

REGIONAL TRENDS IN THE PRODUCTIVITY
OF AMERICAN AGRICULTURE

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This is to certify that the

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ABSTRACT

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by

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This thesis describes the construction of new regional data series on agricultural inputs and their combination with existing regional farm output series to generate new regional productivity series. The productivity estimates are global in the sense that all production inputs and all final products are included. Productivity is defined as total output per unit of total input. Input indices were built up from 87 accounts which were estimated separately. The land input was entered at the rental cost which removes appreciation from the analysis. That portion of feed and seed inputs, which is produced on the farm, was deducted from inputs to avoid double counting. Aggregation was done arithmetically using a Laspeyres weighted aggregate formula with price weight periods, 1947-49 and 1957-59 with a splice at 1955. The reference base was set at 1967 = 100. Regional estimates were made for the 32 year period 1939 thru 1970 and included seven major input subgroups: labor; farm real estate; farm power and machinery; fertilizer and lime; feed, seed and livestock purchases; taxes and interest; and a miscellaneous category. Regional indices for fixed and variable inputs were also constructed.

The new U. S. productivity series was spliced into an existing series at 1939 to make a continuous series from 1910 to 1970. This longer series was utilized to examine the relation between productivity change and the adoption of major agricultural technologies. Economists commonly

Leland Don Lambert

assume that technological change is responsible for shifting production functions, yet few studies have attempted to link productivity change to the adoption of major technologies. The major technologies considered were: mechanization, hybridization, fertilization and pesticides. Although multicollinearity limits the evaluation of individual technologies, the results indicate that a few major technologies were responsible for the bulk of productivity change during this century. Since most of the major technologies were fully exploited by the early 1960s, productivity increase has slackened since that time. For the future, minor technologies will contribute a modest improvement in productivity but major change will have to await the discovery of new major technology.

In the appendix is a detailed description of many USDA and other data series utilized as sources of data. There are candid references to the completeness and accuracy of some of these data sources. The states included in each farm production region follows: NORTHEAST: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland. CORN BELT: Ohio, Indiana, Illinois, Iowa, Missouri. LAKE STATES: Michigan, Wisconsin, Minnesota. APPALACHIAN: Virginia, West Virginia, North Carolina, Kentucky, Tennessee. SOUTHEAST: South Carolina, Georgia, Florida, Alabama. DELTA STATES: Mississippi, Arkansas, Louisiana. SOUTHERN PLAINS: Oklahoma, Texas. NORTHERN PLAINS: North Dakota, South Dakota, Nebraska, Kansas. MOUNTAIN: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada. PACIFIC: Washington, Oregon, California.

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The construction of the input series was a long and tedious process. It was a task which could not be accurately done by one person. The author wishes to acknowledge his gratitude to all who made the project possible, and especially to an outstanding few.

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Finally, I wish to thank Mrs. Rachel Evans, who did the compilations. Many statistical manipulations were required to arrive at each of the input estimates. In some cases dozens of calculations were required. Estimates were made for 87 separate accounts for 10 regions for 32 years, a total of 27,840 final estimates. By taking an active interest in the project, Mrs. Evans was able to make accurate calculations with a minimum of supervision and understood the project thoroughly enough to detect several erroneous instructions.

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CHAPTER I

NEED FOR STUDY

We can suppose that the first crude measures of productivity were simple measures such as milk production per goat. Such measures were valuable because they formed a basis for improving the herd. Down through the ages man has developed more and more sophisticated measures.

Productivity indices are now used for a variety of purposes. Prediction of output forthcoming from a given quantity of inputs is one such use. Also, inputs required to produce a given desired level of outputs can be estimated with productivity measures. The economy's maximum capacity to produce is a measure desired during wartime situations. Economic development is another area using productivity measures. The comparative rate of development between nations, geographical regions and over time periods are of interest to development economists.

Most previous studies of agricultural productivity have been limited to nationally aggregated indices. These indices are inadequate for solving many policy problems since interregional differences in investment and productivity are unknown. Policy makers can more accurately formulate commodity adjustment programs if they know regional productivities and their trends.

Many problems requiring productivity estimates are of a regional or commodity nature. The application of national indices to these problems produce questionable results. Regional indices are needed for accurate regional estimates.

The widening spectrum of commercial vs non-commercial agriculture will eventually require another dimension in the matrix of indices, however, data for this separation are not yet available.

OBJECTIVE

The purpose of this study was to develop global or total productivity indices for ten farm production regions in the 48 states for the period 1939 to 1970. Indices were constructed in such a manner that they could be spliced onto existing U.S. indices which extend back to 1870. They were also designed to incorporate existing regional estimates of farm output. Thus the bulk of the problem was the compilation of regional input indices for the period 1939-70 and the necessary adjustments to make the input and output indices methodologically comparable.

In view of the previous work already completed and the mass of data involved, a Laspeyres quantity index was deemed the most practical means of converting the various inputs and outputs to a common measure. 1947-49 and 1957-59 were chosen as price weight periods with the index spliced at 1955. The reference base was set at 1967 = 100.

In so far as the data permitted, factors and products were entered in physical terms. The remaining items were deflated with the price index or combination of price indices judged to be the most appropriate.

A survey of the literature indicated that economists have arrived at differing estimates of productivity change. The discrepancies are caused by differences in assumptions, concepts and definitions. Thus a working definition is in order before proceeding.

PRODUCTIVITY: Definition:

Much confusion surrounds the definition of the word "productivity". In an economic context, the term was first used to denote the average product of labor as per Peter Steiner:

"Productivity is defined as output per unit of input. The almost universal measure of input is labor input, and physical output per man hour is the general measure of productivity and the one employed here." Peter Steiner, Review of Economics and Statistics, November 1950, pg. 321.

Here Steiner is referring to a relationship such as equation (1)

$$(1) \quad O_t = f(L_t, T_t, u_t) \quad \text{where}$$

t = time
 O_t = index of output
 L_t = index of labor input
 T_t = technology
 u_t = unexplained residual.

This conception is deficient because it does not really measure the efficiency or effectiveness of labor since capital and other inputs are not held constant: e.g., we could replace one-half of the labor with machinery and output per unit of labor would double with no change in labor's effectiveness. This type of measure is more nearly a distribution function rather than a production function.

Since the mid-fifties, economists have applied the term to other partial measures as well as to overall measures of output per unit of input:

"The term productivity is frequently used loosely to denote the ratio of output to any related input or class of inputs. In this sense, there is a spectrum of productivity ratios, each of which indicates the savings achieved in particular cost elements over time as a result of changes in productive efficiency and factor substitutions. In order to attempt to measure changes in productive efficiency as such, however, output must be related to the aggregate of corresponding inputs. This is so because the proportions in which factors are combined usually change over time because of changes in relative factor prices or in technical knowledge."¹

Here, Kendrick is discussing a relationship such as equation (2)

$$(2) \quad O_t = f(L_t, K_t, T_t, u_t) \quad \text{where } K = \text{capital input.}$$

¹John W. Kendrick, "Productivity Trends: Capital and Labor", Review of Economics and Statistics, Vol. XXXVIII, No. 3, (Aug., 1956).

In a later publication Kendrick used the term "total factor productivity" to denote the overall measure. Currently, partial productivities other than labor are usually labeled as such by economists. However, the term productivity is still being used to denote both labor productivity and output per unit of input.

Perhaps a better term for overall productivity would be "convertibility" or "transformability". For this study, the term productivity is defined as total output per unit of total input.

SURVEY OF LITERATURE

The first global or overall measures of agricultural productivity were made by Barton and Cooper.² These were annual U.S. estimates for the period 1910-1945. Barton and Cooper used a Laspeyres weighted aggregate formula. They experimented with two price weight periods, 1910-14 and 1935-39, concluding that the latter period had some advantages. Their study indicates that productivity of U.S. agriculture changed little during the period 1910-1922. There was a gradual but modest increase in productivity from 1922 to 1935. There was a more rapid increase during the last 10 years of the period, 1935-45.

Loomis and Barton³ expanded and revised this series by extending the annual estimates through 1958 and by making decade interval estimates for the period 1870-1900. Two price weight periods were used for this study: 1935-39 and 1947-49 with a splice at 1940.

They found that productivity of U.S. agriculture divided roughly into four periods:

1870-1910 A period of extensification during which a large quantity of good cheap land was brought into production. Total inputs doubled during this period. Productivity increased 32 percent.

²Glen T. Barton and Martin R. Cooper, "Relation of Agricultural Production to Inputs," The Review of Economics and Statistics, Vol. XXX, No. 2, (May, 1948), 117-126.

³Ralph A. Loomis and Glen T. Barton, Productivity of Agriculture, Technical Bulletin No. 1238; U.S. Dept. of Agriculture, 1961.

- 1911-1940 All of the good cheap land was already in production when this period started. Most of the land added during this period was in the semi-arid plains. The last decade was beset with the great depression. Total inputs increased only 18 percent during this period. Productivity increased only 15 percent.
- 1940-1950 This was a period of rapid adoption of technology and rapid increases in productivity. Total inputs increased only 4 percent. Productivity increased 18 percent.
- 1950-1958 During this brief period productivity increased even more dramatically: 23 percent. There was no change in the quantity of inputs used.

Lave published several papers on the subject of growth models and technological change. Many of these papers were subsequently summarized in book form.⁴ He briefly outlines the growth models of Solow, Harrod-Domar, Abramovitz and Kendrick, Johansen and others. There is also a discussion of the aggregate production function and its relationship to growth models and indices of technological change.

Lave attempted to measure technological change in American agriculture at both the county, state, regional and national level. These were decade interval estimates for the period 1850-1960. However, the only inputs considered were labor and capital.

Gilbert⁵ reviewed the problems of quality differences which came up in a previous study of international productivity. He distills out the relevant principles for application to time series studies. He concludes that an increase in output can only be defined unequivocally as an increase in the output of goods common to both the current and base years. He points out that "linking in" new goods should be done

⁴Lester B. Lave, *Technological Change: Its Conception and Measurement*. Prentice-Hall, New Jersey, 1966.

⁵Milton Gilbert, "Quality Changes and Index Numbers," Economic Development and Cultural Change, Vol. IX, No. 3 (April 1961), pp. 187-294.

with care due to the differences in production costs and prices between prototypes and mass production.

Griliches⁶ studied the problem of quality change and its effect on productivity indices. He criticized the USDA index of automobile prices as not accounting for quality change. He also criticized the building cost index as being built up from separate indices of the cost of material and the cost of labor. This procedure misses the increased productivity resulting from improved technology.

Griliches also points up the differences in wages reported depending on whether you ask the buyer or seller and presents a method of separating out quality change in automobiles using multiple regression techniques.

Ruttan^{7,8,9} co-authored three papers concerning agricultural productivity measurement. The other authors were Stout and Callahan. These three papers were apparently based on the same or nearly the same data. They are the most comprehensive attempt at developing a global productivity index for U.S. agriculture by regions. The 1962 paper is vague as to what items were included in inputs and outputs. The 1960 paper states: (page 54)

"This series is not an ideal measure of the value of commodities and services produced by farms since it includes some double counting; interfarm sales of feed and seed, interstate sales of feeder and breeding livestock, and the value of inputs purchased from the nonfarm sector

⁶Zvi Griliches, "Notes on the Measurement of Price and Quality Changes", Studies in Income and Wealth, Vol. 28, Princeton University Press, 1964.

⁷Thomas T. Stout and Vernon W. Ruttan, "Regional Patterns of Technological Change in American Agriculture", JFE, Vol. XL, No. 2, May, 1958.

⁸Vernon W. Ruttan and Thomas T. Stout, "Regional Differences in Factor Shares in American Agriculture 1925-1957", JFE, Vol. XLII, No. 1, February, 1960.

⁹V. M. Ruttan and J. C. Callahan, "Resources Inputs and Output Growth: Comparisons between Agriculture and Forestry", Forest Science, Vol. 8, No. 1, March, 1962.

which is of farm origin are all included in gross income. While adjustments for most of these factors can be made at the national level, it was not possible to adjust the regional data."

