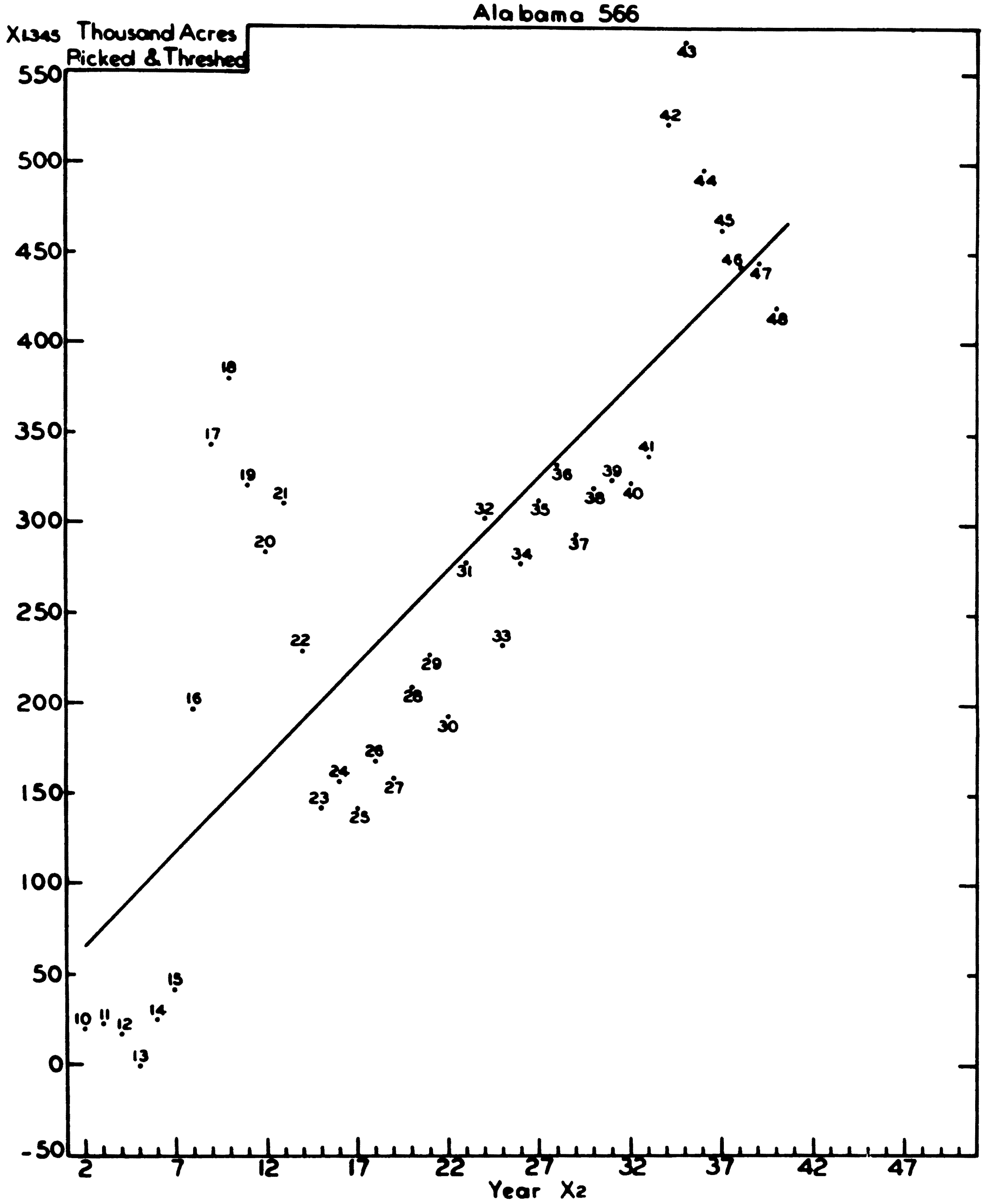


Figure 3. Continued

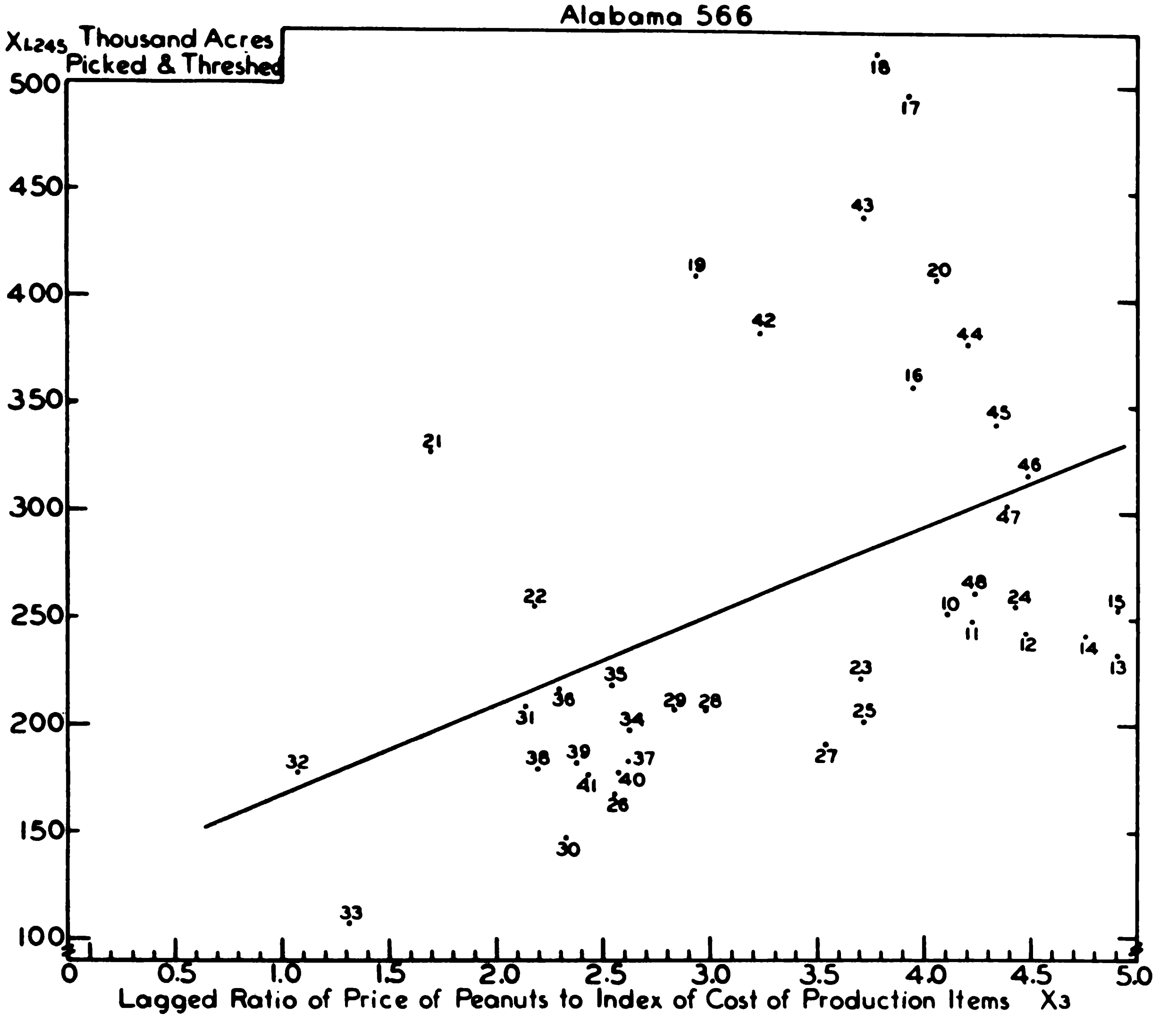
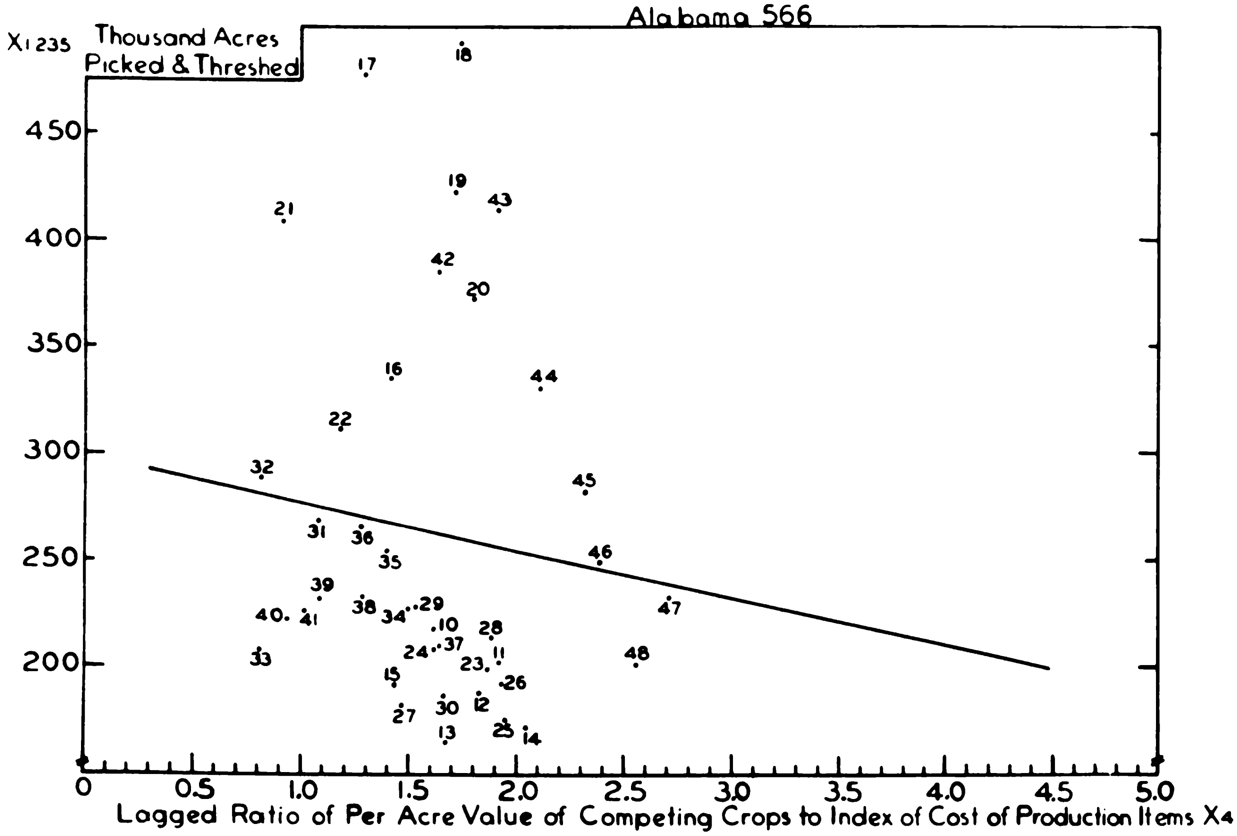


Figure 3. Continued



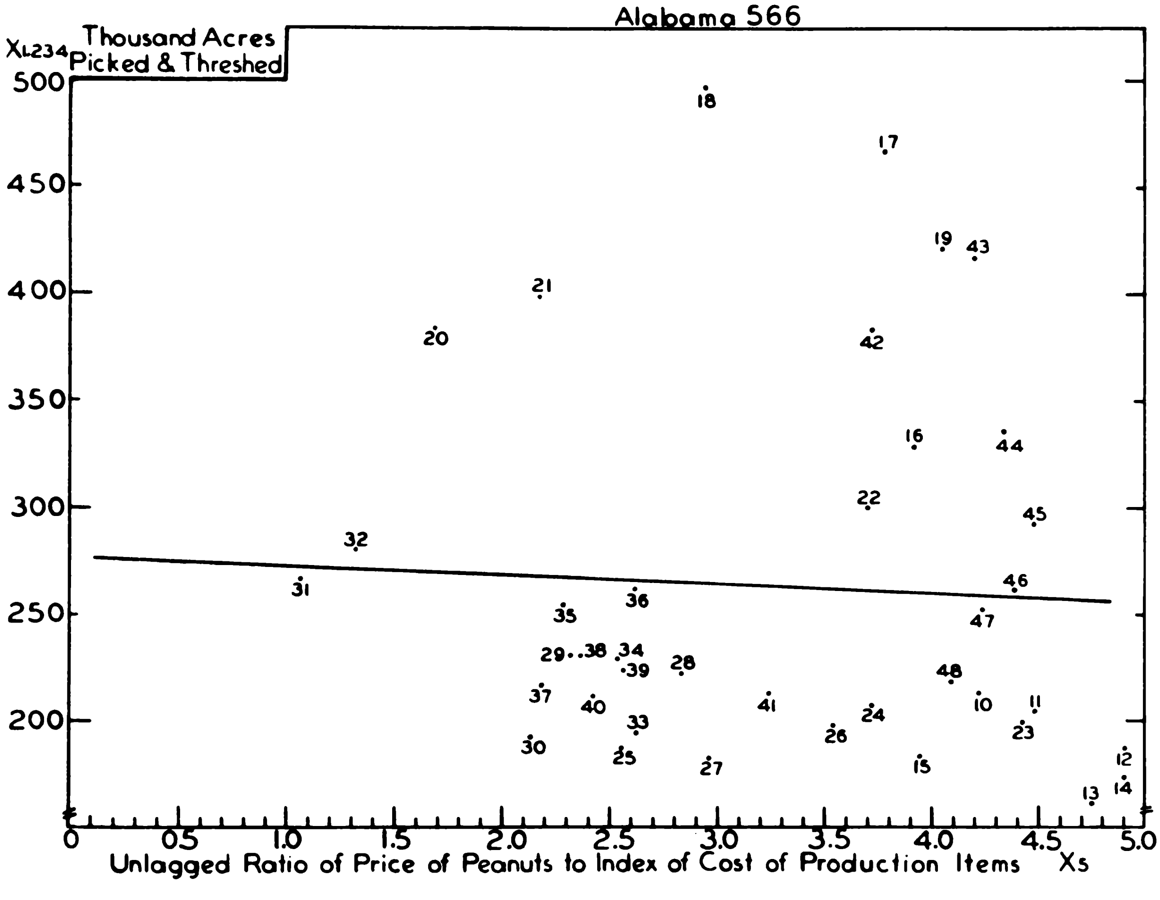


Figure 3. Continued

Georgia - 366 : R^2 = .94

$$X_{10} = - 566.6165 + \underset{(1.3610)}{31.7607X_1^{**}} + \underset{(24.1378)}{37.2533X_{21}} + \underset{(4.7514)}{8.0333X_{22}} + \underset{(6.2002)}{20.1367X_{23}}$$

Florida - 466 : R^2 = .85

$$X_{10} = - 5.2171 + \underset{(0.1864)}{2.4741X_1^{**}} + \underset{(3.9725)}{2.7914X_{21}} + \underset{(1.2931)}{0.1665X_{22}} + \underset{(3.1016)}{0.4259X_{23}}$$

Alabama - 566 : R^2 = .62

$$X_{10} = - 44.2107 + \underset{(1.4128)}{10.4119X_1^{**}} + \underset{(25.1121)}{42.1133X_{21}} - \underset{(48.6535)}{21.9426X_{22}} - \underset{(19.6390)}{4.2707X_{23}}$$

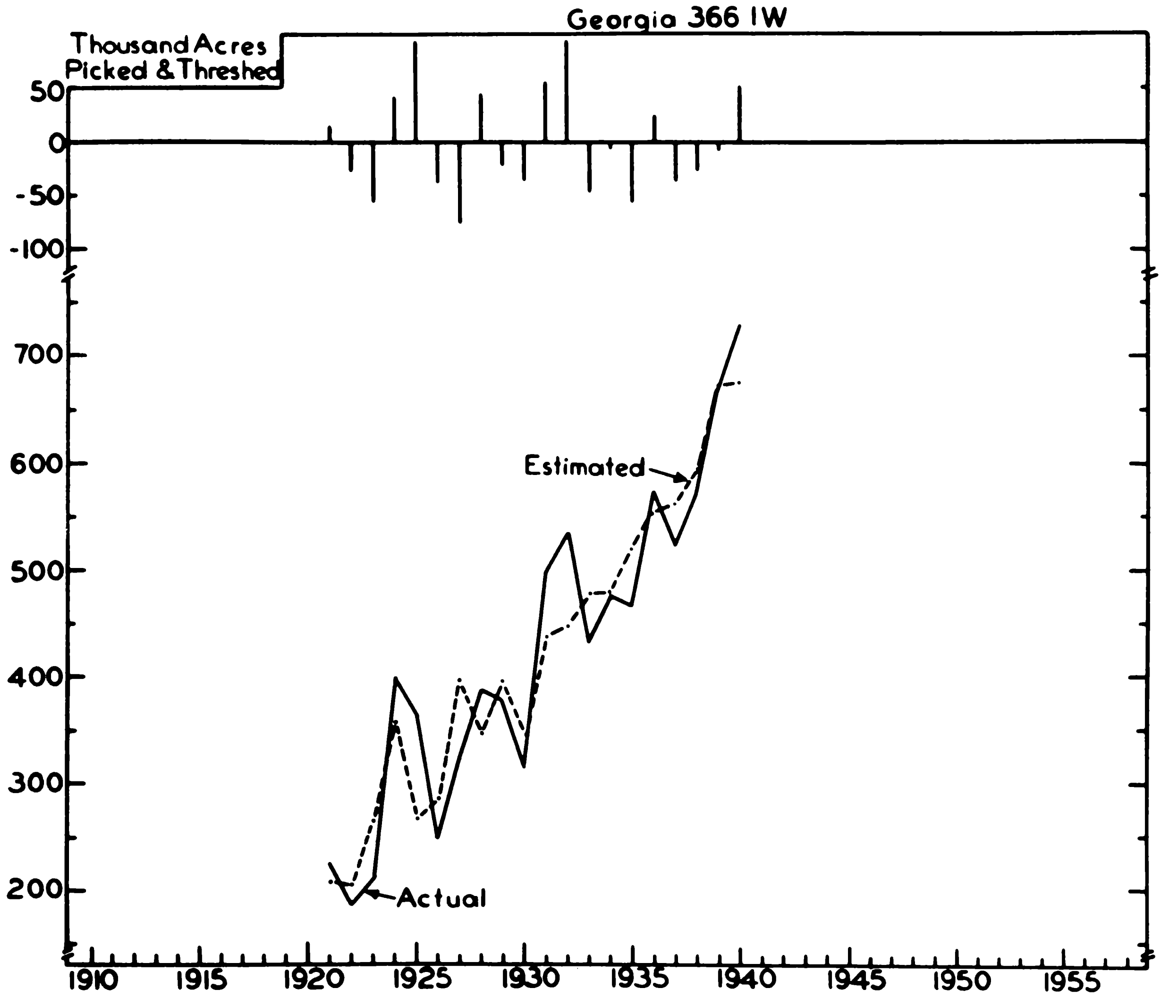
Time is the only variable with a significant coefficient. Inspection of the graphs makes clear the wide dispersion of the data arising from inclusion of the war years, and that these years are largely responsible for reversal of the signs of per-acre value of competing crops when this occurs. Price of peanuts and values of corn and cotton tended to move in the same direction as acreage of peanuts under the influence of exogenous forces. Inspection of the several lines of relationship for the three states in the partial regression charts will reveal that, if the war years are blocked out, new lines of relationship of logical sign may be envisioned. Such is the substance of Model I below. Model H is interesting for its comparative value with Model I, but of course, is not useful.

Model I

This model is designed to remove the forces which distort Model H, namely, the initial formative years of the industry, World War I and II years, and of course, the mandatory acreage allotment period. The inter-war years include the "great depression" of the 1930's, but if all exogenous disturbances are removed, there can be little analysis of the peanut industry. The unlagged price-cost ratio in Model H has been omitted in this model. Model I is presented graphically in Figures 4, 5, and 6 for the respective Southeast states. The equations are:

Georgia - 366IW : R^2 = .89

$$X_{10} = - 887.4505 + \underset{(2.3936)}{23.2580X_1^{**}} + \underset{(23.7952)}{64.6201X_{21}^{*}} - \underset{(6.7771)}{16.2999X_{22}^{*}}$$


Georgia 366 IW
Thousand Acres Picked & Threshed
50
0
-50
-100
700
600
500
400
300
200
Estimated
Actual
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

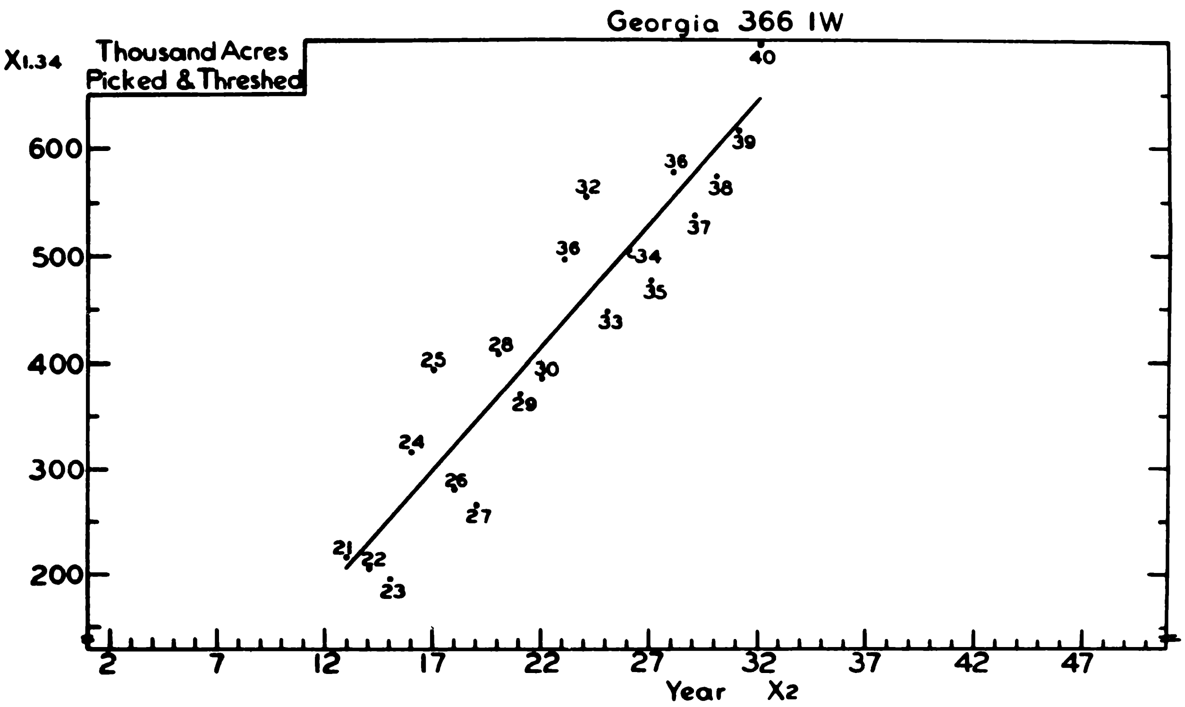
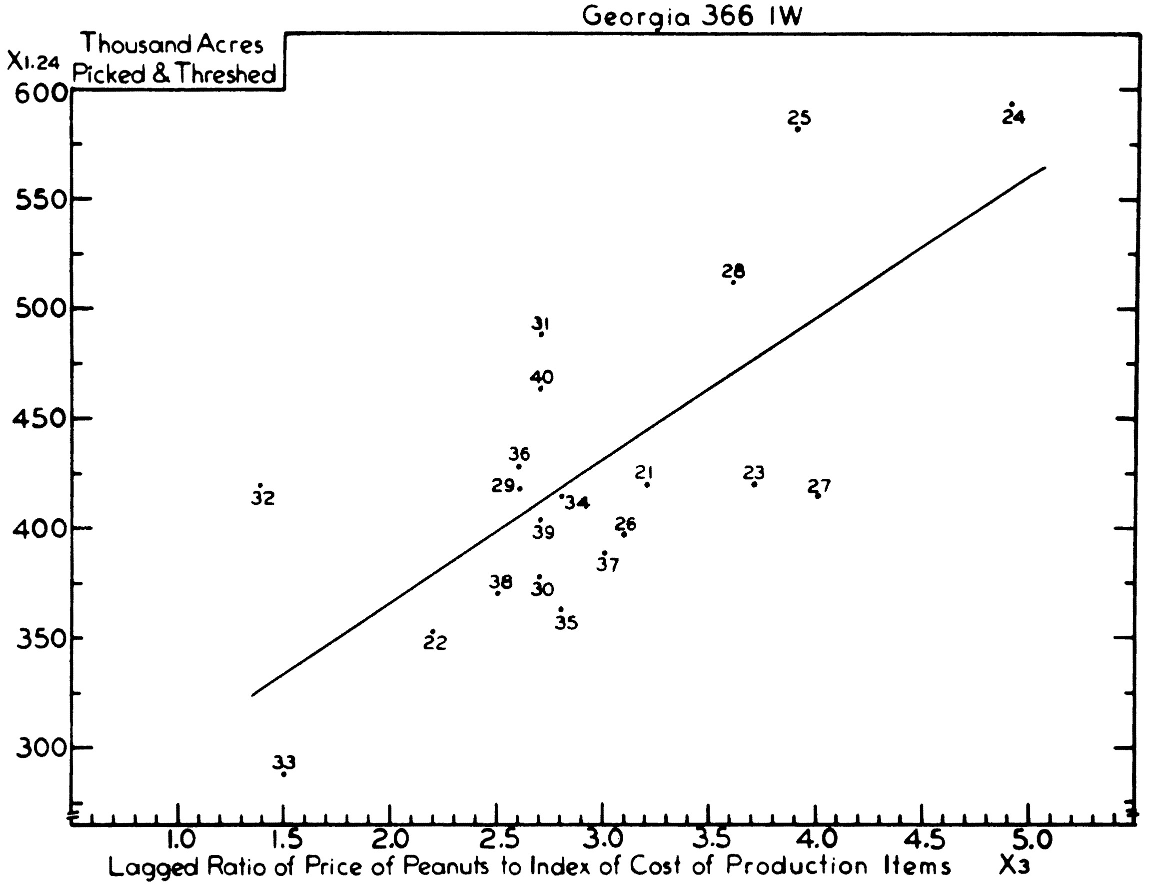

Georgia 366 IW
X1.34
Thousand Acres Picked & Threshed
600
500
400
300
200
2
7
12
17
22
27
32
37
42
47
Year X2

Figure 4.



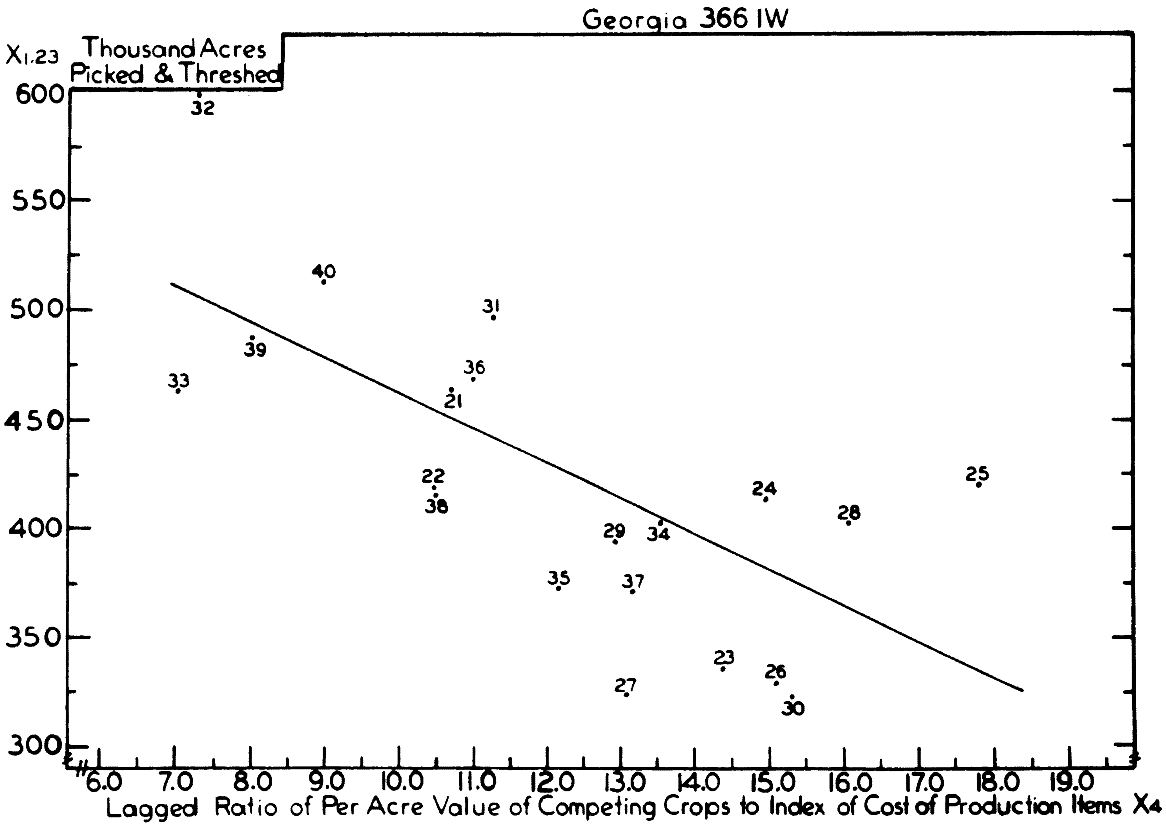


Figure 4. Continued

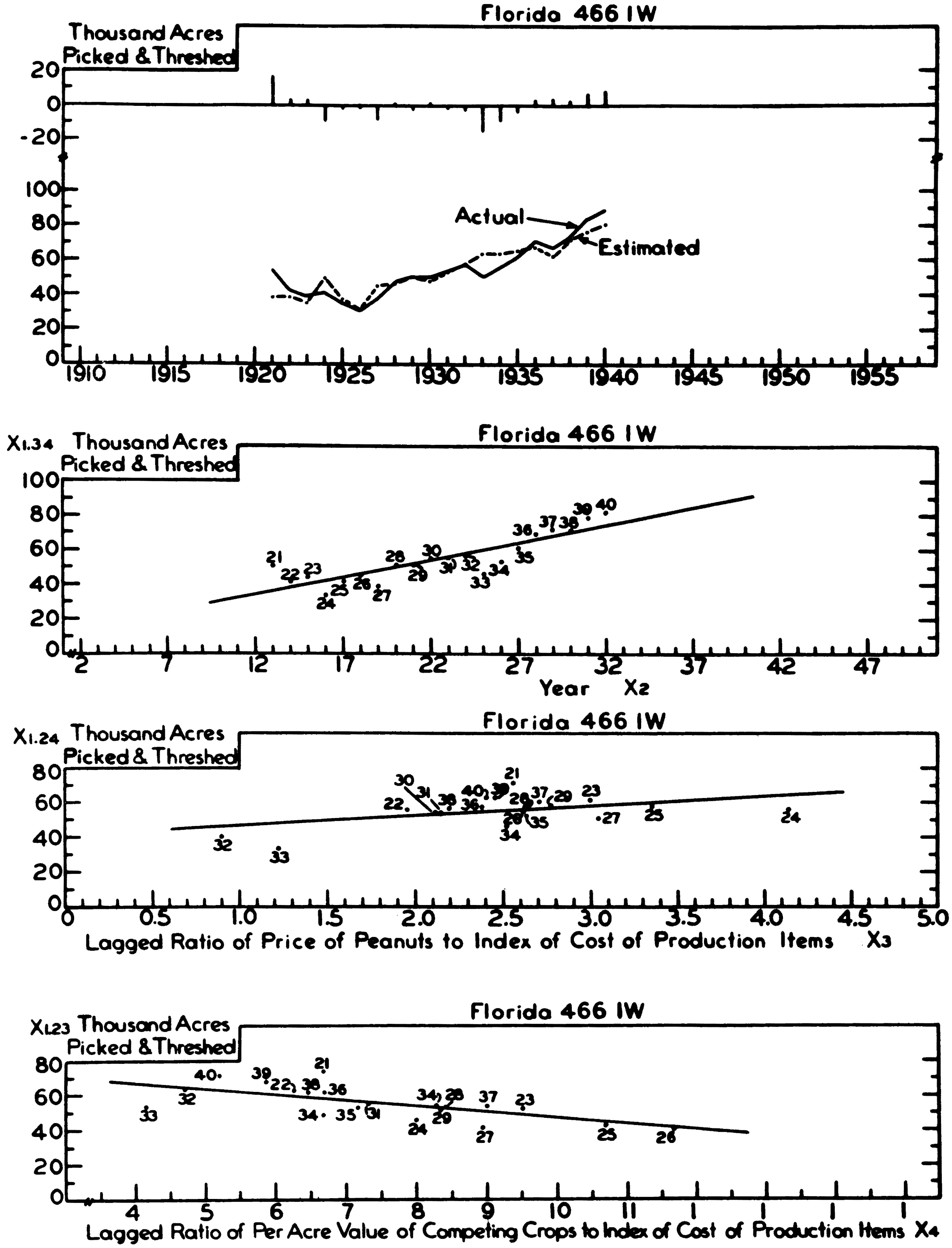
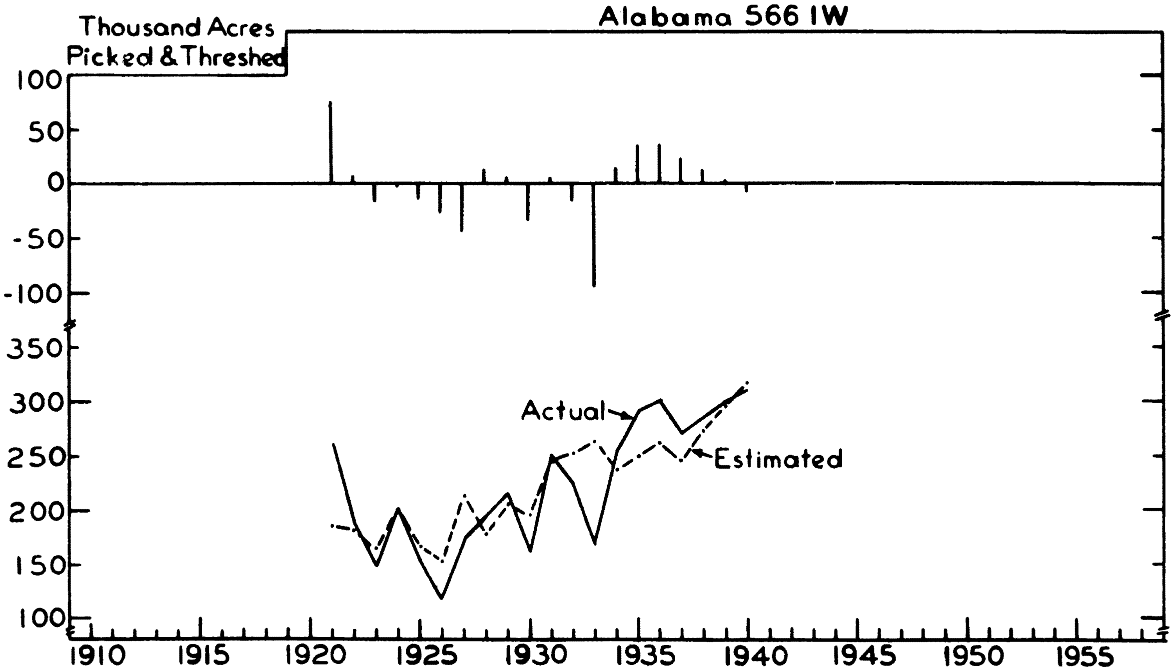
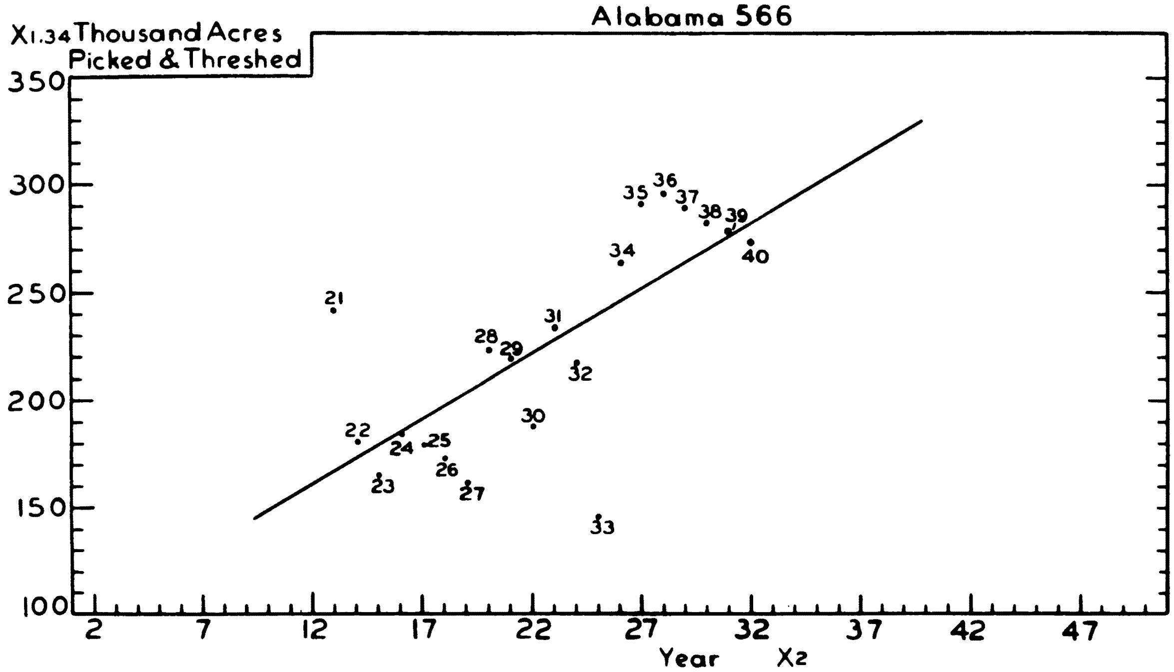

Florida 466 IW
Thousand Acres
Picked & Threshed
Actual
Estimated
Florida 466 IW
$X_{1.34}$ Thousand Acres
Picked & Threshed
Year X_2
Florida 466 IW
$X_{1.24}$ Thousand Acres
Picked & Threshed
Lagged Ratio of Price of Peanuts to Index of Cost of Production Items X_3
Florida 466 IW
$X_{1.23}$ Thousand Acres
Picked & Threshed
Lagged Ratio of Per Acre Value of Competing Crops to Index of Cost of Production Items X_4

Figure 5.

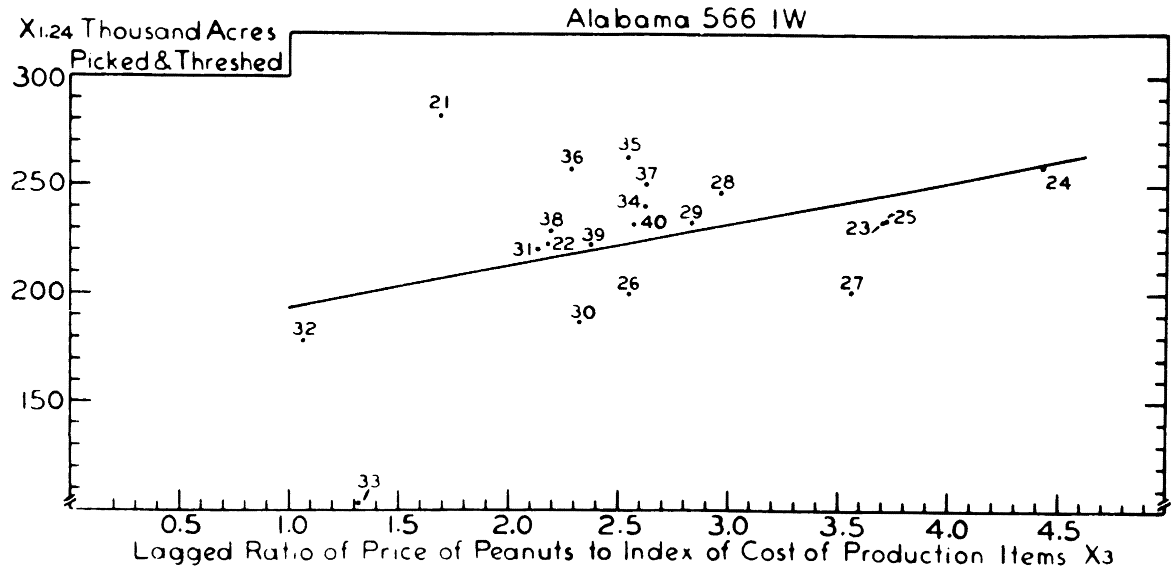


Thousand Acres
Picked & Threshed
Alabama 566 IW
100
50
0
-50
-100
350
300
250
200
150
100
Actual
Estimated
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955



X1.34 Thousand Acres
Picked & Threshed
Alabama 566
350
300
250
200
150
100
2
7
12
17
22
27
32
37
42
47
Year
X2

Figure 6.