This series of studies apparently included considerable double counting.

The most comprehensive productivity measurements were made by Kendrick.¹⁰ These measures were made separately and in total for 10 industry groups of which one was agriculture, forestry and fisheries.

Kendrick also made an extensive study of the problem of definition, alternative concepts, methods of measurement, data limitations, and the effects of business cycles.

His estimates were compiled with a Laspeyres weighted aggregative formula with weight periods: 1939, 1947-49 and 1954. Many of the measures used were drawn or adapted from estimates originally made by Tostlebe, Strauss and Bean, and other researchers in the Department of Agriculture. Annual estimates were made for the period 1869-1957.

Comparison of Estimates

The agricultural productivity estimates by Loomis and Barton, Kendrick, Ruttan, Lave, and those made for this thesis were converted to a 1950 base and are graphed on Figure 1.

THEORETICAL FRAMEWORK

As indicated above, productivity means what it is defined to mean and there is more than one definition in current use. For this study productivity measurement hinges on changes in the rate of total output per unit of total input, both output and input being measured in constant dollars. It is concerned primarily with the relationship between factors and products.

Such a measure is closely related to and is often used as a proxy for technological change. A more accurate measure would be of changes in the aggregate production function but here we run into problems. The

¹⁰John W. Kendrick, *Productivity Trends in the United States*, Princeton University Press, Princeton, 1961.

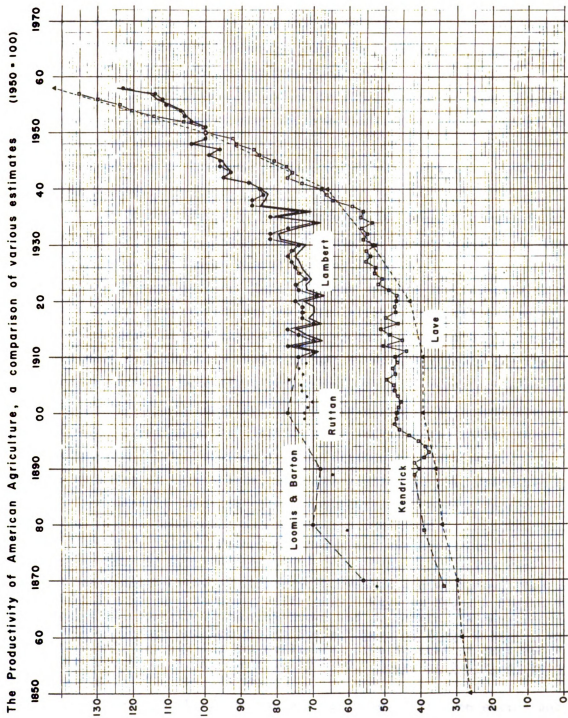


Figure 1

concept of the aggregate production function as advanced by Solow,¹¹ has been a subject of controversy since its inception. The purists claim the problems of aggregating to the industry are formidable, aggregation to the total economy impossible. On the other side, there are economists that claim the aggregate production function is almost as legitimate a concept as the aggregate consumption function.¹²

Since Solow published his paper in 1957, there has been a wealth of literature relating productivity indices, indices of technological change and production functions.¹³

Most efforts to estimate productivity have centered on one of the following methods:

- I. Arithmetic aggregation: This approach has the advantage of being easier to compile, easier for the novice to comprehend. It implicitly assumes a linear production function.
- II. Geometric aggregation: This approach weights the inputs with factor shares rather than prices. It is implicitly related to the Cobb-Douglas rather than a linear production function. It appeals to many as being more realistic but is more difficult for the novice to interpret. Recently a refinement, the CES (constant elasticity of substitution) function has been developed. This function attempts to estimate the elasticity of substitution rather than assume it. This function is more difficult to estimate.

For the purposes of this thesis, an index similar to that described by Domar¹⁴ (and used by Kendrick¹⁵) was considered to be most appropriate,

¹¹Robert M. Solow, "Technical Change and the Aggregate Production Function". Rev. of Econ. & Stat., Vol. 39, (Aug., 1957), pp. 312f.

¹²See Kenneth Arrow, H. Chenery, B. Minhas and R. Solow, "Capital-Labor Substitution and Economic Efficiency," Rev. of Econ. & Stat., Vol. 43, Aug., 1961, pp. 225-40; Murray Brown and J. Popkin, "A Measure of Technological Change and Returns to Scale," Rev. of Econ. & Stat., Vol. 44, Nov., 1962, pp. 402-11; Zvi Griliches, "The Sources of Measured Productivity Growth: U.S. Agriculture 1940-60," Jour. of Political Economy, Vol. 71, Aug., 1963, pp. 331-46.

¹³See Lester B. Lave, Technological Change: Its Conception and Measurement. Prentice-Hall, New Jersey, 1966, pp. 13ff.

¹⁴Evsey D. Domar, "On Total Productivity and All That," Jour. of Political Economy, Vol. LXX, Dec. 62, p. 597-608.

¹⁵John W. Kendrick, Productivity Trends in the United States, Princeton University Press, Princeton, 1961.

in view of budget limitations, time constraints and the output work already completed.

For a two input industry Domar's equation is

$$(3) \quad 0 = A(w_b L + i_b K)$$

where:

A = Index of Productivity

b = weight year or period

w = wage rate

i = interest rate

L = Physical quantity of labor input

K = Physical quantity of capital input

This is known as the Laspeyres quantity index and it can be written as:

$$A_c = \frac{\frac{O_c}{O_b}}{\frac{w_b L_c + i_b K_c}{w_b L_b + i_b K_b}}$$

where: c = current year

Output per unit input is then compared to the reference base period in which both the numerator and denominator = 100. Outputs and inputs in the reference base will not be equal, the difference being profit. Thus the index, in a sense, compares the profit rate in the given year with the profit rate in the base period.

In this abbreviated model only the two inputs labor and capital are indicated and only one price weight period is implied. The index compiled includes 87 separate items with two price weight periods:

1947-1949 for the period 1939-1954,

1957-1959 for the period 1955-1970.

The method used to splice these series is discussed in chapter III.

Measurement Problems

In a strict sense, the index should endeavour to measure the

productivity of that part of agriculture which transforms or creates goods on the farm. In a practical sense, it is not possible to measure the price of all items at the farm gate. Inputs are purchased at the market and products are sold at the market. Thus there is value added by transportation which is not within the confines of the farm as well as a host of other problems.

The proliferation of integrated operations now adds another impediment to price measurement: There is no clean cut transfer of ownership with a price consideration. Rather there is an agreement to share in some subsequent sale nearer the retail level in the marketing chain. Thus, the price received by farmers is, in the case of broilers, based on a diminishing proportion sold through the open market.

Allocation of Output Change to Change in Inputs and Change in Productivity

Following the procedure developed by Mills¹⁶ and Boyne,¹⁷ it is possible to separate the change in output into two portions: that caused by changes in input use and that caused by changes in productivity. Referring to Figure 2, let

I_1 = Input level at beginning of period

I_2 = Input level at end of period

P_1 = Productivity at beginning of period

P_2 = Productivity at end of period

O_1 = Output at beginning of period

O_2 = Output at end of period

Then, if we hold the productivity level constant at P_1 and increase inputs from I_1 to I_2 , the change in output caused by the change in inputs alone is $P_1 \Delta I$. If we hold the input level constant at I_1 and increase productivity to P_2 , the change in output caused by the change in productivity alone is $I_1 \Delta P$. This leaves the residual $\Delta I \Delta P$ shown by the rectangle ab, which is caused by interaction between the change in inputs

¹⁶Fredreck C. Mills, "Productivity and Economic Progress," Occasional Paper 38, NBER (1952), pp. 32f.

¹⁷David H. Boyne, "Changes in the Real Wealth Position of Farm Operators, 1940-1960," Technical Bulletin 294, Michigan State University, 1964.

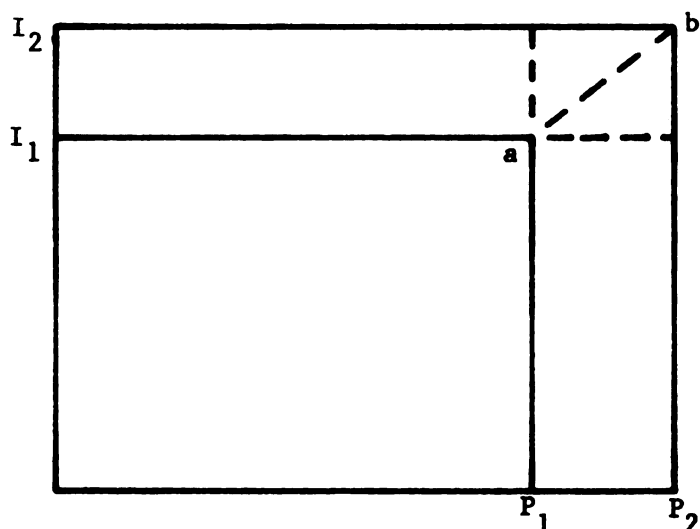


Figure 2

and the change in productivity.

By arbitrarily dividing this residual into equal parts, we can allocate the total change in output between inputs and productivity. The part allocated to the change in inputs is then

$$P_1 \Delta I + \frac{\Delta I \Delta P}{2}$$

The part allocated to the change in productivity is

$$I_1 \Delta P + \frac{\Delta I \Delta P}{2}$$

Alternatively we can reason that to move from a to b, we must start at a and end up at b. It is then assumed that the expansion path is a straight line.

The next three chapters of this thesis detail the methods used to compute the many input accounts, the splicing procedure, output computation and productivity indexing.

In chapter V are estimates incorporating the Mills-Boyne procedure and an effort to establish the relationship between productivity and the major agricultural technologies.

The concluding chapter draws policy implications and outlines expectations for the future.

CHAPTER II

INPUT COMPILATION

A catalogue of the items included in the input index appears on appendix pages 104 to 106 . Details concerning data sources and the methods used to reduce these inputs to constant dollar expenditures also appears in the appendix. A discussion of associated methodological and conceptual problems follows:

LABOR

The labor input can be broken down into three general classes: Hired, operator, and other family labor. Since the labor of the operator and other family members is not paid, it is difficult to establish a weight period price or wage for it. It seems reasonable to assume that the quality of hired labor and other family labor is roughly equal. However, there is evidence which indicates that the operator's labor is of a higher quality than hired labor:

- a. Most operators who liquidate their farm operations take higher paying non-farm jobs rather than becoming hired men.
- b. Considering only the set including tenant operators and hired farm workers, a substantially larger proportion of tenants accumulate sufficient savings to purchase farms. These savings must come from one or more of the following sources:
 - (1) More hours worked as a result of:
 - (a) Longer work week,
 - (b) Less unemployment.
 - (2) Substantial returns to:
 - (a) Investment in machinery and livestock,
 - (b) Management,
 - (c) Entrepreneurship.

(3) Higher returns per hour worked, or greater efficiency.

- c. Professional farm managers often have a choice of operating their client's farms as either tenant operations or "direct" operations. (A direct operation is one run entirely with hired labor.) Although a professional management firm is selling more management with a direct operation, they seldom use this type of operation since it is usually less profitable.

Many researchers apply the mortgage interest rate to the land value, account for the paid inputs, and label the residual as return to labor and management. This approach is defective since this residual includes profit or loss. Thus, the residual can vary with the quality and quantity of both labor and management held constant because of changes in weather or prices.

If we rule out the residual as a measure of labor input, the only alternative remaining is the opportunity cost approach. Here we have some difficulty in identifying the relevant alternative opportunity. Is it the hired farm wage or the industrial wage adjusted for moving costs?

The hired farm wage implies full employment. Thus, it seems likely that many underemployed farm operators would receive an average labor income less than that implied by the hired wage. At the other extreme, there are many operators who are capable of drawing industrial wages and do so when they leave agriculture.

Few studies have been made to determine where the "leavers" go and whether they do better or worse in their off-farm alternative. Loomis,¹⁸ working with data from two counties in Southwest Michigan, found that part time farmers had a preference for farm work. These part time farmers were asked:

- a. How much annual income would you have to have from non-farm work before you would quit farming and
- b. How much annual income would you have to have from the farm before you would quit working off the farm?

The difference between the two figures, \$1,266, is an indication of the dollar value of the amenities which are associated with farming.

¹⁸Ralph A. Loomis, "Working in Two Worlds--Farm and Factory," Michigan State University Agricultural Experiment Station Research Report No. 32, 1965.

Because of these amenities, charging the family labor input at their industrial opportunity cost would result in an entrepreneurial loss for many recent years.

Thus, as a first approximation, a decision was made to charge the family labor at the hired farm wage. Inspection of the residual indicates little left over to justify a higher rate.

Labor Quantity

There are three independent series measuring the quantity of farm labor. The Bureau of Labor Statistics measures the hours worked by those who work the majority of their time in agriculture. The Statistical Reporting Service reports the employment of operators and hired men working one or more hours during the survey week and other family members working 15 or more hours. The Economic Research Service measures the labor required to do the work performed.

These measures are graphed on Figure 3. The differences between the series are believed to be caused by differences in concept and "stand-by" time.

A detailed discussion of the labor data appears on appendix pages 107 to 110.

For hired labor, it is possible to compute an additional measure by dividing the wage bill by the wage rate. These measures are graphed on Figure 4. The ERS quantities on this graph were derived with the procedure indicated in the appendix. It can be reasoned that the stand-by time of the family labor does not have to be paid and is thus not an input in the production function. It can also be argued that all committed inputs should be paid. For those items such as hired labor and machinery, this is a reasonable argument since the labor will not be available unless it is paid for standing by as well as working. The machine is paid for at purchase, thus it is paid whether it is used or standing by. However, this argument is not valid for the operator's labor. He does not pay himself for his underemployment.

The ERS series on labor required is the only complete one for the entire period. A decision was made to enter the family labor at the ERS level based on labor required. For hired labor, six percent was added to

Labor Hours Comparison

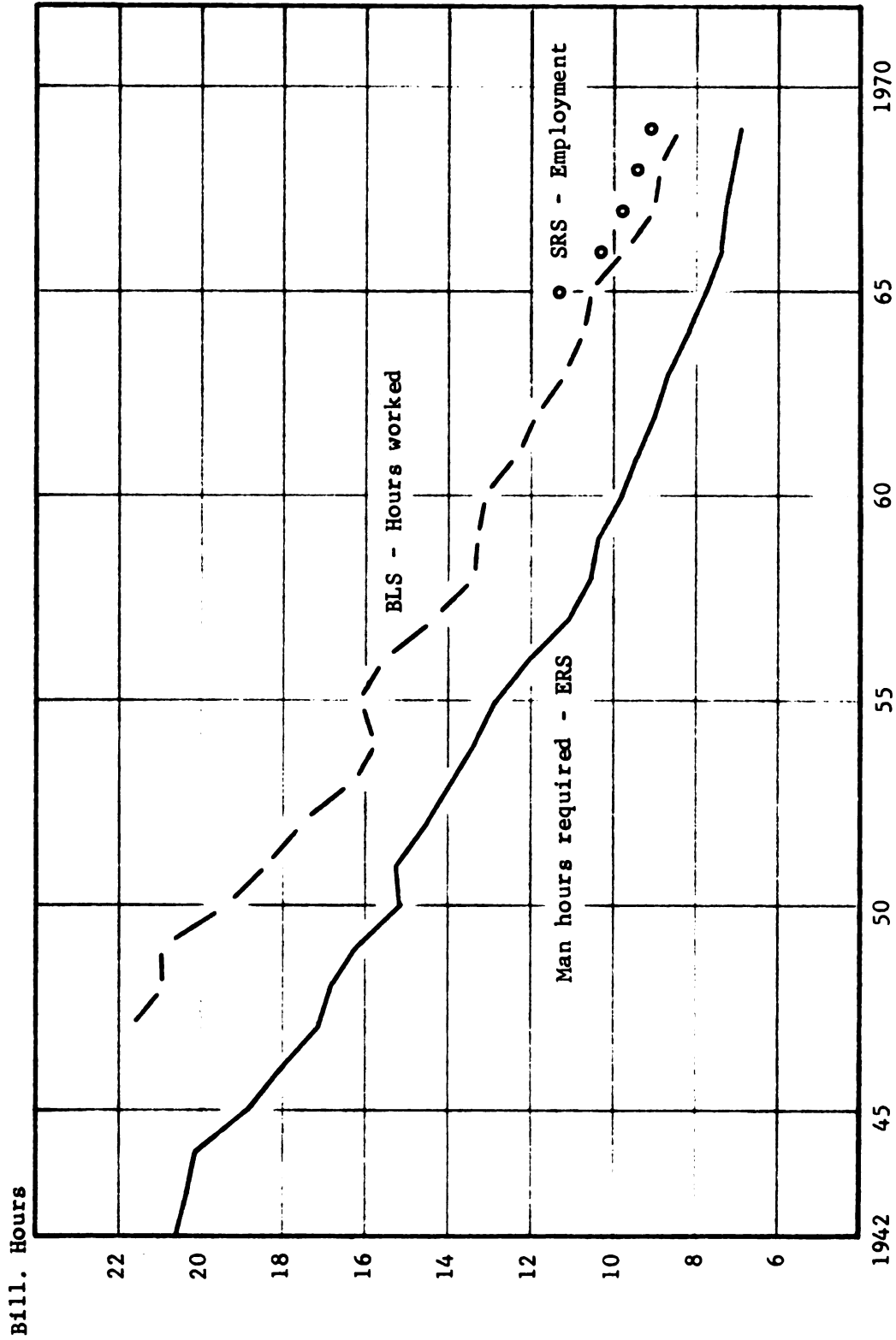


Figure 3

the ERS level to account for "stand-by" time. This is the line labeled ERS + 6 on Figure 4.

This general procedure is consistent with industrial indices since they treat labor as a variable input and thus do not pay directly for its unemployment.

REAL ESTATE

Two means were available to estimate constant dollar values for the real estate input:

- I. Current dollar values of land plus buildings could be deflated with some appropriate deflator.
- II. The physical quantity of land could be multiplied by the weight period value per unit.

The second method has theoretical advantages, but presents the problem that the only per acre values available by classes of land exclude building values. In either case, some means was needed to convert the constant dollar value of the stock of real estate into an annual flow of input.

A decision was made to use method II, thus data were needed on:

- 1) The quantity of land,
- 2) The weight period per unit value,
- 3) The value of buildings,
- 4) Some means to convert the constant dollar value into an annual flow.

The Quantity of Land

A decision was made to use the Agricultural Census as a data series for land quantity since this was the only source available prior to 1950. Census land classifications have changed slightly during the period involved. There has been a general trend to carry through the sub-classifications with additional refinements and with changes in the headings and grouping of some classes.

The Value of the Stock of Land

In order to develop the constant dollar value of the stock of land, it was necessary to develop land classifications which were consistent with the per unit values, and for the 17 western states, also consistent

Hired Labor Hours Comparison

Bill. Hours

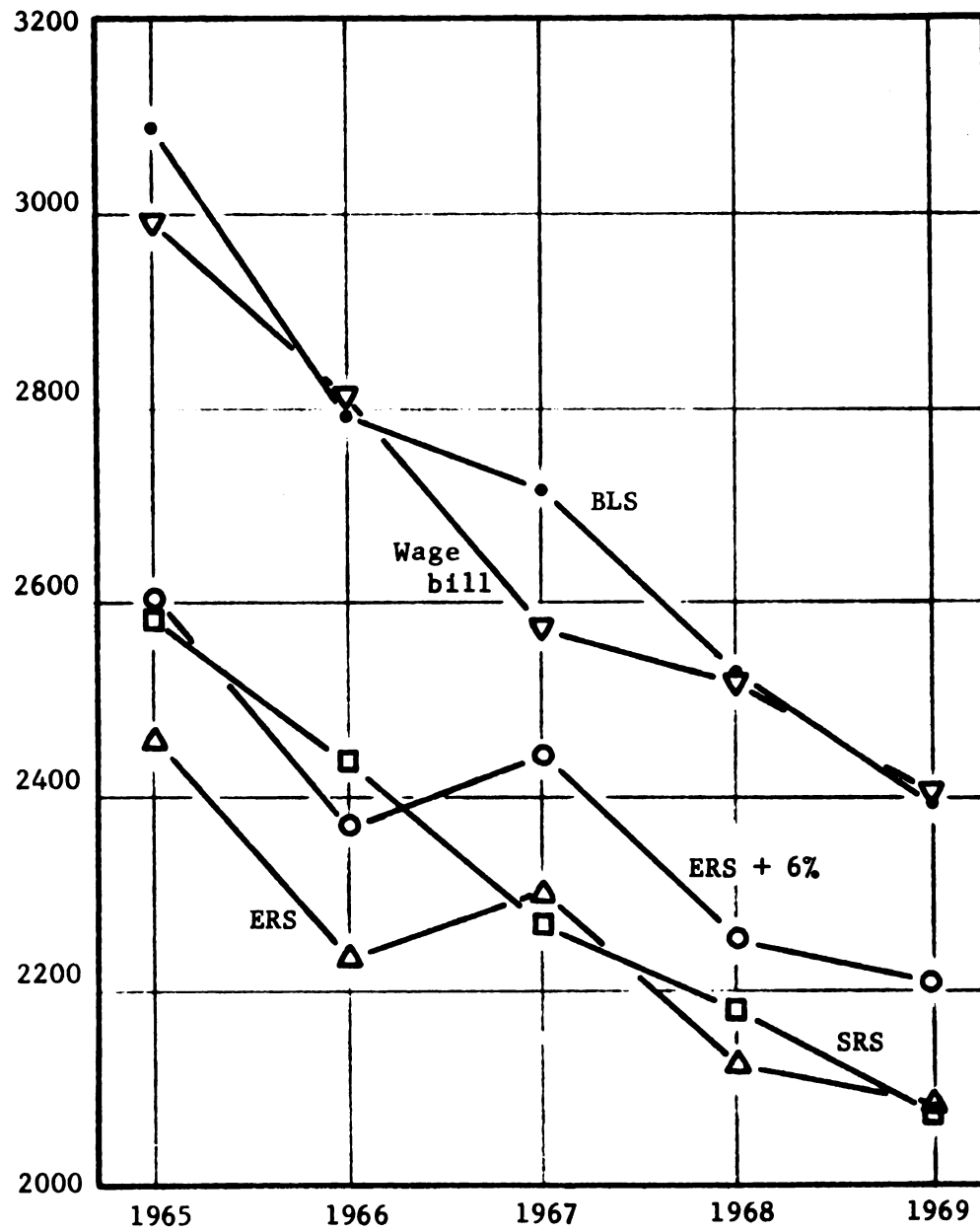


Figure 4

with the rent/value ratios which were used to convert the stock into an annual flow of input. The method used and data series are discussed in the appendix.

The Value of Buildings

In order to build up total land values by classes, it was necessary to use weight period per acre values which excluded buildings. The operator's dwelling was not considered to be a production item, thus it was desired that it be excluded. However, the remainder of the farm buildings are production items and should be included as an input. Service building values were available which could be deflated to obtain a constant dollar value. However, annual regional data were also available on the value of buildings as a proportion of total real estate value. These ratios permitted the calculation of a constant dollar value for land plus service buildings. An illustration of the equation used for this calculation appears in the appendix.

Conversion of the Stock of Land Into an Annual Flow of Input

Many researchers use the mortgage rate of interest as a proxy for the earning rate of land. On a national basis this approach might be acceptable, however, for a regional index, the mortgage rate is defective because:

1. Both the seller and most prospective purchasers of farm land are dealing in a local market; however, the mortgage rate of interest is determined in a national market. Loanable funds are quite mobile and go where the interest rate is highest. Hence, what little inter-regional differences there are in the mortgage rate can be attributed mainly to differential administration costs which are a function of the size of loans. Moreover, loanable funds do not confine themselves to the agricultural market in seeking the greatest return. Thus, the farmer is competing with industrial and commercial borrowers when he approaches the local lending agency.
2. It might be reasoned that a farmer can acquire land by borrowing the capital. Thus his cost of acquiring land is the mortgage interest payments. This would be true

if a farmer could borrow 100 percent of the purchase price. However, the lender discounts for risk, thus the bulk of the risk is borne by the owner's equity which should, *ceteris paribus*, earn a higher return for a greater risk.