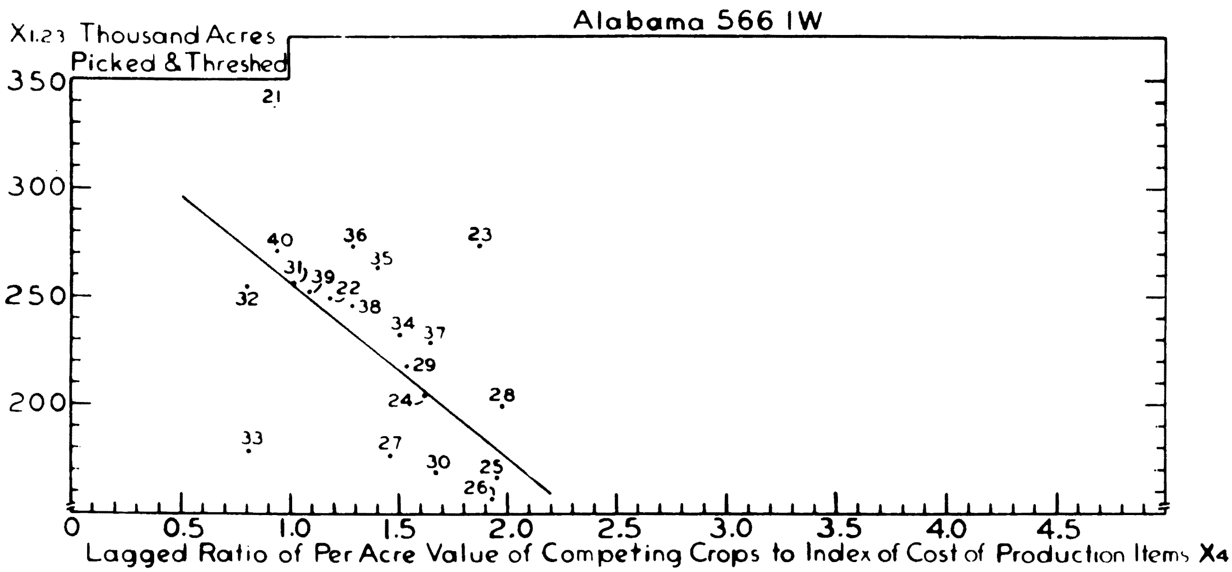


Figure 6. Continued

Florida-466IW : $R^2 = .83$

$$X_{10} = 230.1905 + \underset{(0.9995)}{2.0032X_1^{**}} + \underset{(3.1654)}{5.6442X_{21}} - \underset{(1.2053)}{3.5435X_{22}^{**}}$$

Alabama - 566IW : $R^2 = .64$

$$X_{10} = 149.7734 + \underset{(1.5842)}{6.1198X_1^{**}} + \underset{(15.8799)}{19.5352X_{21}} - \underset{(34.6305)}{81.4607X_{22}^{*}}$$

The signs of all coefficients are now logical, and 7 of the 9 are significant. Even though this model represents a great improvement, the acreage-price relationship appears to be obscured by either intercorrelation or the omission of some variable. The residuals for the year 1921 suggest that the adjustment following World War I had not been completed and that this year should be omitted. The large residuals for 1933 may be largely weather-generated, as well as associated with generally discouraging price levels.

While these relationships are of considerable academic interest, similar conditions are not likely to be repeated. During this period, and in subsequent years, the entire southern agricultural economy experienced a drastic structural adjustment in which peanut acreage played a prominent role in the changing land use. More recently, emphasis is moving in the direction of a livestock economy and rapidly expanding industrial development. This suggests change in opportunity costs and in the nature of the alternatives. These considerations appear to indicate that the interwar-period analyses would not necessarily fit the current situation even though government intervention were to be discontinued.

Accordingly, Model I is regarded with interest, but is set aside for purposes of this study. It could be revisited and probably improved by further investigation, and perhaps would be a useful component of a statistical model for the simultaneous equation approach to production estimates for the interwar period.

Models J, K, L, M, N, O, and P

Models K, L, M, N, O, and P failed to provide useful analyses of underharvested acreage. All were rejected. Signs of coefficients are illogical, all coefficients are non-significant, and multiple correlation coefficients are low. The differential between the acreage allotments and acreage picked and threshed is shown graphically in Figures 1, 2, and 3 for the respective states. The relevant underharvested data are included in the tables of production estimates in the production analysis below.

In recent years of the allotment period, underharvest in Georgia has been less than in the early years of the period. Therefore, an underharvested acreage in line with recent years has been subjectively determined as approximately 13,000 acres less than the minimum allotment of about 528,000 acres. Accordingly, Model J will be used, less an estimated 13,000 acres, for purposes of projecting production to 1965 for Georgia.

In Florida, the differential is comparatively negligible, so Model J will be used for projection.

In Alabama, Model J, less 8,000 acres for underharvest, appears to be a reasonable approximation of acreage expectations.

Some additional investigation was made regarding factors which might be associated with underharvested acreage. A considerable acreage of peanuts is hogged off in this area, although less than in earlier years. It may be logically reasoned that if the price of hogs is high, it may be more profitable to divert acreage of peanuts to hogs than to pick and thresh the peanuts for other uses. To explore this hypothesis, scatter diagrams of the relevant data were prepared; these are presented in Figure 7. If the relationship exists, the logical expectation is that as hog prices increase, underharvested acreage would increase as less acreage would be picked and threshed. Inspection of the scatter diagrams for Georgia and Alabama suggest that the years 1950 and 1951 are heavily influenced by other factors, since the data are widely dispersed.

The magnitude of this dispersion in the Southeast area (and other areas also) may best be understood by reference to Part II, Chronology of Legislation for the Crop Years 1950 and 1951. A two-price system was in effect during these two years under which the grower could harvest, and market without penalty, acreage in excess of his allotment, providing the excess peanuts were marketed at their value for crushing for oil or meal through an agency designated by the United States Department of Agriculture; 68 and 194 million pounds were marketed in this manner for the years 1950 and 1951. This provision was applicable in all three areas but had its greatest effect in the traditionally oil-producing areas of the Southeast and Southwest. Insofar as the analysis of underplantings is concerned, it would be necessary to either eliminate these two years, or make subjective adjustments indicating what underplantings might have been if excess acreage had not been permitted.

An additional consideration is the drought of 1954, probably resulting in abandonment of acreage which happened to coincide with a high price for hogs, although the favorable hog price could well have influenced this diversion as a profitable outlet for poor quality peanuts coupled with high per-unit harvesting costs under poor yield conditions. If these three years are eliminated, or even if they are included, there appears to be a tendency for underharvested acreage to increase as hog prices increase in both Georgia and Alabama. The observations appear too few in number to draw more than this tentative conclusion. The following analysis from Ross[32] in Alabama suggests some additional considerations:

"....my peanut study indicates that growers here do not underplant (their allotment), in fact, they tend to overplant and hog off the residual acreage....Weather is perhaps the largest factor in that some growers may have to abandon a portion of their peanut acreage due to excessive weeds resulting from too much rainfall during the growing season. Also growers are faced with the uncertainty of rain squalls from tropical storms during the harvest months of August, September, and October. This is especially a critical problem to those pull-type or combine operators that harvest from windrows or small piles. The worst storms tend to damage peanuts in the stack.

"Another reason contributing to smaller acreage harvested than total alloted acreage might be those small allotment owners (say less than three acres) which merely do not plant their allotment or they may be in a situation where they are unable to rent out to other farmers.

"A 1957 mimeographed report from the state ASC office showed there were 1,950 allotments distributed throughout Alabama other than in the eleven major peanut producing counties. These allotments are undoubtedly small. Peanuts produced under these allotments more than likely are sold but we are not sure how they are sold. Some may be sold on fruit and vegetable markets such as the one in Birmingham. No doubt some of the peanuts are used by the family on the farm where produced. In this way some of the acreage harvested may not be reported. For example, Blount County had 201 farmers with peanut allotments in 1957. We do not know where these farmers sold their peanuts.

"Dr. Yeager and I are in agreement that no one factor in particular influences lower harvest acreage than total allotment acreage, but combinations of several as I have mentioned. However, we believe weather is the most important.

"We also feel that prices of hogs would have little if any effect in changing a growers planned intentions of harvesting unless the crop fails and he does so as a last resort."

"The possible relationship of underharvested acreage and rainfall was examined by the scattergram method, and also for temperature which

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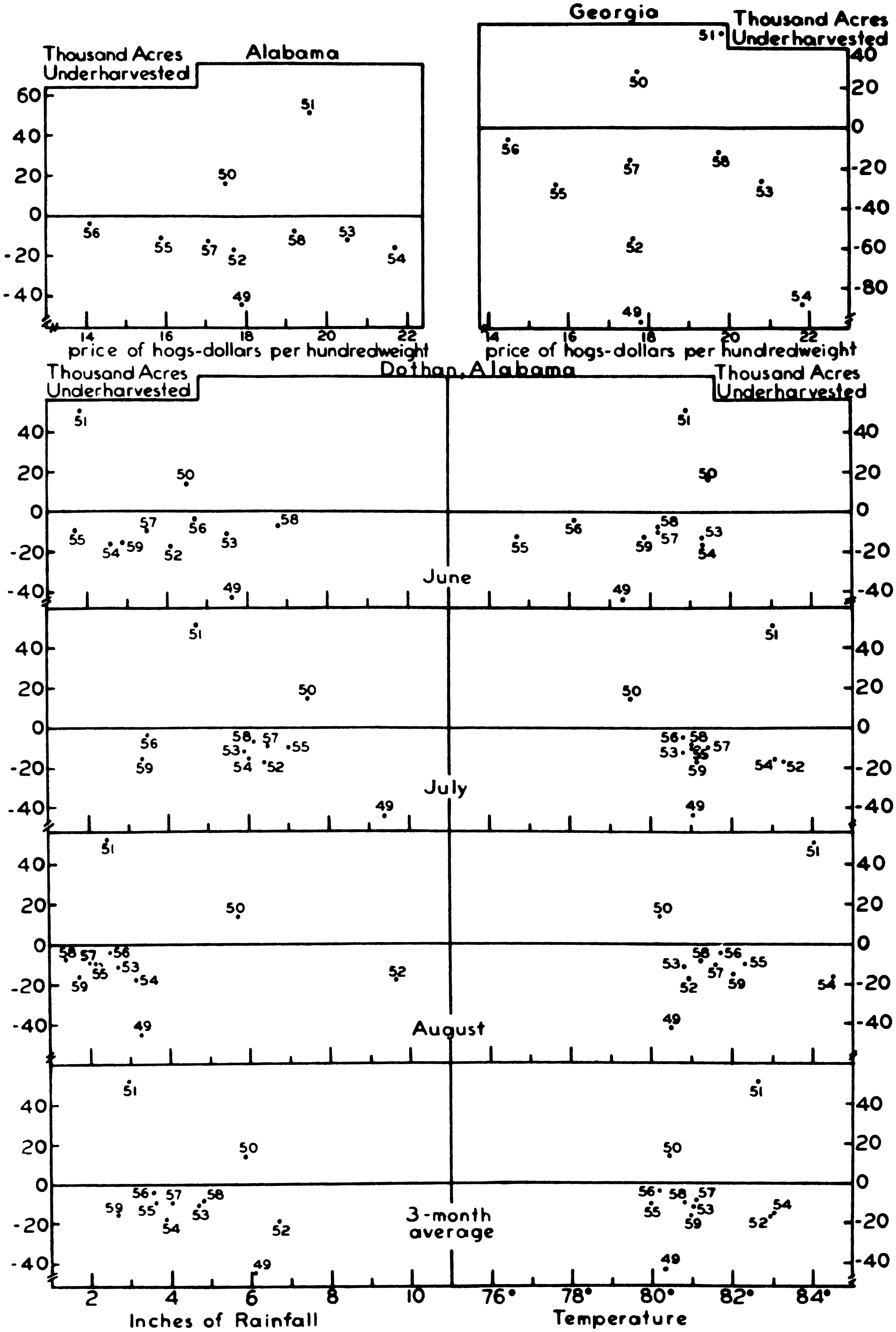
[32]Letter from Jack S. Ross, Department of Agricultural Economics, Alabama Polytechnic Institute, Auburn, Alabama to R. O. Russell, V.P.I. in response to an inquiry, June 24, 1959.

is inversely correlated with rainfall. The expected correlation would be a positive relationship for rainfall and negative for temperature."

These relationships are presented graphically, along with the hog price scattergrams, in Figures 7 and 8 for average monthly rainfall and temperature at Blakely, Georgia and Dothan, Alabama. Also presented are scatter diagrams for the relationship between underharvested acreage for Georgia and Alabama and the June, July, and August rainfall variables X_{15}, X_{16}, and X_{17} in Figure 9. Inspection of these graphs suggests that further analyses would not be rewarding until a longer time period can be used. The above explanation of the large dispersion of the data for 1950 and 1951 is applicable, and the remaining years appear rather indeterminate. It is possible in some cases to construct a line of relationship through the data favorable to the hypotheses; however, it is believed that inspection of the diagrams reveals about as much definite information as might be gained by other methods, considering the small number of observations remaining after allowance for the effect of the two-price program.

Another difficulty in attempting to analyze underharvest has general application. A facet of this was discussed in the preceding section for the Virginia-Carolina area with respect to overharvest in North Carolina. The difficulty is one of variation in crop estimates among sources. An example of this is illustrated by comparison of the underharvest data used for this study and the tables accompanying the discussion in Part II for the 1952, 1953, and 1954 crops as prepared by Mr. Davis, Oils and Peanut Division; based on data from state offices of the Commodity Stabilization Service. The estimates of underharvest are quite different. When a sufficient number of observations become available over time, it would seem advisable, prior to attempting any analysis of underharvest, to make a careful and thorough appraisal of acreage estimates year by year and state by state in order to obtain more precise underharvest data with respect to allotted and unallotted acreage, and unallocated allotment. Small errors in aggregate estimates which may be disregarded as offsetting in aggregate data may be greatly magnified in data such as underharvest because of the residual nature of the data. Unless extreme care is exercised, it is doubtful that observed data can be obtained that would lend itself to reliable economic analysis, particularly when observations are few in number.

Another variable associated with underharvest is acreage placed in the acreage reserve and conservation reserve of the "soil bank" program. The program is of recent date and may not enter the data of this study appreciably. In 1956, according to estimates of the Commodity Stabilization Service, 6,144 acres of peanuts were taken out of production in the Southeast area, and 37,840 acres in the Southwest area. For the United States, 1957 soil bank acreage of peanuts was estimated at 39,000; 1958, 61,000; and 1959, 113,000. These are cumulative totals, since soil bank contracts are of more than one year duration. Quantitative and qualitative appraisal of these estimates by states seems indicated in deriving suitable observed data for underharvest. Such acreage is included in the state allotment legally, but the effect is comparable to a reduction in allotment.



Alabama
Thousand Acres Underharvested
60
40
20
0
-20
-40
14
16
18
20
22
price of hogs-dollars per hundredweight
Georgia
Thousand Acres Underharvested
40
20
0
-20
-40
-60
-80
price of hogs-dollars per hundredweight
Dothan, Alabama
June
July
August
3-month average
2
4
6
8
10
Inches of Rainfall
76°
78°
80°
82°
84°
Temperature

Figure 7.

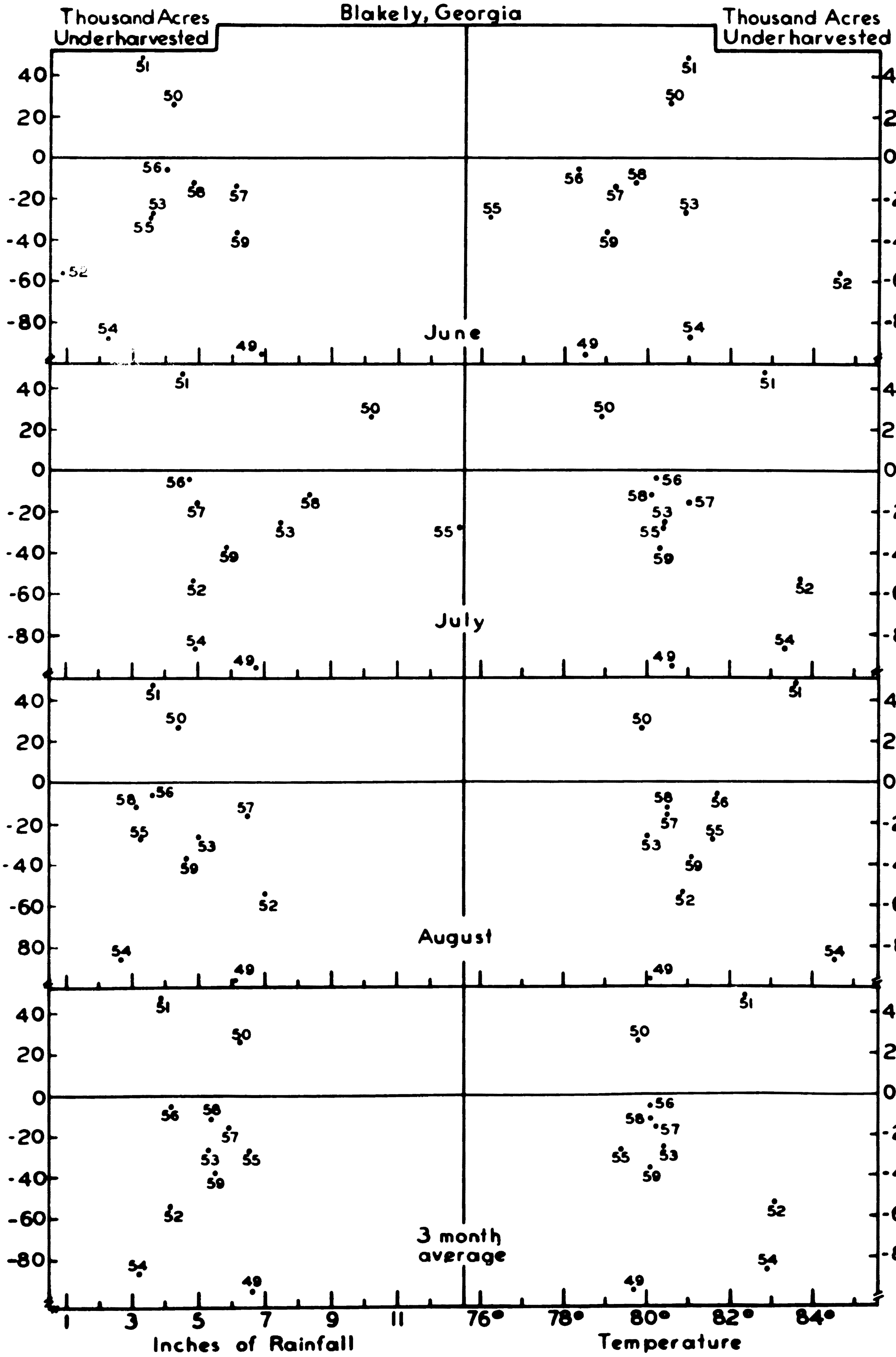

Blakely, Georgia
Thousand Acres Underharvested
Thousand Acres Underharvested
June
July
August
3 month average
Inches of Rainfall
Temperature

Figure 8.

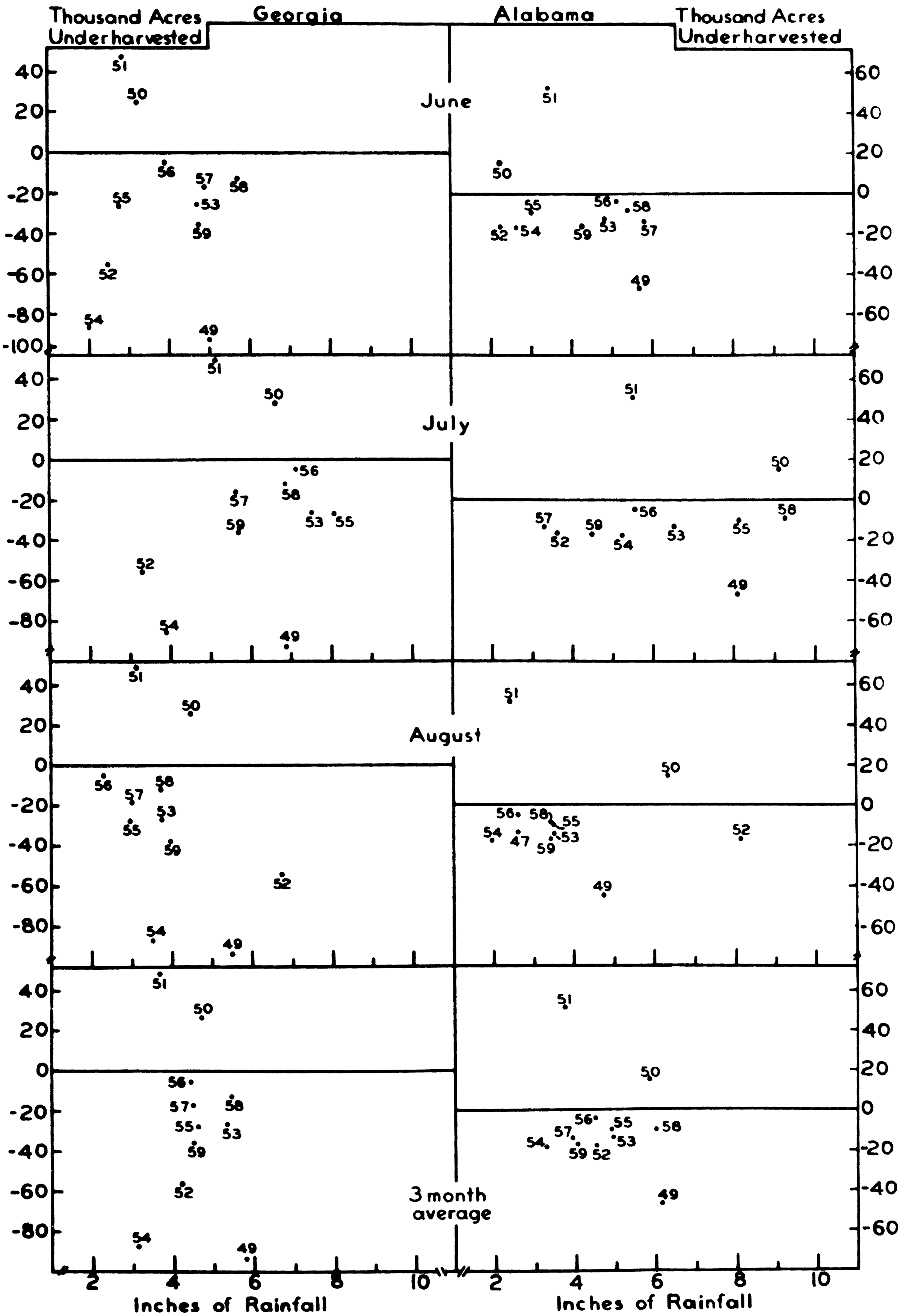

Thousand Acres Underharvested
Georgia
Alabama
Thousand Acres Underharvested
June
July
August
3 month average
Inches of Rainfall
Inches of Rainfall

Figure 9.

In Summary of This Section

It appears that the most useful acreage data for projecting production consists of the acreage allotments adjusted subjectively, as indicated above for Model J, for underharvested acreage.

Yield Estimates

Southeast Area

Variables Used and Models Considered:

X_1 ... Time

X_1^2 ... Time squared

X_2 ... Peanut yield (dependent)

X_5 ... Log peanut price (t-1)

X_9 ... Composite cost squared

X_{10} ... Peanut acreage

X_{15}.... July rainfall

X_{16} ... August rainfall

X_{17} ... September rainfall

X_{19} ... Profitability ratio

Models Considered Time Period - 1909-1958	Data Supplement Reference: Table Number	Equation Numbers: Georgia	Florida	Alabama
A. $X_2=f(X_1, X_5, X_{10})$	14	390	490	590
B. $X_2=f(X_1, X_5, X_{10}, X_{16})$	15	300	400	500
C. $X_2=f(X_1, X_5, X_9, X_{10})$	16	322	422	522
D. $X_2=f(X_1, X_5, X_9, X_{10}, X_{15}, X_{16}, X_{17})$	17	321	421	521
E. $X_2=f(X_1, X_1^2, X_5, X_{10}, X_{15}, X_{16}, X_{17})$	18	302	402	502
F. $X_2=f(X_1, X_5, X_{10}, X_{19})$	19	332	432	532
G. $X_2=f(X_1, X_5, X_{10}, X_{15}, X_{16}, X_{17}, X_{19})$	20	331	431	531

Model A

The coefficients obtained for this model are each significant at the 1% probability level for Georgia and Florida, and are of logical sign. The regression fit in Alabama is not as good since acreage is non-significant. These relationships are presented graphically in Figures 10, 11, and 12 for each of the states Georgia, Florida, and Alabama respectively. The equations are:

Georgia - 390 : $R^2 = .45$

$$X_2 = 494.3572 + \underset{(1.8533)}{6.7136X_1^{**}} + \underset{(84.1470)}{236.2054X_{5t-1}^{**}} - \underset{(0.0761)}{0.2440X_{10}^{**}}$$

Florida - 490 : $R^2 = .68$

$$X_2 = 510.6500 + \underset{(1.3652)}{5.8366X_1^{**}} + \underset{(62.8875)}{324.4535X_{5t-1}^{**}} - \underset{(0.6302)}{3.1679X_{10}^{**}}$$

Alabama - 590 : $R^2 = .37$

$$X_2 = 495.4010 + \underset{(1.5546)}{4.9005X_1^{**}} + \underset{(86.0498)}{189.4879X_{5t-1}^{*}} - \underset{(0.1540)}{0.2853X_{10}}$$

Inspection of the yield-time and yield-acreage relationship for the years 1909 to about 1925 suggests a period of acreage expansion in the formative years of the industry together with an accompanying yield reduction which is beyond the competence of a linear regression for the long-run period. This gives rise to the non-random configuration of the residuals in this formative "era" of the industry. The line of relationship passes through this period at about its mean; hence, the long-run fit is largely unaffected as far as its prediction value is concerned.

A similar but opposite effect occurs toward the end of the time period beginning with the low yield and high acreage of World War II years and progressing into the high yield and low acreage mandatory allotment period. A linear regression for the long-run period fails to deal with this "era" adequately. This is most noticeable in the yield-price relationship, a situation previously encountered and discussed in the yield section of the Virginia-Carolina area, Section IV. These relationships, characteristic of the area, are accentuated in Alabama and

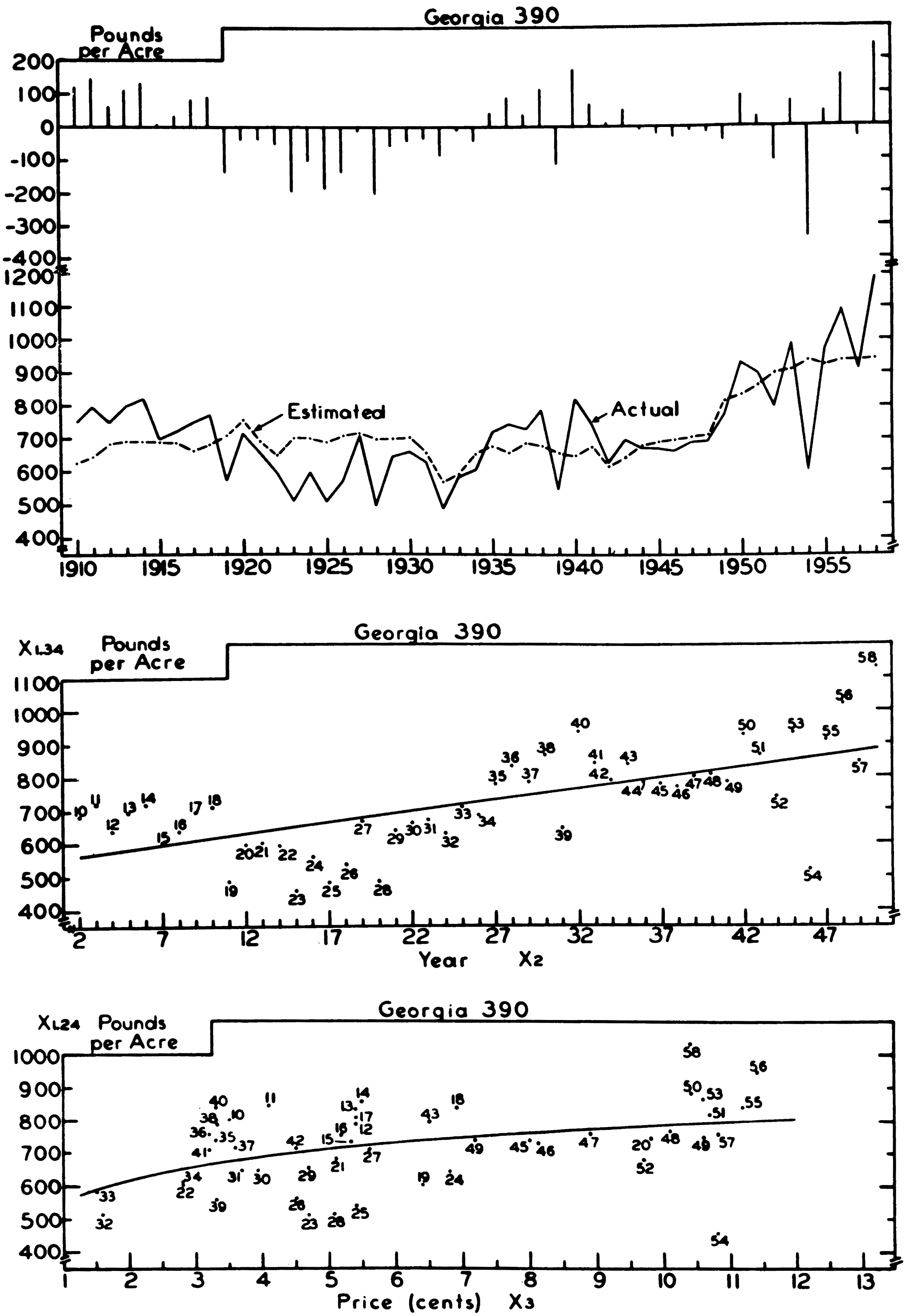

Georgia 390
Pounds per Acre
Estimated
Actual
1910 1915 1920 1925 1930 1935 1940 1945 1950 1955
Georgia 390
$X_{1.34}$ Pounds per Acre
Year X_2
Georgia 390
$X_{1.24}$ Pounds per Acre
Price (cents) X_3

Figure 10.

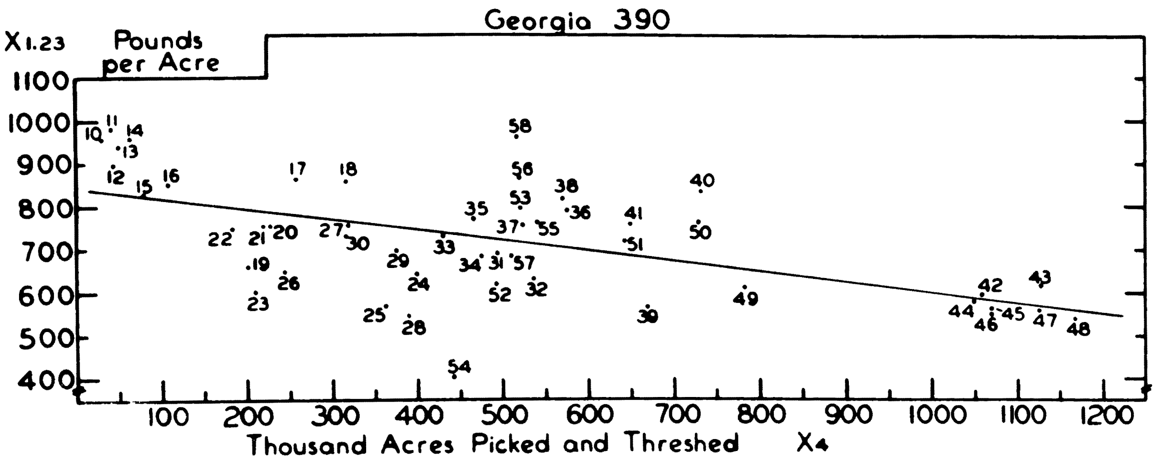
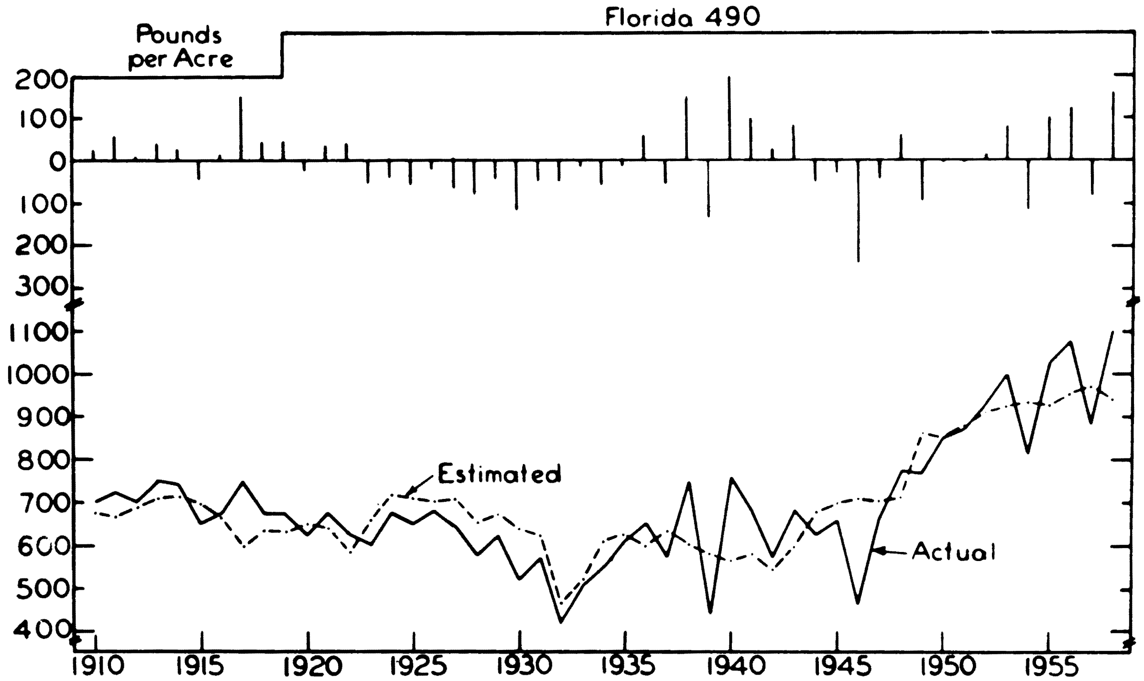


Figure 10. Continued



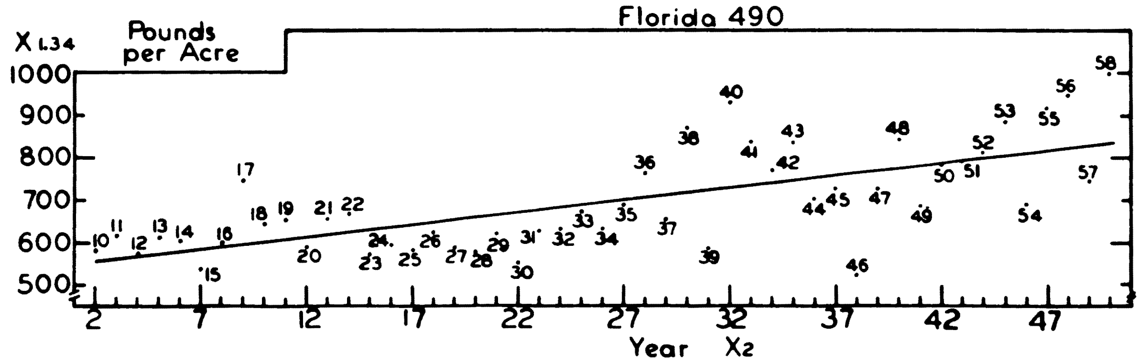


Figure 11.

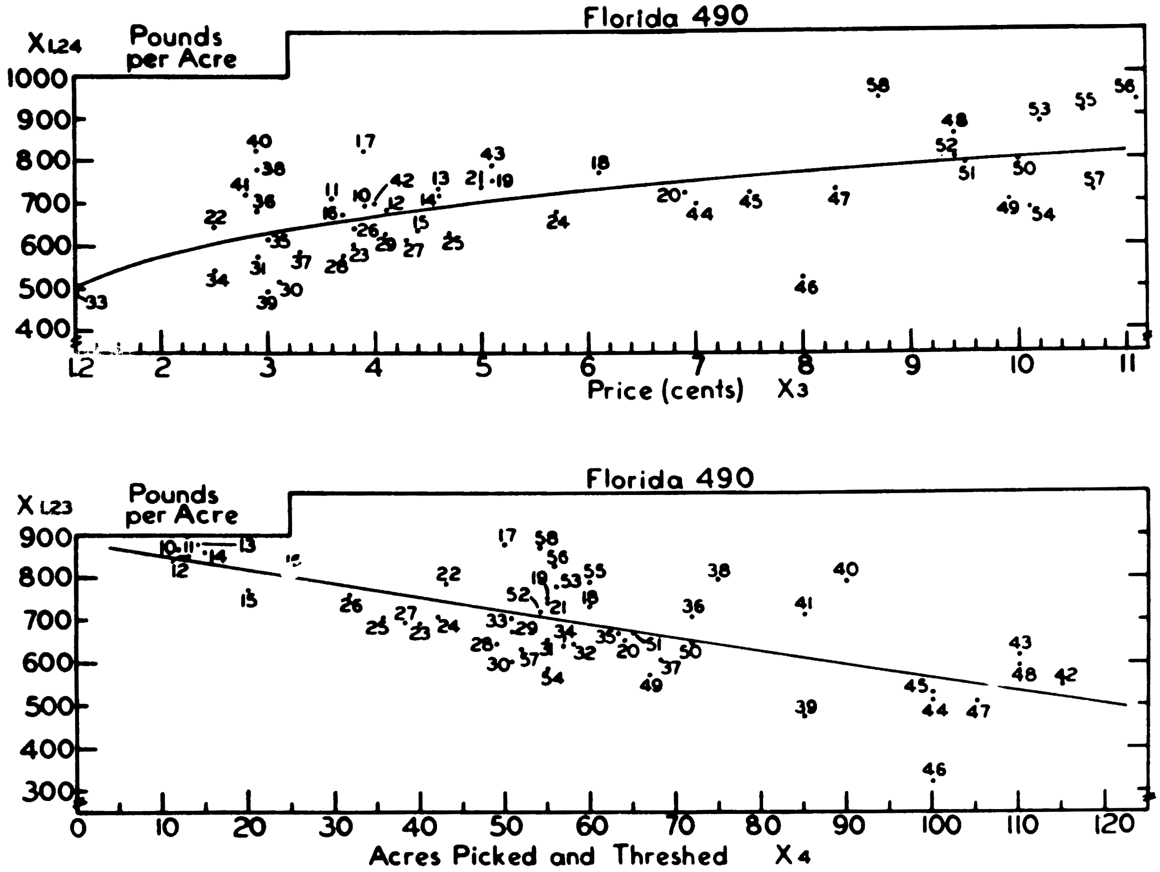


Figure 11. Continued

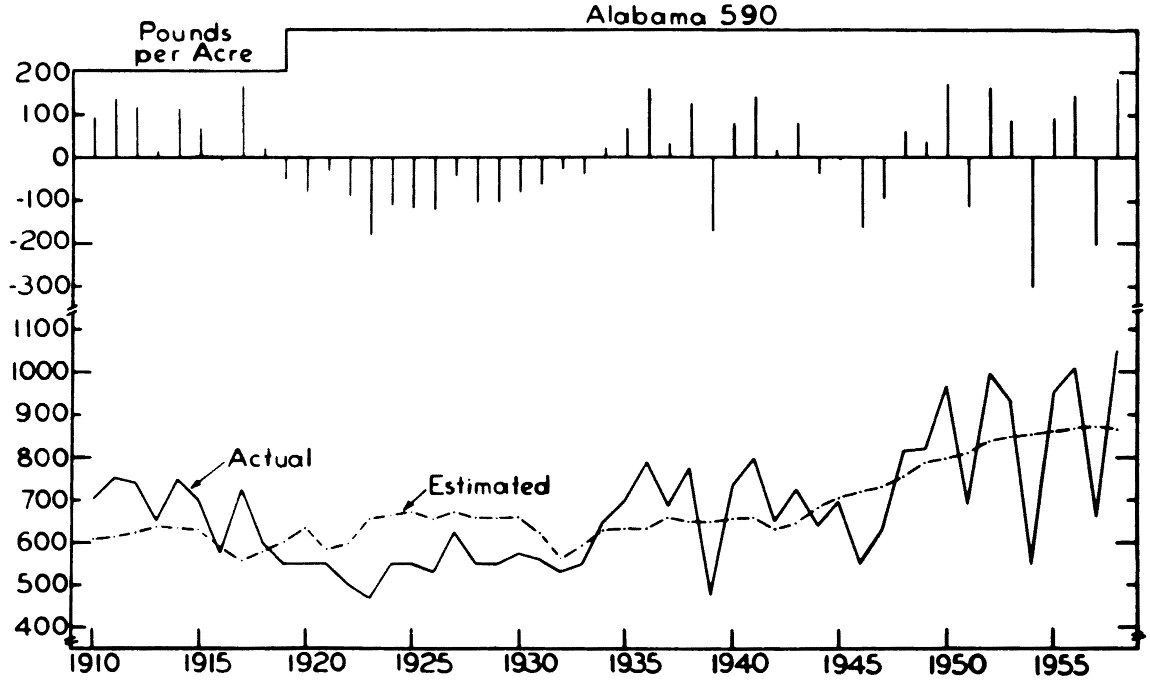
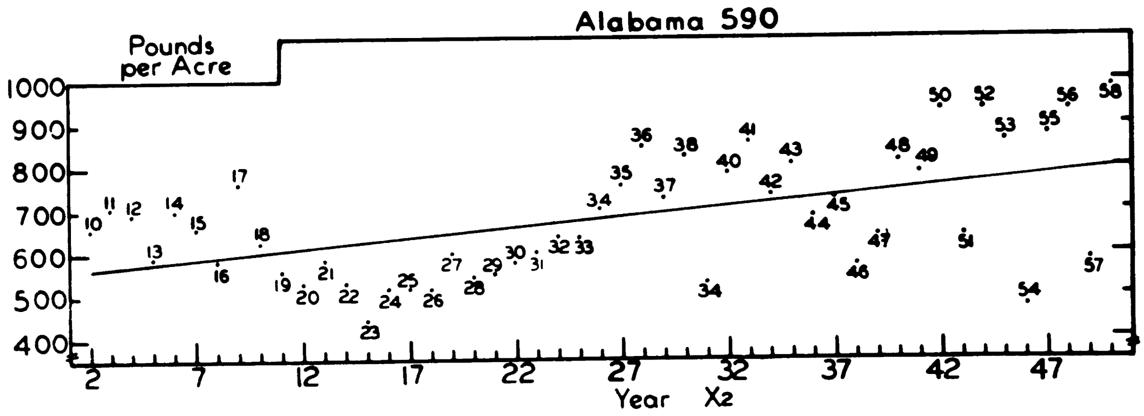
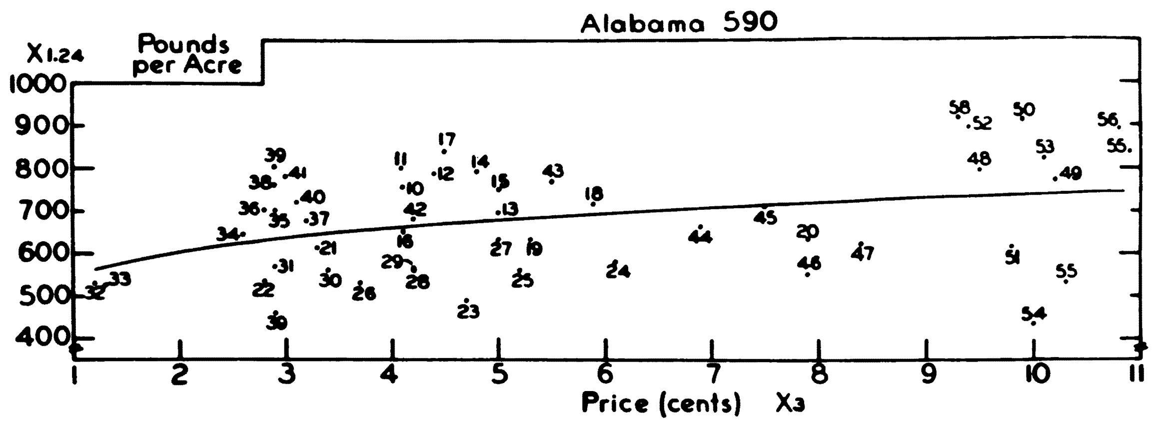


Figure 12.