The mortgage rate of interest implies that the only means of obtaining the use of land is to purchase it. Leasing is an alternative means of obtaining land services. The estimated rent is believed to be superior because:

3. The decision to buy or sell land may be influenced by factors other than value in production. Thus a buyer may pay more than the productivity value of land in order to:
 - a. Gain status of landholder,
 - b. Gain tax advantages,
 - c. Retain control of birthplace,
 - d. Speculate on:
 - (1) General inflation of land prices,
 - (2) Increase in value due to urban expansion,
 - e. Live in the country,
 - f. Live near friends and relatives,
 - g. Be self-employed,
 - h. Gain job security.

There are little data available on the aggregate rental value of all land. However, the rental can be estimated by multiplying real estate values by the ratio of rent to value. By this method we can not only convert the stock of land into an annual flow but we can also sort out some of the other factors which we wish to exclude.

Since the tenant does not benefit from appreciation he will only pay rent on the productivity value (other things being equal), i.e.,

we let P = the productivity value and

S = the extra payment made for speculation, then

$P + S$ = total land value.

Let R = rent justified by productivity, then the tenant is willing to pay rent of R based on productivity value P or a rent/value ratio of R/P . However, the landlord has $P + S$ invested in the land. Thus the ratio of

rent/value received by the landlord is $\frac{R}{P + S}$, a lower figure. Thus the

rent/value capitalization rate accounts for the extra investment which a buyer puts into land in order to speculate, or the income foregone by an existing owner to retain the property.

In a similar manner the rent/value ratio accounts for the extra payment a buyer makes (or owner foregoes) in excess of the productivity value in order to: gain status of landholder, gain tax advantages, and retain control of birthplace.

The rent/value ratio does a less perfect job of separating out extra payments which an owner makes to gain some of the other amenities: country living, location near friends and relatives, self-employment, and job security, since, to a slightly less secure degree, a tenant can also enjoy these amenities and may pay a rent in excess of that justified by the productivity value.

Another factor affecting land values is Government programs. A buyer might pay a premium because of the return possible from participation in a Government program. However, a tenant would also presumably pay a higher rental for the same reason. If this factor has an equal effect, then both the numerator and denominator would be affected equally and the rent/value ratio would remain constant. However, there is no certainty that Government programs will continue in the long run. Since the buyer is concerned with the long run whereas rental contracts are typically for one year, it is likely that Government programs have a greater effect on rents than on values. This may be a partial explanation for the high ratios in the cotton and tobacco producing regions.

Data sources and methods used to compile rent/value ratios are discussed in the appendix, pages 117 thru 119.

INTEREST ON REAL ESTATE MORTGAGES

The procedures outlined for land above would give an accurate estimate of the real estate input providing the farmer owned a 100 percent equity. However, for that portion of the real estate which is mortgaged, the appropriate rate for converting from a stock to a flow is the mortgage rate of interest. Thus, the constant dollar value of land plus service buildings was split into "equity" and "mortgaged" portions by

using the ratio of current dollar mortgages outstanding to the total current dollar value of all real estate. The equity portion was then converted with the rent/value ratio.

Real estate mortgages outstanding were multiplied by the weight period average interest rate paid on real estate mortgages outstanding. The product is what it would have cost farmers to borrow the money if there were no change in interest rates. The interest which the farmers paid the lending agency declined in purchasing power with inflation. Thus the product above was deflated with the index of prices paid by farmers for items used in production, interest, taxes and wage rates.

LAND IN GOVERNMENT PROGRAMS

Underlying the theoretical models for productivity measurement, are the usual assumptions of equilibrium in both the factor and product markets. Here we run into difficulty with government programs. We have chosen to use the Laspeyres quantity index:

$$\begin{aligned} \text{Output Index} &= \frac{P_b Q_c}{P_b Q_b} \\ \text{Productivity Index} &= \frac{\text{Output Index}}{\text{Input Index}} \\ \text{Input Index} &= \frac{C_b Q_c}{C_b Q_b} \end{aligned}$$

where: the P's are output prices, the Q's are quantities, and the C's are input costs.

Government payments pose a problem since they are an income but not a product. On the physical production function, there are inputs committed in order to gain the subsidy but on the output side there is no physical counterpart. To the extent that Government payments are transfer payments, it would appear that there is no corresponding expense. However, there is a tendency for the potential profit from subsidies to be capitalized into the land values. Since there is no certainty that the programs will continue indefinitely, the potential profit will be heavily discounted for this risk. However, this discounting will have little effect on rents since they are for a relatively short term,

especially cash rents. Since the ratio of net cash rent to value was used to convert the stock of land into an annual flow, the rents will be inflated for most of the expected profit from the subsidy. Thus, for the weight period, the inputs will match the outputs if we include government payments as outputs. Over the entire period, this procedure is defective however, since part of the payments have been made as price supports and part as direct payments and there has been a secular change in the proportions of each.

It would be exceedingly difficult to separate out the benefits of the price support programs since they affected the free market prices.

A decision was made to do the analysis both ways, with and without an adjustment for government programs. These results are discussed in chapter IV.

The reasoning used for the government program adjustment follows:

For part of the government programs, the farmer is required to idle certain resources in order to gain price supports. For these inputs, we can reason that the inputs committed to the programs are balanced by the increased value of the output. For some of the government programs, the farmer can choose voluntarily to retire additional resources (mainly land) in order to gain a direct government payment. This payment is generally in excess of the fair rental value of the land retired. Thus a weight period payment rate was computed by dividing the weight period payment (for the land voluntarily retired) by the acres so retired. This weight period payment rate was then applied to the acres voluntarily retired for the entire period. These estimates were then subtracted from the real estate input.

DEPRECIATION

Current dollar estimates of depreciation were obtained from the Farm Income Branch, Economic and Statistical Analysis Division, Economic Research Service, U.S.D.A. (subsequently abbreviated as F.I.B.). These estimates are compiled as the estimated outlay, in current prices, which would be required if farmers were to replace the plant and equipment used up during the year. The estimates are based on a "declining balance method" in which a constant percentage representing the annual rate of depreciation of each type of capital is applied to its estimated

value at the beginning of each year. A more detailed discussion of these estimates appears in the appendix.

The price indices used to deflate these current dollar estimates follow:

Depreciation on service buildings and other structures:

The F.I.B. index of service building construction costs.

Automobile depreciation:

The F.I.B. index of prices paid for new automobiles.

Tractor depreciation:

The F.I.B. index of prices paid for new tractors.

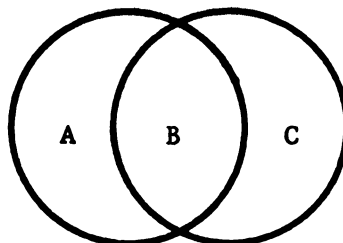
Truck depreciation:

The F.I.B. index of prices paid for trucks.

Depreciation on other farm machinery:

The SRS index of farm machinery prices.

INSURANCE AND ACCIDENTAL DAMAGES TO SERVICE BUILDINGS AND MACHINERY



Referring to the diagram:

Let $A + B$ = insurance premium payments,

$B + C$ = accidental damages,

B = accidental damages covered by insurance,

A = premium payments less claims (or net insurance premiums),

C = uninsured accidental damages.

If farmers did not have insurance they would be out $B + C$. By buying insurance they are out an additional amount A since premiums (typically) exceed indemnities.

Current dollar estimates for this input were obtained from the Farm Income Branch, ESAD. These estimates were compiled as net insurance premiums and total losses. The net insurance premiums were deflated

with the SRS index of prices paid for building and fencing materials. Total losses were deflated with the FIB index of farm service building construction costs.

MAINTENANCE OF SERVICE BUILDINGS AND MACHINERY

Current dollar estimates were obtained from the Farm Income Branch. These estimates cover repairs and maintenance of farm service buildings, and repairs and maintenance of motor vehicles and farm machinery. A detailed summary of the method of compilation appears in the appendix. The price indices used to deflate these estimates follow:

Repairs to service buildings and other structures and land improvements:

The SRS index of prices paid for building and fencing materials. Automobile repairs, parts, and tires:

A composite index made up of 0.66 times the BLS index of prices paid for auto repairs and maintenance, plus 0.34 times the BLS index of prices paid for auto tires.

Tractor repairs, parts, and tires:

A composite index made up of 0.91 times the BLS index of prices paid for auto repairs and maintenance plus 0.09 times the BLS wholesale tractor tire price index.

Truck repairs, parts, and tires:

A composite index made up of 0.70 times the BLS index of prices paid for auto repairs and maintenance plus 0.30 times the BLS wholesale price index of truck and bus tires.

Other farm machines: Repairs, parts, and tires:

A composite index made up of 0.98 times the BLS index of prices paid for auto repairs and maintenance plus 0.02 times the BLS index of prices paid for auto tires.

¹⁹ During the war period and for some of the earlier years of the period, BLS figures were not available. SRS prices were used to bridge these gaps in BLS figures.

About 1/3 of the expenditures for the automobile repairs, parts, and tires account was for tires, thus the indices were weighted 2/3 for repairs and parts and 1/3 for tires. Similar reasoning was used for weighting the indices for farm machinery.

GRAZING FEES

Fees for grazing on public lands were compiled as physical quantities times weight period prices per unit. For most classes of public lands, the unit was acres, for National Forest land, the unit was animal unit months.

Most of the fees on public lands are set at less than the fair market value. In most cases, the difference between the fee charged and the fair market value is a subsidy which is capitalized into the value of the adjoining ranch and thus shows up as land input there.

THE VALUE OF INVENTORY STOCKS

Machinery:

For farm machinery and motor vehicles, national total current dollar inventory values as of 1 January were available from the Farm Income Branch, ESAD. The current year 1 January figures were averaged with the 1 January figure for the following year to approximate an annual average. For tractors, trucks and the production share of automobiles, the national total figures were distributed to regions with the number of machines or vehicles on farms.

To date, there are only two observations on the distribution of other farm machines to regions:

- 1) the 1949 Census,
- 2) the 1955 Survey of Farmers Expenditures.

The 1949 distribution was used for the years 1939-48. A straight line interpolation of the proportional distribution was used for the period 1949-55. The 1955 distribution was used for the period 1956-date.

The following price indices were used to deflate the current dollar estimates:

- Automobiles: The FIB index of prices paid for new automobiles,
- Tractors: The FIB index of prices paid for tractors,
- Trucks: The FIB index of prices paid for trucks,
- Other farm machines: The SRS index of prices paid for farm machinery.

Livestock and Grain

Constant dollar inventory values for these items were compiled by multiplying current quantities by weight period prices per unit. For livestock, the total 1 January inventory value was compiled. For grains and forages, it was reasoned that inventories were near a peak on 1 January, thus a decision was made to reduce these figures by one half to approximate an annual average quantity of grains on hand.

Operating Capital

A part of the demand deposits held by farmers are no doubt intended for consumption rather than production. It is reasonable to assume that this is likewise true of currency holdings. Since there are no data available on currency holdings, it was assumed that currency held for farm production purposes was equal to the demand deposits held for consumption. Thus the total operating capital is equal to demand deposits. Data on demand deposits held by farmers were obtained from the Agricultural Finance Branch, FPED. They were distributed to regions with the distribution of total production expenses from the Farm Income Situation. For the period 1939-48, total production expenses were not available. Thus, the 1949 relationship between production expenses and total cash receipts was applied to total cash receipts for the period 1939-48. The distribution of this derived production expense was used to distribute demand deposits.

Opportunity Cost of Capital Invested in Inventory and Operating Funds

We were able to estimate the rate of return which farmers receive on their equity in land by measuring the ratio of rent to real estate value. Now that we have a return to land, is there any reason to suspect that farmers receive or expect a different rate of return on their other investments? In the past, researchers have customarily used the mortgage rate for converting land stock to flows and the short term interest rate for converting other forms of capital. We have rejected the mortgage rate for converting the land stock. Now how does the chattel mortgage rate fit as a means of converting inventory stocks into an annual flow of inputs?

Chattel mortgages carry a higher interest rate than land mortgages because: the loans are smaller, have a shorter term and thus the administration cost per dollar loaned is higher; the collateral is movable, thus there is greater risk of default with little means of recourse.

Now these factors that determine the chattel rate have no relationship to the rate of return the farmer receives on the investment in question. The figure we are trying to approximate is the rate of return that farmers receive on operating capital. We cannot estimate this directly since farmers do not separate their return to: investment in real estate, investment in operating capital, labor, management, entrepreneurship.

To approach the problem by stages, let us compare, to an owner operator, a tenant operator who rents for cash. In discussing the land input, we concluded that a tenant operator may pay a rent greater than is justified by earnings in order to gain some of the amenities that accrue to a farm operator, i.e., the status that results from being a self employed businessman, country living, a location near friends and relatives. A farmer who owns his own farm gains additional amenities: landholder status, control of birthplace, additional job security, full control of management of farm operation and farm residence, land as a vehicle for speculation. (A tenant operator may speculate on feeder cattle, however, he cannot expect a long term capital gain such as a landowner can.)

Thus we can reason that a farmer would expect a somewhat lower rate of return on his investment in land than he would expect on his investment in operating capital. However, an investment in operating capital is more flexible than an investment in land, i.e., a tenant farmer has less asset fixity than an owner and can get in and out of business with less transfer costs.

Thus the rate for which we are searching should lie somewhere between the rent/value ratio and the chattel mortgage rate. In view of the data available, a decision was made to use the interest rate on real estate mortgages as a proxy for the opportunity cost of equity capital invested in inventory.

INTEREST ADDED BY NON-REAL ESTATE DEBT

Interest on short term debt was handled differently from real estate mortgages in order to simplify computations. For the real estate input, it was fairly simple to divide this single input into an equity and a mortgaged portion. But for non-real estate capital, there were 18 items and it would be both laborious and fictitious to allocate non-real estate debt to each item, so the problem was approached indirectly by reasoning:

Let L = the cost to the farm of acquiring the use of equity capital.

The real estate mortgage rate was assumed to be a good proxy for this opportunity cost.

S = interest rate paid on non-real estate loans.

X = total value of non-real estate capital.

P = quantity of short term capital borrowed.

Then $X - P$ = equity portion of non-real estate capital.

$L(X - P)$ = opportunity cost on equity portion.

SP = interest paid on non-real estate loans.

$L(X - P) + SP$ = total interest on non-real estate capital.

We can more easily obtain the same results by taking the long term rate across the total non-real estate capital and adding on the difference between the long and short term rates times the principal borrowed, i.e.,

$$LX + (S - L)P = L(X - P) + SP$$

The term $(S - L)P$ was then labeled in the input list as "Interest added by non-real estate debt".

Data were not available on P , the quantity of short term capital borrowed. The Farm Income Branch did have data on the current dollar interest paid. The principle can be estimated by dividing interest paid by the interest rate, i.e., $P = SP/S$

Data were also not available on the interest rate being paid on short term loans outstanding. An assumption was made that the current short term rate lagged one year would be a reasonable estimate of the rate for loans outstanding.

The rate of interest was defined to be a price, thus additional manipulation was required to get S on a weight period basis. A mathematical note illustrating the method used appears in the appendix. Also

in the appendix is a discussion of the Farm Income Branch's estimates on interest paid.

The method described above derives the amount of interest that the farmer would have paid the loan company if there had been no change in interest rates. It was still necessary to make an adjustment for changes in the purchasing power of the money paid, thus the figures derived were deflated with the SRS index of production costs.

FUEL AND OIL

Physical data on fuel and oil consumption were available only for the years 1947, 1948, 1953, and 1959. For that reason, a decision was made to deflate expenditures available from the Farm Income Branch.

Inspection of regional price movements indicated that a national price index would not be appropriate since prices moved in different directions in different regions. Thus, regional price indices were constructed based on the tank truck price of regular gasoline as reported by the SRS. Price data were skimpy for the early part of the period. The method used to fill in the void is discussed in the appendix.

CUSTOM WORK

Except for cotton ginning, there was no series available on custom work. To the extent that custom work is done by farmers, the input has already been compiled by its components, i.e., the labor, fuel, depreciation, maintenance, etc., have been accounted for. However, that portion of custom work done by non-farmers is an input which should be considered. The data were sparse on this input. A detailed summary of the means used to build up the estimates appears in the appendix.

OTHER INPUTS IN THE MECHANICAL POWER AND MACHINERY SUBGROUP

Expenditure data were available from the Farm Income Branch for the remaining input items in this subgroup. These items were deflated as follows:

Vehicle licenses: The SRS index of prices paid by farmers, including interest, taxes, and wage rates.

Vehicle insurance: The SRS index of motor vehicle prices.

Blacksmithing, hardware, and small hand tools: The SRS index of prices paid for farm supplies.

Electricity: An index constructed from the price per KWH paid by farmers for electricity.

Harness and saddling: An index constructed from the price of horse collars.

Details concerning these compilations appear in the appendix.

FERTILIZER AND LIMESTONE

Fertilizers are sold as either straight materials, such as ammonium nitrate, superphosphate and potash, or as mixtures of straight materials which are called commercial fertilizers. Price data are available only on some of the more popular analyses of commercial fertilizers. Price data were available on most of the straight materials. The Production Resources Branch, ERS, maintains a data series on the physical quantities of primary plant nutrients (N,P,K) applied. Thus a decision was made to value all of the straight materials, whether they were applied as such or as commercial mixtures, and add on the cost of mixing the part that was mixed.

A preliminary attempt was made at determining the weight period cost of mixing the primary ingredients into commercial fertilizers by taking the price of straight materials (weighted by quantities used) times nutrient quantities. This gave the cost at the farm level, that is, what farmers would have paid had they purchased all their fertilizer at a straight material price. This was then subtracted from the Farm Income Branches' total expenditures to get at the difference which would represent mixing costs. Substantial negative mixing cost in the Corn Belt and Lake States, indicated that this method would not be appropriate. The difficulty was believed to lie in the method by which the Census asked the question concerning fertilizer expenditures. The Census indicates that some of the answers may have been net of government payments. This was apparently the trouble since an analysis by states revealed that the discrepancies were in those states which use large

quantities of rock phosphate.

The method used was as follows:

The composite fertilizer grade was calculated for each region, then a grade as nearly the same as possible was found for which a price was available. Mixing cost was then assumed to be the difference between what farmers paid for this grade and what they would have paid if they had purchased the equivalent quantity of nutrients at straight material prices.

Nonfarm use was estimated and subtracted from the total. Details concerning the procedures used for fertilizers and limestone appear in the appendix.

FEED AND SEED

Special Problems Associated with Farm Produced Inputs

Of all the inputs compiled, the feed and seed inputs presented the most problems both:

- a. conceptually
- b. concerning gaps in the data or the lack of data entirely
- c. and concerning major discrepancies in the data.

Conceptual Problems

A small portion of the crops produced is subsequently used for seed. A large portion of many crops is used for feed for livestock. These items require special handling since they are both outputs and inputs. For example, suppose the utilization of the oat crop is:

- 2 percent is used for seed
- 80 percent is used for feed for livestock
- 18 percent is used for food and industrial uses.

If we account the livestock produced as an output, and also the oats produced as an output we sum to more output than was available for consumption. To avoid this double counting we have to deduct the intermediate products. That is, the livestock and crop output available for consumption is equal to livestock output plus crop output minus the crops used for feed and seed.

Another complication which enters the feed and seed input is the

processing by "middlemen". In the case of oilseeds, the farmer sells the beans to a processor who separates the oil from the meal. The processor will in turn sell the meal to a formulator who mixes the meal with other ingredients and sells this back to the farmer. The value added by processing and formulating is a non-farm input. However, an additional complication arises from interregional trade. The oilseeds may be produced in one region but used for feed in a different region. To measure directly the value added by transportation and handling to grains that move in interregional trade, we would have to know where the grain came from. Since complete data on interregional grain movements were not available, a search was made for an alternative means of measurement. Two alternatives were available:

1. By making numerous simplifying assumptions, a crude approximation to interregional grain movements might be simulated with a linear programming transportation model. Fox²⁰ made such an analysis for the period 1939-1950. The coefficient of determination between regional prices estimated by the model and actual prices averaged 0.88 for the period 1939-48. However, the r^2 was only 0.28 for the drought year (feeding year) 1947-48.
2. The second alternative assumes equilibrium in the feed and seed supply industry. Using feed as an example, as diagrammed in Figure 5, suppose 100 bu. of grain was shipped from the Corn Belt region to the Northeast region. The price received by farmers for grain in the Northeast region must be equal to the price received by farmers in the Corn Belt plus the cost of transporting the grain from the Corn Belt to the Northeast region. If the price in the Corn Belt were higher, then the Northeast feeder would purchase grain locally and there would be no movement. If the price in the Corn Belt were lower, then it would be

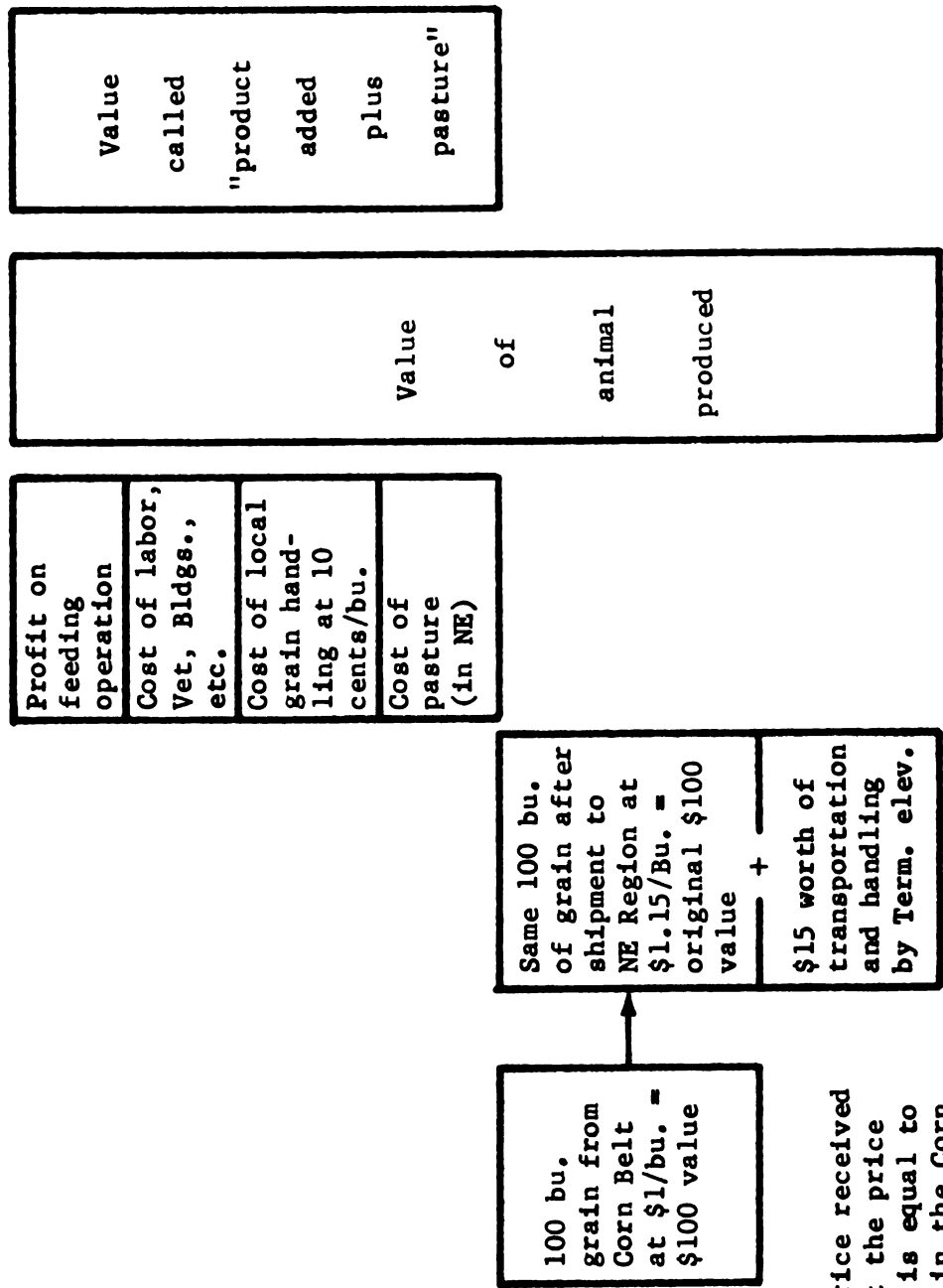
²⁰ Karl A. Fox, "A Spatial Equilibrium Model of the Livestock-Feed Economy in the United States". Econometrica, Vol. 21, No. 4, pp547-566.

more economical for all feeders to import their grain and locally produced grain could not find a market at the higher price. Thus, if there is equilibrium, when we deduct the value of feed fed from livestock production, if we value the feed at the price received by farmers in the region where the imported feed is fed, we are deducting the exact amount paid to Corn Belt farmers for the feed plus the cost of transporting it to the Northeast region. Of course the feeder in the Northeast region may pay more for grain than the price received by farmers for grain. He would not if he bought his grain from neighboring farmers, however, if the grain moves through the local elevator, there will be a local handling charge.