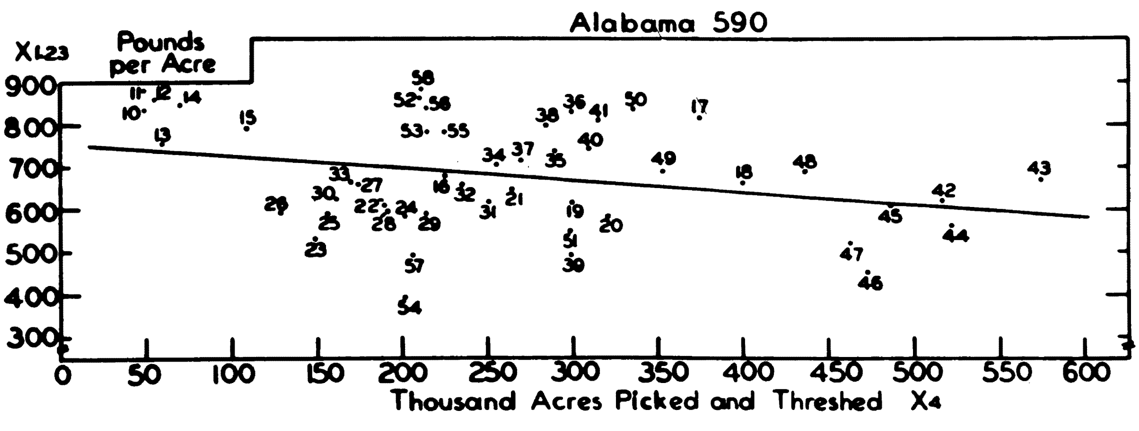


Figure 12. Continued

account for the relatively poor fit. As explained in the Virginia-Carolina discussion, it does not seem appropriate to project to the future the trend developed beginning with war-time generated low yields and high acreage on through the opposite conditions prevailing in recent years. While no detailed investigation has been included, general knowledge indicates that most of the large residuals are weather-generated.

Since these models are reasonably satisfactory for prediction purposes, they are not rejected. Somewhat better models for Georgia and Alabama are discussed below.

Model B

The addition of July rainfall to the Model A variables brought the acreage coefficient for Alabama into significant focus and effected an increase in the multiple correlation coefficient from .37 to .40. The rainfall variable itself is not significant at the 5% level but is of logical sign and effective in improving the over-all relationship. Otherwise, Model B is presumed to have the same characteristics as Model A. This model for Alabama is presented graphically in Figure 13. Its equation is:

Alabama - 500 : $R^2 = .40$

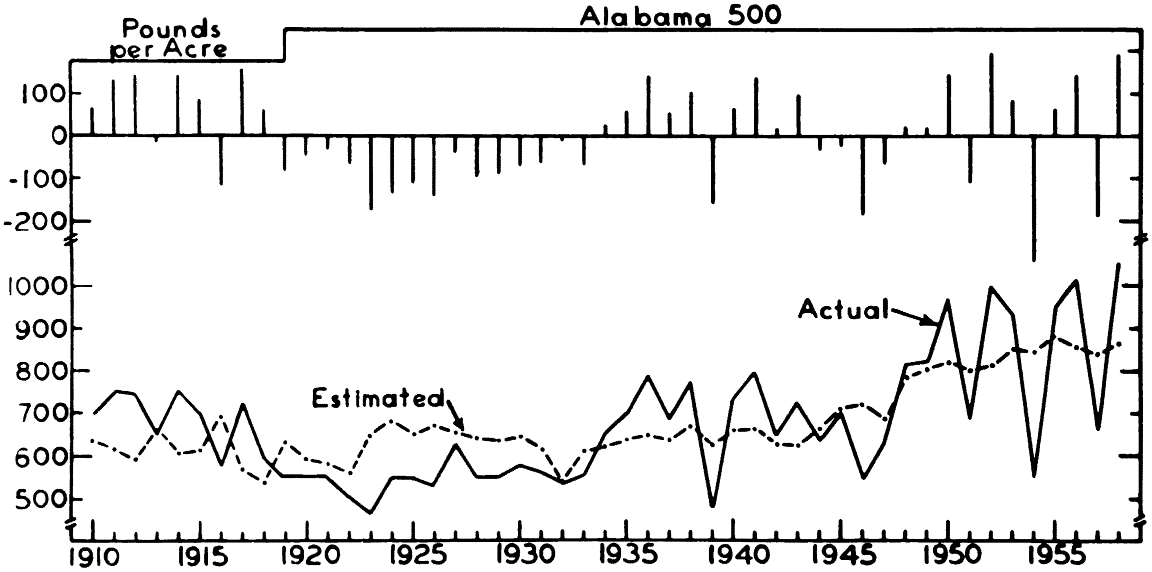
$$X_2 = 429.5761 + \underset{(1.5342)}{4.8688X_1^{**}} + \underset{(85.4592)}{203.8214X_{5t-1}^{*}} - \underset{(0.1546)}{0.3273X_{10}^{*}} + \underset{(7.2091)}{10.7215X_{16}}$$

Model C

This model is designed to test the effect of including the composite cost variable with the variables in Model A. Composite cost enters all regressions with logical sign but is significant only in Georgia. There are doubtless problems of intercorrelation which obscure the effect of cost since, as a composite of prices of corn and cotton as well as direct costs, it may well be intercorrelated with other independent variables. The model is a somewhat better fit in Georgia than Models A or B, but no better for Florida, and not as good in Alabama. Model C for Georgia is presented graphically in Figure 14. Its equation is:

Georgia - 322 : $R^2 = .50$

$$X_2 = 412.5682 + \underset{(1.7871)}{6.6760X_1^{**}} + \underset{(128.6732)}{445.7691X_{5t-1}^{**}} - \underset{(0.0015)}{0.0031X_9^{*}} - \underset{(0.0737)}{0.2290X_{10}^{**}}$$


Alabama 500
Pounds per Acre
Actual
Estimated

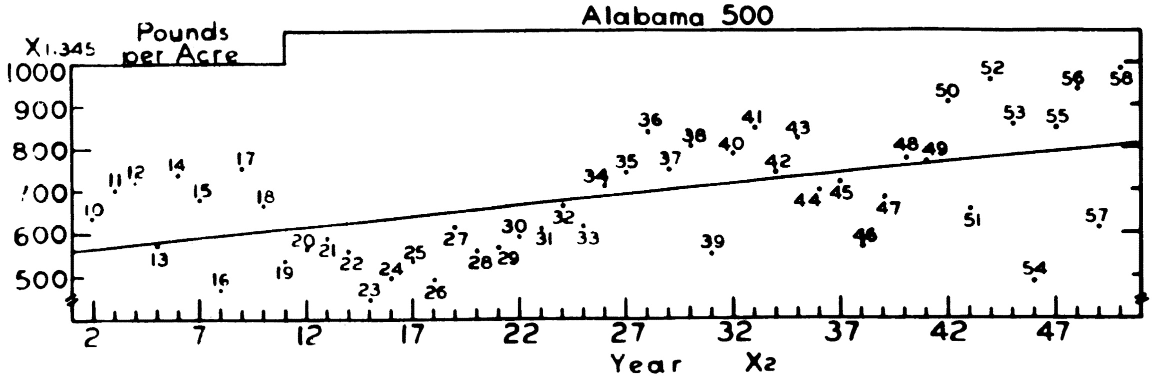
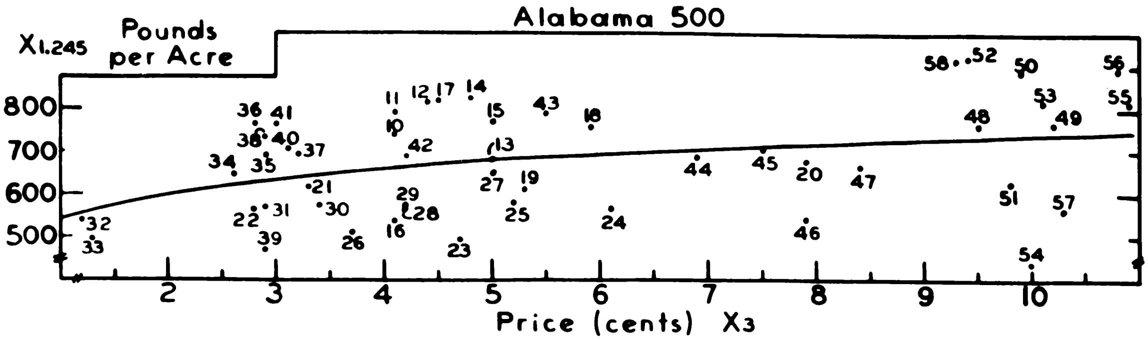
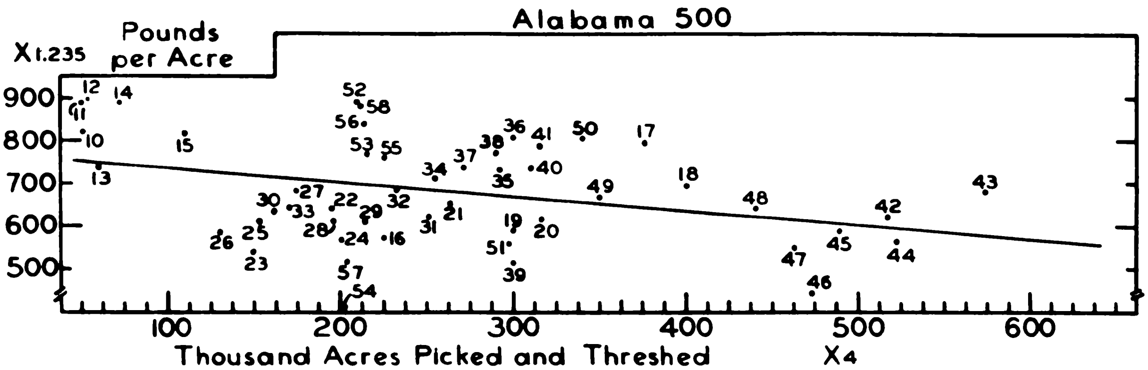

Alabama 500
$X_{1.345}$
Pounds per Acre
Year
X_2

Figure 13.





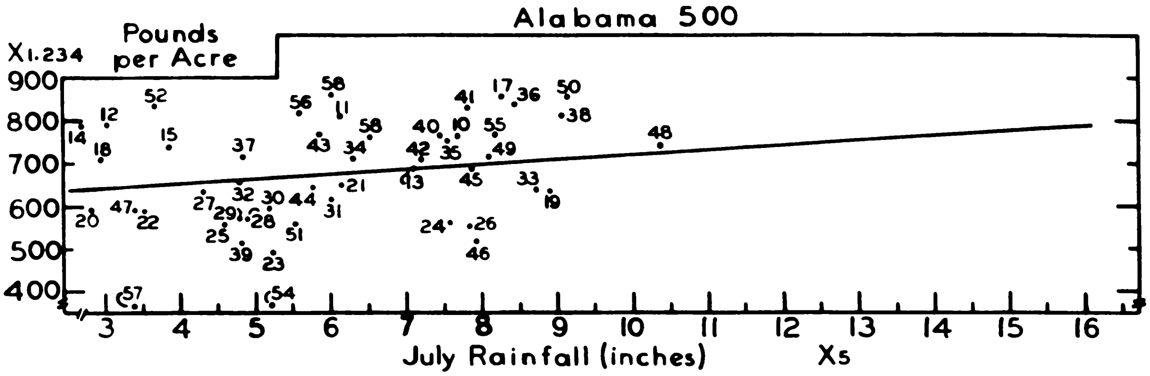
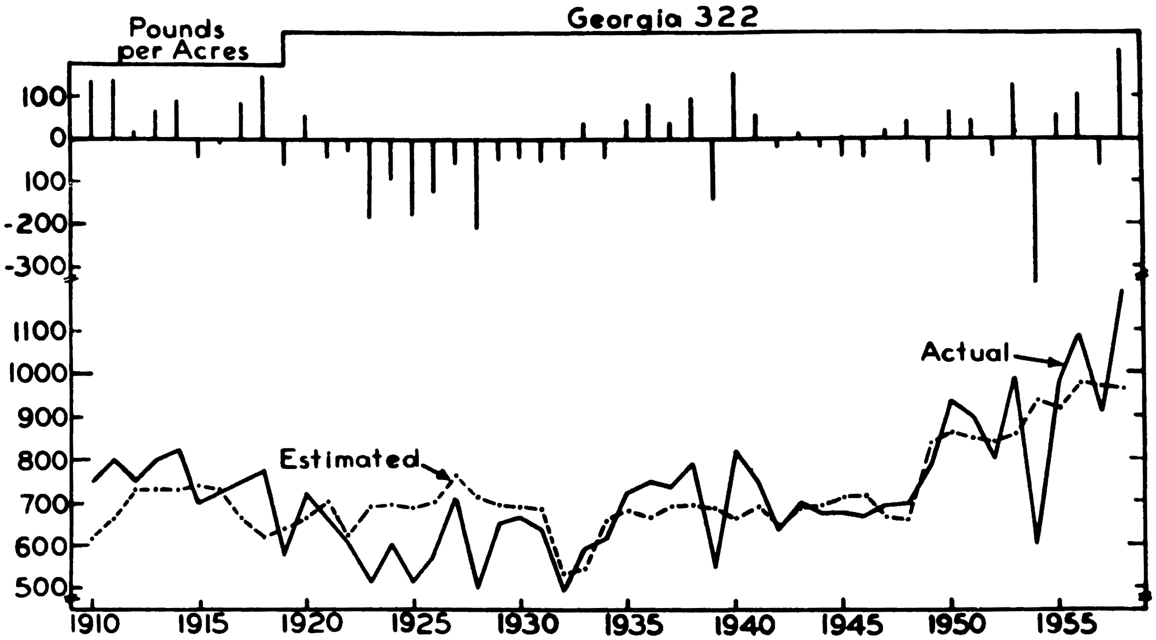


Figure 13. Continued


Georgia 322
Pounds per Acres
100
0
100
-200
-300
1100
1000
900
800
700
600
500
Actual
Estimated
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

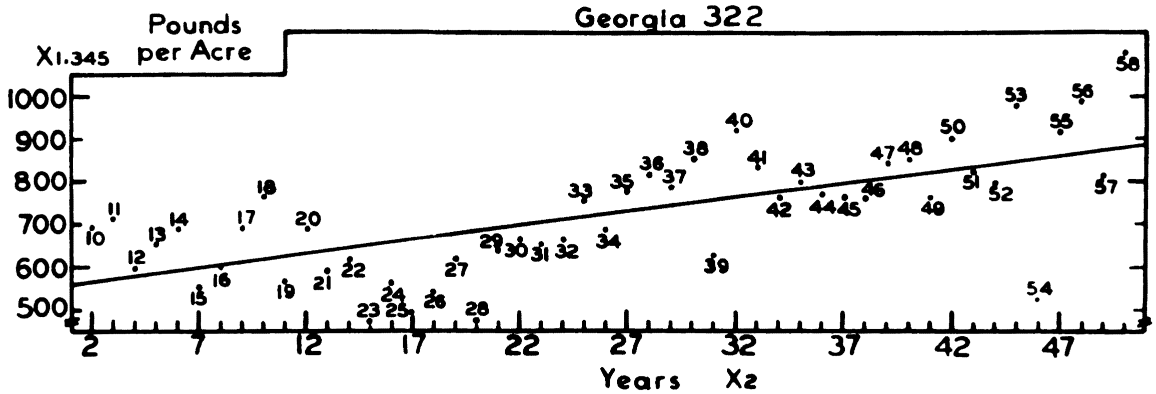

Georgia 322
X1.345
Pounds per Acre
1000
900
800
700
600
500
2
7
12
17
22
27
32
37
42
47
Years X2

Figure 14.

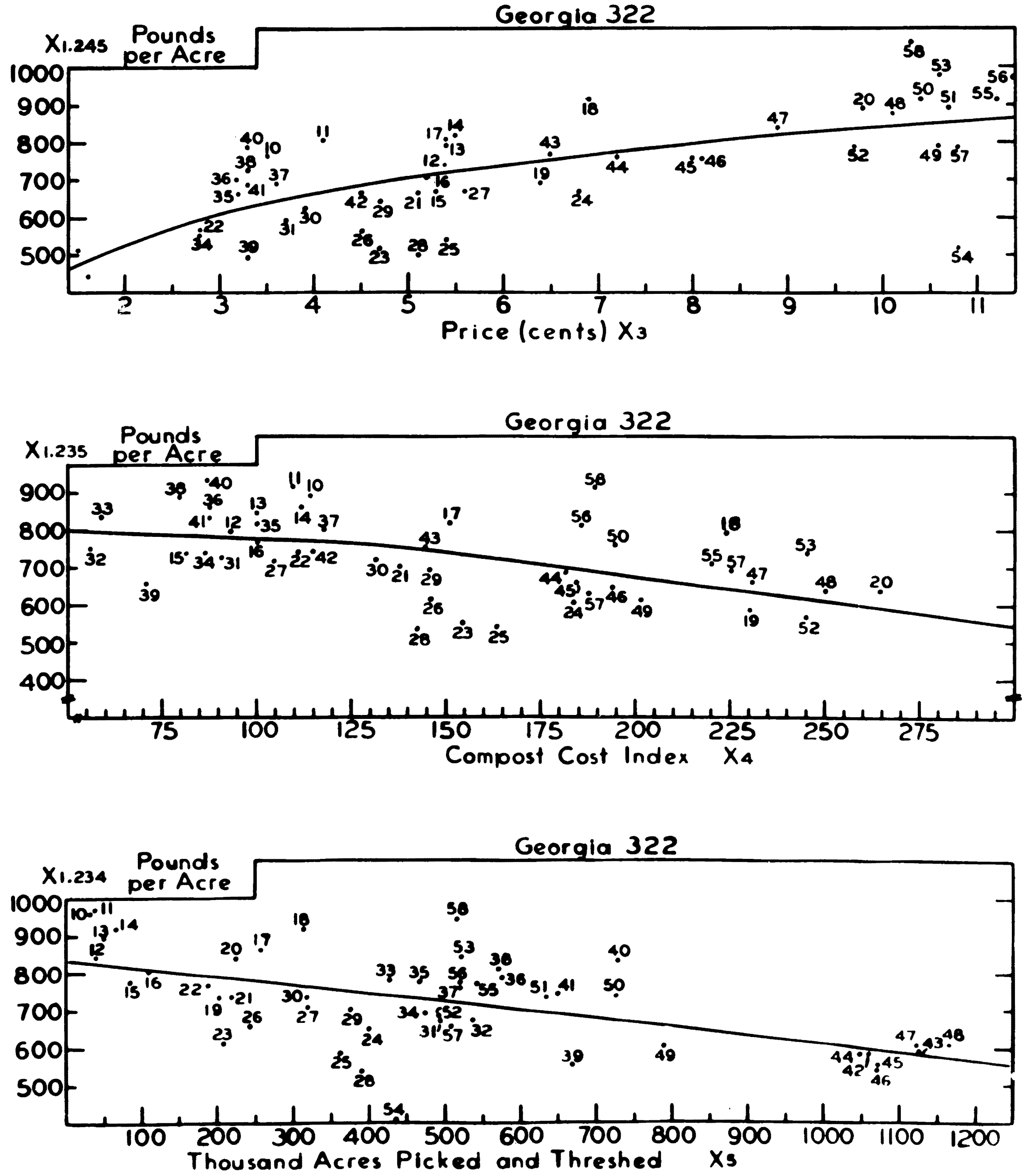


Figure 14. Continued

A quadratic acreage variable would probably reduce the non-random residual effect in the early years, but the added usefulness for prediction purposes is open to question.

Model D

To Model C were added the three rainfall variables. As in the Virginia-Carolina area, it seems evident that an average monthly total rainfall is too crude a measure of weather effect since none of the rainfall coefficients is significant. A rather wide variation in rainfall about its mean can evidently be tolerated by peanuts. A shortage in one month may be offset by an ample supply at another time. The net effect in many years may also be obscured by numerous other factors such as disease or insects, or lack of them. Extreme and persistent drought or hurricane rains which are equally damaging do not occur often enough to measure the effect even in a general long-run regression. The signs of the rainfall coefficients are consistent and in agreement with the weather hypotheses except for June, when in some way, rainfall is negatively associated with yield. The rationale may be excessive grass, weeds, and plant growth, as discussed in the Virginia-Carolina area.

The attempt to develop an adequate weather index for the humid areas may be regarded as unsuccessful in terms of mean total rainfall by months.

Model E

Inspection of the charts accompanying this section suggest a long-run curvilinear time trend. A quadratic time trend was found to be significantly different from linear in a previous analysis of Southeast area data.[33] The effect of adding quadratic time obscures the effect of other variables for the most part. This probably arises from intercorrelation. While the regression fit is improved, it is probably the result of special conditions which will not likely be repeated. These are the formative "era" period and the late period "era" discussed under Model A above, particularly the latter period which includes the high acreage and low yield of World War II followed immediately by the high yield and low acreage of the mandatory allotment period. Since the projection of these conditions into the future in this area appears unwarranted, Model E is set aside. It is not rejected because it might have uses for one year projections especially if re-visited with current data.

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[33] D. Upton Livermore, "Trends in Peanut Yields," Virginia Farm Economics, No. 154, (May 1958), pp. 9-18.

Models F and G

The pecularities of the profitability ratio behavior subject these models to rejection without further consideration.

In Summary of This Section

The following models may be regarded as reasonably adequate for projection purposes: Models A or C in Georgia; Model A in Florida; and Models A or B in Alabama. Of the choices, Model C in Georgia, and Model B in Alabama seem preferable and will be used later in the projection of production estimates.

Production Estimates

Southeast Area

Variables Used and Models Considered:

X_1 ... Time

X_1^2 ... Time squared

X_5 ... Peanut price (t-1)

X_{10}... Peanut production (dependent)

X_{12}... Value of peanuts (t-1)

X_{13}... Value of competing crops (t-1)

X_{14}... Acreage of competing crops (t-1)

X_{15} ... July rainfall

X_{15}^2... July rainfall squared

X_{16}... August rainfall

X_{16}^2... August rainfall squared

X_{17} ... September rainfall

X_{17}^2... September rainfall squared

X_{24} ... Per acre value competing crops (t-1)

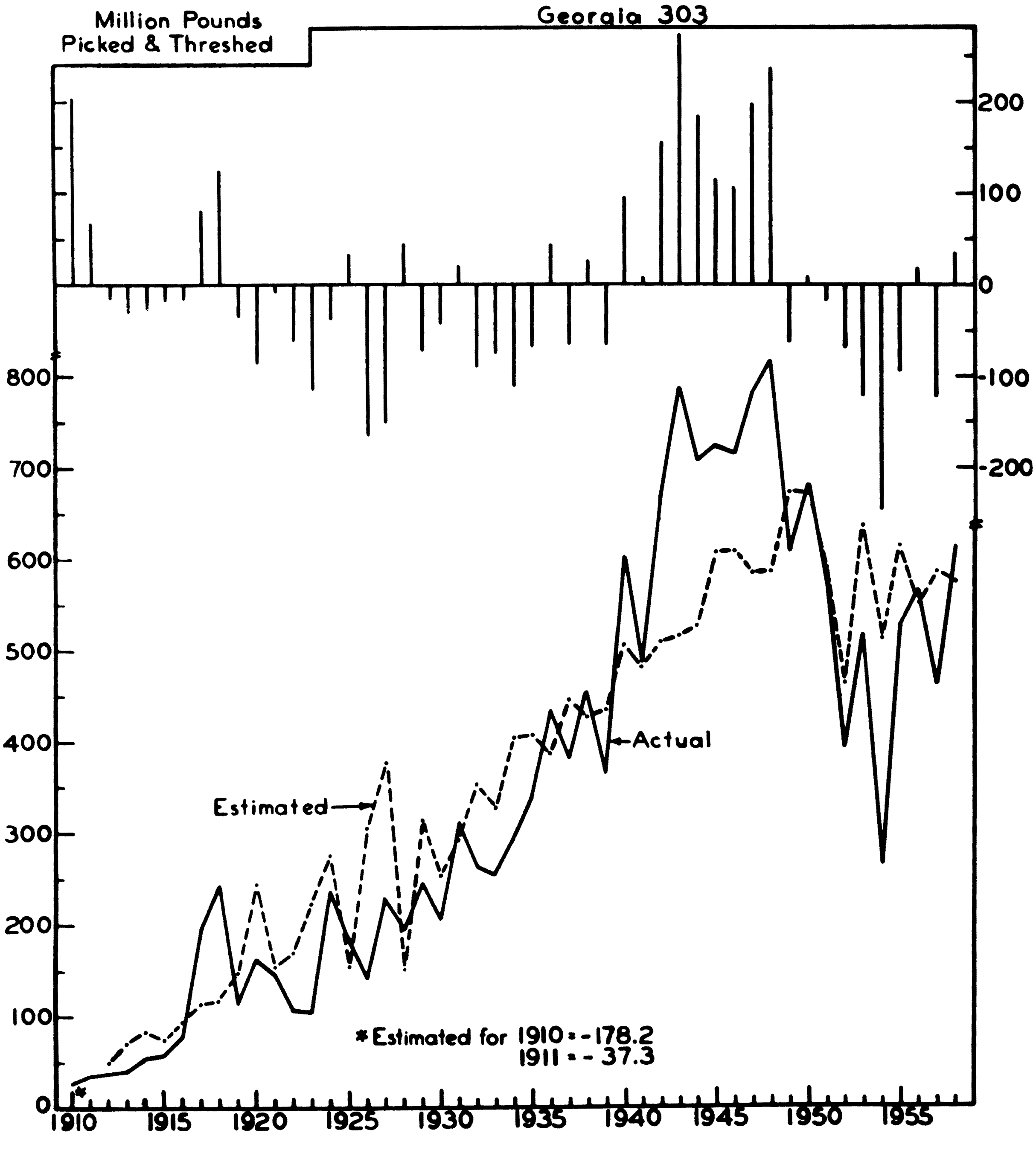
Models Considered	Time Period	Table Number	Data Supplement Reference Equation Numbers Georgia	Florida	Alabama
A. $X_{11}=f(X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17})$ ...	1909-1958	21	311	411	511
B. $X_{11}=f(X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17})$ ...	1909-1948	22	319	419	519
C. $X_{11}=f(X_1, X_1^2, X_3, X_{24}, X_{15}, X_{16}, X_{17}, X_{15}^2, X_{16}^2, X_{17}^2)$.........	1909-1958	23	303	403	503
D. $X_{11}=f(X_1, X_1^2, X_3, X_{24}, X_{15}, X_{16}, X_{17}, X_{15}^2, X_{16}^2, X_{17}^2)$.........	1909-1948	24	304	404	504

Models A and B

The concepts under which these models were formulated are stated in the production estimate sub-section of Section IV. The multiple correlation coefficients in Model B are higher than in Model A, suggesting that Model A, which includes the mandatory allotment period, does not fit the data. The production trend over all years is not linear. Accordingly, Model A is rejected. Model B has little to offer other than to say that peanut production is associated with the value of the peanut crop in the preceding year in Georgia and Florida but not in Alabama. In Florida, the coefficient for value of competing crops is significant; but in Alabama, only the coefficient of acreage of competing crops is significant. Rainfall data fail to enter any of the equations significantly. Problems of intercorrelation probably associated with war years, and general ineffectiveness suggest rejection of Model B as inconclusive pending further investigation.

Models C and D

Comparison of the multiple correlation coefficients for these two models suggests that Model D, which omits the mandatory allotment period, is the better regression fit. Inspection of Figure 15 for Model C in Georgia suggests that a time period ending in 1948 for these models would probably have smaller residuals during World War II. A substantial distortion is introduced by including all years in Model C and allowing the full effect of exogenous forces to enter the equation. While there



Million Pounds
Picked & Threshed
Georgia 303
200
100
0
-100
-200
800
700
600
500
400
300
200
100
0
Estimated
Actual
* Estimated for 1910 = -178.2
1911 = - 37.3
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

Figure 15.

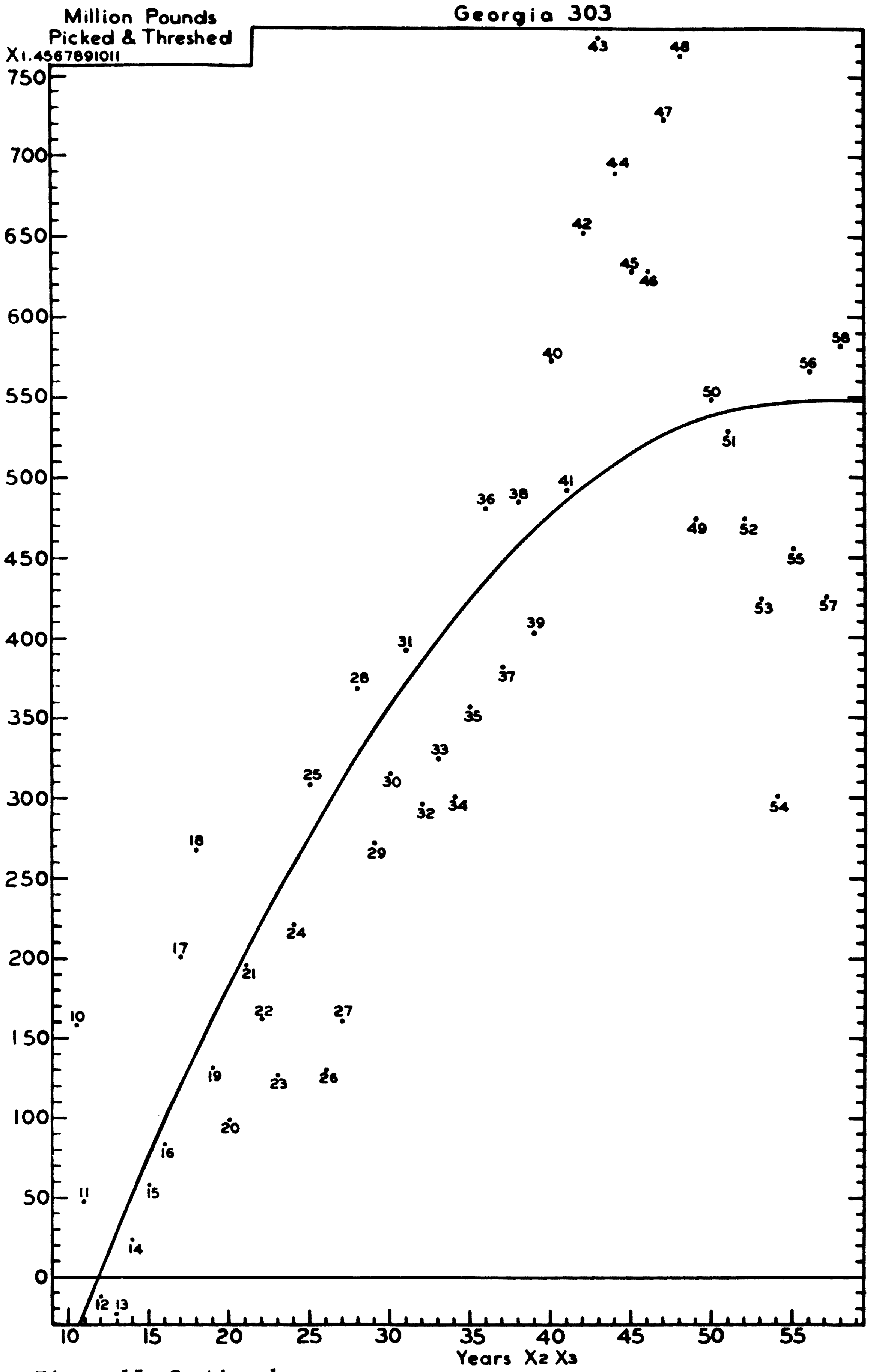


Figure 15. Continued

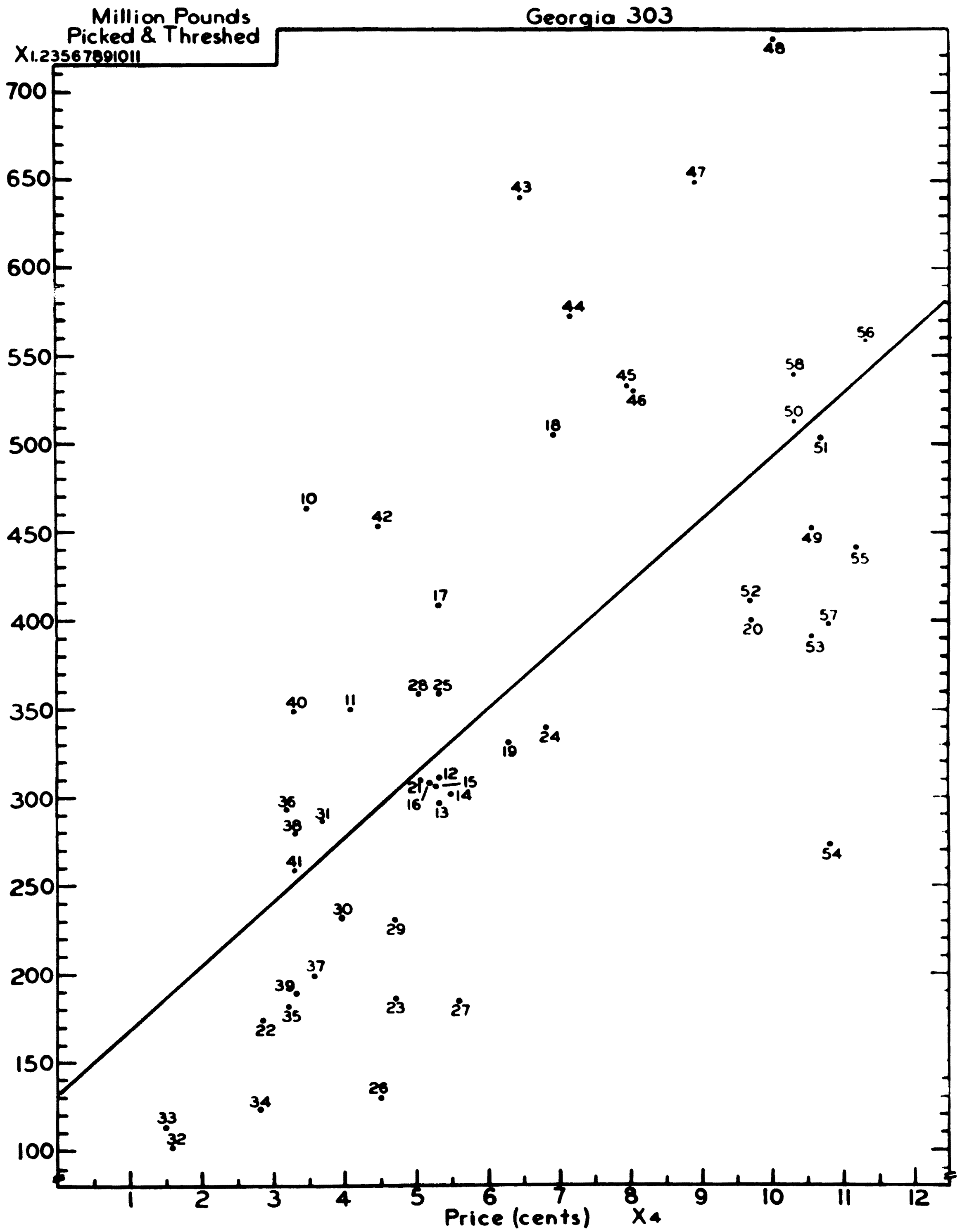


Figure 15. Continued

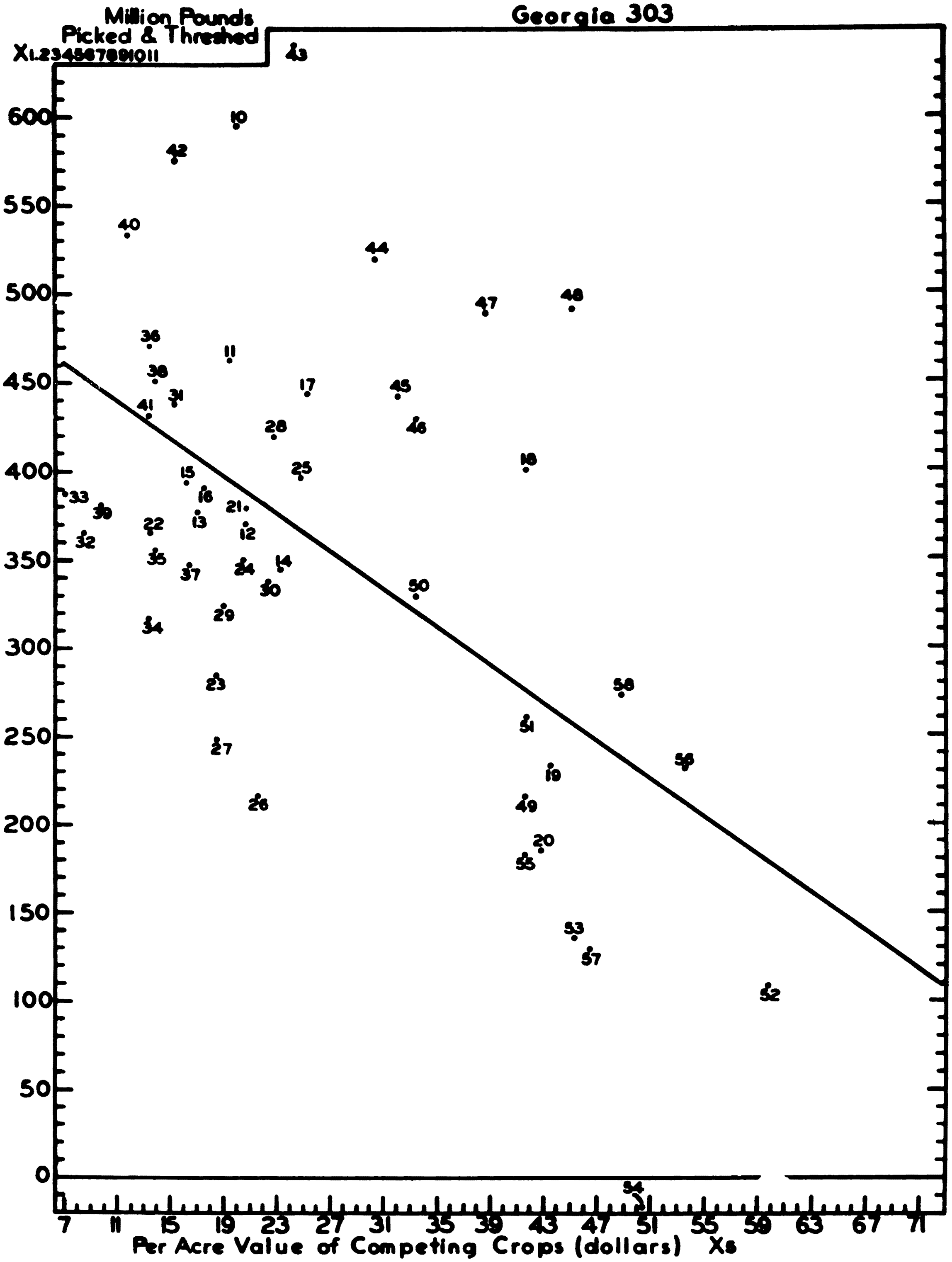


Figure 15. Continued

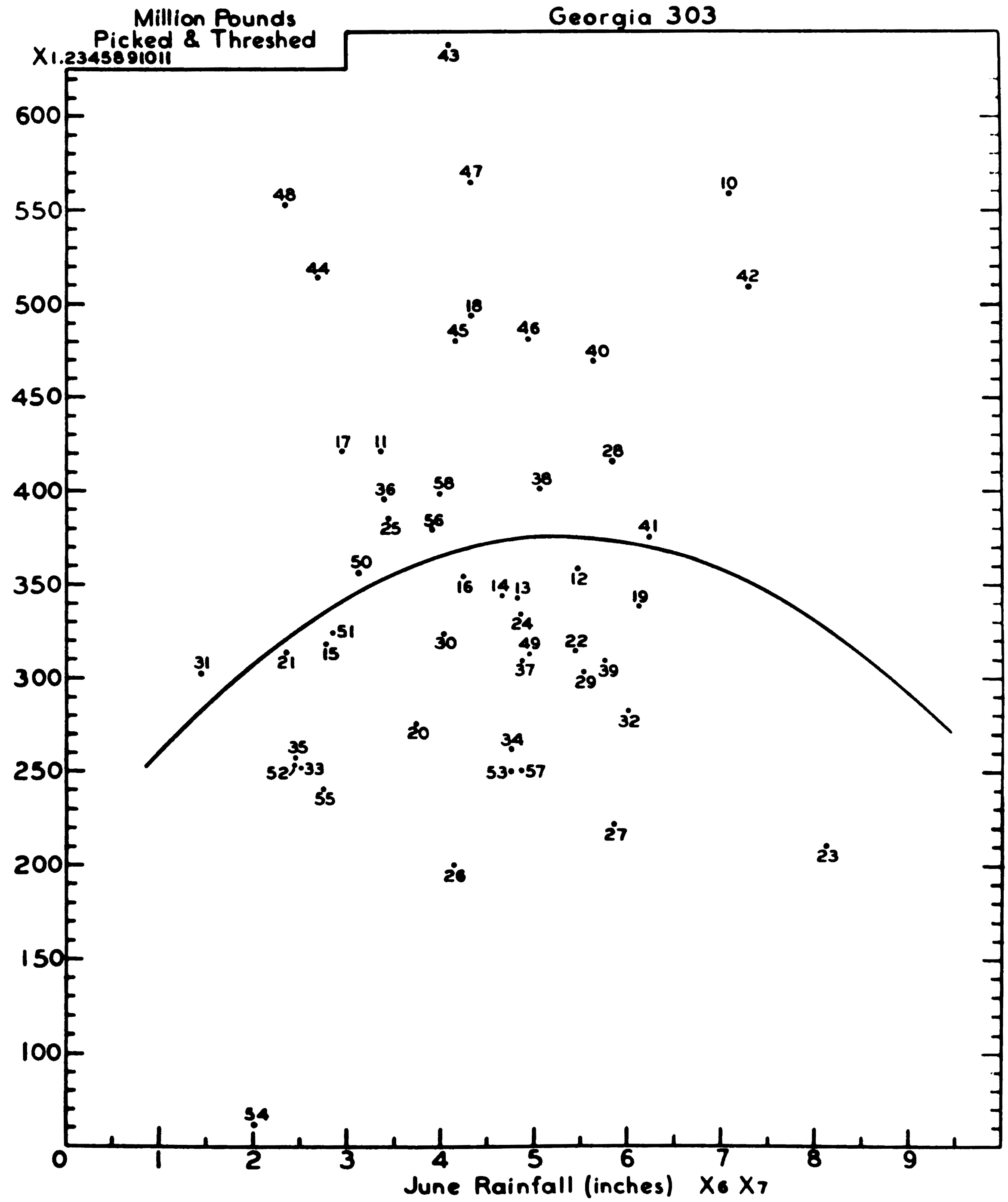


Figure 15. Continued

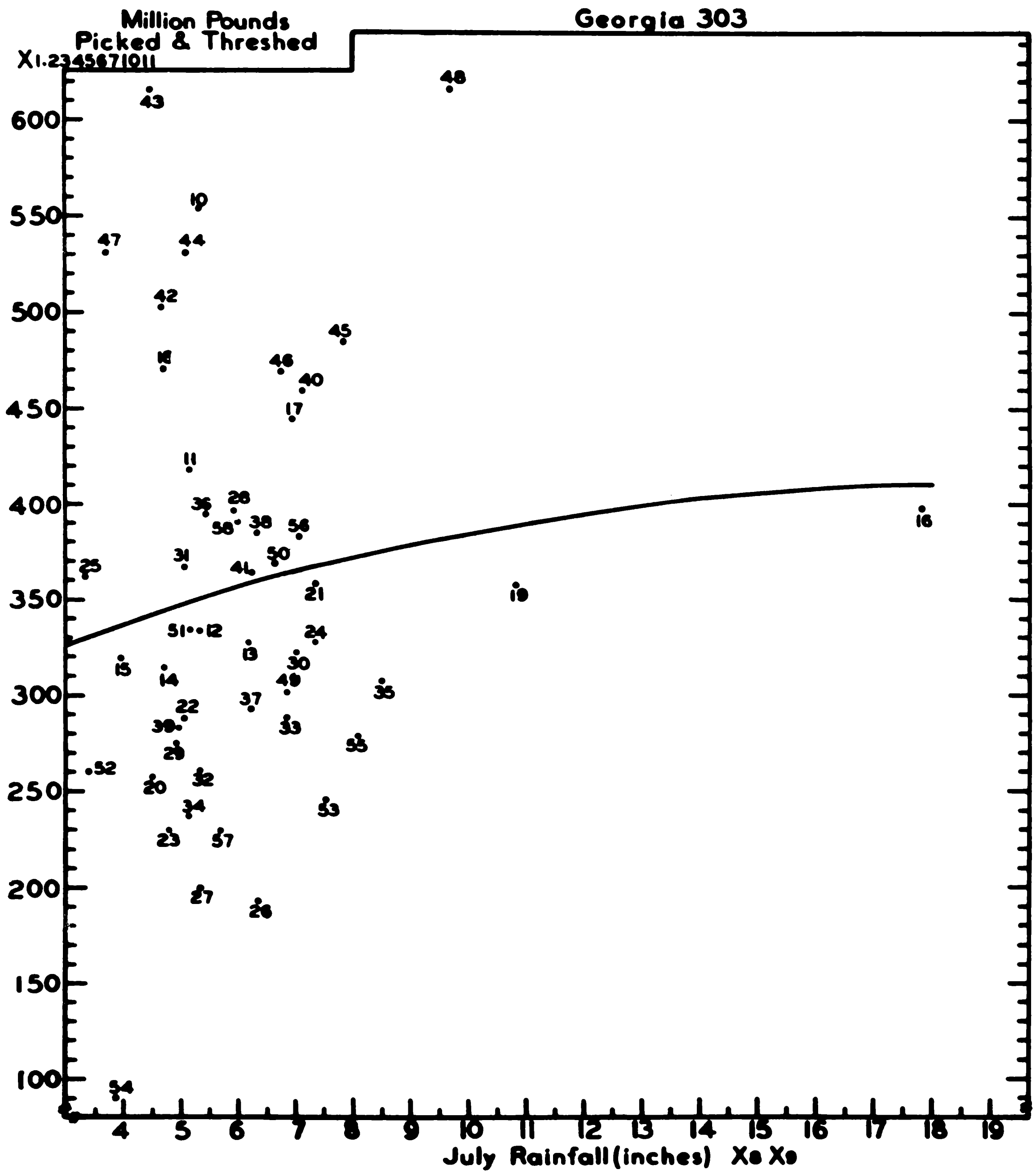


Figure 15. Continued

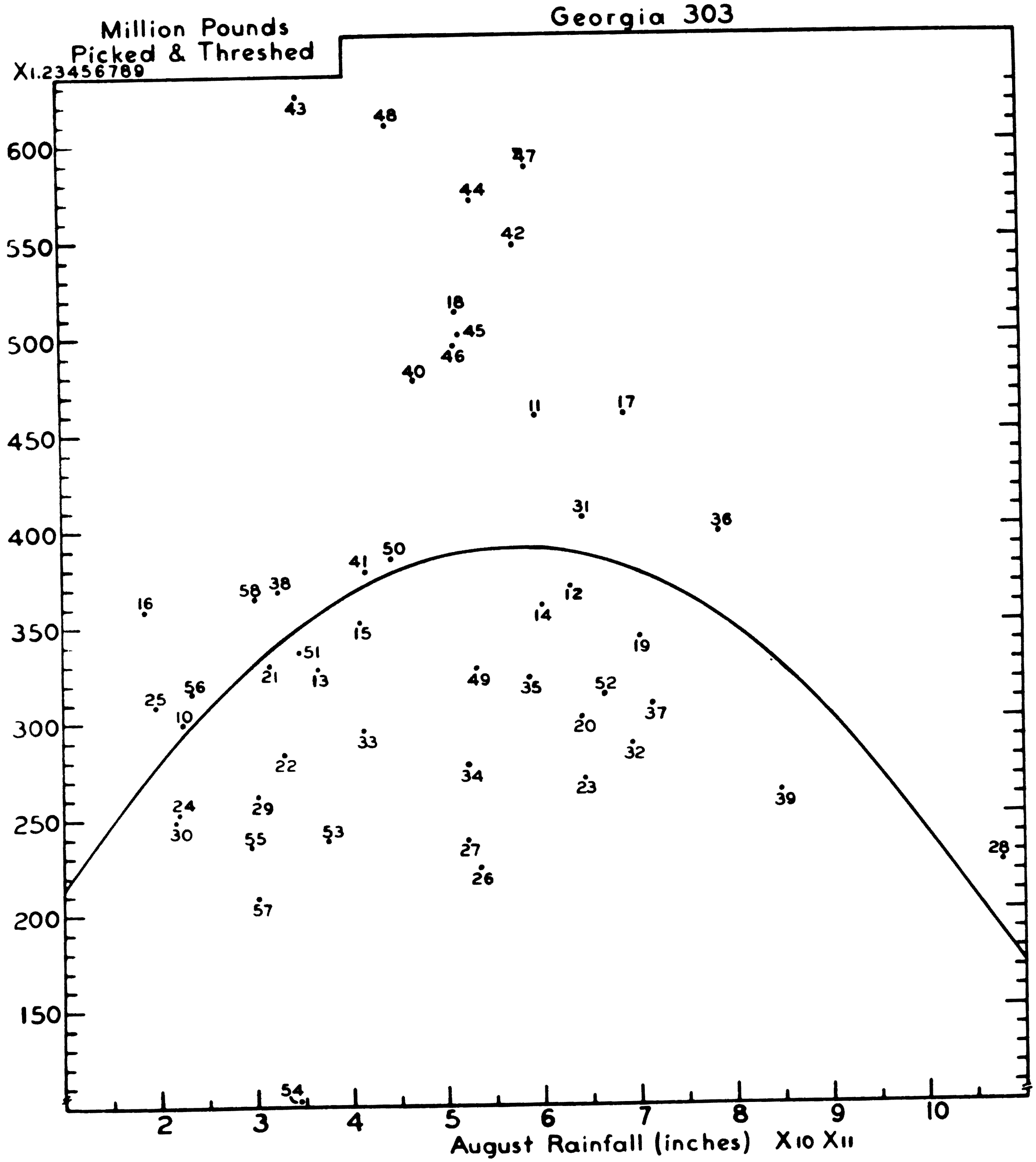


Figure 15. Continued

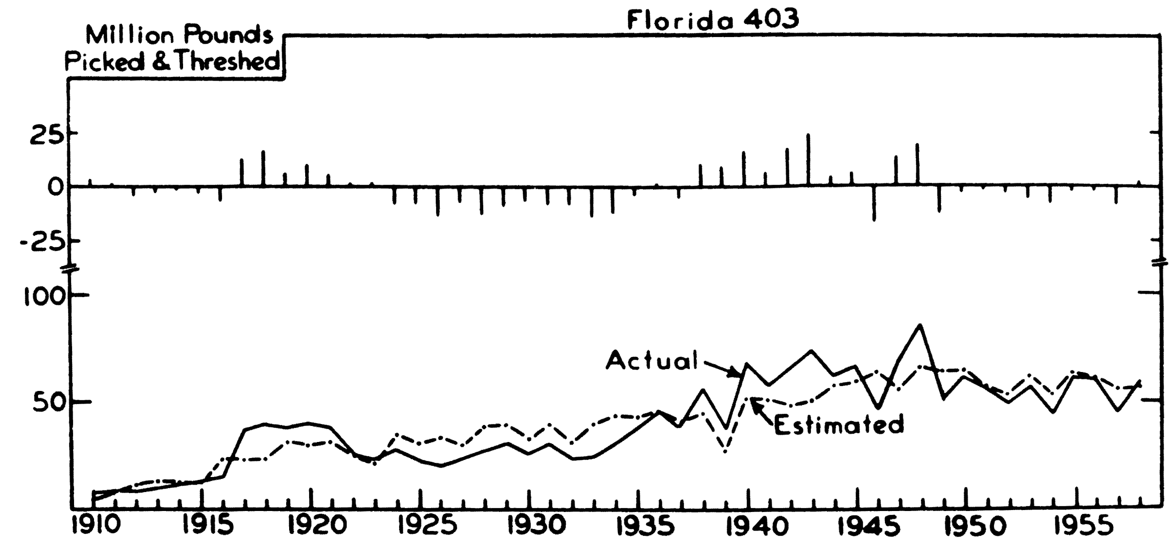


Figure 16.

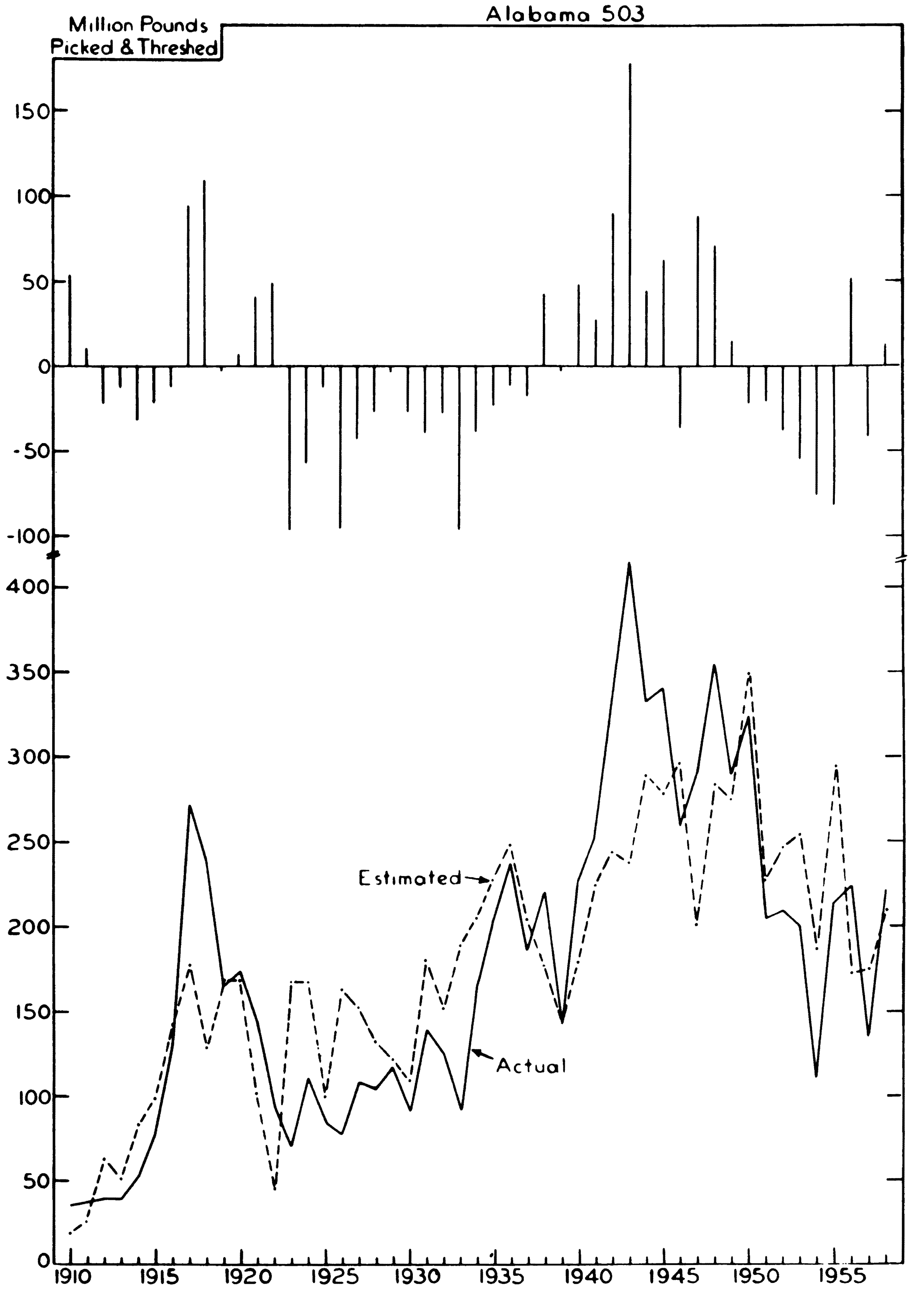

Alabama 503
Million Pounds
Picked & Threshed
150
100
50
0
-50
-100
400
350
300
250
200
150
100
50
0
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
Estimated
Actual

Figure 17.

are a number of significant coefficients in the regressions for Model C, inspection of the relationships in Figure 15 leads one to the conclusion that they are of doubtful validity since they are clearly the cumulative product of a series of abnormal situations. As stated above for Virginia-Carolina, it is expecting too much of one equation to cope with all of the exogenous forces for the long-run period. As will be illustrated below, projecting production with these models provides illogical estimates. Accordingly, Models C and D are rejected. Residuals for Florida and Alabama are also charted in Figures 16 and 17. The equations for Model C[34] are:

Georgia - 303 : $R^2 = .79$

$$X_{11} = -8577.7616 + \underset{(89.2445)}{314.8950X_1^{**}} - \underset{(1.4233)}{2.8072X_1^2} + \underset{(178.2073)}{359.1874X_{3t-1}} - \underset{(34.2554)}{53.2178X_{24}}$$

$$+ \underset{(614.4713)}{650.1395X_{15}} + \underset{(290.3173)}{123.4129X_{16}} + \underset{(406.8767)}{915.0963X_{17}^{*}} - \underset{(66.9105)}{61.2629X_{15}^2} - \underset{(14.9971)}{3.2110X_{16}^2}$$

$$- \underset{(36.2137)}{80.2593X_{17}^{*2}}$$

Florida - 403 : $R^2 = .75$

$$X_{11} = -6394.3155 + \underset{(87.0251)}{288.7909X_1^{**}} - \underset{(1.4209)}{2.9368X_1^{*2}} + \underset{(162.7869)}{136.7869X_{3t-1}} + \underset{(56.1084)}{8.3662X_{24}}$$

$$+ \underset{(329.4126)}{258.8433X_{15}} + \underset{(347.2518)}{335.2140X_{16}} + \underset{(301.7453)}{417.3488X_{17}} - \underset{(23.6341)}{23.0849X_{15}^2} - \underset{(19.4937)}{12.5102X_{16}^2}$$

$$- \underset{(19.2053)}{28.6148X_{17}^2}$$

---

[34]Inadvertently, the decimals in some variables were not correctly coded for electronic computer purposes; consequently, the coefficients and related data could not be completely uncoded until X_{11} values were determined. Accordingly, the coefficient and standard error values are relative rather than actual values.

Alabama - 503 : $R^2 = .64$

$$X_{11} = -3123.8333 + \underset{(49.7843)}{136.8921X_1^{**}} - \underset{(0.8000)}{1.5028X_1^2} + \underset{(109.5003)}{238.8302X_{3t-1}^{*}} - \underset{(180.4237)}{251.5786X_{24}}$$

$$- \underset{(224.3594)}{14.9235X_{15}} + \underset{(139.1548)}{129.1182X_{16}} + \underset{(116.3636)}{343.2047X_{17}^{**}} - \underset{(22.4365)}{1.8167X_{15}^2} - \underset{(8.2440)}{3.4845X_{16}^2}$$

$$- \underset{(7.8844)}{18.6803X_{17}^{2*}}$$

The production estimates derived from Model C are included in accompanying Tables 1, 2 and 3 only for comparative purposes.

Production Projections

In the acreage section of this chapter it was concluded that, for purposes of projection to 1965, the acreage allotment, Model J, would be the most valid estimate of future acreage in the Southeast area. This conclusion would obtain after taking into account subjectively an estimated underharvested acreage. Similarly, in the yield estimates section, it was decided that Model C in Georgia would be preferred, Model A in Florida, and Model B in Alabama.

Pursuant to this appraisal, actual and estimated production have been considered beginning with the mandatory allotment period in 1949 to 1958, and projected for the period 1959 to 1965. The accompanying Tables 1, 2, and 3 set forth the essential information. Projections were made under the following assumptions for Georgia, Florida, and Alabama, respectively.

Yield-allotment equations:

1) price, 9.0¢; 8.5¢; and 8.5¢
2) acreage, 515,000; 55,300; and 210,000
3) square of 1955-58 average composite cost, Georgia only 38,005

Production equations:

1) price, 9.0¢; 8.5¢; and 8.5¢
2) 1954-58 average per acre value of competing crops: \$48.12; \$29.37; and \$59.71

3) 49-year mean inches total rainfall:

	Georgia	Florida	Alabama
June	4.35	5.80	4.31
July	6.19	7.52	6.29
August	4.84	6.63	4.98

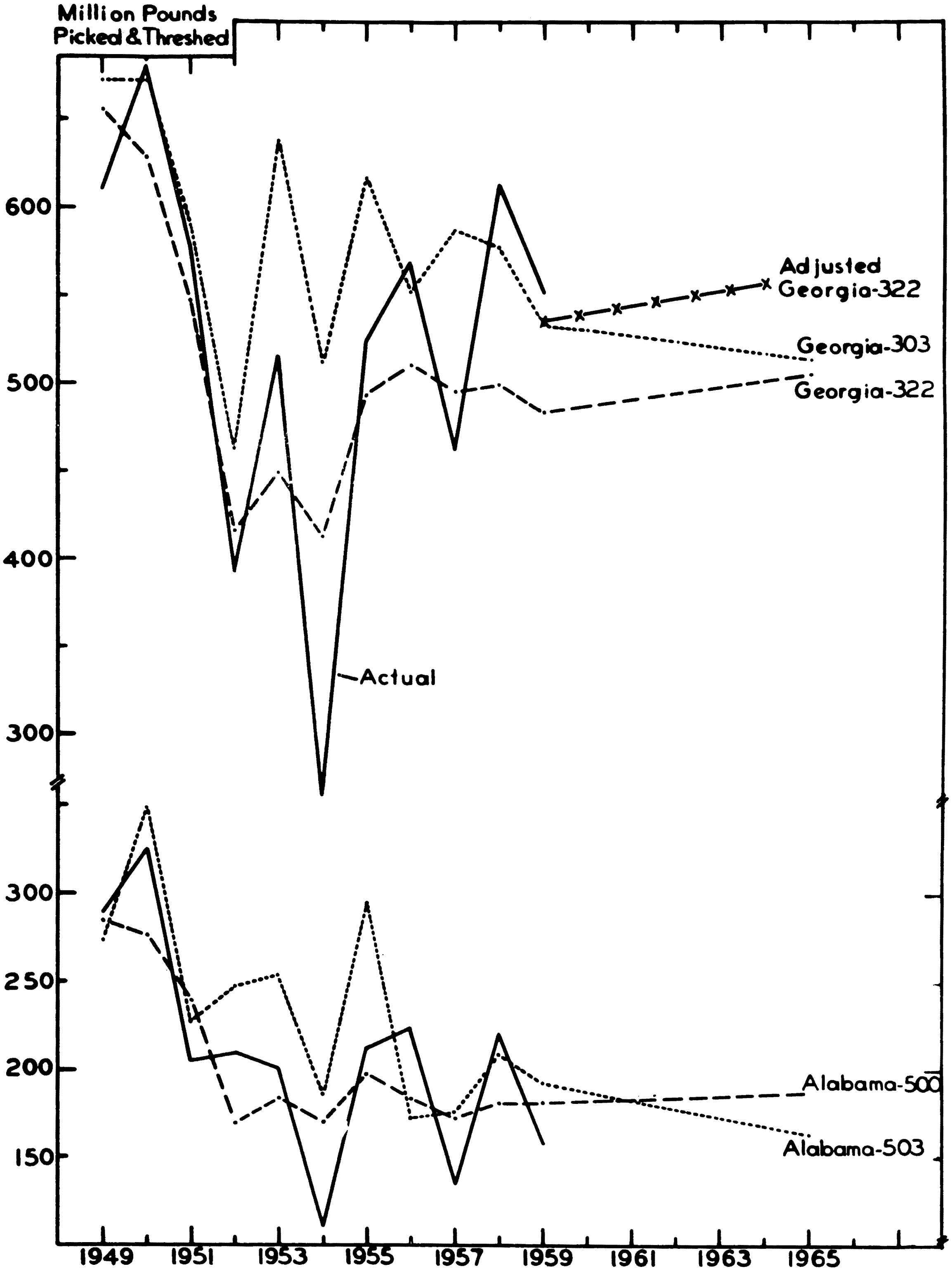
The above values were assumed constant with only time increasing, (1910 = 2 for yield equations; 1910 = 10 for production equations).

Comparative data are presented graphically in Figures 18 and 19 for selected equations for each state and for the Southeast area. Again, it should be recalled in viewing these that not until 1957 did acreage and price decline to the current levels on which the assumptions are based.

The production equation (Model C) projects to the future a reflection of all past events, particularly the high World War II production and the recent decline. As a matter of judgement, the declining production projected by this equation may be disregarded as illogical. This is represented in the charts by a dotted line.

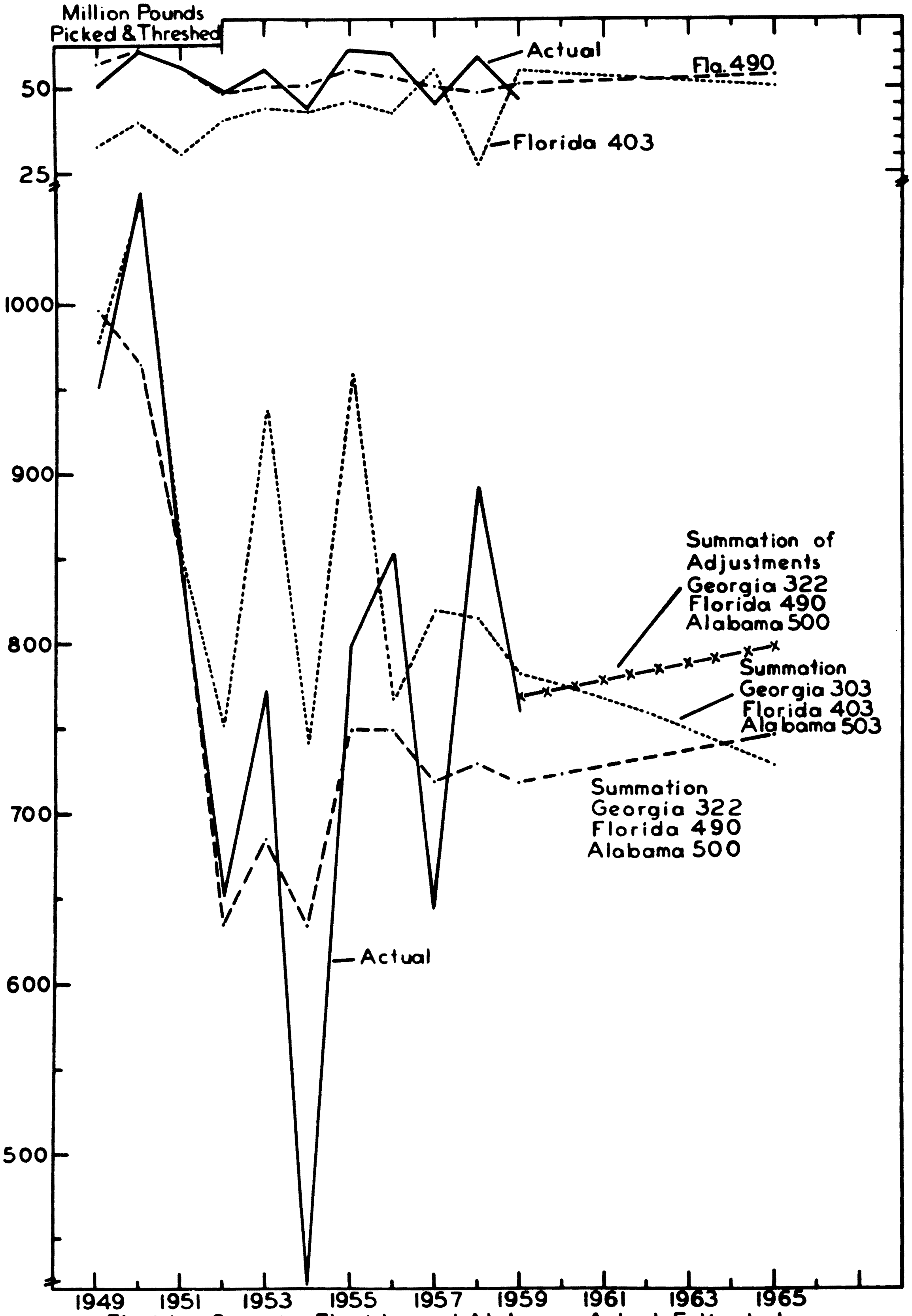
Regarding an adjustment for underharvest, the yield per acre from the estimating equation has been applied to 515,000 acres in Georgia, or about 12,000 acres less than the allotment. In Florida, no adjustment for underharvest was estimated. In Alabama, underharvest is estimated at 8,000 acres, so the yield per acre from the estimating equation was applied to 210,000 acres. The estimates of production are represented in Figure 19 by a broken line and may be compared with actual production data, which appears as a solid line from 1949 to date, 1959.

Certain adjustments in the level of yield per acre in certain states appear desirable. These adjustments and a summary of the data for the area will be presented in the summary section on national production. The effect of the adjustments on production is represented by the "adjustment" line in Figure 19 for the projected period 1959-1965. The yield level in Georgia only has been adjusted.



Georgia; Alabama: Actual, Estimated, and Projected Production of Peanuts from Specified Equations

Figure 18.



Florida: Georgia, Florida, and Alabama: Actual, Estimated, and Projected Peanut Production from Specified Equations

Figure 19.

Table 1.--Production of peanuts in Georgia: actual and estimated, 1949-1958; and projected, 1959-1965, using specified yield and production equations under assumptions of price, 9.0 cents; acreage, 515,000 acres; 1955-1958 average composite cost; 1954-1958 average per acre value of specified competing crops; and 49-year mean total rainfall in June, July, and August.

Year	Acreage			Yield		Production						
							Yield regression Ga. - 322[a]			Production regression Ga. - 303[b]		
	Actual A	Allotted A'	Under harvest	Actual Y	Ga.-322 estimated $\hat{Y}$	Actual P=AY	Estimated $\hat{P}=A\hat{Y}$	Residual $P-\hat{P}$	Percent $\hat{P}/P$	Estimated $\hat{P}$	Residual $P-\hat{P}$	Percent $\hat{P}/P$
				Pounds	Pounds	Thousand Pounds	Thousand Pounds	Thousand Pounds		Thousand Pounds	Thousand Pounds	
1949...	783,000	878,023	-95,023	780	837	610,740	655,371	-44,631	107	672,100	-61,360	110
1950...	728,000	701,400	26,600	935	863	680,680	628,264	52,416	92	672,400	8,280	99
1951...	641,000	592,929	48,071	900	854	576,900	547,414	29,486	95	590,400	-13,500	102
1952...	492,000	548,344	-56,344	800	846	393,600	416,232	-22,632	106	463,900	-70,300	118
1953...	522,000	548,590	-26,590	990	863	516,780	450,486	66,294	87	638,600	-121,820	124
1954...	440,000	527,247	-87,247	605	938	266,200	412,720	-146,520	155	512,800	-246,600	193
1955...	538,000	565,689	-27,689	975	920	524,550	494,960	29,590	94	617,800	-93,250	118
1956...	522,000	527,688	-5,688	1,090	980	568,980	511,560	57,420	90	551,700	17,280	97
1957...	510,000	527,853	-17,853	910	974	464,100	496,740	-32,640	107	587,100	-123,000	127
1958...	515,000[c]	527,844	-12,844	1,190[c]	971	612,850[c]	500,065	112,785	82	578,700	34,150	94
1959[d]..	(491,000)	528,504	(-37,504)	(1,125)	941	(552,375)	484,615	(67,760)	88	533,100	(19,275)	97
1960...		515,000[e]			948		488,220			531,200		
1961...		515,000			955		491,825			528,700		
1962...		515,000			961		494,915			525,700		
1963...		515,000			968		498,520			522,100		
1964...		515,000			975		502,125			517,900		
1965...		515,000			981		505,215			513,200		

[a]See Data Supplement, Table 16, for coefficients; also see page 103.

[b]See Data Supplement, Table 23, for coefficients; also see page 119.

[c]Revised.

[d]Data included in the regression coefficients ended with 1958. Figures in parenthesis are preliminary for 1959.

[e]Used for projecting production 1959-1965.

Table 2.--Production of peanuts in Florida: actual and estimated, 1949-1958; and projected, 1959-1965, using specified yield and production equations under assumptions of price 8.5 cents; acreage, 55,300 acres; 1954-1958 average per acre value of specified competing crops; and 49-year mean total rainfall in June, July, and August.

Year	Acreage			Yield		Production						
							Yield regression Fla. - 490[a]			Production regression Fla. - 403[b]		
	Actual A	Allotted A'	Under harvest	Actual Y	Fla-490 estimated $\hat{Y}$	Actual $P=AY$	Estimated $\hat{P}=A\hat{Y}$	Residual $P-\hat{P}$	Per-cent $\hat{P}/P$	Estimated $\hat{P}$	Residual $P-\hat{P}$	Per-cent $\hat{P}/P$
				Pounds	Pounds	Thousand Pounds	Thousand Pounds	Thousand Pounds		Thousand Pounds	Thousand Pounds	
1949......	67,000	83,822	-16,822	765	861	51,260	57,687	-6,427	113	32,975	18,285	64
1950......	72,000	73,236	-1,236	850	852	61,200	61,344	-144	100	40,247	20,953	66
1951......	65,000	61,943	3,057	870	873	56,550	56,745	-195	100	31,440	25,110	56
1952......	54,000	57,539	-3,539	925	912	49,950	49,248	702	99	40,515	9,435	81
1953......	56,000	58,216	-2,216	1,000	923	56,000	51,688	4,312	92	44,029	11,971	79
1954......	55,000	55,052	-52	810	931	44,550	51,205	-6,655	115	43,257	1,293	97
1955......	60,000	60,396	-396	1,025	928	61,500	55,680	5,820	91	46,675	14,825	76
1956......	56,000	56,179	-179	1,075	953	60,200	53,368	6,832	89	42,573	17,627	71
1957......	52,000	55,457	-3,457	880	966	45,760	50,232	-4,472	110	55,530	-9,770	121
1958......	52,000[c]	55,315	-3,315	1,120[c]	939	58,240[c]	48,828	9,412	84	27,659	30,581	48
1959[d].....	(49,000)	55,336	(-6,336)	(960)	935	(47,040)	51,706	(-4,666)	110	55,416	(-8,376)	118
1960......		55,300[e]			941		52,037			54,809		
1961......		55,300			946		52,314			54,144		
1962......		55,300			952		52,646			53,419		
1963......		55,300			958		52,977			52,636		
1964......		55,300			964		53,309			51,794		
1965......		55,300			970		53,641			50,894		

[a] See Data Supplement, Table 14, for coefficients; also see page 98.

[b] See Data Supplement, Table 23, for coefficients; also see page 119.

[c] Revised.

[d] Data included in the regression coefficients ended with 1958. Figures in parenthesis are preliminary for 1959.

[e] Used for projecting production 1959-1965.

Table 3.--Production of peanuts in Alabama: actual and estimated, 1949-1958; and projected, 1959-1965, using specified yield and production equations under assumptions of price, 8.5 cents; acreage, 210,000; 1954-1958 average per acre value of specified competing crops; and 49-year mean total rainfall in June, July, and August.

Year	Acreage			Yield		Production						
							Yield regression Ala. - 500[a]			Production regression Ala. - 503[b]		
	Actual A	Allotted A'	Under harvest	Actual Y	Ala-500 estimated $\hat{Y}$	Actual P=AY	Estimated $\hat{P}=A\hat{Y}$	Residual $P-\hat{P}$	Percent $\hat{P}/P$	Estimated $\hat{P}$	Residual $P-\hat{P}$	Percent $\hat{P}/P$
				Pounds	Pounds	Thousand Pounds	Thousand Pounds	Thousand Pounds		Thousand Pounds	Thousand Pounds	
1949....	353,000	399,821	-46,821	820	806	289,500	284,518	4,982	98	274,296	15,204	95
1950....	335,000	319,373	15,627	970	825	325,000	276,375	48,625	85	349,133	-24,133	107
1951....	298,000	245,365	52,635	690	803	205,600	239,294	-33,694	116	227,138	-21,538	111
1952....	209,000	227,555	-18,555	1,000	812	209,000	169,708	39,292	81	247,746	-38,746	119
1953....	215,000	228,302	-13,302	930	853	200,000	183,395	16,605	92	254,940	-54,940	128
1954....	201,000	219,060	-18,060	550	848	110,600	170,448	-59,848	154	186,203	-75,603	168
1955....	225,000	235,529	-10,529	950	883	213,800	198,675	15,125	93	295,264	-81,464	138
1956....	214,000	218,939	-4,939	1,010	864	224,700	184,896	39,804	82	172,795	51,905	77
1957....	205,000	218,766	-13,766	660	843	135,300	172,815	-37,515	128	176,937	-41,637	131
1958....	209,000[c]	218,912	-9,912	1,060[c]	866	221,540[c]	180,994	40,546	82	209,257	12,283	95
1959[d]....	201,000	218,633	-17,633	(800)	867	(160,800)	182,070	(-21,270)	113	193,456	(-32,656)	120
1960....		210,000[e]			871		182,910			189,262		
1961....		210,000			876		183,960			184,768		
1962....		210,000			881		185,010			179,973		
1963....		210,000			886		186,060			174,878		
1964....		210,000			890		186,900			169,482		
1965....		210,000			895		187,950			163,785		

[a]See Data Supplement, Table 15, for coefficients; also see page 103

[b]See Data Supplement, Table 23, for coefficients; also see page 120.

[c]Revised.

[d]Data included in the regression coefficients ended with 1958. Figures in parenthesis are preliminary for 1959.

[e]Used for projecting production 1959-1965.

SECTION VI

ACREAGE, YIELD, AND PRODUCTION ESTIMATES

SOUTHWEST AREA

The procedures used for reporting the analysis for the Southwest area are the same as those set forth at the beginning of Section IV with respect to symbols and equations selected.

Acreage Estimates

Southwest Area

Variables Used and Models Considered:

X_1 ... Time
X_3 ... Price of peanuts
X_5 ... Log peanut price (t-1)
X_6 ... U. S. cost index
X_7 ... U. S. cost index squared
X_{10}... Peanut acreage (dependent)
X_{14}... Acreage of competing crops
X_{15}... July rainfall
X_{16}... August rainfall
X_{17}... September rainfall
X_{21}... Peanut price-cost ratio (t-1)
X_{22}... Per acre value-cost ratio competing crops (t-1)
X_{23}... Same as X_{21} but not lagged
X_{25}... Excess acreage penalty
X_{26}... State acreage allotment
X_{27}... Three month average rainfall in Texas
Y_1 ... Underharvested peanut acreage (dependent)
Y_2... Ratio peanut acreage to acreage allotment (dependent)

Models Considered	Time Period	Data Supplement Reference: Table Number	Equation Numbers: Texas	Equation Numbers: Oklahoma
A. $X_{10}=f(X_5, X_7)$	1909-1958	1	640	740
B. $X_{10}=f(X_5, X_7)$	1909-1948	2	649	749
C. $X_{10}=f(X_5, X_7, X_{14})$	1909-1958	3	660	760
D. $X_{10}=f(X_5, X_7, X_{14})$	1909-1948	4	669	769
E. $X_{10}=f(X_5, X_7, X_{14t-1})$	1909-1948	5	667	767
F. $X_{10}=f(X_1, X_{21}, X_{22}, X_{23}, X_{15}, X_{16}, X_{17})$	1909-1958	6	663	763
G. $X_{10}=f(X_1, X_{21}, X_{22}, X_{23}, X_{15}, X_{16}, X_{17})$	1909-1948	6	664	764
H. $X_{10}=f(X_1, X_{21}, X_{22}, X_{23})$	1909-1948	6	666	766
I. $X_{10}=f(X_1, X_{21}, X_{22})$	1921-1941	7	666IW	766IW
J. $X_{10}=f(X_{26})$	1949-1958	none	(Subjective)	
K. $Y_{11}=f(X_3, X_{25})$	1949-1958	8	9-6-1	9-7-1
L. $Y_{12}=f(X_{3t-1}, X_{25})$	1949-1958	9	0-6-1	0-7-1
M. $Y_{13}=f(X_{21}, X_{25})$	1949-1958	10	2-6-1	2-7-1
N. $Y_{21}=f(X_3, X_{25})$	1949-1958	11	9-6-2	9-7-2
O. $Y_{22}=f(X_{3t-1}, X_{25})$	1949-1958	12	0-6-2	0-7-2
P. $Y_{23}=f(X_{21}, X_{25})$	1949-1958	13	2-6-2	2-7-2
Q. $Y_1=f(X_{27})$	1949-1958	(Table given in text.)		
R. $Y_1=f(X_{16})$	1949-1958	(Table given in text.)		

Models A and B

Low multiple correlation coefficients and illogical signs in Models A and B suggest omission of important variables and wide dispersion of the data characteristic of the changing economic structure and the exogenous forces affecting the industry. Both models were rejected.

Models C, D, and E

Acreage of competing crops enters the equation with significant coefficients of logical sign, but it is not known that this relationship would hold if a time variable were to be included. The signs for price and cost are consistently illogical suggesting that there may be intercorrelation as these variables move together over time. This may be associated with the large upsurge of acreage in World Wars I and II. It is difficult to be definite about these models without graphing the relationships; however, the intercorrelation inference is drawn from behavior of the coefficients in models discussed and illustrated below. As indicated above for other areas, acreage of competing crops might prove to be a useful variable, perhaps more so than price or value of such crops. However, further study of the relationships is needed for adequate evaluation.

Models F and G

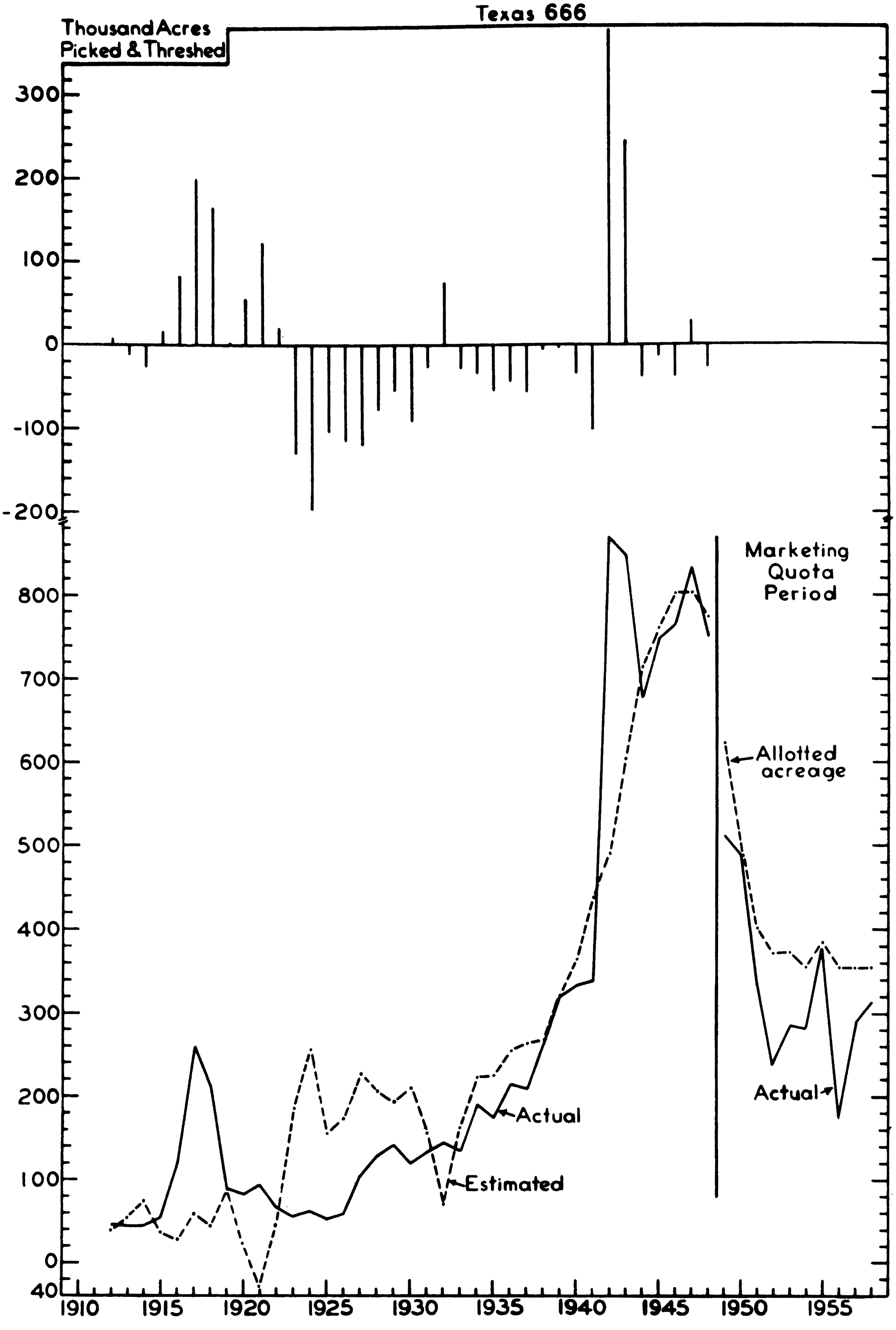
The time variable in all acreage equations is highly significant. While this relationship is not particularly objectionable for short term prediction purposes under relatively stable conditions, alone it fails to be helpful in appraising probable response under other assumptions. Model F may be ruled out as an inappropriate time period for the data which is non-linear for the period. Models F and G were mainly used to test relationships, if any, between acreage and rainfall. Since none was found, Model G was also rejected.