Interregional trade in seed introduces yet another complication: differences in quality. Much of the legume seed produced in the midwest comes from hayfields that were accidentally not needed for hay production. Much of the high quality certified seed is produced in the Pacific region. Thus the price received in the Corn Belt region for common seed is lower than the price received in the Pacific region for certified seed plus the cost of transportation to the Corn Belt.

This problem is taken care of in the process of computing the value added if we compute this as the difference between the price received and the price paid in the region where planted. For example, assume the Corn Belt region plants three bushels of alfalfa seed (Figure 6), one bushel being certified seed imported from the Pacific region, the remaining 2 bushels being produced locally. Assume further that all the seed is processed in the Corn Belt. Thus the value of the certified seed after shipment to the Corn Belt is equal to the price paid to Pacific region farmers (\$30) plus the cost of transporting it to the Corn Belt, (\$5). Assume further that the price paid to

Figure 5



Price grain in NE Region at price received by farmers. This assumes that the price received by farmers in the NE is equal to the price received by farmers in the Corn Belt + the cost of transportation and handling by terminal elevators required to get the grain from entrance dock of the local Corn Belt elevator to the rail siding in the NE Region.

Corn Belt farmers for common alfalfa seed is \$20/bu and the cost of processing is \$10/bu. Thus the total cost of the three bushels of seed is \$105 or an average price paid per bu. of \$35. This cost is broken down as follows:

2 bu. of locally produced common seed	\$40.
priced at the price received by farmers (\$20/bu)	
1 bu. of imported certified seed priced	30.
at the price received by farmers in the exporting region (\$30)	
Cost of transporting imported seed	5.
Cost of processing and local handling at \$10/bu.	30.
	\$105.

Of this total, the intermediate products produced by Corn Belt farmers are the 2 bu. of common seed produced locally with a farm value of \$40. Thus from the viewpoint of the Corn Belt, the value added by non-farmers is \$105 - \$40 or \$65.

We can arrive at this \$65 value added indirectly as follows: Call the value added the difference between the price paid and the price received by Corn Belt farmers: $\$35 - \$20 = \$15/\text{bu.}$ times the quantity planted (3 bu.) gives a simulated value added of \$45. When we mark off the intermediate products, we use the quantity planted rather than the quantity produced. Thus we mark off 3 bu. at \$20/bu. or \$60. Since this is \$20 more than the value of intermediate products actually produced in the Corn Belt, the total charged to Corn Belt input is $\$45 + \$20 = \$65$ which is equal to the \$65 which we arrived at directly.

For the purposes of this analysis, it is not necessary to know in which region the seed was processed

Figure 6

Assume:

3 bu. of alfalfa seed were planted in the Corn Belt:

- 1 bu was certified seed imported from the Pacific Region
- 2 bushels were common seed produced locally

Price received by Corn Belt farmers for 2 bu. clean common alfalfa seed at \$20/bu. = \$40.

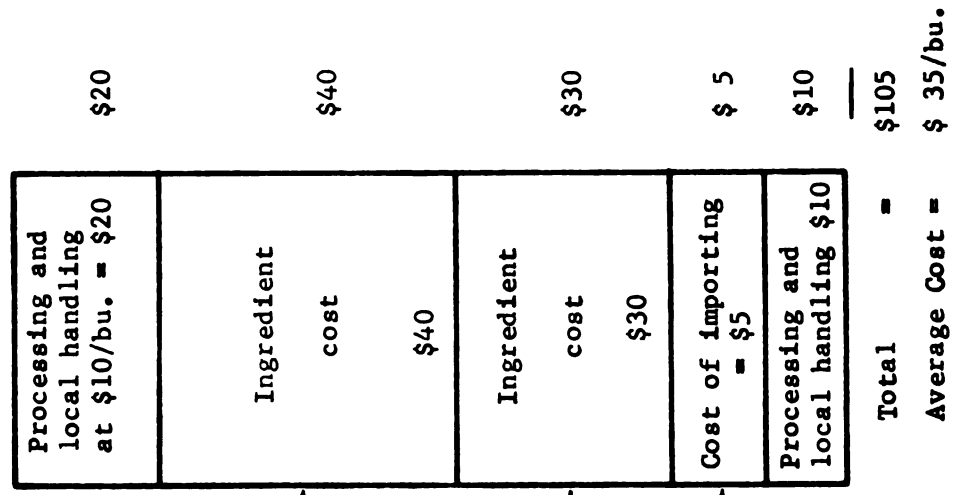
Price received by farmers in Pacific region for 1 bu. clean certified alfalfa seed at \$30/bu. = \$30.

Value of same 1 bu. certified alfalfa seed after transport to Corn Belt = original \$30 + \$5 importing cost

Expenditures for seed: 3 bu. at \$35 = \$105
Value of production: 2 bu. at \$20 = \$40
Expenditures for seed minus seed produced: \$105 - 40 = \$65

Breakdown:

Payment for imported seed \$30
Transporting imported seed 5
Processing and local handling for imported seed 10
Processing and local handling for locally produced seed 20
\$65



since we wish to charge the processing costs to the region which plants the seed. To be accurate a local handling cost was added since the above analysis prices the seed deducted from production at the price received by farmers.

A discussion of the data available and the method of compilation appears in the appendix.

THE FEED INPUT

Expenditures figures were available on feed purchases, however, they could not be used because:

1. Until the 1964 Census, the Census questionnaire did not separate:

- a. Grains from supplements
- b. formula feeds from feeds fed as such
- c. purchases from neighbors from purchases made through commercial channels.

e.g., the question from the 1950 Census was worded as follows:

How much was spent last year for FEED for livestock and poultry? (include cost of grain, hay, mill feeds, concentrates, and roughages; also amounts paid for grinding and milling feed.)

2. Even if 1 were available, it would still be necessary to reduce the purchased feed input to physical terms in order to determine the farm value of the raw materials.

The Data Gap

After an extensive survey of data available on the feed input, it was obvious that an exhaustive data search would have to be made to arrive at regional feed input figures having any acceptable degree of accuracy. Thus, approximately 180 publications, including all those in the National Agricultural Library with feed statistics were searched for data. Cardex files were made for 104 of these publications to facilitate data retrieval.

This exhaustive search turned up reasonably complete regional data which could be used in the form presented only for the one year period 1 October 1949 to 30 September 1950. A discussion of the means used to simulate the missing data follows:

Feed Grains, proportion going through commercial channels.

An abortive attempt was made to estimate these proportions by starting with the following procedure:

Let q = Feed grains fed (from Production Resources Branch, FPED, Statistical Bulletin 337 and unpublished worksheets).

w = Feed grains fed on farms where grown (from SRS, Statistical Bulletins 115, 208, 311 and 404).

Then $q - w$ = Feed grains purchased from all sources.

However, this procedure produced negative purchases for the 1957-59 period for two regions, the Lake States and the Northern Plains.

In an effort to pinpoint the source of the discrepancy, a tabulation by states was made for the 1964 crop year. This resulted in negative purchases for the states of Michigan and North Dakota and positive purchases which were obviously too small for many remaining states. A conference with the Feed Grains Branch, SRS, indicated that the figures for "Feed grains fed on farms where grown" were obtained by subtracting what farmers report as sold from what they report as produced. These data were obtained from questionnaire C.E. 2-308, a copy of which appears on appendix page 140.

Labeling this residual as "Feed fed on farms where grown" is suspect for the following reasons:

- I. No account is taken of change in stocks.
- II. There is an implicit assumption that farmers report grains under CCC loan or purchase agreement as "sold or to be sold". The discrepancy suggests that this assumption is unwarranted. Legally, liquidation of grains under CCC loan is a foreclosure of chattel mortgage rather than a sale. Purchase agreements also lack one of the two requirements of a legal sale contract: The CCC offers to buy but the farmer does not accept the offer at the time the purchase

agreement is signed. Thus the purchase agreement resembles an option to sell rather than a sales contract.

- III. If a cash grain farmer is asked "How much grain was sold or will be sold?" This is tantamount to asking him "How much will your income be?" If this question is asked by the USDA, a Federal agency, how is the farmer to know that the Internal Revenue Service, another Federal agency, will not review his report? Thus it is prudent to expect some grain farmers to make a conservative report, especially as to their anticipated future sales.

Statistical Bulletin 268, "Grain Transportation Statistics for the North Central Region" estimated the sales of feed grains by country elevators to farmers for the calendar year 1958. Thus this year was chosen to attempt an adjustment that would arrive at a plausible estimate of feed grains used for feed on farms where grown. A discussion of the means used to manufacture the missing data appears in the appendix.

HIRED TRUCKING, FREIGHT AND EXPRESS

A data series was available on the cost of hauling milk but no series were available for other items. Data for the single year, 1955, were available from the survey of farmers expenditures. Thus for all items except milk, an assumption was made that the 1955 relationship between hired transportation and the value of farm output was a constant that could be applied to all years.

The method of computation is detailed in the appendix.

POULTRY PURCHASES

Physical quantity data series on the numbers of baby chickens and turkeys purchased were obtained from the Farm Income Branch. The average weight period price paid was obtained by dividing expenditures by the quantity purchased. Both the chickens and turkeys were divided into two classes: Laying chickens and broilers and heavy turkeys and light turkeys.

OTHER INPUTS IN THE FEED, SEED AND LIVESTOCK SUBGROUP

Expenditure data were available from the Farm Income Branch for the remaining input items in this subgroup. These items were deflated as follows:

Milk hauling: A composite index including farm wage rates, auto repairs and truck tires.

Livestock marketing: The SRS index of items used in production, interest, taxes and wage rates.

Details concerning these compilations appear in the appendix.

REAL ESTATE TAXES

Data on this input are for taxes levied rather than taxes paid. A discussion with Thomas Hady, Economic Development Division, ERS, indicated that there was a secular trend for the states to require payment the same year the taxes are levied. Thus this input was compiled for the year levied although it must be recognized that for some states for some years, especially the early years, the taxes may not have been paid until later.

The tax figures available included taxes on the dwelling. To remove dwelling taxes, the ratio of the values:

$$\frac{\text{land} + \text{service buildings}}{\text{land} + \text{all buildings}}$$

was applied to the total tax figures.

These current dollar estimates were deflated with the Commerce Department's implicit price deflator: "State and Local Government Purchases of Goods and Services".

Data sources for this input are discussed in the appendix.