Model H

This model is the same as Model G with the rainfall variables omitted. These relationships are presented graphically in Figures 1 and 2. The multiple correlation coefficients are relatively high. The equations are:

Texas - 666 : $R^2 = .83$

$$X_{10} = -804.2035 + \underset{(1.7388)}{24.4112X_1^{**}} + \underset{(37.5330)}{68.5278X_{21}} - \underset{(6.1742)}{3.6114X_{22}} + \underset{(33.1604)}{96.3706X_{23}^{*}}$$



Texas 666
Thousand Acres
Picked & Threshed
300
200
100
0
-100
-200
800
700
600
500
400
300
200
100
0
40
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
Marketing
Quota
Period
Allotted
acreage
Actual
Actual
Estimated

Figure 1.

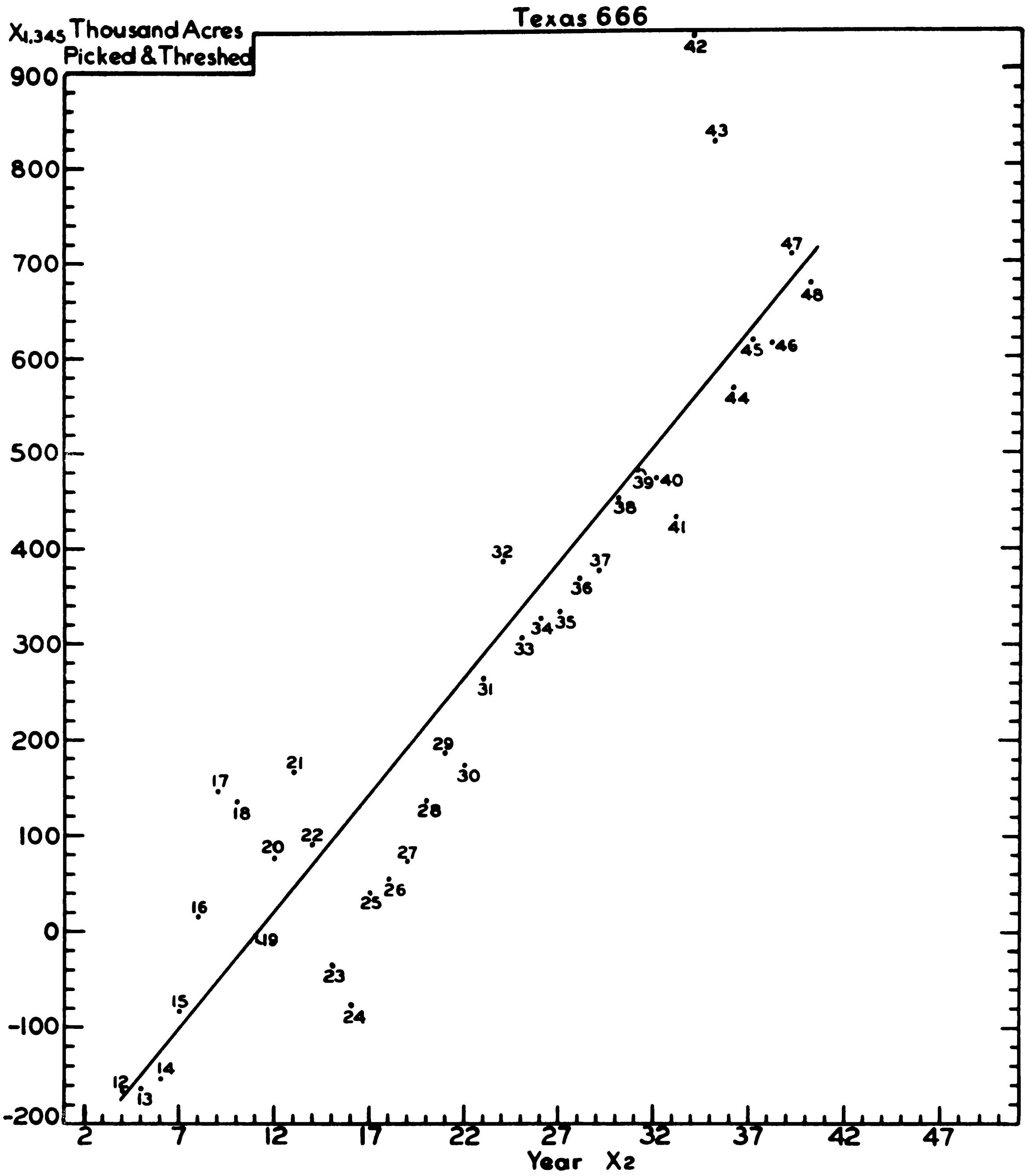


Figure 1. Continued

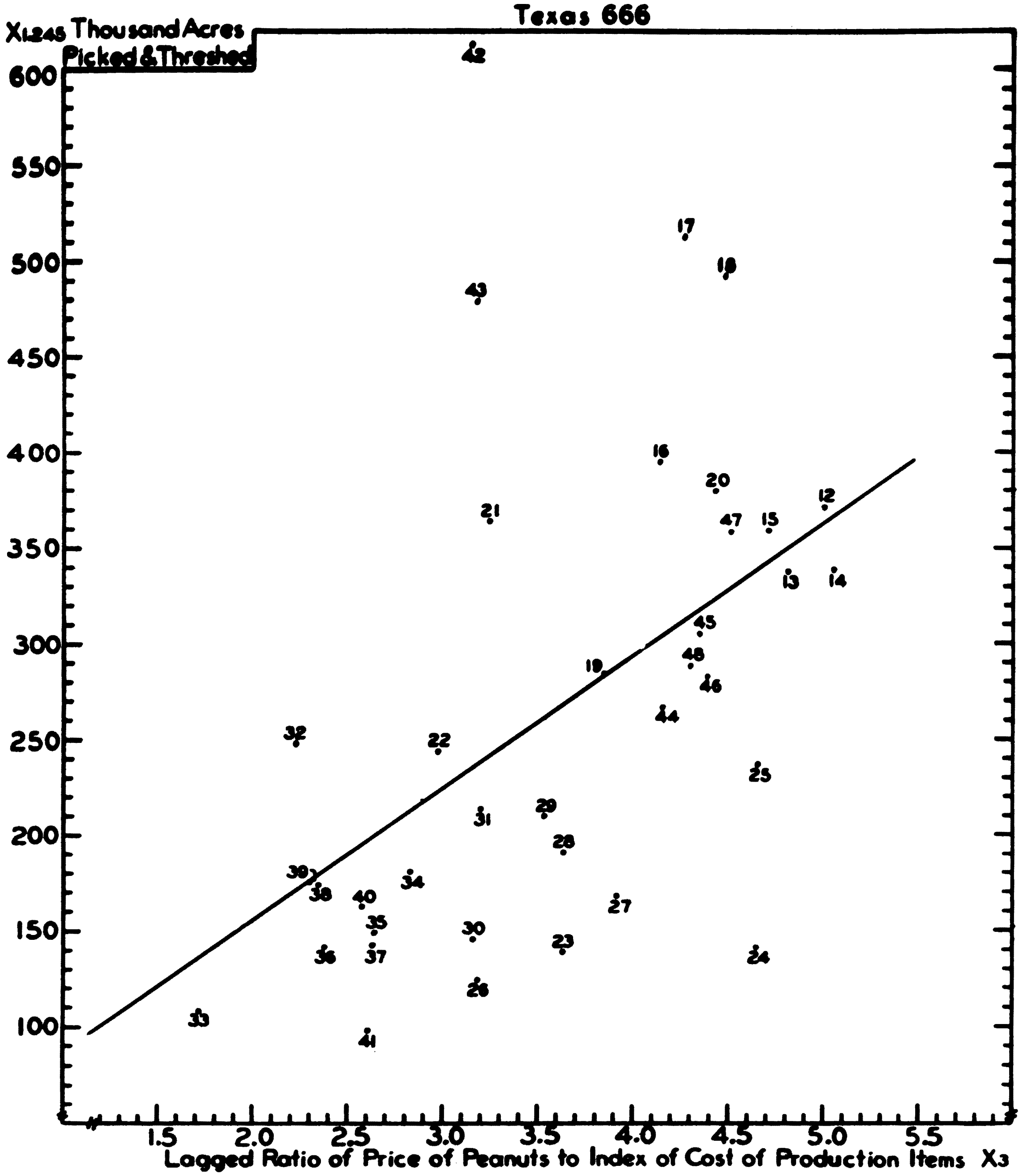


Figure 1. Continued

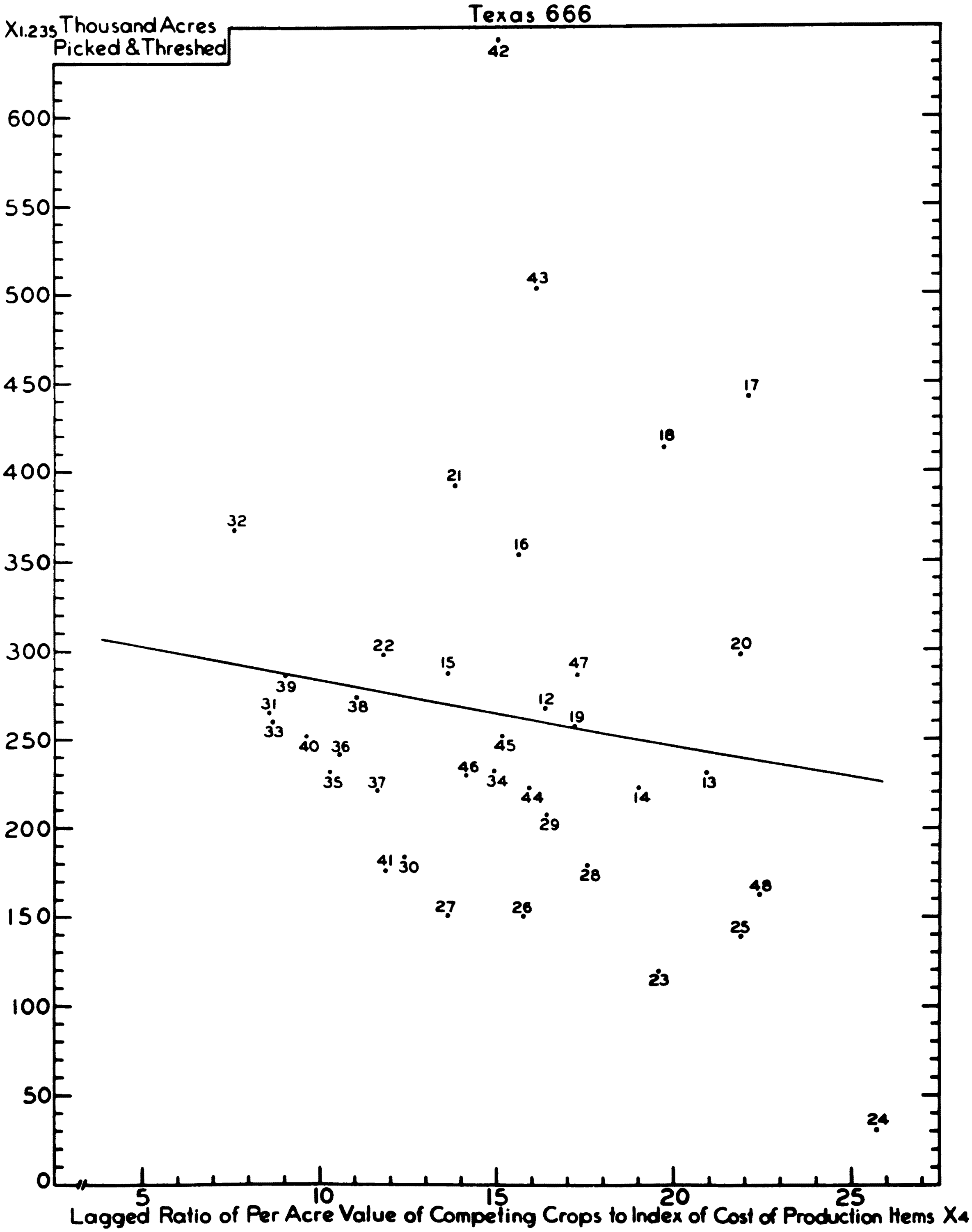


Figure 1. Continued

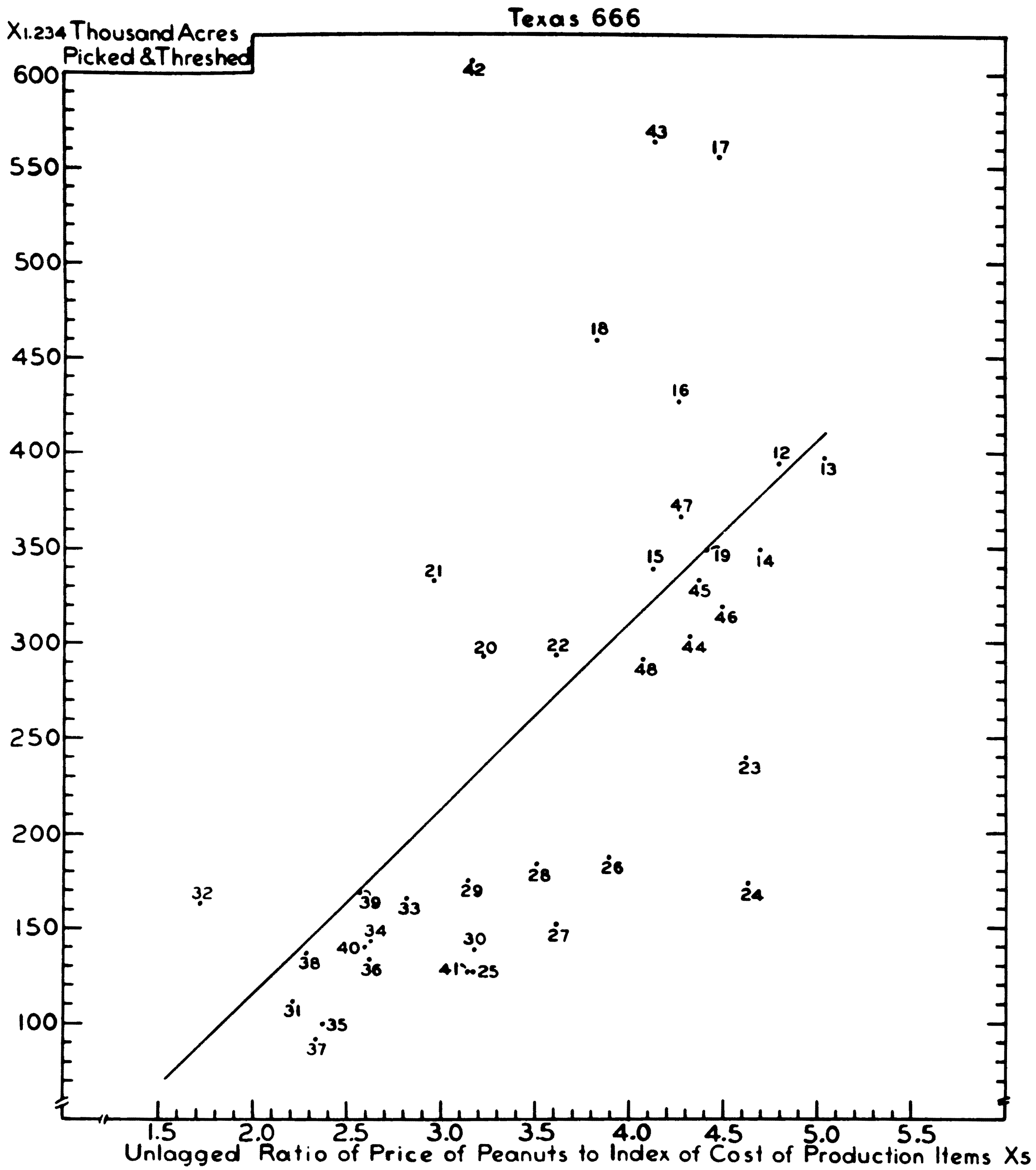


Figure 1. Continued

Oklahoma - 766 : R^2 = .80

$$X_{10} = -292.1764 + 7.8961X_1^{**} + 14.8747X_{21} + 17.3611X_{22} + 27.4265X_{23}^{*}$$
$$(0.5995) \quad (10.5120) \quad (15.2409) \quad (9.7109)$$

The unlagged price-cost ratio is significant but inspection of the graphs suggests that this has little more merit than its lagged counterpart. Observation of the data in the partial regression charts indicates that favorable price-cost ratios prevailed during the war years and less favorable at other times. This is also true for the ratio of per acre value of competing crops to cost of production items, probably accounting for its illogical sign. Presumably, the ratios favored peanut production, or peanuts are more easily expanded, or quite possibly there is ample room for expanding all crops when price-cost conditions stimulate it. In a comparable study for the Southwest (combined data);[35] significant price coefficients were obtained only when World War II years, 1943-1948, were combined with the period 1920-1940; but not when the latter period was used alone. The configuration of these data appears to agree with the study by Badger, although the variables differ. It would appear that response to war-time prices is great, but at other times prior to 1949, a lesser response is obscured by other factors not adequately accounted for.

Model I

Inspection of the charts for Model H suggests that if war years are removed, the lines of relationship for acreage price and acreage-competing crop values would have slopes little different from zero for the 1920's and 1930's. This is true in Model I for the inter-war period. Time is the only significant coefficient. The residuals for this model are presented graphically in Figure 3 for Texas and Oklahoma. Possibly the price-cost ratios for peanuts and per acre value-cost ratios for competing crops are intercorrelated and off-setting. The notion persists, however, that something more than intercorrelation is involved; weather is an influence on harvested acreage as will be shown below. There may well be other influences not considered in these models.

Models J, K, L, M, N, O, and P

The underharvested acreage models K, L, M, N, O, and P failed to provide any consistent or logical explanation for the rather large

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[35] Daniel D. Badger and James S. Plaxico, Selected Supply and Demand Relationships in the Peanut Industry, Processed Series P-338, (Stillwater: Oklahoma State University, 1959), pp. 12-16.

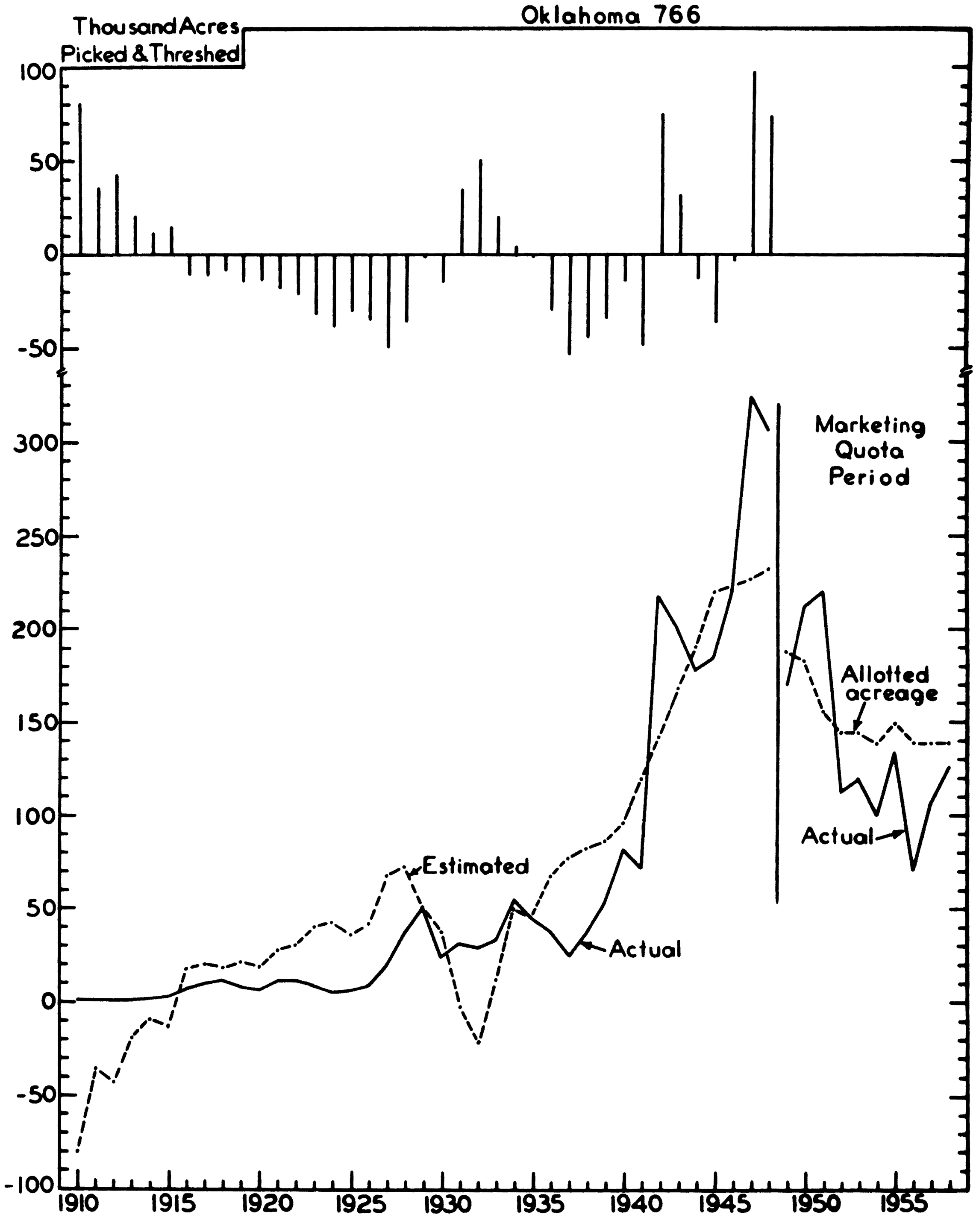
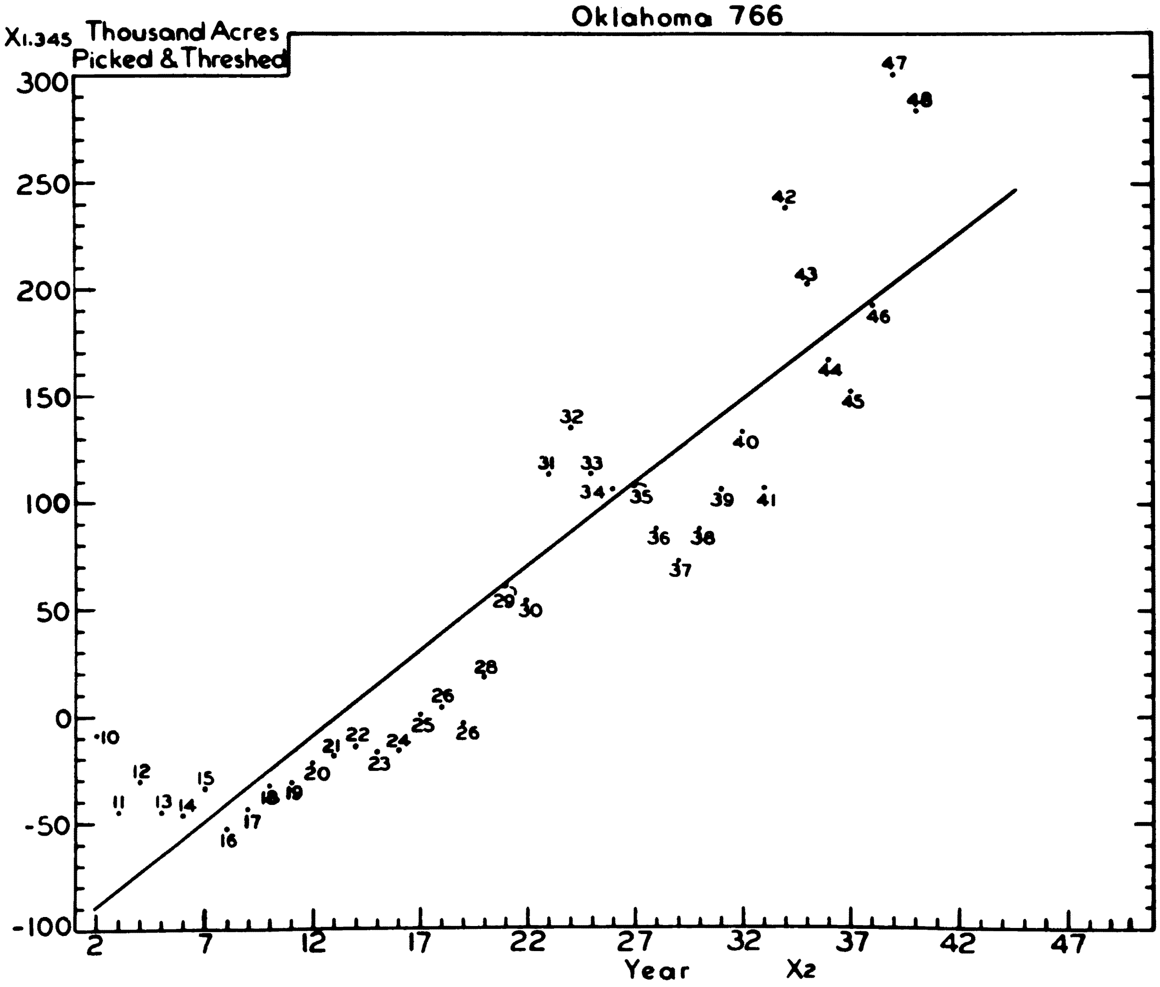

Thousand Acres
Picked & Threshed
Oklahoma 766
100
50
0
-50
300
250
200
150
100
50
0
-50
-100
Marketing
Quota
Period
Allotted
acreage
Actual
Estimated
Actual
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

Figure 2.



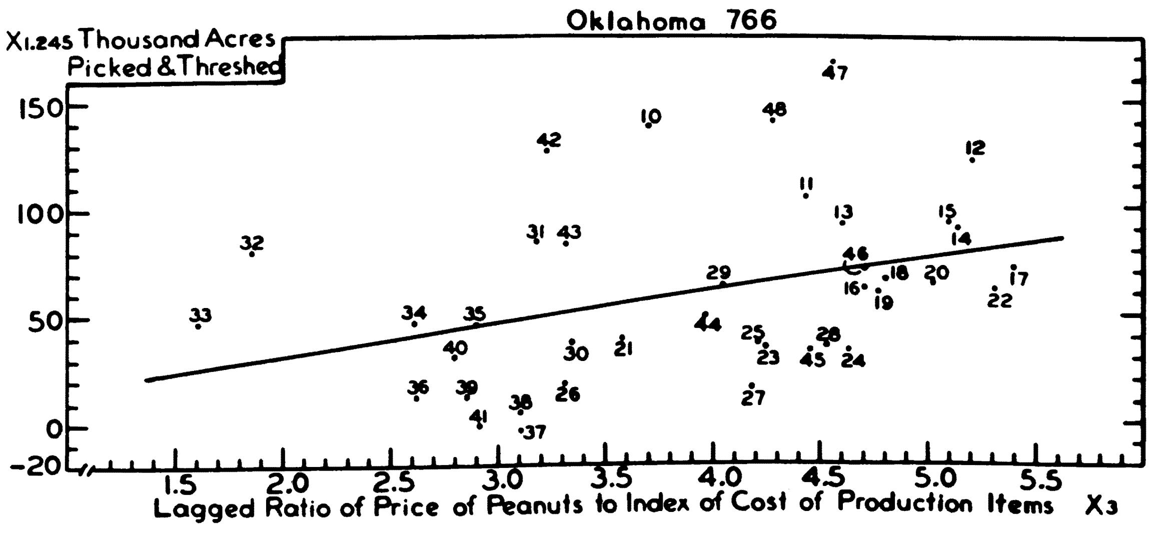
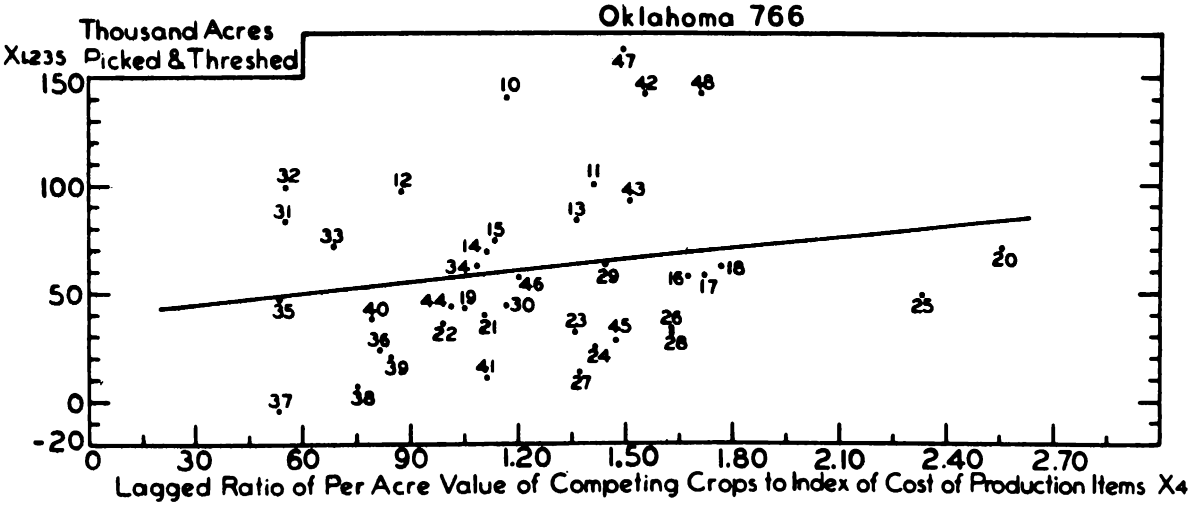


Figure 2. Continued



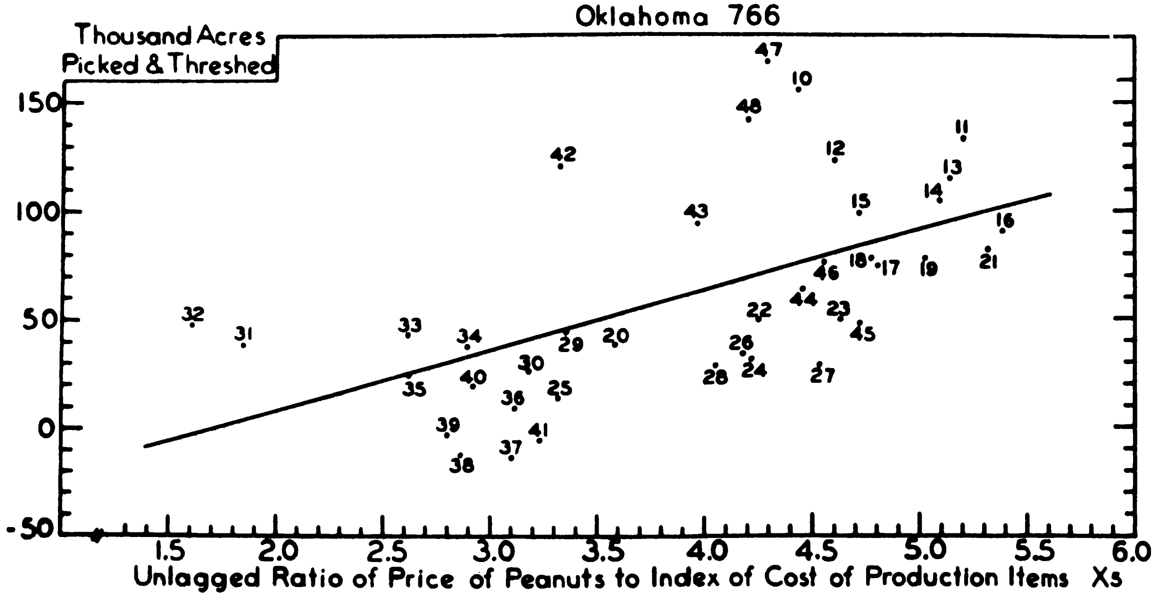


Figure 2. Continued

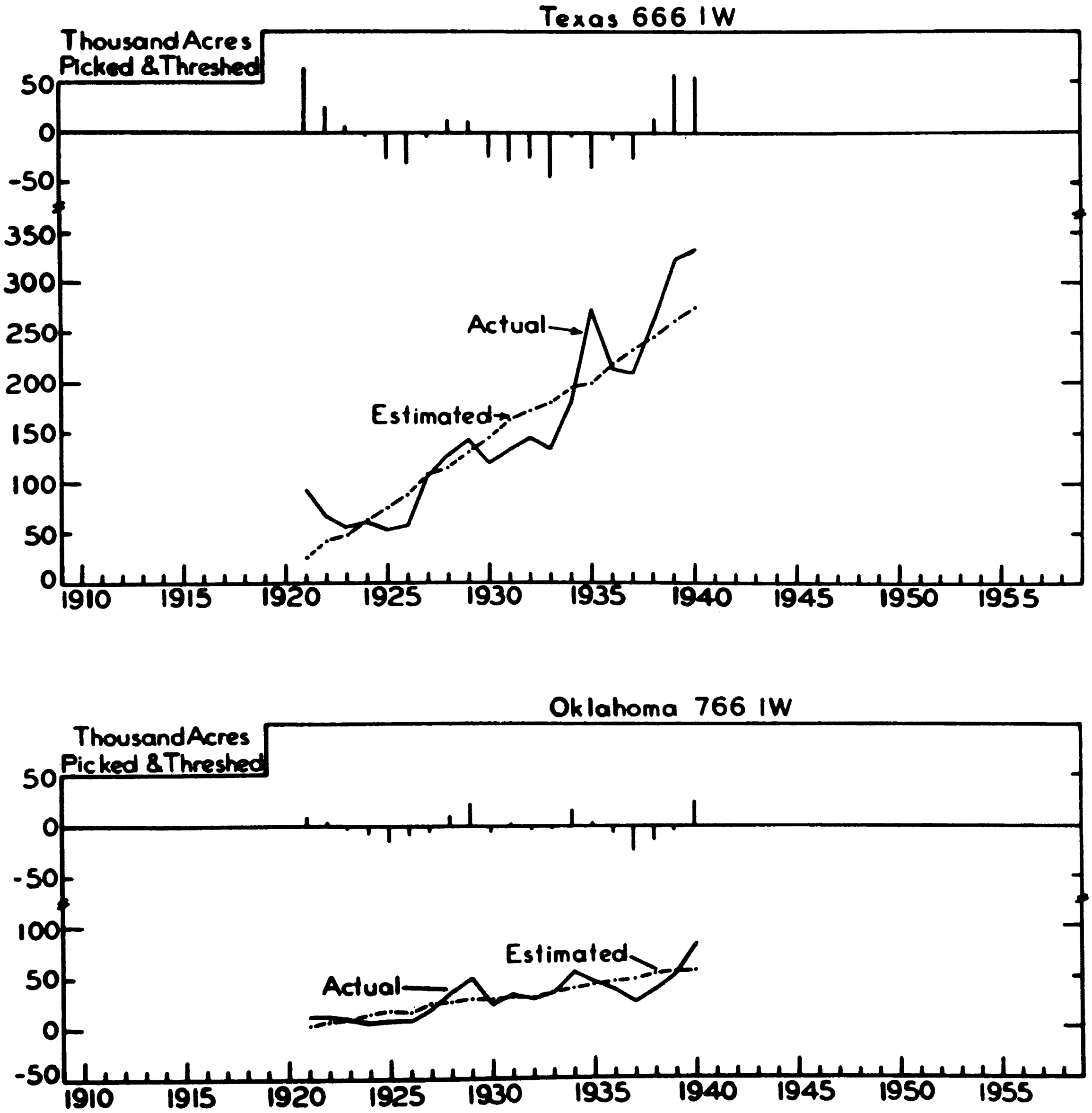

Texas 666 IW
Thousand Acres Picked & Threshed
50
0
-50
350
300
250
200
150
100
50
0
Actual
Estimated
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955
Oklahoma 766 IW
Thousand Acres Picked & Threshed
50
0
-50
100
50
0
-50
Estimated
Actual
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

Figure 3.

differentials between allotted and harvested acreage. Accordingly, all were rejected in favor of Model J, with underharvest handled subjectively for purposes of projecting production. Models Q and R below indicate that rainfall should be included in underharvest models if economic factors are not to be obscured. Again, reference is made to the two-price system and excess acreage program for 1951 and 1952 whereby growers could market excess production for oil and meal uses (see Part II). The underharvest data for Oklahoma suggest participation in this program since 1951 and 1952 are the only years when overharvest occurred. There was no overharvest in Texas, but the effect of the oil program may have been obscured by weather effect. Another factor which renders economic analysis difficult in terms of accurate observed data is the acreage reserve and conservation reserve of "soil bank" legislation. Even assuming an accurate quantitative appraisal of such land were readily available, a qualitative appraisal of such land would be difficult. It is presumed that it represents land considerably less productive than average. Accordingly, the net effect on production is difficult to appraise. As indicated in the discussion of the Southeast area, 37,840 acres of Southwest peanut acreage were withdrawn under soil bank provisions in 1956. The 1959 figure for the United States suggests that by 1959, this amount may have been increased in the Southwest. The effect on production is probably less than average, and unknown.

Model Q

After some investigation, it was found that an average of the rainfall for the three critical months combined (June, July, and August) in Texas was significantly associated with underharvested acreage. The analysis for this single-variable regression is given in the accompanying Table 1. This relationship combined with a 30-day weather forecast for Texas might be helpful in appraising the prospective peanut crop well in advance of harvest. The suggestion has not been tested. It would be desirable to appraise more thoroughly some of the non-weather factors, such as those discussed above, before accepting the rainfall coefficient. The observed variables might need some adjustment.

Model R

An association comparable to Model Q was found between underharvested acreage and August rainfall in Oklahoma. An untested suggestion is offered that this might have similar use in appraising the prospective crop in non-irrigated areas of the state if used in connection with a 30-day weather forecast. The analysis for this relationship is given in accompanying Table 2. The shortcomings of Model Q are equally applicable to Model R.

Table 1.--Underharvested acreage (Y_1) expressed as a function of 3-month average of rainfall in June, July, and August (X_{15}, X_{16}, and X_{17}). Texas, 1949-1958.

Year	Underharvested acreage Y_1	3-month average rainfall X	Estimated by equation $\hat{Y}_1$	Residual $Y-\hat{Y}$
	Thousand acres	Inches	Thousand acres	Thousand acres
1949.....	-112.8	2.76	- 40.1	-72.7
1950.....	- 9.9	3.13	- 21.0	11.1
1951.....	- 63.2	2.22	- 68.1	4.8
1952.....	-134.0	1.02	-130.1	- 3.9
1953.....	- 85.6	2.16	- 71.1	-14.5
1954.....	- 75.8	1.18	-121.8	46.0
1955.....	5.4	2.70	- 43.2	48.6
1956.....	-181.9	1.03	-129.6	-52.3
1957.....	- 69.7	1.66	- 97.0	27.3
1958.....	- 49.7	2.47	- 55.1	5.4

The following values apply to Table 1:

$\hat{Y} = -182.9 + 51.7364X$

SS regression :	14,236.347
SS error......:	13,649.713
MS error......:	1,706.214
F-Test value..:	8.34
R^2...........:	0.51
s_b ....:	17.91

The following values apply to Table 2:

$\hat{Y} = -63.4092 + 14.0736X$

SS regression :	4,686.0122
SS error......:	1,998.5438
MS error......:	249.8180
F-Test value..:	18.76
R^2...........:	0.70
s_b ....:	3.25

Table 2.--Underharvested acreage (Y_1) expressed as a function of August rainfall (X_{16}). Oklahoma, 1949-1958.

Year	Underharvested acreage Y_1	August rainfall X_{16}	Estimated by equation $\hat{Y}$	Residual $Y-\hat{Y}$
	Thousand acres	Inches	Thousand acres	Thousand acres
1949.....	-18.3	1.62	-40.6	22.3
1950.....	28.4	5.53	14.4	14.0
1951.....	-64.2	1.32	-44.8	-19.4
1952.....	-31.7	1.51	-42.1	10.4
1953.....	-25.4	2.85	-23.3	- 2.1
1954.....	-38.0	1.62	-40.6	2.6
1955.....	-15.2	3.34	-16.4	1.2
1956.....	-68.3	0.81	-52.0	-16.3
1957.....	-29.3	1.80	-38.1	8.8
1958.....	-14.2	5.03	7.4	-21.6

In Summary of This Section

None of the above models is useful for projection purposes other than Model J when adjusted subjectively; accordingly, this model will be used with an adjustment for underharvest in Texas of approximately 66,000 acres, and similarly, 18,000 acres in Oklahoma. These are rather large differentials but are rough means of the past few years since minimum allotments have become effective. Year to year variation appears highly associated with rainfall, but projection involves assumption of mean rainfall conditions.