PERSONAL PROPERTY TAXES

Data for the years 1939-1959 were obtained from the Farm Income Branch. For subsequent years, the data were obtained from the Community Facilities Branch, Economic Development Division. These current dollar expenditures were deflated with the same index used for real estate taxes.

DAIRY SUPPLIES

Current dollar expenditures for this item were obtained from the Farm Income Branch. For a deflator, for the period 1939-1954, an index was constructed based on a simple average of prices paid for milk pails and milk cans. For the period 1955 to date, it was reasoned that most dairy farmers were using bulk cooling equipment, thus a decision was made to base the price index for this period on the price of laundry detergent.

PESTICIDES

Because of the many kinds of pesticides and a lack of adequate quantity data, a decision was made to deflate expenditure figures.

Dr. Shepard, ASCS, was consulted regarding the construction of a price index. Data sources and details of computation appear in the appendix.

COTTON GINNING

The following figures were obtained from the Farm Income Branch:

- a. Expenditures for cotton ginning for the weight period years.
- b. The number of bales of cotton ginned for all years.

From these figures were derived the weight period cost per bale by regions. These rates were then applied to the number of bales ginned to obtain expenditures in weight period prices.

IRRIGATION OPERATION AND MAINTENANCE COST

Current dollar expenditures for this item were obtained from the Farm Income Branch. For the period 1949 to date, the index of "Irrigation Operation and Maintenance Cost" compiled by the Bureau of Reclamation, was used as a deflator. Since this index was not available for earlier years, a decision was made to use the Engineering News Record index of construction costs for that period. These data sources are discussed more fully in the appendix.

OTHER INPUTS IN THE MISCELLANEOUS SUBGROUP

Expenditure data were available from the Farm Income Branch for the remaining input items in this subgroup. These items were deflated as follows:

Crop insurance: The index of crop values.

Containers: An index of prices of selected items including baskets, bags and crates.

Binding materials: An index constructed from the cost of baler twine.

Veterinary services: The SRS index of prices paid for farm supplies.

Telephone services: An index constructed from the base rate for local service.

CHAPTER III

INDEXING PROCEDURE

After the various inputs were compiled into constant dollar estimates, the two periods, 1939-1954 and 1955-1970 were spliced at 1955 to put the entire series on a 1957-1959 price weight equivalent basis.

The splicing procedure is illustrated as follows:

Let P = price
 Q = quantity
 s = splice year
 c = current year
 E = early period
 L = late period

Then:
$$\frac{Q_s^P L}{Q_s^P E} \cdot Q_c^P E = Q_c^P L$$

These splices were made separately for each Farm Production Region. For the indices of individual input items, the splice was made at the individual input level. For the total input index, the splice was made for all inputs combined, i.e.,

$$\frac{\sum Q_s^P L}{\sum Q_s^P E} \cdot \sum Q_c^P E = \sum Q_c^P L$$

For the indices of major input subgroups, the splice was made at the subgroup level.

The year 1967 was used as a reference base, i.e., the 1967 expenditure was arbitrarily set equal to 100 and other years were expressed as a percent of the 1967 expenditure. The output values were indexed in a similar manner.

CHAPTER IV

RESULTS

In order to gain a longer historical perspective for part of the analyses which follows, the new national series was spliced onto the existing national series compiled by Loomis and Barton and maintained by Don Durost. This series is weighted with 1935-39 average prices. The splice was made at 1939 using the technique outlined in chapter III.

The Weight Period Profit Rate

As a broad check on the accuracy of the compilations, a comparison was made of the total income and total expenses during the weight periods.

If equilibrium prevailed, we would expect income and expenses to be equal assuming a normal profit. A normal profit implies opportunity cost on equity capital and family labor and management. The indices were constructed assuming the average rental rate on real estate and the mortgage rate of interest on non-real estate capital. Labor presented a problem in that it was difficult to identify the relevant alternative opportunity. As a preliminary estimate, a decision was made to enter the family labor at the hired rate. Inspection of the residual would then suggest whether a higher rate was indicated.

The results were compiled both on an aggregate basis by regions and on a per farm basis. The results appear on the page following. The early weight period results (1947-49) indicate a modest profit for five regions, a meager profit for four regions, and a loss for the Pacific region. For Pacific region farmers this indicates that, on average, their labor returned them \$164 less than their hired help. Of course they could live partially on their return to capital and this is apparently what many Pacific region farmers did do. Over the entire period, there was also substantial capital gains which this analysis does not include.

For the 1957-59 weight period the results were even worse. The Northern Plains farmers made a modest profit, Corn Belt and Southern

Table 1. The Weight Period Profit Rate

	<u>Northeast</u>	<u>Lake States</u>	<u>Corn Belt</u>	<u>Northern Plains</u>	<u>Appalachian</u>	<u>Southeast</u>	<u>Delta States</u>	<u>Southern Plains</u>	<u>Mountain</u>	<u>Pacific</u>	<u>United States</u>
<u>1947-49 Weight Period</u>											
Outputs: 1947-49 ave., mil. \$	2378	2966	6387	3191	2493	1756	1512	2590	1787	2626	27,686
Inputs: 1947-49 ave., mil. \$	2298	2421	4450	2312	2338	1671	1391	2207	1601	2672	23,361
Profits: 1947-49 ave., mil. \$	80	545	1937	879	155	85	121	383	186	-46	4,325
Average profit per farm, dollars	154	1029	1846	2282	149	128	202	738	879	-164	746
<u>1957-59 Weight Period</u>											
Outputs: 1957-59 ave., mil. \$	2248	3050	6646	3284	2400	1971	1474	2591	2124	3258	29,049
Inputs: 1957-59 ave., mil. \$	2718	3244	6471	2979	2780	2084	1575	2581	2139	3443	30,012
Profits: 1957-59 ave., mil. \$	-470	-194	175	305	-380	-113	-101	10	-15	-185	-963
Average profit per farm, dollars	-1414	-447	208	928	-508	-271	-275	27	-83	-832	-228

Plains farmers made a meager profit and the remaining regions lost money. Losses were substantial in the Northeast and Pacific regions.

Input Indices

As indicated in chapter II, the input indices were compiled both with and without an adjustment for the land in government programs. The input indices including all land in farms are to be seen in Table 2. The indices with the adjustment for land in government programs appears in Table 3. Also, in Table 4 are the differences between the two indices. The greatest difference nationally was nearly 3 points in 1962. Most regional differences were greater with the greatest, 6.4 points, in the Delta region. The difference between the indices also exceeded 5 points in the Corn Belt, Northern Plains and Southeast regions.

As discussed in chapter II, there are theoretical advantages in making the adjustment for the land in government programs. For this reason, the balance of the analysis is based on the total input index figures in Table 3.

Adjusted Input Indices

The adjusted index for the United States, 1910-1970, is graphed on Figure 8, page 66. The regional indices for the period 1939-1970 are graphed on Figure 7.

The total use of inputs in American agriculture has remained remarkably constant on a national basis. The range from 1939 to 1970 was only 11 index points. The low point for the U.S. was 1962, the high at 1951. At 1944, the use of inputs ended an upward trend which began in the mid-thirties. There was a downward trend from 1952 to 1962. From 1962 to 1970 the use of inputs increased every year.

Regional Trends in Input Use

There has been somewhat more variation in input use when we look at the regions. Inputs in the Northeast changed little from 1939 to 1951, but from 1951 to 1964 there was a 28 point decrease. Since 1964 the Northeast index has changed only 2 points.

Table 2. Indices of Total Agricultural Inputs (includes all land in farms) (1967 = 100)

Year	North- east	Lake States	Corn Belt	Northern Plains	Appala- chian	South- east	Delta States	Southern Plains	Mountain	Pacific	United States
1939	126.08	100.26	83.87	82.00	101.93	93.32	109.59	108.96	80.03	77.36	93.35
1940	128.26	103.18	85.06	83.79	99.69	93.05	106.08	112.81	81.80	78.48	94.45
1941	129.00	102.60	85.79	87.70	98.57	88.67	105.52	110.00	83.79	79.30	94.58
1942	130.89	106.75	88.33	93.59	101.04	92.04	109.64	114.38	86.15	79.66	97.60
1943	130.63	106.18	90.03	96.70	103.06	93.86	107.41	112.98	87.83	81.36	98.63
1944	132.02	106.52	90.30	97.07	106.94	94.22	107.92	113.26	88.36	83.31	99.58
1945	130.18	105.16	87.30	94.12	105.41	92.48	101.25	104.99	87.18	83.94	97.01
1946	127.69	101.73	86.64	90.37	107.33	91.15	97.30	101.05	85.85	85.90	95.60
1947	124.54	98.86	85.48	89.78	107.88	92.91	100.59	105.89	87.12	85.54	95.59
1948	125.14	97.77	87.10	90.64	108.48	94.57	110.69	104.23	88.58	86.43	96.76
1949	127.73	100.91	90.42	88.71	110.77	94.55	108.38	109.82	91.75	87.74	98.73
1950	128.43	100.33	90.45	90.10	109.69	92.64	103.45	103.68	91.86	88.02	97.89
1951	127.76	101.92	92.81	92.57	113.44	98.45	108.15	108.43	94.79	91.94	100.91
1952	125.90	102.51	94.25	93.50	113.21	97.50	108.12	105.97	94.91	91.66	100.90
1953	123.75	102.93	94.22	93.45	110.00	96.86	108.82	104.66	94.61	90.36	100.17
1954	121.99	103.62	94.66	94.19	108.70	95.12	102.20	101.93	95.23	89.62	99.40
1955	119.56	104.35	95.47	94.13	107.28	95.86	101.68	100.80	94.72	90.42	99.32
1956	117.26	103.08	93.78	90.54	104.83	92.98	97.84	97.34	93.71	91.94	97.41
1957	113.18	101.32	92.80	89.54	98.86	88.26	91.15	94.79	93.16	91.18	94.99
1958	111.82	100.20	92.27	90.16	98.44	87.42	88.41	96.04	93.94	92.49	94.79
1959	108.96	100.81	94.04	91.16	100.13	90.21	92.57	97.09	94.39	94.62	96.09
1960	107.18	98.96	92.13	90.66	98.18	88.84	91.44	96.15	93.85	95.02	94.88
1961	105.49	98.71	90.74	89.75	97.93	89.24	92.16	96.08	93.55	96.13	94.47
1962	104.76	98.19	91.61	91.35	98.93	89.70	90.80	95.90	94.30	97.80	95.00
1963	103.39	97.45	93.13	92.61	99.84	90.02	93.43	96.57	95.21	98.28	95.72
1964	101.45	98.66	94.16	93.39	99.46	92.10	96.03	96.76	96.48	99.67	96.54
1965	101.14	97.62	94.12	94.35	98.97	93.59	97.25	99.44	96.28	99.43	96.83
1966	101.19	98.02	97.83	98.30	98.58	96.37	97.73	97.93	98.33	98.99	98.29
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	99.39	101.05	100.71	102.90	99.82	100.49	104.34	102.76	101.70	102.10	101.39
1969	99.38	101.60	99.94	103.32	100.32	101.16	102.80	104.29	104.02	102.42	101.67
1970	99.02	101.40	99.85	104.37	102.55	103.47	106.58	105.66	104.17	102.20	102.40

Table 3. Indices of Total Agricultural Inputs. (Excludes land "voluntarily" retired by government programs)
(1967 = 100)