Yield Estimates

Southwest Area

Variables Used and Models Considered:

X_1 ... Time
X_1^2 ... Time squared
X_2 ... Yield of peanuts (dependent)
X_5 ... Log price of peanuts (t-1)
X_9 ... Composite cost squared
X_{10}... Peanut acreage
X_{15}... June rainfall, Texas
X_{16}... July rainfall, Texas
X_{17}... August rainfall, Texas
X_{15}... July rainfall, Oklahoma
X_{16}... August rainfall, Oklahoma
X_{17}... September rainfall, Oklahoma
X_{19}... Profitability ratio

Models Considered Time Period 1909-1958	Data Supplement Reference: Table Number	Equation Numbers: Texas	Equation Numbers: Oklahoma
A. $X_2=f(X_1, X_5, X_{10})$	14	690	790
B. $X_2=f(X_1, X_5, X_{10}, X_{16})$	15	600	700
C. $X_2=f(X_1, X_5, X_9, X_{10})$	16	622	722
D. $X_2=f(X_1, X_5, X_9, X_{10}, X_{15}, X_{16}, X_{17})$	17	621	721
E. $X_2=f(X_1, X_1^2, X_5, X_9, X_{10}, X_{15}, X_{16}, X_{17})$	17	$621t^2$	---
F. $X_2=f(X_1, X_1^2, X_5, X_{10}, X_{15}, X_{16}, X_{17})$	18	602	702
G. $X_2=f(X_1, X_5, X_{10}, X_{19})$	19	632	732
H. $X_2=f(X_1, X_5, X_{10}, X_{15}, X_{16}, X_{17}, X_{19})$	20	631	731

Model A

This model establishes that the long run linear yield trend in Texas has been slightly negative, and that it has been only slightly positive in Oklahoma. Inspection of the charts presented below suggests that these results are in accord with essential facts, but do not take into account effectively the upturn in recent years. Low multiple correlation coefficients suggest that important variables have been omitted. Accordingly, the models were rejected.

Model B

The addition of the rainfall variable in the second critical month had little effect in Texas, but was highly effective in Oklahoma. This clearly illustrates the need for an adequate weather index before firm conclusions can be drawn from the behavior of the coefficients of economic variables when analyzing production response.[36] These relationships are presented graphically in Figure 4, for Oklahoma. The equation is:

Oklahoma - 700 : $R^2 = .52$

$$X_2 = 74.7077 + \underset{(1.8481)}{3.7932X_1^{*}} + \underset{(95.1194)}{480.7436X_{5t-1}^{**}} - \underset{(0.3024)}{1.1045X_{10}^{**}} + \underset{(10.3026)}{46.1707X_{16}^{**}}$$

Model C

Composite cost entered the equation significantly in Texas but not in Oklahoma. The reason for this difference is not known. The charts accompanying this section include a line of relationship for yield-composite cost in Texas (Figures 5 and 6). The cost index increased substantially in war years, as did price, and of course, both have increased in recent years. Accordingly, intercorrelation may affect the relationships; prices of competing products are included in the index which lends support to this explanation.

Model D

This is the same set of variables as Model C with rainfall added for the three critical months. The behavior of the composite cost coefficient is the same as in Model C. August rainfall in Texas enters

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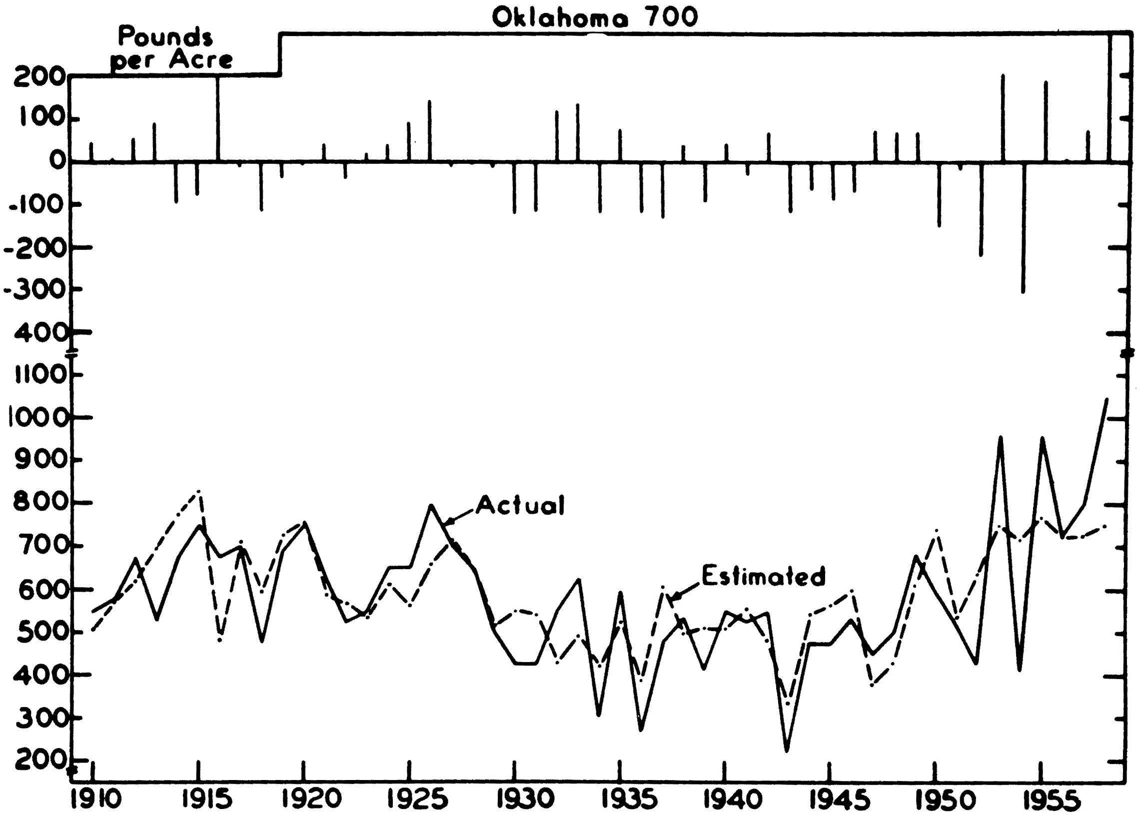
[36] James L. Stallings, "Weather Indexes-Notes," Journal of Farm Economics, XLII, No. 1 (February, 1960), pp. 180-186.


Oklahoma 700
Pounds per Acre
200
100
0
-100
-200
-300
400
1100
1000
900
800
700
600
500
400
300
200
Actual
Estimated
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

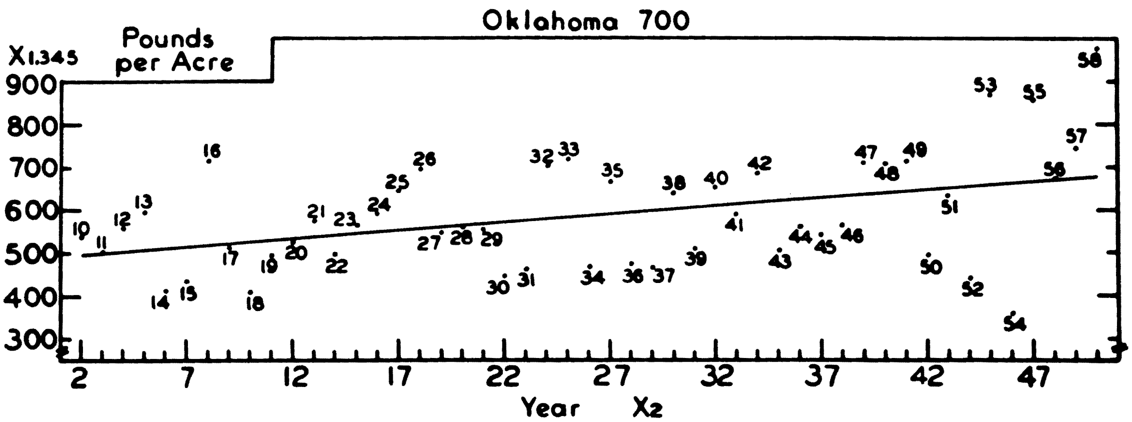

Oklahoma 700
Pounds per Acre
X1.345
900
800
700
600
500
400
300
2
7
12
17
22
27
32
37
42
47
Year X2

Figure 4.

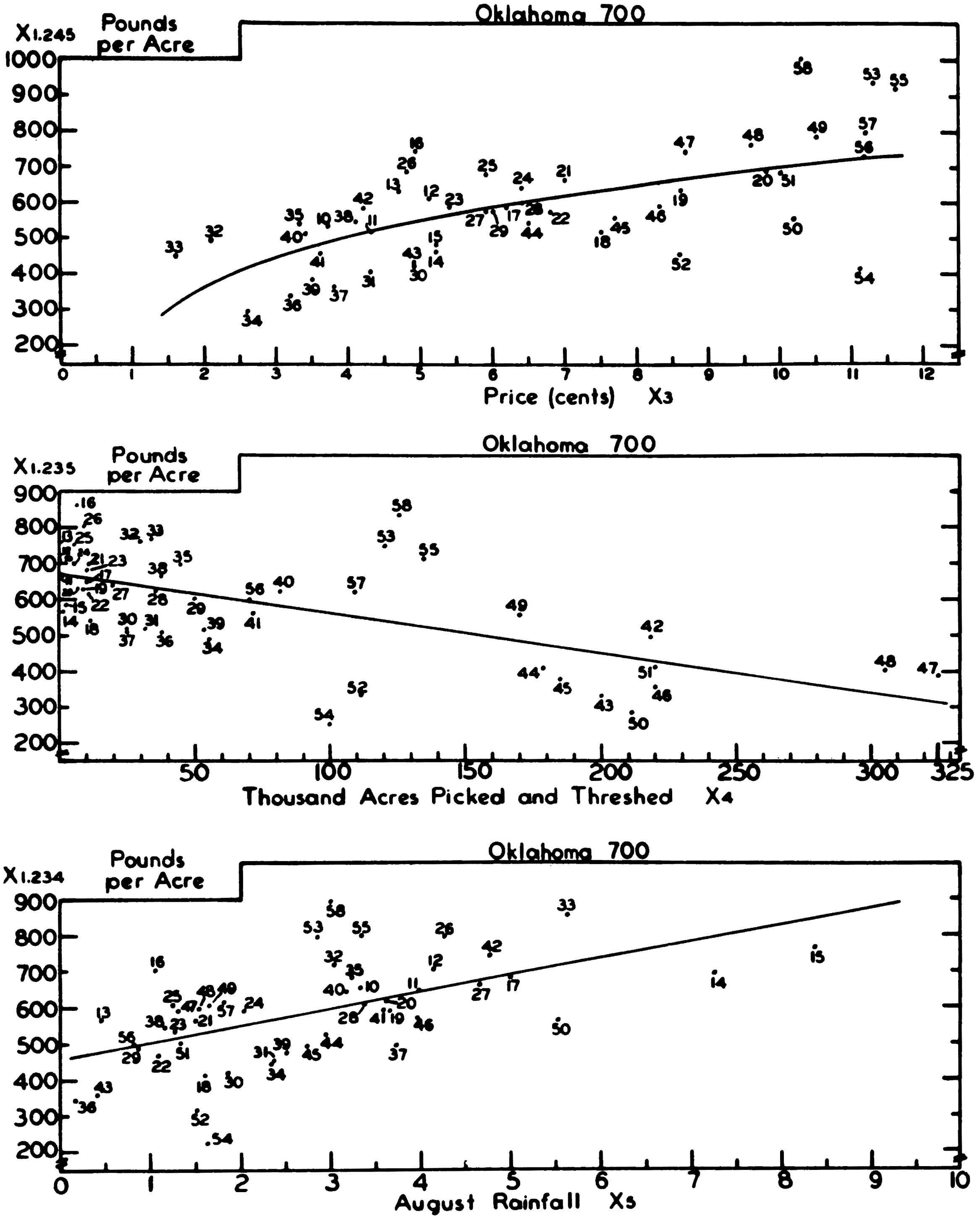


Figure 4. Continued

the equation effectively. Evidently, August weather is highly influential in both states. The Texas relationships for this model are presented graphically in Figure 5. The equation is:

Texas - 621 : $R^2 = .58$

$$X_2 = 271.9108 - \underset{(1.3206)}{1.5338X_1} + \underset{(126.8826)}{421.1334X^{**}_{5t-1}} - \underset{(0.0010)}{0.0026X^{**}_{9}} - \underset{(0.0684)}{0.1904X^{**}_{10}}$$
$$+ \underset{(7.9341)}{7.4342X_{15}} + \underset{(12.8997)}{12.3279X_{16}} + \underset{(8.7919)}{37.7759X^{**}_{17}}$$

Model E

A previous study[37] indicated that yield trends are curvilinear in the Southwest. Inspection of the data in the accompanying charts suggests a long-run decline ending with World War II, and then an upturn for the past decade. To test this, quadratic time was added to Model D for Texas. The results are illustrated in Figure 6. The equation is:

Texas - $621t^2$: $R^2 = .72$

$$X_2 = 585.6160 - \underset{(4.3541)}{20.1149X_1^{**}} + \underset{(0.0825)}{0.3646X_1^{**2}} + \underset{(125.5143)}{119.5894X_{5t-1}} - \underset{(0.0008)}{0.0016X_9}$$
$$- \underset{(0.0589)}{0.1218X^{*}_{10}} + \underset{(6.7320)}{13.5975X^{*}_{15}} + \underset{(10.8140)}{19.0141X_{16}} + \underset{(7.3766)}{33.0273X^{**}_{17}}$$

Time and quadratic time become highly significant but the coefficients of price and cost are decreased. The coefficients for rainfall are also increased. Time (technology) and price are doubtless correlated; the time coefficients are probably overestimated with corresponding underestimates for price and cost. Both June and July weather enter the equation quite effectively. It was this effect which led to the investigation of the 3-month average rainfall association with underharvested acreage discussed in the acreage section.

Model F

Quadratic time is introduced in both states without composite cost. Otherwise the model is the same as Model E. The results are about the same in Texas as Model E. Not much change occurs in the model

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[37] D. Upton Livermore, "Trends in Peanut Yields," Virginia Farm Economics, No. 154 (May, 1958), pp. 9-18.

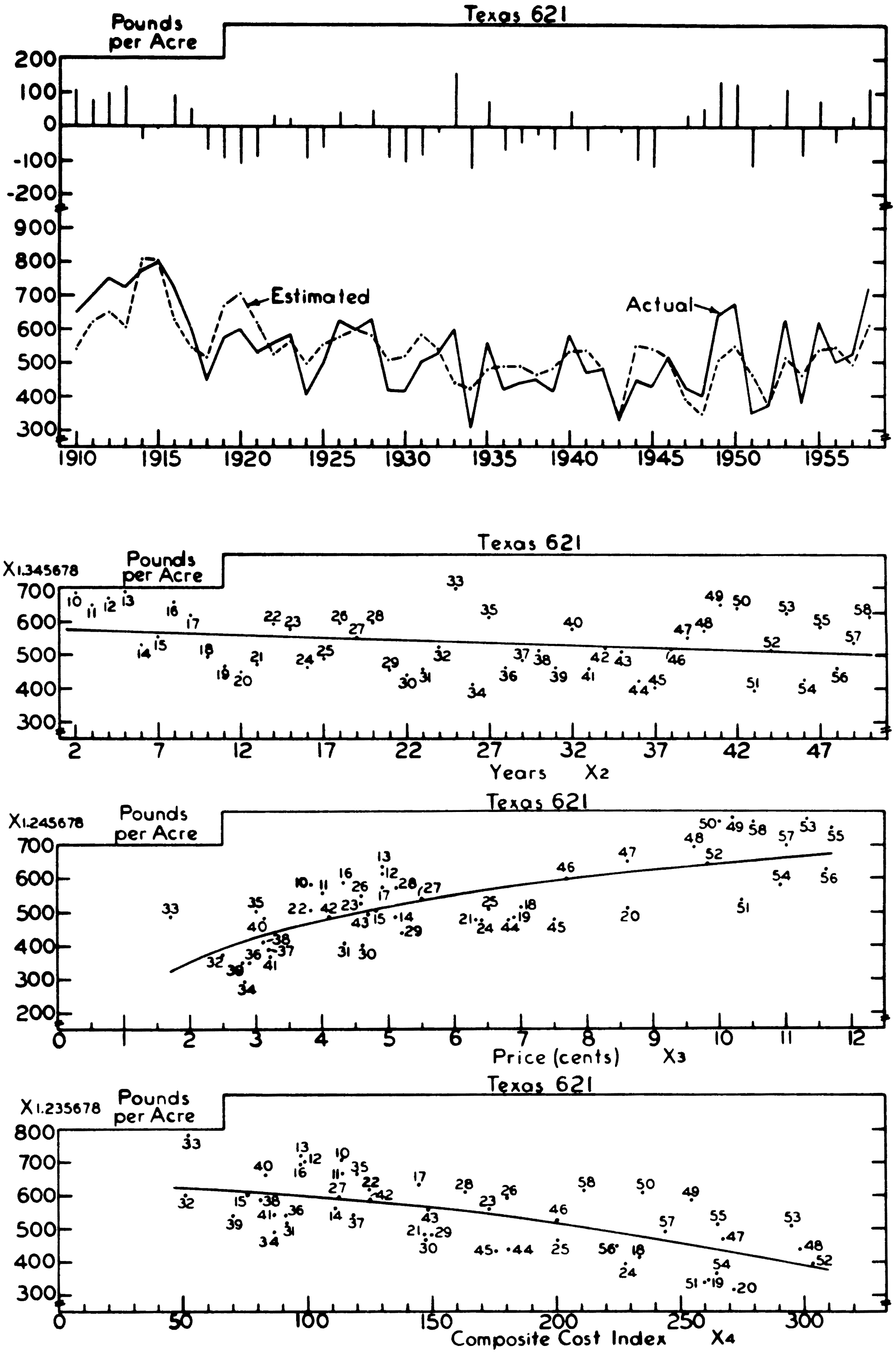

Texas 621
Pounds per Acre
Estimated
Actual
Texas 621
X1.345678
Pounds per Acre
Years X2
Texas 621
X1.245678
Pounds per Acre
Price (cents) X3
Texas 621
X1.235678
Pounds per Acre
Composite Cost Index X4

Figure 5.

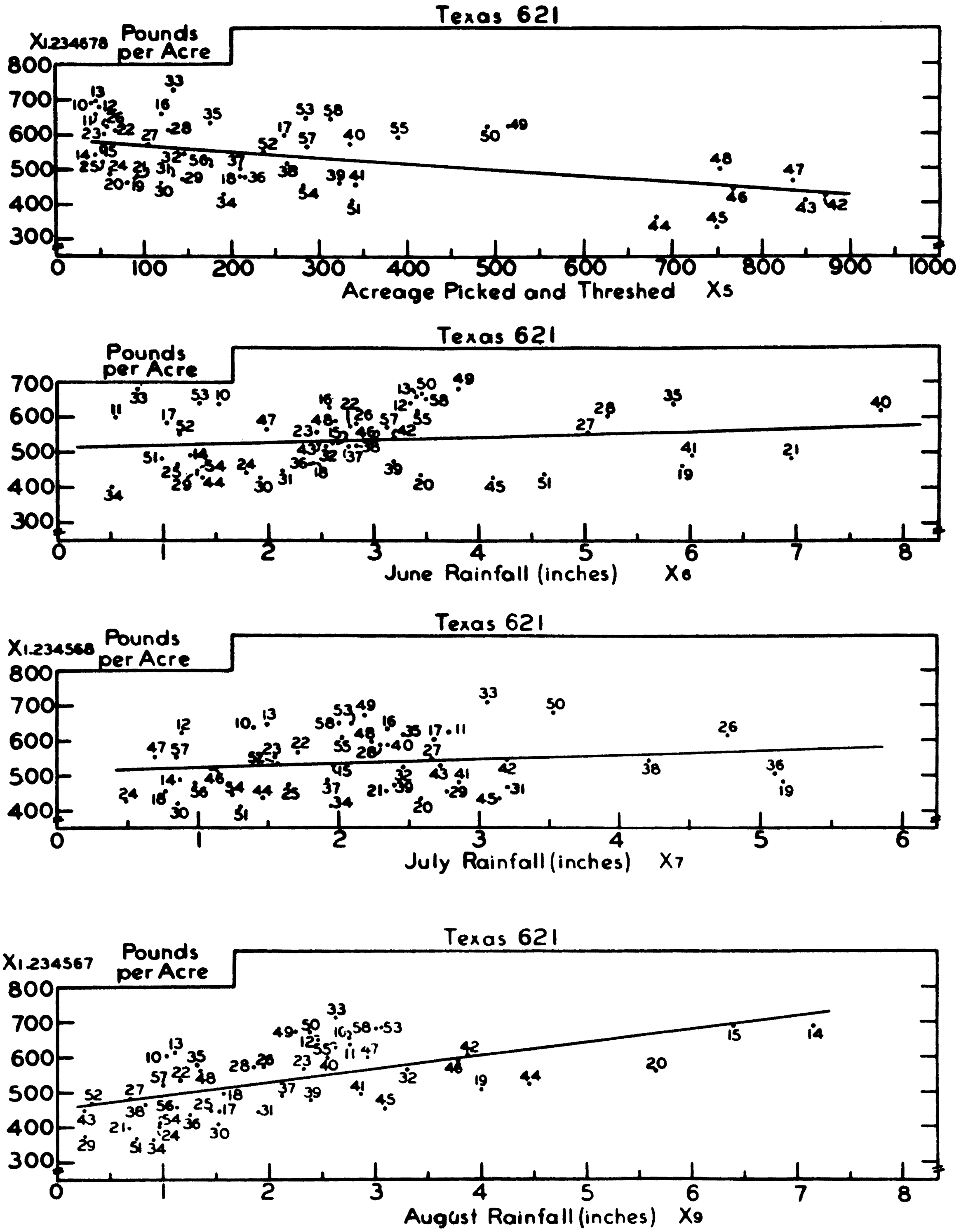
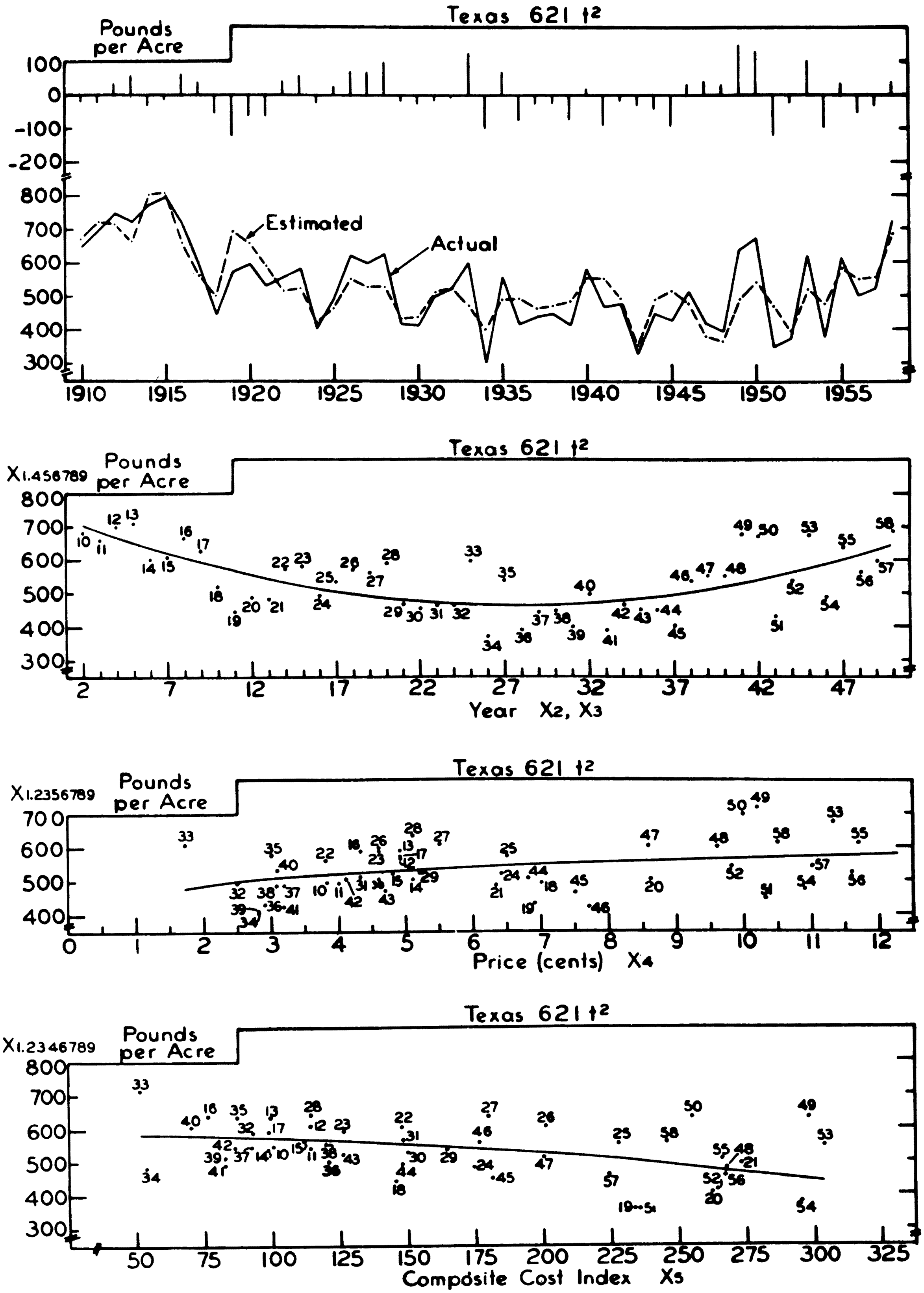


Figure 5. Continued



Texas 621 †2
Pounds per Acre
Estimated
Actual
Texas 621 †2
X1.456789 Pounds per Acre
Year X2, X3
Texas 621 †2
X1.2356789 Pounds per Acre
Price (cents) X4
Texas 621 †2
X1.2346789 Pounds per Acre
Composite Cost Index X5

Figure 6.

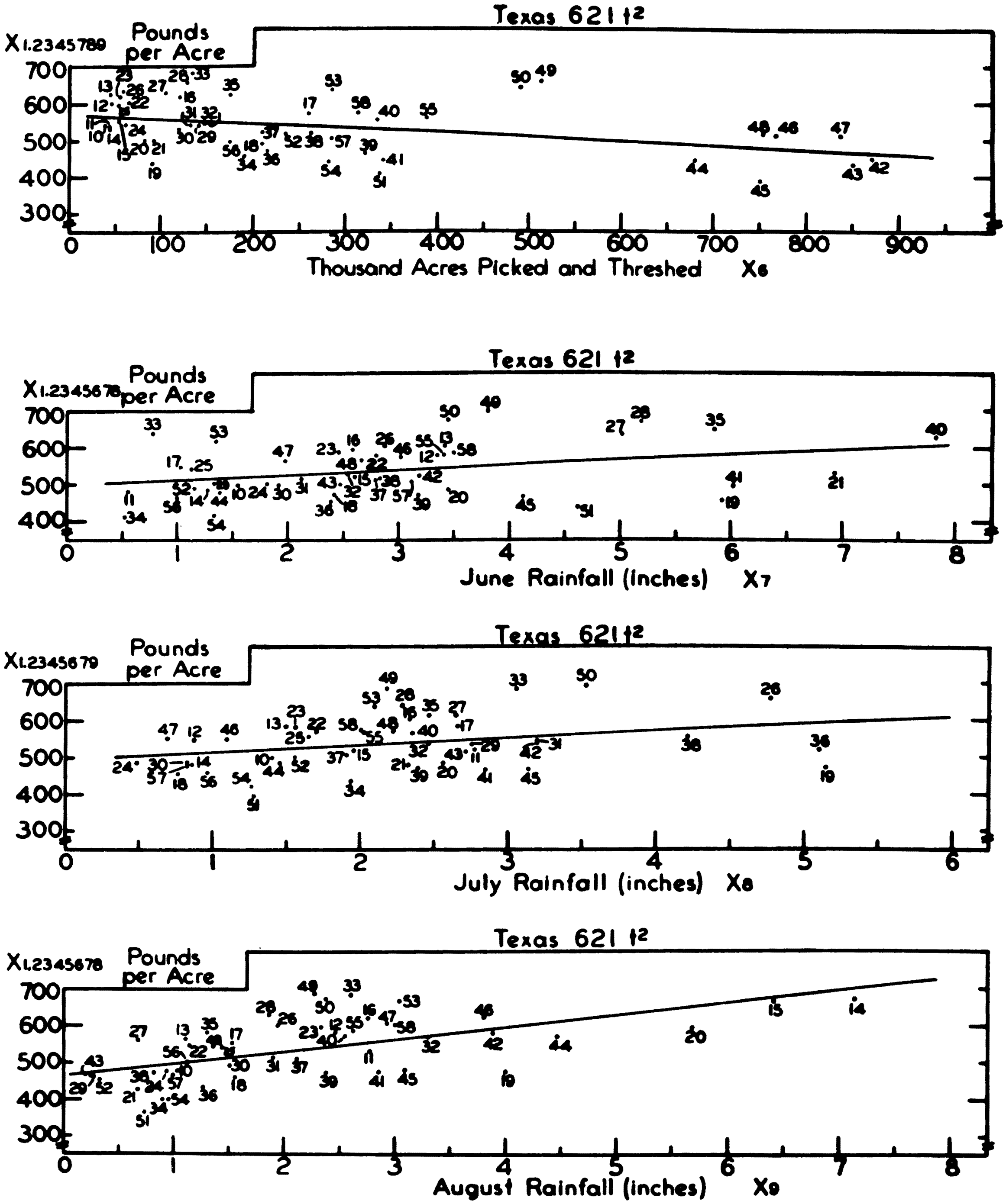


Figure 6. Continued

for Oklahoma; the effect due to time is mainly a result of a decrease in other coefficients, presumed to be the effect of intercorrelation as indicated above for Model E.

Models G and H

As for other areas of production, these models were rejected because of the peculiar and ineffective behavior of the profitability ratio variable.

In Summary of This Section

In contrast to other areas where the long-run yield trend was different from the trend in this area, it seems advisable to use yield models which include quadratic time. Some of the same configuration of the data which seemed to preclude the use of quadratic time in other areas is also present in the Southwest, but the abrupt changes are not as pronounced preceding the mandatory allotment period; nor is the quadratic effect as great. Additionally, the presence of significant coefficients other than time help to modify the curvilinear effect. Additionally, the recent technology in the area, primarily irrigation, lends credence to rather rapid increases in yields in the near future, such as would be projected by quadratic time.

Accordingly, for projections to 1965, Model E for Texas and Model F for Oklahoma are used. For estimates under differing assumptions, it would probably be better to use models less dependent upon time, although the reliability of individual coefficients in this type of analysis is always open to question.

It will be noted that the general hypothesis regarding rainfall in the humid areas does not apply entirely in its application in the Southwest subhumid area. All relationships for yield and rainfall should probably consist of positive expectations rather than an expected negative relationship in the third critical month, as was hypothesized for the humid states.

Production Estimates

Southwest Area

Variables Used and Models Considered:

X_1 ... Time
X_1^2 ... Time squared
X_3 ... Peanut price (t-1)
X_{11}... Peanut production (dependent)
X_{12}... Value of peanuts (t-1)
X_{13}... Value of competing crops (t-1)
X_{14}... Acreage of competing crops (t-1)
X_{15}... July rainfall, Oklahoma
X_{15}^2.. July rainfall squared, Oklahoma
X_{16}... August rainfall, Oklahoma
X_{16}^2.. August rainfall squared, Oklahoma
X_{17}... September rainfall, Oklahoma
X_{17}^2.. September rainfall squared, Oklahoma
X_{15}.. June rainfall, Texas
X_{15}^2... June rainfall squared, Texas
X_{16}.. July rainfall, Texas
X_{16}^2.. July rainfall squared, Texas
X_{17}.. August rainfall, Texas
X_{17}^2.. August rainfall squared, Texas
X_{24}... Per acre value competing crops (t-1)

Models Considered	Time Period	Data Supplement Reference: Table Number	Equation Numbers: Texas	Equation Numbers: Oklahoma
A. $X_{11} = f(X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17})$.....	1909-1958	21	611	711
B. $X_{11} = f(X_{12}, X_{13}, X_{14}, X_{15}, X_{16}, X_{17})$.....	1909-1948	22	619	719
C. $X_{11} = f(X_1, X_1^2, X_3, X_{24}, X_{15}, X_{16}, X_{17}, X_{15}^2, X_{16}^2, X_{17}^2)$.....	1909-1958	23	603	703
D. $X_{11} = f(X_1, X_1^2, X_3, X_{24}, X_{15}, X_{16}, X_{17}, X_{15}^2, X_{16}^2, X_{17}^2)$.....	1909-1948	24	604	704

Models A and B

The concepts under which these models were formulated are discussed in the comparable subsection of Section IV for the Virginia-Carolina area. They are exploratory and inconclusive. Exclusion of the mandatory allotment period in Model B provides a better fit, as might be expected, considering the change in structure which occurred in 1949. The significant relationships for value of peanuts and competing crop acreage or value are not unexpected, considering probable intercorrelation, but more rainfall effect was expected than was obtained. The models are not regarded as useful.

Models C and D

These models break down rather completely because of the changing structure of the industry, inclusion of war years, and inclusion of formative years prior to World War I. The distortions thus introduced are again more than can be dealt with in one equation for one time period. Further investigation for selected time periods might be rewarding in the area; but in their present form, the models are not useful.

For purposes of illustration, Model C has been presented graphically in Figures 7 and 8. The equations are:

Texas - 603 : $R^2 = .59$

$$X_{11} = -2654.2961 + 74.5094X_1 - 0.3988X_1^2 + 185.9975X_3 - 33.3058X_{24}$$

(57.9277) (0.9208) (162.5406) (29.2512)

$$+ 296.8607X_{15} + 481.2691X_{16} + 547.2476X_{17}^{*} - 38.8742X_{15}^2$$

(258.4850) (413.9514) (255.1383) (33.1334)

$$- 83.9246X_{16}^2 - 60.2808X_{17}^2$$

(71.6163) (37.5248)

Oklahoma - 703 : $R^2 = .75$

$$X_{11} = -885.9452 + 17.3516X_1 + 0.0966X_1^2 + 57.4149X_3 - 59.5506X_{24}$$

(19.0478) (0.2936) (31.5563) (61.3322)

$$+ 37.5003X_{15} + 33.1219X_{16} + 128.4622X_{17}^{*} - 2.2975X_{15}^2 - 2.4077X_{16}^2$$

(63.1853) (77.7681) (70.3370) (7.1582) (9.7339)

$$- 13.6635X_{17}^2$$

(8.2841)

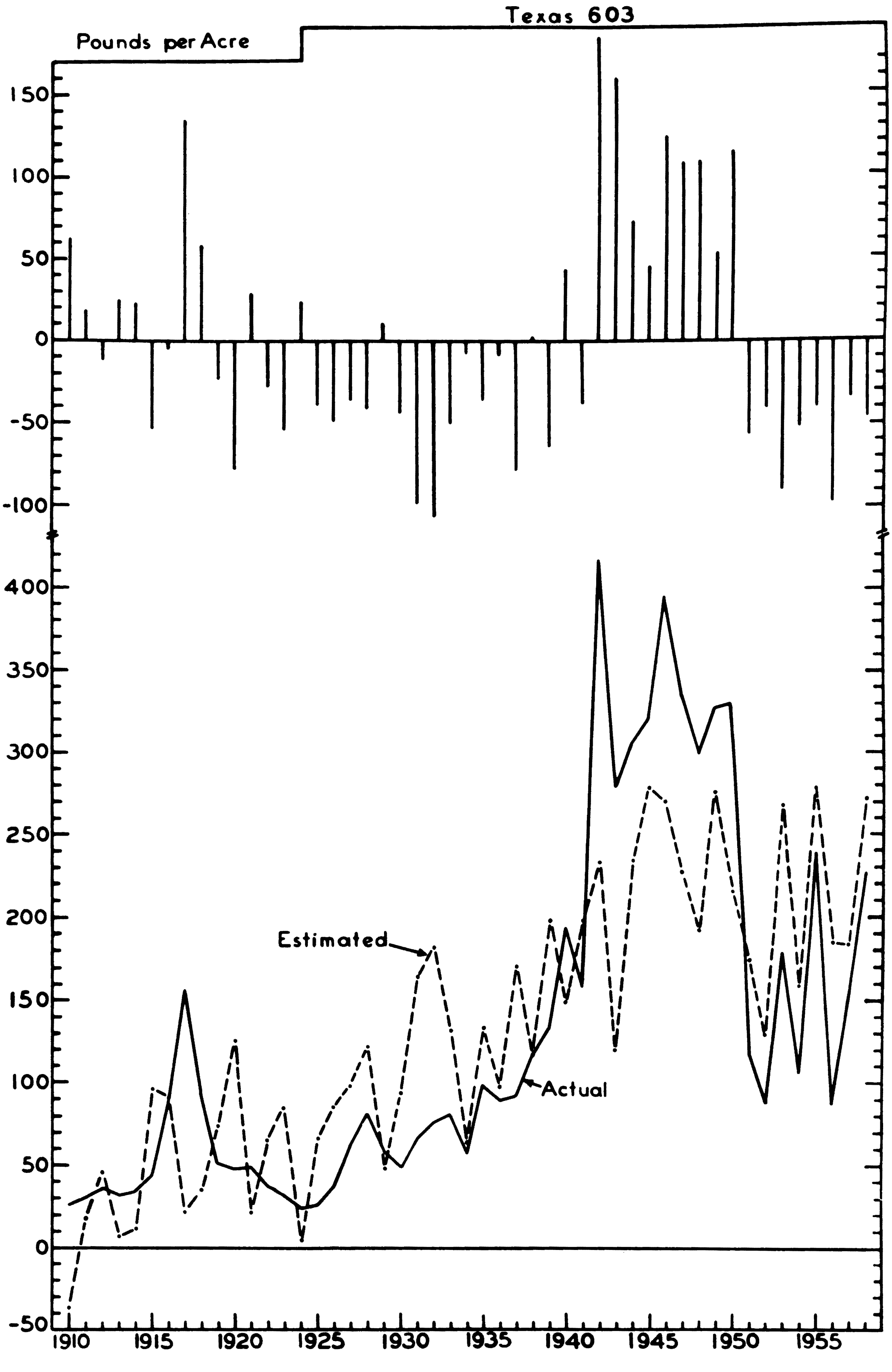

Texas 603
Pounds per Acre
150
100
50
0
-50
-100
400
350
300
250
200
150
100
50
0
-50
Estimated
Actual
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

Figure 7.

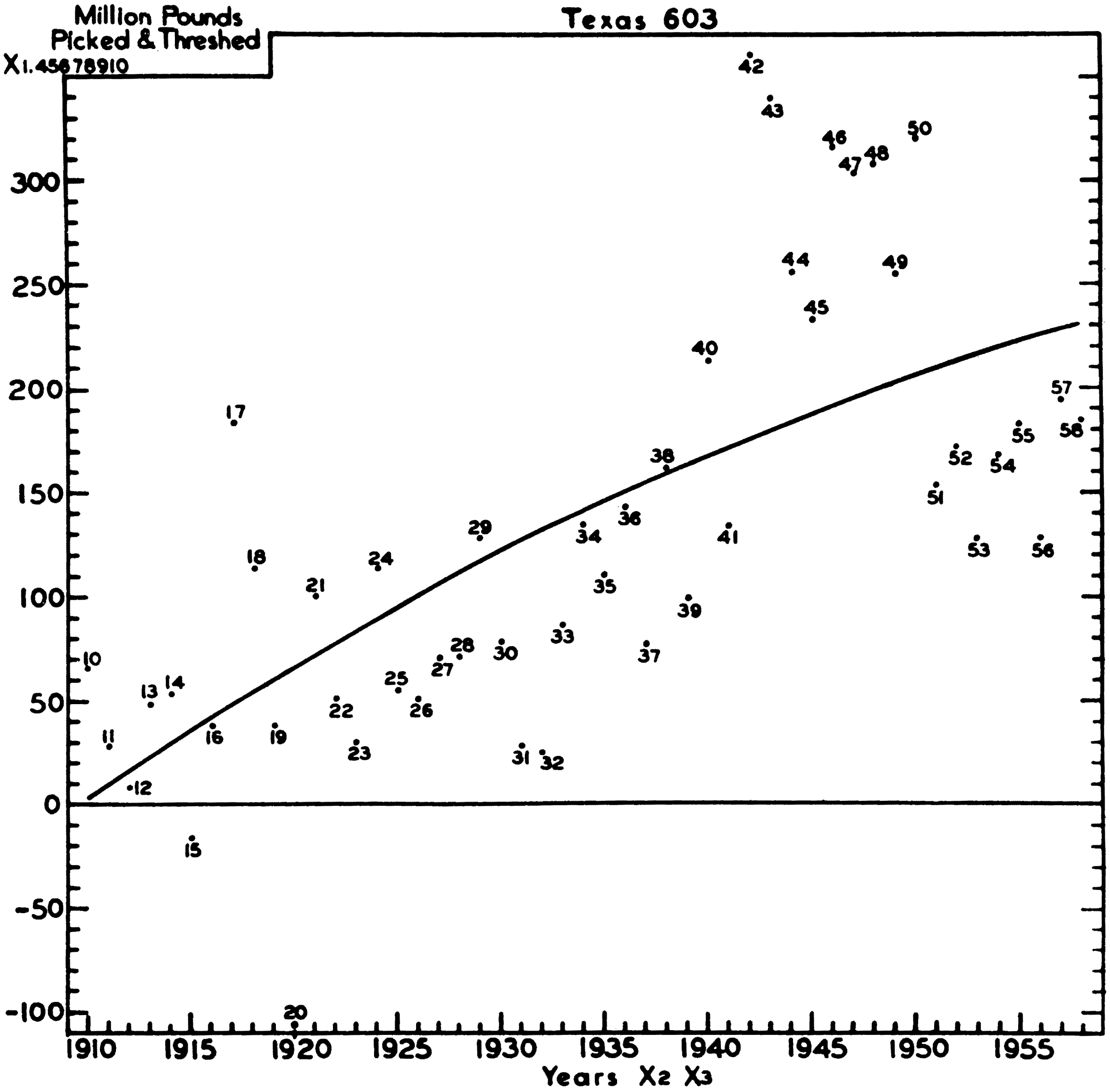


Figure 7. Continued

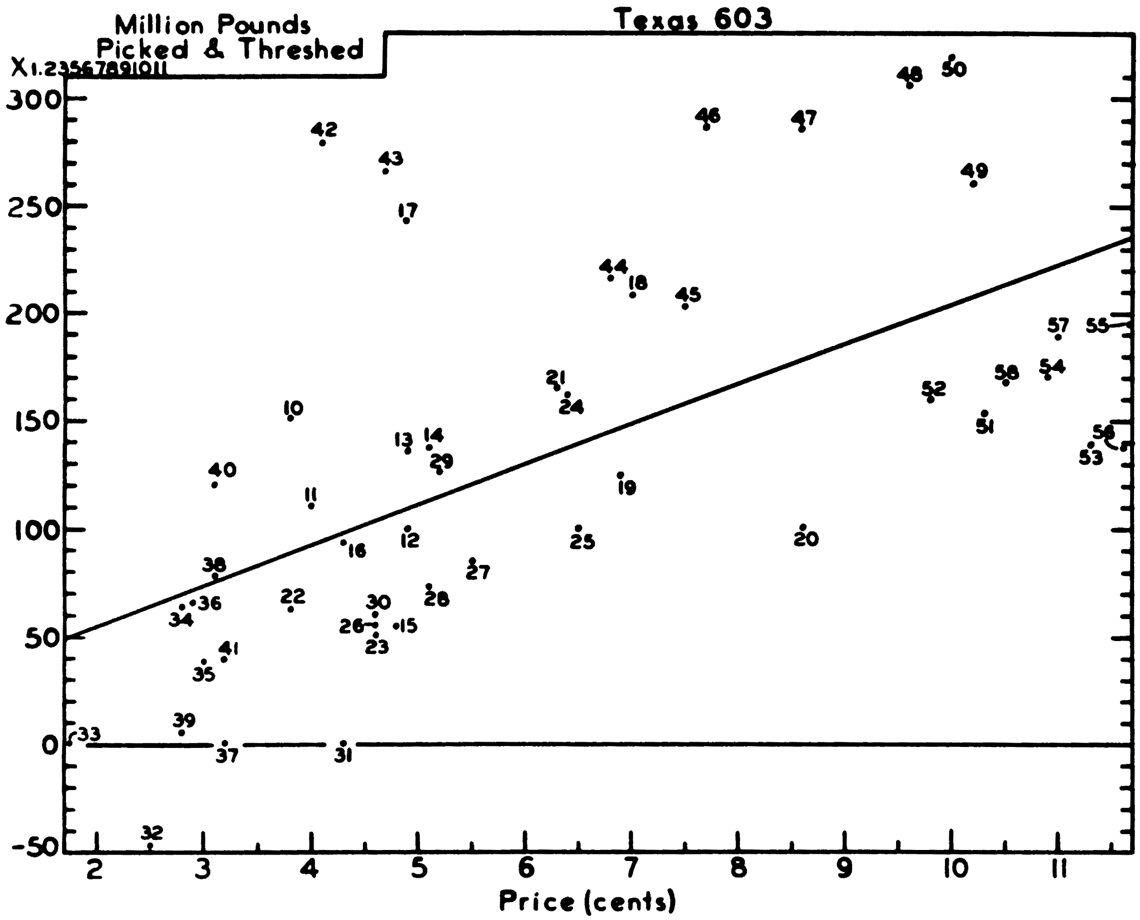
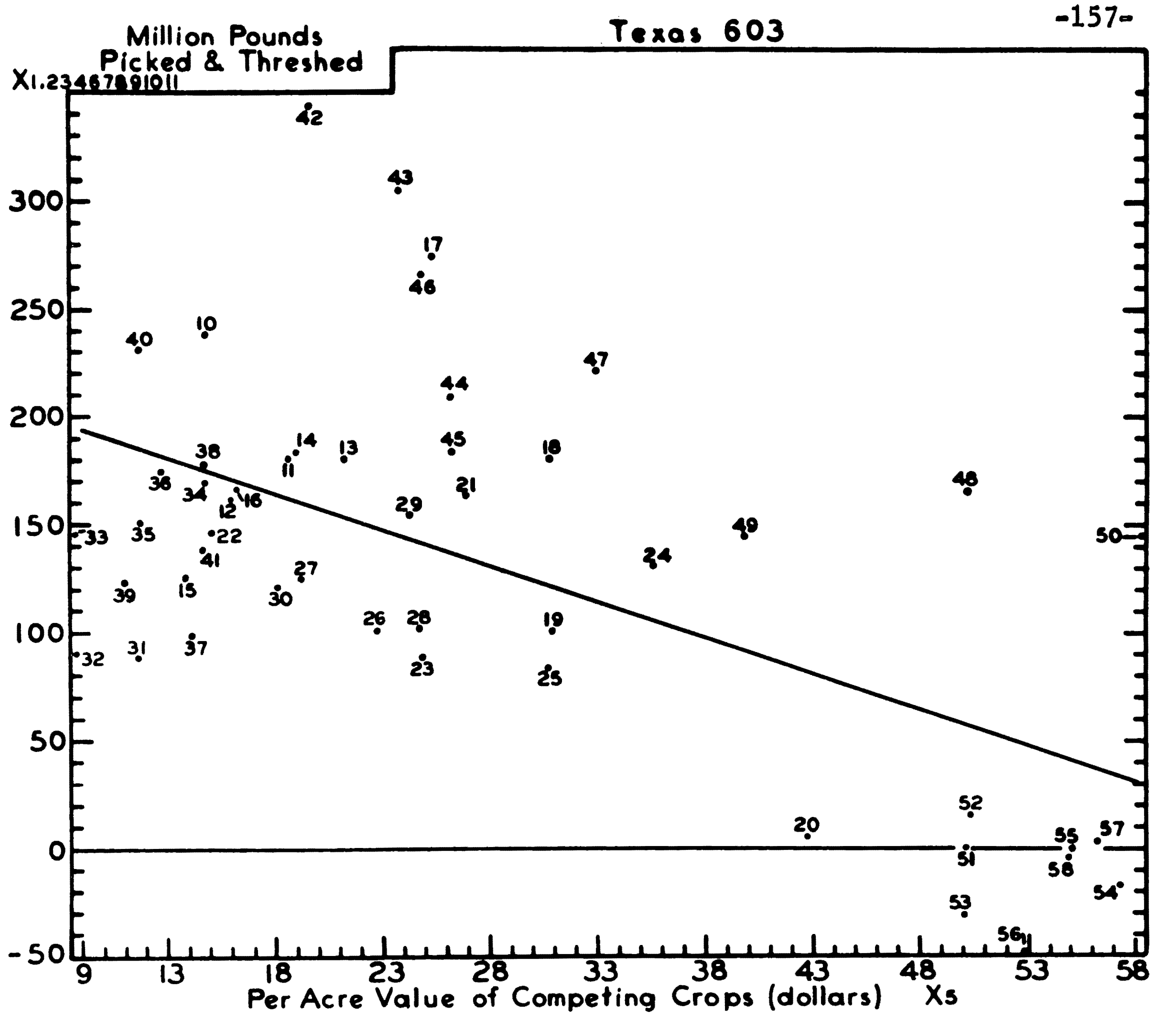


Figure 7. Continued



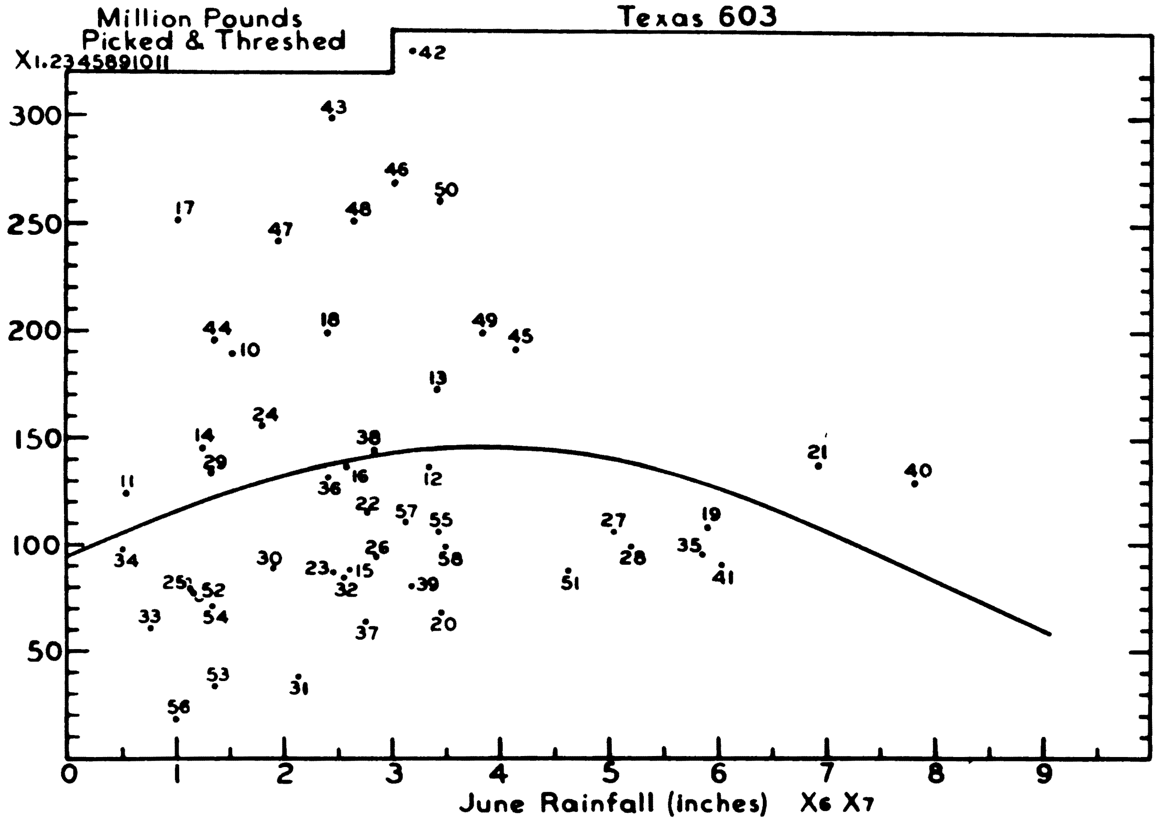
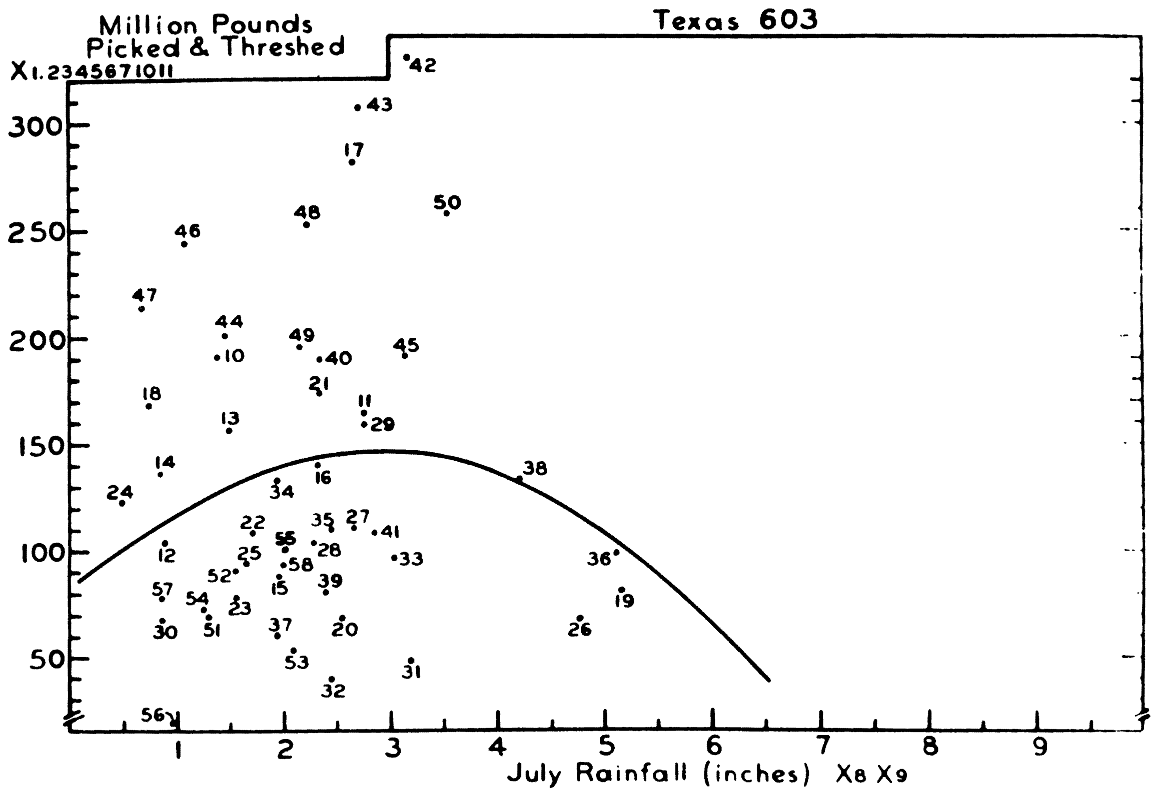


Figure 7. Continued



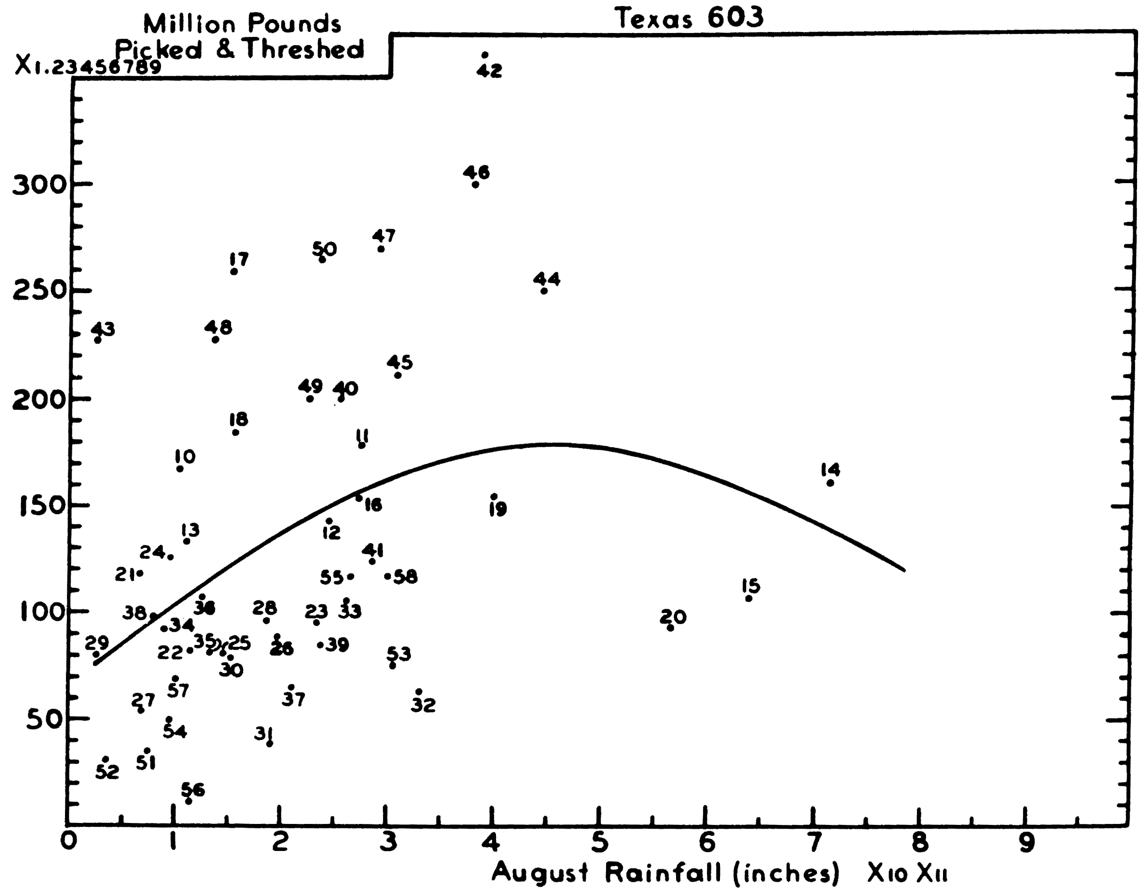


Figure 7. Continued

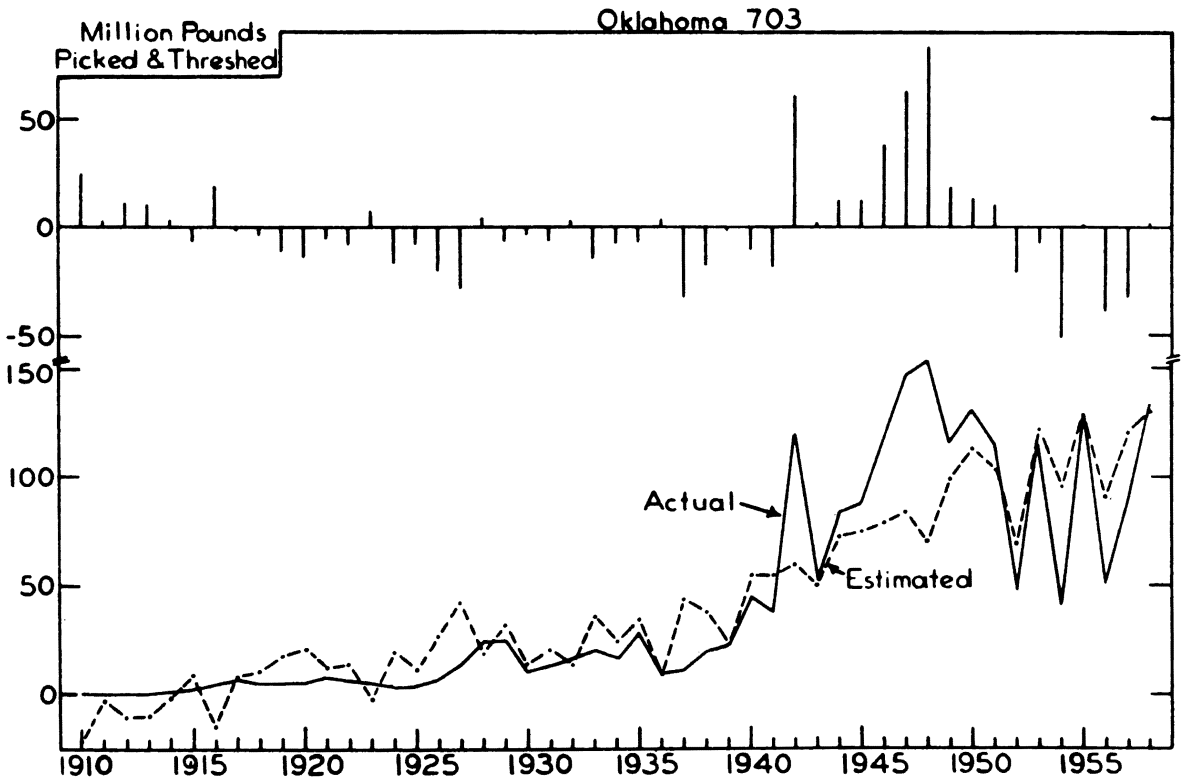

Oklahoma 703
Million Pounds
Picked & Threshed
50
0
-50
150
100
50
0
Actual
Estimated
1910
1915
1920
1925
1930
1935
1940
1945
1950
1955

Figure 8.

Strangely enough, Model C projects future production which is not far from that derived by other means, but this does not lend much credence to the usefulness of the model. It would be interesting to fit this model to the mandatory allotment period, but there are about as many variables as there are degrees of freedom.

Projections to 1965

In the section on acreage estimates, it was concluded that acreage allotments adjusted for underharvest would be used in projecting production. Similarly, in the yield section, Models E for Texas and F for Oklahoma were selected. Pursuant to these decisions, the yields projected by Model E for Texas have been applied to a prospective harvested acreage of 290,000 for the period 1959-1965. This assumes an underharvest of about 66,000 acres. In similar fashion, the yields projected by Model F in Oklahoma have been applied to an acreage of 120,000. This assumes an underharvest of about 18,000 acres.

The accompanying Tables 3 and 4 set forth the actual, estimated, and projected production beginning in 1949 when mandatory acreage allotments were initiated. Also included in the tables for comparative purposes only are the estimated and projected production data for the production equation, Model C discussed above.

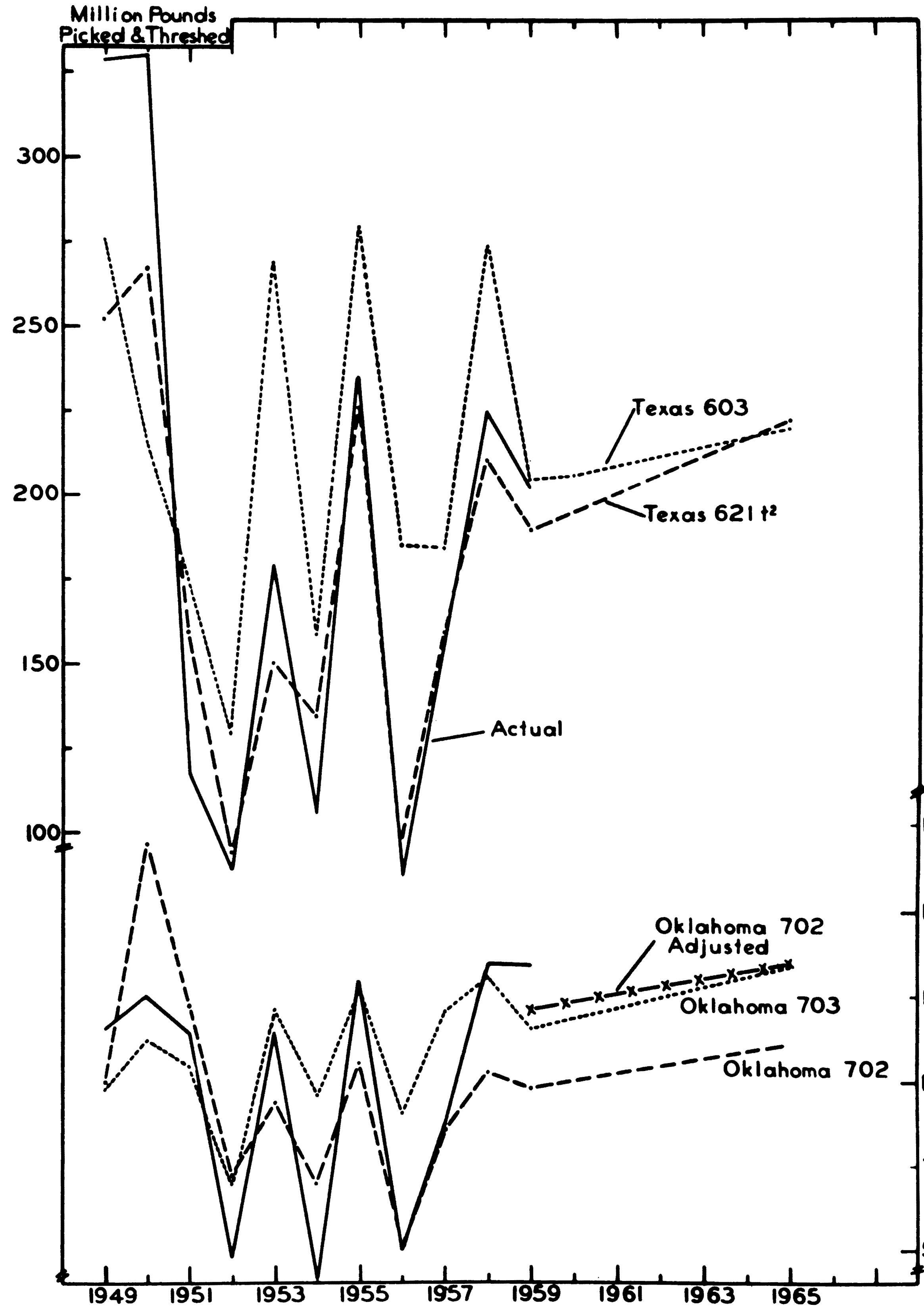
The assumptions under which projections have been made are, for Texas and Oklahoma, respectively:

1) Price: 9.5¢; 9.5¢
2) Acreage: 290,000; 120,000
3) Composite Cost: 1955-1958 average: (226)[2], Texas only
4) Per acre value of competing crops: $55.37; $35.29
5) 49-year mean rainfall in inches:

	Texas		Oklahoma
June	2.90	July	2.74
July	2.21	August	2.78
August	2.22	September	3.32

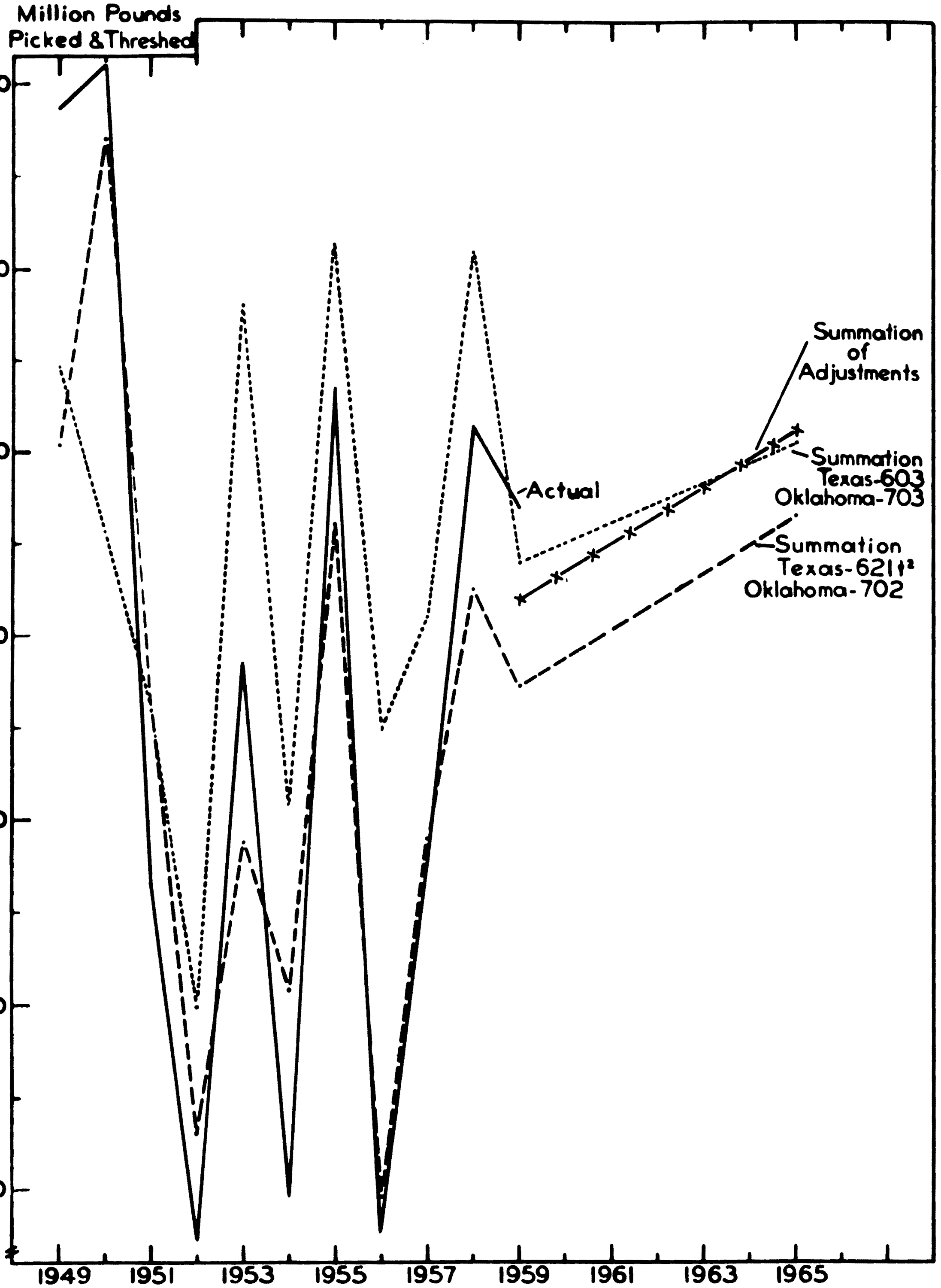
The comparative production data are presented graphically in Figures 9 and 10. The solid line represents actual production from 1949 to date, 1959. The broken line represents production as derived from the product of acreage less underharvest and yields estimated from the specified yield equations. In similar manner, the dotted line gives the estimate derived from the specified estimating production equation from Model C.

To be discussed in the summary section on national production are certain subjective adjustments. These are represented by the "adjusted" projection line in the summary chart, and pertain to adjusted data for Oklahoma only.



Texas and Oklahoma: Actual, Estimated, and Projected Peanut Production from Specified Equations

Figure 9.



Southwest Area: Actual, Estimated, and Projected Peanut Production from Specified Equations

Figure 10.

Table 3.--Production of peanuts in Texas: actual and estimated, 1949-1958; and projected, 1959-1965, using specified yield and production equations under assumptions of price 9.5 cents; acreage 290,000, 1955-1958 average composite cost; 1954-1958 average per acre value of specified competing crops; and 49-year mean total rainfall in June, July, and August.

Year	Acreage			Yield		Production						
							Yield regression Tex. - 621t2[a]			Production regression Tex. - 603[b]		
	Actual	Allotted	Under harvest	Actual	Texas 621t2 estimated	Actual	Estimated	Residual	Percent	Estimated	Residual	Percent
	A	A'		Y	$\hat{Y}$	P=AY	$\hat{P}=A\hat{Y}$	$P-\hat{P}$	$\hat{P}/P$	$\hat{P}$	$P-\hat{P}$	$\hat{P}/P$
				Pounds	Pounds	Thousand Pounds	Thousand Pounds	Thousand Pounds		Thousand Pounds	Thousand Pounds	
1949...	513,000	625,788	-112,788	640	492	328,300	252,396	75,904	77	276,000	52,300	84
1950...	490,000	499,873	-9,873	675	545	330,800	267,050	63,750	81	216,700	114,100	66
1951...	338,000	401,234	-63,234	350	472	118,300	159,536	-41,236	135	175,200	-56,900	148
1952...	273,000	371,050	-134,050	375	399	88,900	94,563	-5,663	106	129,700	-40,800	146
1953...	287,000	372,060	-85,060	625	524	179,400	150,388	29,012	84	268,800	-89,400	150
1954...	281,000	356,847	-75,847	380	478	106,800	134,318	-27,518	126	158,500	-51,700	148
1955...	389,000	383,611	5,389	615	581	239,200	226,009	13,191	95	279,500	-40,300	117
1956...	175,000	356,909	-181,909	500	552	87,500	96,600	-9,100	110	185,100	-97,600	212
1957...	287,000	356,669	-69,669	525	557	150,700	159,859	-9,159	106	184,900	-34,200	123
1958...	307,000[c]	356,661	-49,661	730[c]	685	224,110[c]	210,295	13,815	94	273,800	-49,690	122
1959[d]..	(289,000)	356,483	-67,483	(700)	652	(202,300)	189,000	(13,220)	94	204,257	(-1,957)	101
1960...		290,000[e]			669		194,010			206,963		
1961...		290,000			687		199,230			209,588		
1962...		290,000			706		204,740			212,134		
1963...		290,000			725		210,250			214,600		
1964...		290,000			746		216,340			216,986		
1965...		290,000			767		222,430			219,292		

[a]See Data Supplement, Table 17, for coefficients; also page 146.

[b]See Data Supplement, Table 23, for coefficients; also page 153.

[c]Revised.

[d]Data included in the regression coefficients ended with 1958. Figures in parenthesis are preliminary for 1959.

[e]Used for projecting production, 1959-1965.

Table 4.--Production of peanuts in Oklahoma: actual and estimated, 1949-1958; and projected, 1959-1965, using specified yield and production equations under assumptions of price, 9.5 cents; acreage, 120,000; 1954-1958 per acre value of specified competing crops; and mean total rainfall for July, August, and September.

Year	Acreage			Yield		Production						
							Yield regression Okla. - 702[a]			Production regression Okal. - 703[b]		
	Actual A	Allotted A'	Under harvest	Actual Y	Okla-702[a] estimated $\hat{Y}$	Actual P=AY	Estimated $\hat{P}=A\hat{Y}$	Residual $P-\hat{P}$	Percent $\hat{P}/P$	Estimated $\hat{P}$	Residual $P-\hat{P}$	Percent $\hat{P}/P$
				Pounds	Pounds	Thousand Pounds	Thousand Pounds	Thousand Pounds		Thousand Pounds	Thousand Pounds	
1949...	170,000	188,335	-18,335	680	586	115,600	99,620	15,980	86	97,698	17,902	85
1950...	212,000	183,600	28,400	590	795	125,100	168,540	-43,440	135	112,078	13,022	90
1951...	220,000	155,812	64,188	520	556	114,400	122,320	-7,920	107	104,172	10,228	91
1952...	112,000	143,727	-31,727	425	643	47,600	72,016	24,416	151	69,208	-21,608	145
1953...	119,000	144,379	-25,379	960	789	114,200	93,891	20,309	82	121,187	-6,987	106
1954...	100,000	138,013	-38,013	410	697	41,200	69,700	-28,500	169	95,676	-54,476	232
1955...	134,000	149,217	-15,217	960	787	128,600	105,458	23,142	82	127,546	1,054	99
1956...	70,000	138,349	-68,349	725	728	50,700	50,960	-260	101	90,021	-39,321	178
1957...	109,000	138,264	-29,264	800	787	87,200	85,783	1,417	98	120,503	-33,303	138
1958...	124,000[c]	138,228	-14,228[c]	1,075[c]	829	133,300[c]	102,796	30,504	77	130,925	2,375	98
1959[d]..	(121,000)	(138,269)	-17,269	(1,100)	814	(133,100)	97,680	(35,420)	(73)	115,952	(17,148)	(87)
1960...		120,000[e]			831		99,720			118,836		
1961...		120,000			849		101,880			121,740		
1962...		120,000			867		104,040			124,663		
1963...		120,000			885		106,200			127,605		
1964...		120,000			904		108,480			130,567		
1965...		120,000			924		110,880			133,545		

[a] See Data Supplement, Table 18, for coefficients.

[b] See Data Supplement, Table 23, for coefficients; also page 153.

[c] Revised.

[d] Data included in the regression coefficients ended with 1958. Figures in parenthesis are preliminary for 1959.

[e] Used for projecting production, 1959-1965.

SECTION VII

ESTIMATED PEANUT SUPPLIES

AND REQUIREMENTS, UNITED STATES

1959-1965

As indicated in Section I, the purpose of this study is to project the magnitude of total peanut production response for 1959-1965 under specified assumptions regarding price support, acreage allotments and related factors; compare this estimate with prospective requirements for the same period; and thus derive prospective quantities to be diverted from normal trade channels by government action in the market. The production estimates for the seven major producing states, as discussed in Sections IV, V, and VI may now be summarized. An additional source of supply will be taken into consideration, namely, production from a number of minor states which were excluded from the analysis. Also, the small quantity of imported peanuts will now be considered at the appropriate time.

The time of the problem under investigation was established in Section I as 1954 and succeeding years. The present economic and institutional structure of the industry which gave rise to the problem was established in 1949. Accordingly, the summarization and analysis of peanut supplies and requirements will be cast in the framework of these time periods.

It should first be emphasized that projection always contains hazard no matter how refined the tools of estimation. Some variable may have been overlooked entirely, or some usually obscure factor may assume sudden prominence. (Cranberry growers, jet plane manufacturers, and statesmen attending summit conferences have experienced such occasions, to cite examples.) Peanut program administrators have occasion most every year to be conscious of the abnormal situation which forestalls realization of the most carefully drawn projection charts which take into account events of the past and experienced judgements about the future. Nevertheless, judgements about the future must and will be made, either formally or informally. Short and long range planning by business and government requires this exercise of human thought which leads to action. Without it, progress would be purely random.

The kind of projection envisioned here is not one that attempts to specify actual production in a particular year, but rather one that establishes a _level_ of production and a _rate_ of change under assumed policy courses of action and expected responses to such action. Year to year deviation from these norms is anticipated but does not obscure the general trend of events toward the expressed or implied goals of the individuals, firms, and agencies concerned.

Supply Estimates and Projections

The tabular data presented in the three preceding sections provide the actual, estimated, and projected production for each of the seven major states. Included in these data are two sets of estimating equations:

a) yield equation estimates applied to acreage allotments after subjective allowance for over- or underharvested acreage,

b) equations designed to estimate production directly.

It was indicated at the close of each section that certain subjective adjustments would be desirable to take into account certain technological progress which has occurred mainly since 1956. This recognizes that the time period for the yield equations is 1909-1958, and that therefore the influence of the data for the last three years of the period would likely be substantially less, proportionately, than the magnitude of the technology would seem to warrant for projection purposes. Discussion of these adjustments was deferred to this section in order that they might be viewed in the national context. First, the unadjusted data should be examined.

Unadjusted Projections

In accompanying Table 1 are summarized the following production data for each state and area:

a) production as estimated by the respective yield equations when applied to actual acreage harvested, 1949-1958;

b) projected production as estimated by the respective yield equations when applied to acreage allotments after subjective adjustments for under- or overharvested acreage, 1959-1965;

c) actual production in "other" states 1949-1958, and projected for 1959-1965 as the mean of the 1957-1959 production;

d) actual production, for comparative purposes, 1949-1958 with preliminary data for 1959 included parenthetically;

e) residual differences (and percentages) between actual and estimated production, 1949-1958.

Table 1.--Production of peanuts: actual, estimated, and projected production from acreage allotments adjusted for over- and underharvest and applied to yields per acre as estimated from specified predicting equations.[a] Projected data include 103.9 million pounds upward adjustment for technological progress since 1956. Virginia-Carolina, Southeast, Southwest areas, and United States. 1949-1965.

	1949	1950	1951	1952	1953	1954	1955	1956	1957
					- million pounds -				
Estimates:									
Virginia	212.0	220.7	224.8	204.7	196.2	195.7	210.7	214.5	201.5
North Carolina	304.3	306.0	313.5	280.8	271.9	271.6	289.8	302.0	287.0
Other states[b]	4.0	32.0	2.1	1.6	1.2	1.4	2.8	2.5	2.5
Total V-C	520.3	558.7	540.4	487.1	470.3	468.7	503.3	519.0	491.1
Actual V-C	439.8	483.1	562.6	548.9	490.4	424.5	388.0	599.4	527.5
Residual V-C	-80.5	-75.6	22.2	61.8	20.1	-44.2	-115.3	80.4	36.4
Estimates:									
Georgia	655.4	628.3	547.4	416.2	450.5	412.7	495.0	511.6	496.7
Florida	57.7	61.3	56.8	49.2	51.7	51.2	55.7	53.4	50.2
Alabama	284.5	276.4	239.3	169.7	183.4	170.5	198.7	184.9	172.8
Other states[b]	17.0	19.4	14.3	9.9	9.7	7.3	11.7	15.0	14.7
Total SE	1,014.6	985.4	857.8	645.0	695.3	641.7	761.1	764.9	734.4
Actual SE	968.5	1,086.3	853.4	662.4	782.5	388.7	811.6	869.0	659.8
Residual SE	-46.1	100.9	-4.4	17.4	87.2	-253.1	50.5	104.1	-74.6
Estimates:									
Texas	252.4	267.1	159.5	94.6	150.4	134.3	226.0	96.6	159.8
Oklahoma	99.6	168.5	122.3	72.0	93.9	69.7	105.5	51.0	85.8
Other states[b]	12.5	10.1	10.2	8.0	7.7	7.6	8.1	9.2	11.4
Total SW	364.5	445.7	292.1	174.6	252.0	211.6	339.6	156.8	257.0
Actual SW	456.4	466.0	242.9	144.5	301.3	155.6	375.9	147.4	249.3
Residual SW	91.9	20.3	-49.1	-30.1	49.3	-56.0	36.3	-9.4	-7.7
U. S. Total (Est)	1,899.4	1,989.7	1,690.2	1,306.8	1,417.6	1,322.0	1,603.9	1,440.6	1,482.6
U. S. Actual	1,864.8	2,035.4	1,658.8	1,355.9	1,574.2	968.8	1,575.5	1,615.7	1,436.6
U. S. Residual	-34.6	45.7	-31.4	49.1	156.6	-353.2	-28.4	175.1	-46.0
Estimate/Actual	102	98	102	96	90	136	102	89	103
Adjustment from Table 2	-	-	-	-	-	-	-	-	-
Adj'd. projection	-	-	-	-	-	-	-	-	-

Table 1.--(Continued)

	1958	1959	1960	1961	1962	1963	1964	1965
				- million pounds -				
Estimates:								
Virginia	202.0	203.4	205.3	207.2	209.1	211.0	213.0	215.0
North Carolina	286.2	290.5	293.9	297.1	300.3	303.5	306.9	310.1
Other states[b]	2.5	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Total V-C	490.7	496.2	501.5	506.6	511.7	516.8	522.2	527.4
Actual V-C	554.1	(480.9)	-	-	-	-	-	-
Residual V-C	63.4	-15.3	-	-	-	-	-	-
Estimates:								
Georgia	500.1	484.6	488.2	491.8	494.9	498.5	502.1	505.2
Florida	48.8	51.7	52.0	52.3	52.6	53.0	53.3	53.6
Alabama	181.0	182.1	182.9	184.0	185.0	186.1	186.9	188.0
Other states[b]	16.2	14.2	14.2	14.2	14.2	14.1	14.2	14.2
Total SE	746.1	732.5	737.3	742.3	746.7	751.7	756.5	761.0
Actual SE	908.8	(771.6)	-	-	-	-	-	-
Residaul SE	162.7	39.1	-	-	-	-	-	-
Estimates:								
Texas	210.3	189.1	194.0	199.2	204.7	210.3	216.3	222.4
Oklahoma	102.8	97.7	99.7	101.9	104.0	106.2	108.5	110.9
Other states[b]	15.4	13.0	13.1	13.1	13.1	13.0	13.1	13.1
Total SW	328.5	299.8	306.8	314.2	321.8	329.5	337.9	346.4
Actual SW	372.9	(349.6)	-	-	-	-	-	-
Residual SW	44.4	49.8	-	-	-	-	-	-
U. S. Total (Est)	1,565.3	1,528.6	1,545.6	1,563.0	1,580.3	1,598.1	1,616.6	1,634.7
U. S. Actual	1,835.8	(1,602.1)	-	-	-	-	-	-
U. S. Residual	270.5	(73.5)	-	-	-	-	-	-
Estimate/Actual	85	(95)	-	-	-	-	-	-
Adjustment from Table 2	-	103.9	103.9	103.9	103.9	103.9	103.9	103.9
Adj'd. projection	-	1,632.5	1,649.5	1,666.9	1,684.2	1,702.0	1,720.5	1,738.6

[a]Virginia 190, North Carolina 290, Georgia 322, Florida 490, Alabama 500, Texas 621t^2 and Oklahoma 702.

[b]"Other states" not included in yield estimating equations. 1957-1959 weighted average production used for projections for Tennessee, South Carolina, Mississippi, Arkansas, Louisiana, and New Mexico.

These data constitute the arithmetical summation of the data presented in the relevant production subsections of Sections IV, V, and VI, but include for each area and for the United States the production in other specified states which is relatively minor.

Total production for the United States increases from 1,529 million pounds in 1959 to 1,635 by 1965. The rate of increase is approximately 17 million pounds per year, or about 1.1%.

The 1956-1959 average actual production is about 118 million pounds more than that estimated by the yield equations as applied to acreage allotments after adjustment for estimated over- and underharvested acreage. Comparatively, for the first four years of the period, 1949-1952, the residual differences are nearly in balance. The interim period is difficult to assess or include with the others because of severe weather conditions in 1954 and 1955 in the humid areas, for which no satisfactory weather variable was found for the estimating equations.

All large residuals in the period 1954-1959 resulting from overestimation of the actual production are in the Virginia-Carolina and Southeast areas, with the exception of 1954 in the Southwest. All are believed to be associated with adverse weather. Accordingly, after allowing for adverse weather, the yield equations appear to underestimate production in this period in a manner not characteristic of earlier years. In consideration of these data and yield residuals as shown on the charts for the same period in preceding sections, it is believed that recently applied technology is not adequately reflected.

Regarding the rate of increase in production, this is a reflection of the long-run rate of increase in yields per acre and is a slower rate than has prevailed in recent years. As pointed out in each of the preceding sections, it does not seem advisable to project the rate of recent years without evidence of higher prices, lower acreage, or new technology as yet unapplied, such as a "break-through" on direct application of fertilizer, or control of stemrot. This is not to say that the current rate will not continue, but merely that, until the evidence is clear, the more conservative rate seems the better part of judgement at this time considering the length of the projection period. Comparative data are depicted graphically in Figure 1. Actual production is represented by the solid line, and production as estimated by the yield equations applied to acreage allotments adjusted for over- or underharvested acreage is shown by the broken line.

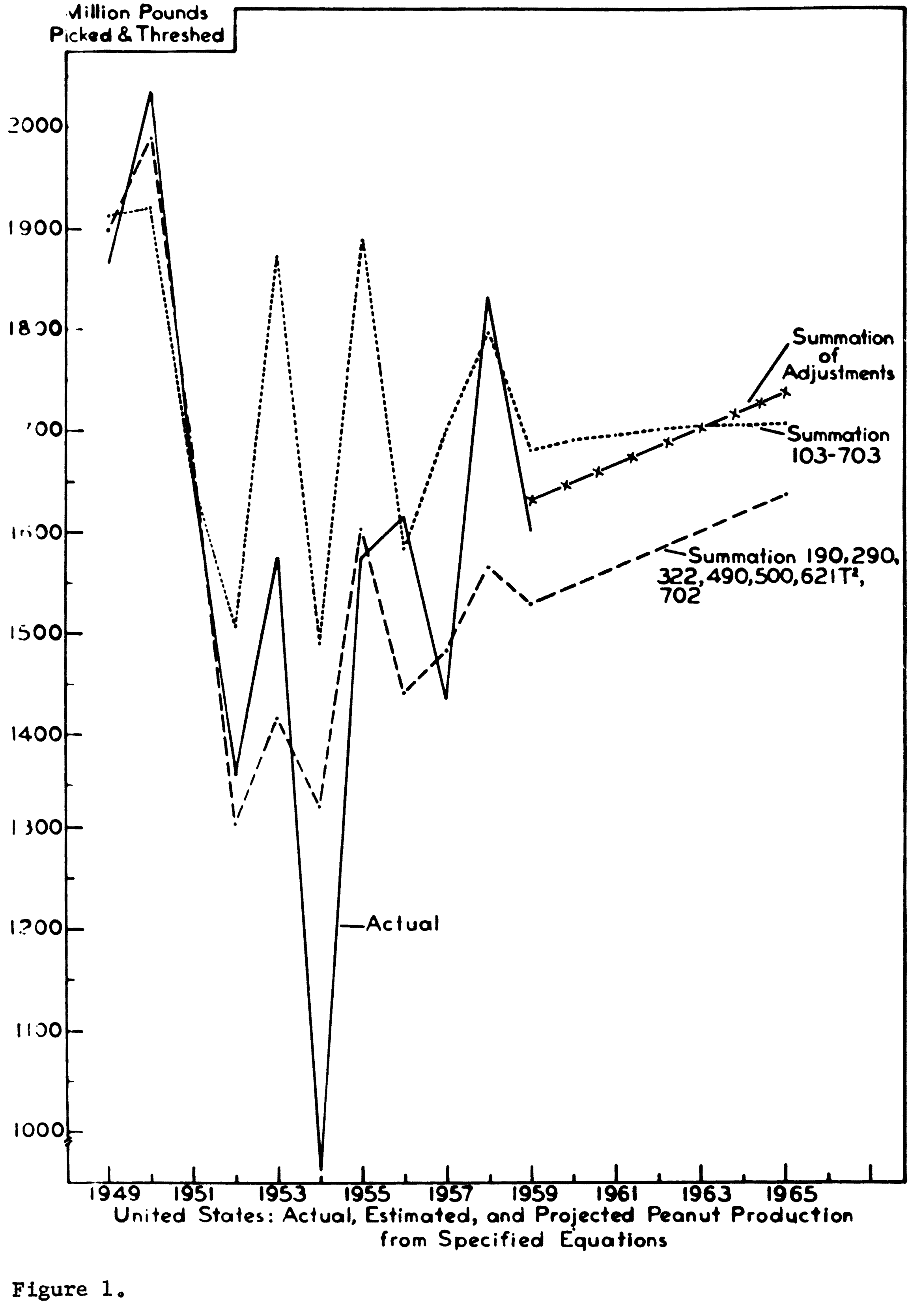

Million Pounds
Picked & Threshed
2000
1900
1800
700
1600
1500
1400
1300
1200
1100
1000
Summation of Adjustments
Summation 103-703
Summation 190,290, 322,490,500,621T², 702
Actual
1949
1951
1953
1955
1957
1959
1961
1963
1965
United States: Actual, Estimated, and Projected Peanut Production from Specified Equations

Figure 1.

Adjustments for Recent Technology

In light of the above considerations, reference is now made to Part I on technological progress with respect to recent varietal innovations in the Virginia-Carolina area, and the Southeast area. Attention is also directed to the description of the progress of irrigation in the Southwest area, particularly in Oklahoma. Review of the yield regression charts and residual yields for recent years for each of the states as presented in Sections IV, V, and VI is also invited in this connection.

The introduction of varieties 56-R and NC-2 in the Virginia-Carolina area would enter the predicting equations (as a time factor) for no more than 3 of the 50 years of the yield analysis. It is believed a similar situation prevails with respect to new varieties in Georgia. Irrigation in Oklahoma began to become a highly significant factor around 1955 or 1956. In consideration of these principal advances in technological progress of recent date, it is believed that production may now have achieved a higher level than the estimating equations suggest.

Accordingly, a subjective increase in yield, for the projection years 1959-1965, of 100 pounds for each of the states Virginia, North Carolina, and Georgia; and 200 pounds in Oklahoma is indicated. These additions and the resulting production for the respective states are set forth in Table 2. The annual increase in total production as a result of these adjustments appears at the lower right of Table 1 as an addition of 103.9 million pounds to the production projected by the yield estimating equations. The upward adjustment in the Southeast is perhaps more conservative than for the Virginia-Carolina area since no change has been made in Florida and Alabama. The evidence does not seem as clear for these two states although perhaps some adjustment should be made. On the other hand, for the area as a whole perhaps the adjustment in Georgia with none in Florida and Oklahoma will be adequate on balance. It is difficult to appraise adjustments of this kind from literature without accompanying discussions with close observers in the area. The method of computing the adjustment in Oklahoma is given in Table 2. It is not clear that a similar adjustment is warranted in Texas at this time. These adjustments are depicted in Figure 1 beginning in 1959 with the dash-X line.

Direct Production Estimates

In Table 3 is presented, in manner similar to Table 1, a national summary of the results of using the selected production equations. As indicated in previous sections, the derived estimates are contrary to that which is considered logical when viewed from state to state as presented in the relevant production subsections of Sections IV, V, and VI. However, the error among states is largely offsetting, giving national data at a nearly constant figure toward the end of the projection period. As indicated previously, the model is not useful. In Figure 1, these data are represented by a dotted line.

Table 2.--Subjective yield and production adjustments to allow for recent and prospective technological progress in Virginia, North Carolina, Georgia, Oklahoma, and United States, 1959-1965.

State	Acres	Estimated increase in yield per acre	Net production increase	Principal reason for adjustment
	Acres	Pounds	Pounds	
Virginia	106,000	100	10,600,000	Variety 56-R
North Carolina	178,000	100	17,800,000	Variety NC-2
Georgia	515,000	100	51,500,000	New varieties
Oklahoma	120,000	200[a]	24,000,000	Irrigation
United States	-------	---	103,900,000	Sum of new technology since about 1956

[a] Assumes average yield would approximate 700 pounds if irrigation had not been introduced. Accordingly, 3,000 pounds have been applied to 26,000 irrigated acres, and 700 pounds to the remaining 94,000 acres.

Table 3.--Production of peanuts: actual, estimated, and projected from specified production equations,[a] Virginia-Carolina, Southest, and Southwest areas, and United States. 1949-1965.

	1949	1950	1951	1952	1953	1954	1955	1956	1957
					- million pounds -				
Estimates:									
Virginia	226.0	199.1	221.8	227.4	222.6	185.1	208.6	205.5	235.3
North Carolina	304.0	287.0	278.7	306.8	304.4	297.4	287.1	307.8	313.3
Other states[b]	4.0	32.0	2.1	1.6	1.2	1.4	2.9	2.6	2.5
Total V-C	534.0	518.1	502.6	535.8	528.2	483.9	498.6	515.9	551.1
Actual V-C	439.8	483.1	562.6	548.9	490.4	424.5	388.0	599.4	527.5
Residual V-C	-94.2	35.0	60.0	13.1	-37.8	-59.4	-110.6	83.5	-23.6
Estimates:									
Georgia	672.1	672.4	590.4	463.9	638.6	512.8	617.8	551.7	587.1
Florida	33.0	40.2	31.5	40.5	44.0	43.3	46.7	42.6	55.5
Alabama	274.3	349.1	227.1	247.7	255.0	186.2	295.3	172.8	176.9
Other states[b]	17.0	19.5	14.3	9.9	9.7	7.3	11.7	15.0	14.7
Total SE	996.4	1,081.2	863.3	762.0	947.3	749.6	971.5	782.1	834.2
Actual SE	968.5	1,086.3	853.4	662.4	782.5	388.7	811.6	868.9	659.8
Residual SE	-27.9	5.1	- 9.9	-99.6	-164.8	-360.9	-159.9	86.8	174.4
Estimates:									
Texas	276.0	217.0	175.2	129.7	268.8	158.5	279.5	185.1	184.9
Oklahoma	97.7	112.1	104.2	69.2	121.2	95.7	127.5	90.0	120.5
Other states[b]	12.5	60.1	10.2	8.1	7.7	7.6	8.1	9.2	11.4
Total SW	386.2	388.9	289.6	207.0	397.7	261.8	415.1	284.3	316.8
Actual SW	456.4	466.0	242.9	144.6	301.4	155.6	375.9	147.4	249.3
Residual SW	70.2	77.1	-46.7	-62.4	-96.4	-106.2	-39.2	-136.9	-67.5
U. S. Total (Est)	1,916.6	1,938.2	1,655.4	1,504.7	1,873.2	1,495.3	1,885.1	1,582.3	1,702.2
U. S. Actual	1,864.8	2,035.4	1,658.9	1,355.9	1,574.2	968.8	1,575.4	1,615.7	1,436.6
U. S. Residual	-51.8	97.2	3.5	-148.8	-299.0	-526.5	-309.7	33.4	-265.6
Estimate/Actual	103	95	100	111	119	154	120	98	118

Table 3.--(Continued)

	1958	1959	1960	1961	1962	1963	1964	1965
				- million pounds -				
Estimates:								
Virginia	222.3	229.7	233.5	237.5	241.5	245.5	249.7	253.9
North Carolina	320.6	325.4	328.5	331.5	334.5	337.3	340.1	342.7
Other states[b]	2.5	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Total V-C	545.4	557.4	564.3	571.3	578.3	585.1	592.1	598.9
Actual V-C	554.1	480.9	-	-	-	-	-	-
Residual V-C	8.7	-76.5	-	-	-	-	-	-
Estimates:								
Georgia	578.7	533.1	531.2	528.7	525.7	522.1	517.9	513.2
Florida	27.6	55.4	54.8	54.1	53.4	52.6	51.8	50.9
Alabama	209.3	193.4	189.3	184.8	180.0	174.9	169.5	163.8
Other states[b]	16.2	14.2	14.1	14.2	14.2	14.2	14.1	14.1
Total SE	831.8	796.1	789.4	781.8	773.3	763.8	753.3	742.0
Actual SE	908.8	(771.6)	-	-	-	-	-	-
Residual SE	-77.0	-24.6	-	-	-	-	-	-
Estimates:								
Texas	273.8	204.2	207.0	209.6	212.1	214.6	217.0	219.3
Oklahoma	130.9	116.0	118.8	121.7	124.7	127.6	130.6	133.5
Other states[b]	15.5	13.1	13.0	13.1	13.0	13.1	13.0	13.1
Total SW	420.2	333.3	338.8	344.4	349.8	355.3	360.6	365.9
Actual SW	372.9	(349.7)	-	-	-	-	-	-
Residual SW	-	-	-	-	-	-	-	-
U. S. Total (Est)	1,797.4	1,686.8	1,692.6	1,697.5	1,701.4	1,704.1	1,706.0	1,706.9
U. S. Actual	1,835.8	(1,602.1)	-	-	-	-	-	-
U. S. Residual	38.4	-84.7	-	-	-	-	-	-
Estimate/Actual	98	105	-	-	-	-	-	-

[a]Virginia 103, North Carolina 203, Georgia 303, Florida 403, Alabama 503, Texas 603, Oklahoma 703.

[b]"Other states" not included in estimating equations. 1957 weighted average production used for projection for Tennessee, South Carolina, Mississippi, Arkansas, Louisiana, and New Mexico.

Projected Requirements

Consideration may now be given to prospective consumption and other uses for the period 1959-1965. Requirements center on two main kinds of data: the national population and the quantity of peanuts consumed per person. As a so-called demand shifter, the rate of change in total quantity consumed is, in the case of peanuts, closely associated with United States population. The amount consumed per person is, in the aggregate, associated with price of peanuts, price of closely related commodities which may be complementary or competitive, and disposable personal income per person.

Since current and prospective population figures are available from the census, the remaining factor to determine is per capita consumption. There are two methods: (1) determine the current rate of per capita consumption, note trends, make assumptions about the future behavior of the rate, and apply the assumed quantities to population data to determine prospective total requirements for edible consumption, (2) obtain an estimate of per capita consumption using a demand function which establishes the per capita consumption relation with factors which generate it such as price of the commodity, price of competing products, disposable income, and a time factor. In either case, projections involve assumptions. Under (a) above, the assumption deals directly with the future behavior of per capita consumption. Under (b) above, assumptions deal with the future behavior of the factors which generate per capita consumption.

As a matter of interest, both methods will be used. Both are subject to the limitations inherent in the judgement of the estimator as decisions are made about either the future of per capita consumption directly, or about the future magnitude of the factors to be applied to the coefficients in a per capita consumption estimating equation. Furthermore, the per capita estimating equation may have shortcomings.

Prospective Surplus Supply Under An Assumed Per Capita Consumption Rate

In addition to edible uses, other uses for total supply need to be considered. These include annual uses for seed, home use by growers, quantities which may be fed or lost, exports, shrinkage and loss in storage, quantities in commercial hands for processing and manufacturing, and carryover of surpluses. In the course of the discussion in Section I, Table 1 was introduced. This gives the relevant data for these items for the years 1954 to 1959, with estimates by the Oils and Peanut Division for the marketing years 1959-1960 and 1960-1961. Included in this table are the data for total commercial edible and crushing use, i.e., the quantity consumed annually by the population. In this case, commercial crushing for oil is a residual byproduct of the shelling and manufacturing process. In Table 4 are presented these quantities converted to per capita consumption rates for the years 1954-1960. For the projection period 1961-1965 an assumed per capita consumption rate of 7.25 pounds, farmers' stock basis (155% of kernel basis),

Table 4.--Estimated per capita consumption of peanuts for edible and commercial crushing use, farmers stock basis. United States, 1954-1958.

Marketing year beginning August 1	Total Edible and commerical crushing[a]	Population[b] January 1. Marketing year	Consumption[c] per capita
	Thousand pounds	Thousands	Pounds
1954..................	1,107,600	164,000	6.75
1955..................	1,058,800	166,800	6.35
1956..................	1,149,200	169,800	6.77
1957..................	1,271,000	172,700	7.36
1958..................	1,258,400	175,600	7.17
1959..................	1,296,000	178,500	7.26
1960..................	1,294,000	181,600	7.12
1961..................	1,328,200	183,200	7.25
1962..................	1,349,950	186,200	7.25
1963..................	1,372,250	189,300	7.25
1964..................	1,395,625	192,500	7.25
1965..................	1,419,550	195,800	7.25

[a] Estimates 1954-1960 obtained from Oils and Peanut Division, Commodity Stabilization Service, U. S. D. A., as of February 25, 1960.

[b] Including Armed Forces overseas, Farm Population and Rural Life Branch, Agricultural Economics Division, AMS, U. S. D. A. Memorandum, April 8, 1960.

[c] Assumed rate for 1961-1965 applied to population to obtain total edible and commerical crushing estimates.

has been applied to the projected population to obtain the consumption requirements for the period.

Using the data from Tables 1 and 4, prospective supply and disappearance of peanuts has been determined for the years 1959 to 1965 as presented in Table 5 under the specified assumptions regarding inventory, which cancels out since ending inventory of one year is the beginning inventory for the next; imports which equate with exports; and seed, etc. which are relatively fixed from year to year. Production, edible uses, and excess supplies are, then, the remaining year to year variables. The residual represents excess supplies to be diverted from the commercial market by government purchases, and sales for export and crushing uses.

Recalling that the annual rate of increase in production is projected at slightly more than 1%, and considering that population is increasing at about 1.7% annually, it will be seen that excess supplies would tend to decline over time, as indicated in Table 5. If the projected per capita consumption of 7.25 pounds is underestimated, excess supplies would, of course, be lower. This procedure and related assumptions project per capita consumption at a rate but slightly higher than that which has prevailed for many years, except in time of war.

In summary of the above estimating procedures:

a) Production increases at about 1% annually.

b) Total consumption increases about 1.7% annually as population increases, with per capita consumption possibly maintaining, at 7.25 pounds, a somewhat higher level as a result of lower peanut price in part, but also as a result of prospective increases in consumer disposable income, considered subjectively.

c) Excess supplies tend to decline but the decline is not sufficient to modify current surpluses appreciably; diversion will be necessary at an annual level approximating 200 million pounds, representing an annual loss of about $10 million to Commodity Credit Corporation, assuming sales for crushing and export are made at a loss of 5¢ per pound.

The implications for the grower are that (1) minimum acreage allotments will remain in effect for the next several years, and (2) the price support level will probably be adversely affected by excess supplies, probably remaining below 90% of parity. The latter is partly determined by administrative policy concerning the handling of government-owned stocks. Since the drought of 1954, which necessitated large imports, Commodity Credit Corporation ending inventories have been maintained

Table 5.--Projected production and consumption of peanuts under assumptions of 400 million pounds annual inventory; 2 million pounds imports and exports; 102 million pounds commercial crushing; 122 million pounds for seed, home use, feed and loss; and specified per capita consumption.[a]

Item	1959	1960	1961	1962	1963	1964	1965
				(million pounds)			
Supply							
Beginning stocks	400.0	400.0	400.0	400.0	400.0	400.0	400.0
Production	1,632.5	1,649.5	1,666.9	1,684.2	1,702.0	1,720.5	1,738.6
Imports	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total supply	2,034.5	2,051.5	2,068.9	2,086.2	2,104.0	2,122.5	2,140.6
Disappearance							
Commercial crushing and edible	1,296.0[b]	1,294.0[b]	1,328.2	1,350.0	1,372.2	1,395.6	1,419.6
Export	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Seed, home use, etc.	122.0	122.0	122.0	122.0	122.0	122.0	122.0
Total edible and related use	1,420.0	1,418.0	1,452.2	1,474.0	1,496.2	1,519.6	1,543.6
Ending stocks[c]	400.0	400.0	400.0	400.0	400.0	400.0	400.0
Total Disappearance	1,820.0	1,818.0	1,852.2	1,874.0	1,896.2	1,919.6	1,943.6
Excess supply	214.0	233.5	216.7	212.0	208.0	202.9	197.0

[a] Farmers stock basis (pounds) 1959, 7.26; 1960, 7.12; 1961-1965, 7.25.

[b] Estimated by Oils and Peanut Division C. S. S., U.S.D.A.

[c] Includes both commercial stocks and Commodity Credit Corporation inventory, assumed level.

at a rather high level until the succeeding crop is assuredly adequate. These stocks are included in the computation of the supply percentage in price support determination, thus they adversely affect the price support level. One of the basic legislative concepts of the support price programs is that of "assuring adequate supplies." Under the circumstances of the "sliding scale" support price provision, there are differences of opinion as to the "adequacy" of the amount of Commodity Credit Corporation ending inventory.

In conclusion concerning this estimating procedure, it might be observed that the rate of yield increase is probably conservative; the assumed static rate of per capita consumption may be regarded as conservative considering the peanut price assumptions made under an expanding general economy; therefore, it is not likely that the cost of the program for diversion, on the average, will exceed current levels. Should yields per acre increase at a somewhat faster rate, it is possible also that per capita consumption might exceed the assumed rate.

Prospective Surplus Under Equation Estimated Per Capita Consumption Rates

Badger and Plaxico[38] recently developed a per capita consumption estimating equation which will now be used to predict consumption of farmers' stock peanuts per capita as a function of the passage of time, the farm price of peanuts, per capita disposable income, and marketing charges. In conference with the senior author, data for these variables for the projection period, 1954 to 1965, have been developed so as to have as close comparability as possible to the data used in their study since the necessary information was not provided in the publication. The authors fitted a least squares regression to the above indicated data for the period 1920-1956. The coefficient of price was significant at the 5% probability level, and except for the time variable which was not significant, the other coefficients were significant at the 1% level.

For the projection period, the price of peanuts received by farmers has been assumed at 9.5¢, the same as was used in the yield estimating equations. Disposable personal income has been projected from $316 billion in 1958 to $417 billion in 1965 as of March 1 of the marketing year. The marketing charges index, constructed by Badger to reflect changes in transportation and labor costs, was projected from a level of 235 in 1958 to 258 in 1965. These data were transformed to suitable indexes appropriately deflated and are presented in Table 6 beginning with the year 1954. Farm peanut price was deflated by the wholesale price index and per capita consumer disposable income was deflated by the consumer price index. The wholesale price index was projected from an index of 225 in 1958 to 231 in 1965, 1935-39 index basis; and the consumer price index from 206 to 211, 1935-39 index basis. The per capita consumption

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[38]Daniel D. Badger and James S. Plaxico, Selected Supply and Demand Relationships in the Peanut Industry, Processed Series P-338, (Stillwater: Oklahoma State University, 1959), p. 29.

Table 6.--Estimated and projected per capita consumption[a] of farmers stock peanuts (excluding oil) as a function of farm price of peanuts deflated by the wholesale price index, disposable personal income per capita deflated by the consumer price index, and index of marketing charges.

Year	Time	Farm Peanut Price Index[b] 1935-39=100	Index of Per Capita Disposable Personal Income deflated by CPI 1935-39=100	Marketing Charges Index 1935-39=100	Estimated Per Capita Consumption Peanuts[c]	Total Population Including Armed Forces	Total Estimated Consumption[d]	Actual Per Capita Consumption[e]
					Pounds	Thousands	Thousand pounds	
1954	35	172.4	159.6	218.7	6.24	164,000	1,023,360	6.75
1955	36	164.7	166.5	226.3	6.58	166,800	1,097,544	6.34
1956	37	152.8	170.5	230.0	6.92	169,800	1,175,160	6.77
1957	38	136.7	170.1	232.0	7.23	172,700	1,248,621	7.35
1958	39	140.4	170.0	235.0	7.10	175,600	1,246,760	7.17
1959	40	123.7	175.0	238.0	7.74	178,500	1,381,590	7.26
1960	41	123.7	179.0	240.0	7.91	181,600	1,436,456	7.13
1961	42	123.7	181.0	244.0	7.99	183,200	1,463,768	--
1962	43	123.7	185.0	248.0	8.19	186,200	1,524,978	--
1963	44	123.7	186.0	250.0	8.33	189,300	1,576,869	--
1964	45	123.7	190.0	255.0	8.43	192,500	1,622,775	--
1965	46	123.7	193.0	258.0	8.60	195,800	1,683,880	--

[a] $\hat{y} = 1.4820 + .0035$ (time) -0.3229 (log price index) $+ 0.2545$ (log income index) $- 0.6895$ (log marketing charge index). From Selected Supply and Demand Relationships in the Peanut Industry, Daniel D. Badger and James S. Plaxico, Oklahoma State University, equation 10.1, Table 10, p. 29.

[b] Assumed farm price, 9.5 cents for 1959-1965.

[c] Derived from above estimating equation.

[d] Derived from equation estimate of per capita consumption applied to population.

[e] Data derived from total edible and crushing data in Table 1, Section 1, as estimated by Oils and Peanut Division, CSS, United States Department of Agriculture.

of farmers stock peanuts estimated by these data when applied to the Badger equation are also presented in Table 6. Consumption increases from 6.24 in 1954 to 8.60 pounds in 1965. This suggests a new peacetime rate of consumption. In view of the new high levels assumed for consumer income coupled with a relatively low farm peanut price, the results seem quite logical except for one thing--the stickiness and relative fixity that per capita consumption of peanuts has exhibited in the past. There is the added consideration of Kromer's observation as cited in Section I; the lower farm price may be offset to a greater extent by higher marketing margins than this equation reflects. Actual per capita consumption as given in Table 6 for 1954-1958, based on data in Table 1, Section I, does show a tendency to increase but not at as rapid a rate as for the prediction equation.

In Table 7 is presented projected supply and disappearance based on per capita consumption rates from Table 6. Supply is the same as that used before in Table 5 based on the yield estimating equations as adjusted for technology. The increase in per capita consumption rate over the period 1959-1965 is sufficient to eliminate all excess supply by 1965, and draw down commercial and Commodity Credit Corporation stocks to a level of about that which is needed for commercial carryover only.

In summary of the above estimating procedures:

a) Production increases, as before, at about 1% annually.

b) Total consumption increases at a more rapid rate not only because of an increase in population but also because of an additional impetus from an annual increase in per capita consumption.

c) All excess supplies disappear by 1963.

The implications for the grower are that (1) minimum acreage allotments will not be adequate beyond 1963; allotments will have to be increased, or (2) support price of peanuts can be increased which will tend to increase supply and reduce requirements, or (3) a combination of price and acreage change could be made effective.

The advent of either of the supply-demand situations projected above, the one of continuing but slowly declining surplus and the other of rapidly disappearing surplus, leaves unresolved certain questions concerning program policy. Should a surplus be permitted to disappear? If not, what should be its normal magnitude? How should a calculated surplus be distributed among areas and types of peanuts? Is the minimum acreage allotment legislation of 1951, as described in Part II, a "fair" distribution of the right to produce peanuts? If not, should the advent of an acreage increase be used to correct inequities? For example, why should Virginia have an allotment of less acreage than it had in 1910 in contrast to all other states? Why should surplus

Table 7.--Projected production and consumption of peanuts under assumption of initial annual inventory of 400 million pounds; 2 million pounds imports and exports; 122 million pounds for seed home use, feed, and loss; and per capita consumption as determined by the demand equation specified in Table 6.

Item	1959	1960	1961	1962	1963	1964	1965
	(million pounds)						
Supply							
Beginning stocks	400.0	400.0	400.0	400.0	400.0	400.0	400.0
Production	1,632.5	1,649.5	1,666.9	1,648.2	1,702.0	1,720.5	1,738.6
Imports	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total Supply	2,034.5	2,051.5	2,068.9	2,086.2	2,104.0	2,122.5	2,116.3
Disappearance							
Commercial edible and crushing	1,381.6	1,436.5	1,463.8	1,525.0	1,576.9	1,622.8	1,683.9
Exports	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Seed, Home use, etc.	122.0	122.0	122.0	122.0	122.0	122.0	122.0
Total Edible and Related Use	1,505.6	1,560.5	1,587.8	1,649.0	1,700.9	1,746.8	1,807.9
Ending stocks	400.0	400.0	400.0	400.0	400.0	375.7	308.4
Total Disappearance	1,905.6	1,960.5	1,987.8	2,049.0	2,100.9	2,122.5	2,116.3
Excess supply	129.0	91.0	81.1	37.2	3.1	---	---

be centered largely in one geographic area? Should a calculated surplus be insulated from supply percentage determinations? Should growers carry the surplus, instead of government, by means of a two-price plan, one for edible use, and one for crushing, such that crushing-use peanuts could be diverted to edible use in case of a short crop? Should importation of peanuts be substituted for a calculated surplus as a less costly means of assuring adequate supplies for consumers? Should a federal marketing order system of multiple pricing be introduced as a substitute for parity relationship pricing and the present means of handling surplus including acreage control?

The examination of these questions would form the basis of additional investigation. It is hoped that this study may have made some contribution to the understanding of the form of the relationships involved to the end that the industry will plot a wise policy course of action in the future.

SECTION VIII

EVALUATION OF THE STATISTICAL METHODOLOGY[39]

An economic analysis is seldom so precise as to exclude certain "feelings" about it as the work progresses. Discussed in this chapter are certain conclusions concerning the shortcomings of the procedures employed and difficulties encountered. These are necessarily intuitive and possibly tentative pending further study. It is not possible to demonstrate or substantiate all of the considerations set forth. The experience gained in this study corroborates the view frequently stated by students of economic problems that methods of prediction need to be based on a profound knowledge of the industry, and careful subjective appraisal of the economic and psychological factors which give rise to a necessity for constant adjustments to change. Time series analysis alone would seem inadequate as all statistical and analytical assumptions are seldom met in full. There are enumerated below several probelm areas which, in any further comparable studies of the industry, should receive more thorough consideration:

1) The pace of technological progress is so rapid that it is difficult to appraise without on-the-scene observations and discussions with growers and industry representatives. The current work of research workers should be known and appraised. Accordingly, research time and travel should be allocated for these purposes, or adequate provision made for obtaining comparable results through a team approach by the experiment stations appropriately concerned. "Long-distance" appraisals are subject to uncertainty, error, and omission.

2) This study has not eliminated sufficiently the errors in measurement of certain variables. Expost appraisal suggests that least squares procedures as applied to "underharvest" acreage models had little likelihood of success because of unaccounted for changes in institutional arrangements and "errors" in the data. Some of these defects have been discussed in preceding sections and should serve as a basis for initial work in any further analysis.

3) Regarding acreage data in general, a more thorough attempt to identify meaningfully associated variables and psychological factors should be made. Time as a variable adds little to basic knowledge when it assumes a primary position in the analysis.

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[39]The author gratefully acknowledges substantial contributions by Dr. Glenn L. Johnson to the substance and language of this section in order to strengthen my modest econometric training and experience, and to provide a more useful reference for students who encounter similar problems of economic measurement.

4) It is unlikely that supply parameter estimates that are as useful for policy purposes as would be desired can be developed until a more adequate index of weather effect is available. The variance due to weather obscures the effect of economic factors.

5) An aggregate production cost index seems inadequate in its application to the variety of conditions in the separate production areas. The ratio of prices received to prices paid does not necessarily reflect the appropriate change in profitability when other important factors have changed. Possibly some combination of time series data and cross sectional data would be an improvement; or cost accounts, if maintained consistently, would assist in obtaining a more adequate measure of variation.

6) The method of least squares analysis fails to provide results useful for all purposes unless certain basic assumptions with regard to time series data are met. These conditions will be discussed below in some detail since they are of considerable importance regarding interpretation of the results obtained. Unfortunately, it is seldom that, in economic analysis, the assumptions underlying least squares procedures can be met in full.

Least Squares Assumptions

The Markoff Theorem specifies the following conditions for a least squares regression of the type used in this study:

$$y = a + bx_{1_i} + bx_{2_i} \ldots + bx_{n_i} \ldots + u_i$$

1) The probability density function of the residual term u_i can be arbitrarily specified. The usual specification is that of normal distribution with mean zero and finite (unchanging) variance.

2) The u_i must be independent of the x_i and the u_i must be mutually independent.

3) The x_i must be known values which are observed without error.

Quenouille [40] points out that to the degree these assumptions do not hold, invalid conclusions may be drawn with respect to estimates of the parameters.

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[40] M. H. Quenouille, Associated Measurements, (Butterworth's Scientific Publication, London, 1952), p. 153.

Errors in the Data

With respect to above item (3) of the Markoff Theorem, inspection of the observed data for acreage and yield in the early years suggests the possibility that estimating errors may be greater in early years than in later years, although the degree of error in either period is not known. Additionally, as has already been explained, considerable uncertainty surrounds the determination of "underharvest" data. In further studies, omission of the early years should be considered.

Specification Biases in the Equations

Regarding items (1) and (2) of the Markoff Theorem, it is not known that all important variables have been identified and included in the equations. In fact, it is quite certain that some important variables have been omitted. Some of these omitted independent variables are correlated with the independent variables under consideration. As a result, the deviations from the regression lines are not of the same variability throughout the range of certain variables and some of the regression estimates are biased. In the long-run yield regressions, for example, it is known that important changes in economic and physical structure have occurred. To an even greater extent, this condition prevails among the acreage and production regressions. It is doubtful that the assumption of an unchanging normal distribution holds. Further, it is probable that "last year's," unexplained residuals are sometimes associated with "this year's," and those of two years earlier. Accordingly, problems of serial correlation are often inherent in the data.

Hald[41] indicates that correlation (r) between two variables may be unreliable when one or both of the series are serially correlated since this condition may indicate lack of independence among included and omitted independent variables. For such indication as they may provide, correlation coefficients for several variables are presented in Table 1 for certain time periods, mainly the entire range of data.

Durbin-Watson tests for serial correlation in the residuals for specified yield regressions are set forth in Table 2. Friedman and Foote[42] describe the Durbin-Watson test as a "method by which the unexplained residuals from an equation fitted by least squares may be tested

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[41]Anders Hald, Statistical Theory with Engineering Applications, (John Wiley & Sons, Inc., N.Y., 1952), pp. 613-614.

[42]Joan Friedman and Richard J. Foote, Computational Methods for Handling Simultaneous Equations, Agriculture Handbook No. 94, (Washington: United States Department of Agriculture, November, 1955), pp. 77-78.

Table 1.--Correlation coefficients for selected pairs of independent variables.

State	Price (X_3)		Price (X_{3t-1})		Price-Cost Ratio (X_{21})		
	Time (X_1) 1909-1958	Peanut Acreage (X_{10}) 1909-1958	Peanut Acreage (X_{10}) 1910-1958	Cost (X_6) 1910-1958	Ratio of Per Acre Value of Competing Crops to Cost (X_{22}) 1920-1940	Time (X_1) 1920-1940	Ratio of Per Acre Value of Competing Crops to Cost (X_{22}) 1910-1948
Virginia	.68	.26	.30	.96	---	---	.64
North Carolina	.66	.09	.04	---	---	---	---
Georgia	.62	.40	.31	.92	.82	.56	.77
Florida	.68	.31	.23	---	.67	.53	---
Alabama	.65	.28	.20	---	.79	.51	---
Texas	.62	.41	.30	.93	---	---	.87
Oklahoma	.56	.54	.47	---	---	---	---

Table 2.--Durbin-Watson test for serial correlation of the unexplained residuals for selected regressions

Regression Equation Numbers	Variables								N	K'	d_L	d_U	d'	4-d'	Results
	X_1	X_1^2	$X_{5(t-1)}$	X_9	X_{10}	X_{16}	X_{21}	X_{22}							
Yield equations:															
Virginia-190.......	*		*		*				49	3	1.34	1.59	1.56	2.44	Inconclusive
Virginia-100t^2.....	*	*	*		*	*			49	5	1.26	1.69	1.76	2.24	No correlation
N. Carolina-290....	*		*		*				49	3	1.34	1.59	1.79	2.21	No correlation
Georgia-322........	*		*	*	*				49	4	1.30	1.64	1.82	2.18	No correlation
Georgia-390........	*		*		*				49	3	1.34	1.59	1.58	2.42	Inconclusive
Florida-490........	*		*		*				49	3	1.34	1.59	2.03	1.97	No correlation
Alabama-590........	*		*		*				49	3	1.34	1.59	1.82	2.18	No correlation
Alabama-500........	*		*		*	*				4	1.30	1.64	1.88	2.12	No correlation
Oklahoma...........	*		*		*	*			49	4	1.30	1.64	2.30	1.70	No correlation
Acreage equations:															
Georgia-366IW......	*						*	*	20	3	.89	1.55	1.38	2.62	Inconclusive
Florida-466IW......	*						*	*	20	3	.89	1.55	.92	3.08	Inconclusive
Alabama-466IW......	*						*	*	20	3	.89	1.55	2.08	1.12	Inconclusive

to see if successive values are correlated," i.e., serially correlated. The following statistic is computed:

$$d' = \frac{\sum_{t=2}^{N} (d_t - d_{t-1})^2}{\sum_{t=1}^{N} d_t^2}$$

where d_t is the unexplained residual for observation t, N is the number of observations in the analysis and k' is the number of independent or predetermined variables in the equation. A table prepared by Durbin and Watson is used to obtain the critical values for a 2-tailed test at the 5% probability level. The values of d' and 4-d' are computed and referred to the appropriate value for d_L and d_U in the table. The two computed values relate to the two tails of the sampling distribution: d' relating to positive serial correlation, and 4-d' to negative serial correlation. If d' or 4-d' is less than d_L, residuals are assumed to be serially correlated, either positively or negatively. If both d' and 4-d' are greater than d_U, no serial correlation is assumed. If neither of the computed values is less than d_L, but one of them lies between d_L and d_U, the test is inconclusive. The limits d_L and d_U are regarded as only approximate when applied, as in this instance, to equations fitted by least squares containing a lagged endogenous variable.

In Table 2, it will be noted that the test has been applied for the most part to selected yield equations. Other equations were not tested extensively because they were not regarded as useful in drawing conclusions from the study. For the equations tested, the results suggest either no serial correlation, or "inconclusive" results.

Effect of Shortcomings on Forecasts

The primary use of regression analysis in this study is to obtain production forecasts. Johnson[43] suggests that in a least squares model such that $y = f(x_1, x_2, x_3 / x_4, x_5) \neq u$, where $u = f(x_6, x_7 .... x_n)$, a knowledge of high intercorrelation between x_1, x_2, ($r_{12} \geq .5$) does not interfere with the forecasting usefulness of the equation. However, the reliability of the estimates of the regression coefficients of x_1, and x_2 is reduced; and if one coefficient, b_1, is overestimated, the other,

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[43]Glenn L. Johnson, Professor of Agricultural Economics, M.S.U., Interview, April 15, 1960. Also see Quenouille, op. cit. 199f.

b_2, is likely underestimated and vice versa. "Outside" information is required as evidence of over- or underestimation. The estimates of b_1 and b_2, however, are not regarded as biased.

Knowledge of high intercorrelation between x_i and x_j ($r_{ij} > .5$) may be cause for more concern, though, again, the predictive power of the regression equation will not be reduced by such correlation so long as the $x_i x_j$ relationship does not change. If x_6 is omitted, the estimate of b_i, however, would be biased as its estimate would reflect the influence of both x_i and x_j, a consideration not reflected in the estimate of the standard error for b_i.

As an example, $r_{12} > .5$ could be the case for the independent variables price, x_1, and a measure of technology, x_2, used to predict yield. Price and technology are positively correlated in the first instance. Technological advance is expected to be related to yield. Price is also expected to affect yield. The regression coefficient for price would not be regarded as a reliable measure of the influence of price on yield if the high r_{12} increased the standard error of b_1 unduly. The same would be true of the coefficient for technology. Yet the resulting prediction of yield could be reasonably accurate. The standard error of estimate of the function could be small, as overestimation of b_1 could be offset by underestimation of b_2 or vice versa. Though overestimation of b_1 is offset by underestimation of b_2 and vice versa, the estimates of b_1 and b_2 are regarded as unbiased. If b_1 or b_2 shculd be greatly over- or underestimated, reversal of logical signs could result. The situation is different if price and technology are assumed to be negatively correlated.

As an example of $r_{26} < -.5$, consider the case for the independent variable price x_2 and a hypothetical omitted variable for poor land, x_6. Price is expected to be positively related to yield while expansion to poor land could be expected to be negatively related to yield. The estimate of the regression coefficient for price could be decreased or offset by the effect of poorer land. In this case, the regression coefficient for price b_2 may be regarded as biased downward; however, the predictions from the equation are unbiased.

As a further example, consider $r_{27} > .5$ where x_2 is price of peanuts and the omitted variable x_7 is price of competing crops. The price of peanuts x_2 will be positively related to acreage of peanuts while price of competing crops will be negatively related; the regression coefficient b_2 will be biased upward; however, predictions from the equation would be unbiased.

In Summary

Both subjective appraisals and objective analyses could have been strengthened by more profound first-hand knowledge of conditions and practices in the several geographic areas. The attainment of more reliable parameter estimates awaits better observed data for both weather effect and cost factors, and a means of placing less dependence on time as a "catch-all" variable. Although statistical shortcomings, such as knowledge of high intercorrelation among independent variables, do not interfere with the forecasting usefulness of the equations, the parameter estimates do not provide the measures of elasticities most useful for policy-making decisions.

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