Year	North- east	Lake States	Corn Belt	Northern Plains	Appala- chian	South- east	Delta States	Southern Plains	Mountain	Pacific	United States
1939	127.22	101.57	85.21	83.59	105.77	98.24	115.97	112.33	80.86	77.61	95.38
1940	129.42	104.53	86.42	85.41	103.44	97.95	112.25	116.30	82.65	78.74	96.50
1941	130.17	103.94	87.16	89.40	102.28	93.34	111.66	113.40	84.66	79.55	96.63
1942	132.07	108.15	89.74	95.40	104.84	96.89	116.02	117.92	87.05	79.92	99.72
1943	131.81	107.57	91.47	98.58	106.93	98.81	113.66	116.47	88.74	81.62	100.77
1944	133.22	107.91	91.74	98.95	110.96	99.18	114.20	116.77	89.28	83.58	101.74
1945	131.36	106.54	88.69	95.94	109.37	97.36	107.14	108.24	88.08	84.21	99.11
1946	128.84	103.06	88.02	92.12	111.37	95.95	102.96	104.17	86.75	86.18	97.68
1947	125.67	100.15	86.84	91.52	111.94	97.80	106.45	109.16	88.02	85.82	97.66
1948	126.27	99.06	88.49	92.39	112.55	99.56	117.13	107.45	89.51	86.71	98.86
1949	128.88	102.23	91.86	90.43	114.94	99.53	114.69	113.21	92.69	88.03	100.87
1950	129.60	101.64	91.89	91.84	113.81	97.52	109.47	106.89	92.81	88.30	100.01
1951	128.92	103.26	94.29	94.36	117.70	103.64	114.44	111.78	95.77	92.24	103.10
1952	127.04	103.85	95.75	95.31	117.47	102.63	114.42	109.25	95.89	91.96	103.09
1953	124.87	104.28	95.72	95.26	114.13	101.97	115.15	107.90	95.58	90.65	102.35
1954	123.09	104.98	96.17	96.01	112.79	100.14	108.15	105.08	96.22	89.91	101.55
1955	120.64	105.72	96.99	95.96	111.31	100.91	107.60	103.91	95.71	90.71	101.47
1956	118.23	104.12	93.92	90.01	108.20	97.60	103.31	98.36	93.77	92.20	98.62
1957	113.74	101.69	92.74	86.58	101.32	90.96	94.37	94.33	92.14	90.97	95.22
1958	112.20	100.05	91.52	89.36	100.21	88.47	89.89	95.31	93.50	92.51	94.80
1959	109.06	100.46	94.41	90.54	102.56	92.60	95.58	97.39	93.73	94.45	96.61
1960	106.92	98.22	92.05	89.10	100.00	90.28	93.80	95.99	92.96	94.75	94.90
1961	104.72	96.48	85.86	85.23	97.41	89.27	93.59	94.03	92.36	95.76	92.36
1962	103.78	95.66	86.23	85.04	97.14	88.71	91.69	93.02	92.32	96.82	92.14
1963	102.59	95.28	89.21	87.39	98.73	89.37	94.85	94.52	93.48	97.61	93.58
1964	100.95	96.76	90.06	87.87	98.84	91.36	98.28	94.99	94.84	99.09	94.50
1965	100.75	95.77	90.15	89.97	98.25	92.65	99.72	98.07	94.96	99.02	95.01
1966	100.94	97.03	96.15	96.59	97.76	95.01	97.49	96.05	97.57	98.74	97.19
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	99.27	100.43	98.83	101.78	99.38	100.43	106.05	102.55	101.66	102.19	100.82
1969	99.17	100.68	97.66	101.98	100.07	102.72	106.62	104.84	103.97	102.37	101.24
1970	99.02	100.87	98.07	103.96	102.80	105.87	110.97	106.55	104.41	102.23	102.42

Table 4. Differences in Total Input Indices Caused by Adjustment for Land in Govt. Programs. (1967 = 100)

Year	North- east	Lake States	Corn Belt	Northern Plains	Appala- chian	South- east	Delta States	Southern Plains	Mountain	Pacific	United States
1939	-1.14	-1.31	-1.34	-1.59	-3.84	-4.92	-6.38	-3.37	-.83	-.25	-2.03
1940	-1.16	-1.35	-1.36	-1.62	-3.75	-4.90	-6.17	-3.49	-.85	-.26	-2.05
1941	-1.17	-1.34	-1.37	-1.70	-3.71	-4.67	-6.14	-3.40	-.87	-.25	-2.05
1942	-1.18	-1.40	-1.41	-1.81	-3.80	-4.85	-6.38	-3.54	-.90	-.26	-2.12
1943	-1.18	-1.39	-1.44	-1.88	-3.87	-4.95	-6.25	-3.49	-.91	-.26	-2.14
1944	-1.20	-1.39	-1.44	-1.88	-4.02	-4.96	-6.28	-3.51	-.92	-.27	-2.16
1945	-1.18	-1.38	-1.39	-1.82	-3.96	-4.88	-5.89	-3.25	-.90	-.27	-2.10
1946	-1.15	-1.33	-1.38	-1.75	-4.04	-4.80	-5.66	-3.12	-.90	-.28	-2.08
1947	-1.13	-1.29	-1.36	-1.74	-4.06	-4.89	-5.86	-3.27	-.90	-.28	-2.07
1948	-1.13	-1.29	-1.39	-1.75	-4.07	-4.99	-6.44	-3.22	-.93	-.28	-2.10
1949	-1.15	-1.32	-1.44	-1.72	-4.17	-4.98	-6.31	-3.39	-.94	-.29	-2.14
1950	-1.17	-1.31	-1.44	-1.74	-4.12	-4.88	-6.02	-.21	-.95	-.28	-2.12
1951	-1.16	-1.34	-1.48	-1.79	-4.26	-5.19	-6.29	-3.35	-.98	-.33	-2.19
1952	-1.14	-1.34	-1.50	-1.81	-4.26	-5.13	-6.30	-3.28	-.98	-.30	-2.19
1953	-1.12	-1.35	-1.50	-1.81	-4.13	-5.11	-6.33	-3.24	-.97	-.29	-2.18
1954	-1.10	-1.36	-1.51	-1.82	-4.09	-5.02	-5.95	-3.15	-.99	-.29	-2.15
1955	-1.08	-1.37	-1.52	-1.83	-4.03	-5.05	-5.92	-3.11	-.99	-.29	-2.15
1956	-.97	-1.04	-.14	.53	-3.37	-4.62	-5.47	-1.02	-.06	-.26	-1.21
1957	-.56	-.37	.06	2.96	-2.46	-2.70	-3.22	.46	1.02	.21	-.23
1958	-.38	.15	.75	.80	-1.77	-1.05	-1.48	.73	.44	-.02	-.01
1959	-.10	.35	-.37	.62	-2.43	-2.39	-3.01	-.30	.66	.17	-.52
1960	.26	.74	.08	1.56	-1.82	-1.44	-2.36	.16	.89	.27	-.02
1961	.77	2.23	4.88	4.52	.52	-.03	-1.43	2.05	1.19	.37	2.11
1962	.98	2.53	5.38	6.31	1.79	.99	-.89	2.88	1.98	.98	2.86
1963	.80	2.17	3.92	5.22	1.11	.65	-1.42	2.05	1.73	.67	2.14
1964	.50	1.90	4.10	5.22	.62	.74	-2.25	1.77	1.64	.58	2.04
1965	.39	1.85	3.97	4.38	.72	.94	-2.47	1.37	1.32	.41	1.82
1966	.25	.99	1.68	1.71	.82	1.36	.24	1.88	.76	.25	1.10
1967	0	0	0	0	0	0	0	0	0	0	0
1968	.12	.62	1.88	1.12	.44	.06	-1.71	.21	.04	-.09	.57
1969	.21	.92	2.88	1.34	.25	-1.56	-3.82	-.55	.05	.05	.43
1970	0	.53	1.78	.41	-.25	-2.40	-4.39	-.89	-.24	-.03	.02

FARM INPUTS

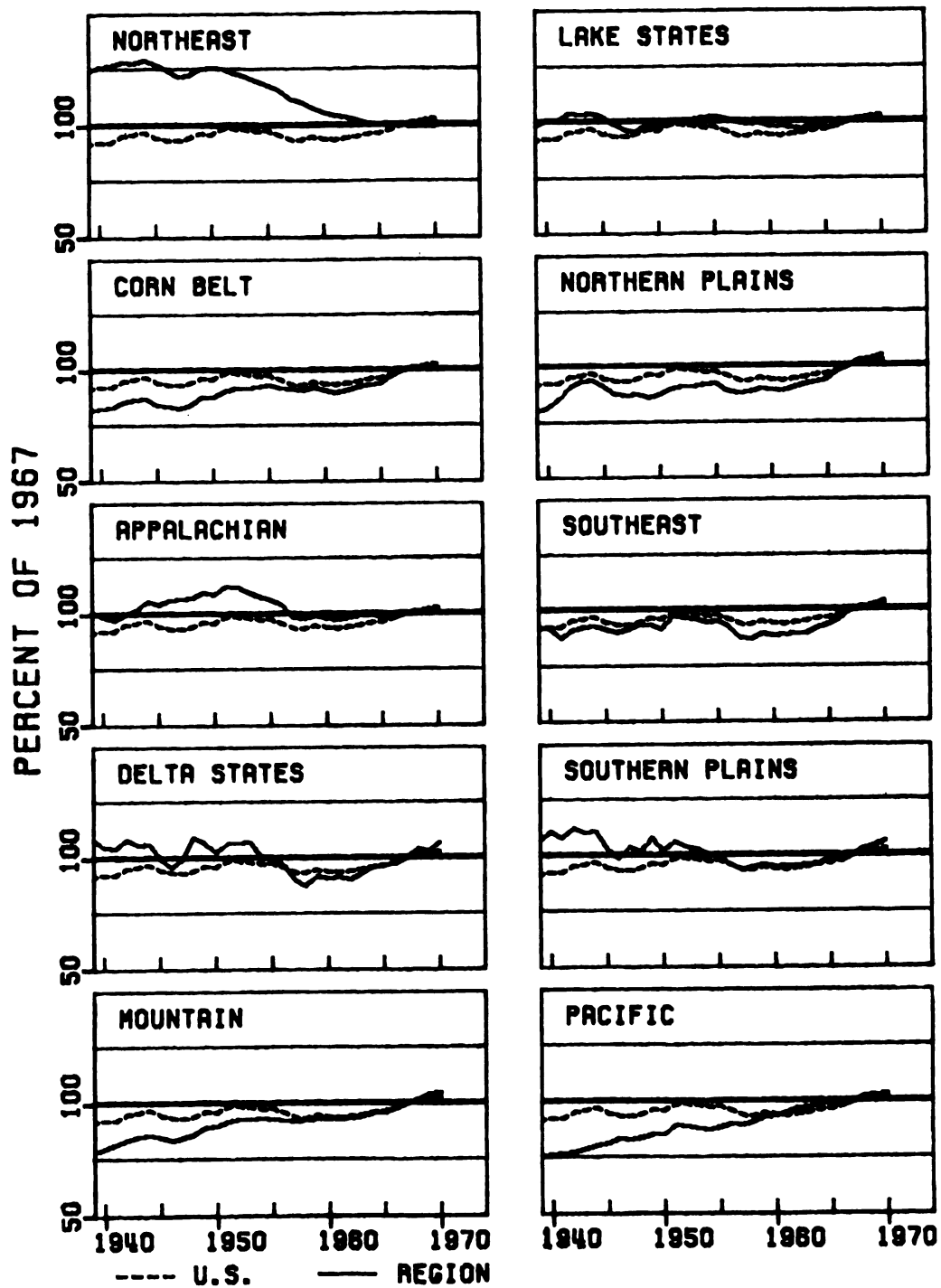


Figure 7

In the Lake States and Southeast regions input use has followed along with the U.S. average. In the Corn Belt and Mountain regions, there was an upward trend from 1939 to 1955. Input use in these regions stayed on a plateau for the next 10 years. The trend has been upward since 1965.

In the Northern Plains region, there was a 15 point increase in inputs from 1939 to 1944. From 1944 until 1962, Northern Plains inputs followed along with the national trend. Since 1962, input use in this region has increased every year for a total of 19 points.

In the Appalachian region, inputs rose 15 points from 1941 to 1951, then fell back 17 points by 1958. There has been little change in input use in this region since 1958.

In the Delta and Southern Plains regions there was a general decrease from 1939 to about 1959. Since 1959 input use in these regions has increased along with the national trend.

In the Pacific region there has been a general nearly straight line increase in input use since 1939. The total increase was 25 index points.

The greatest change in input use was in the Northeast region with a decline of 34 points from 1944 to 1968. The Pacific region showed the greatest increase with the low point at 1939 and the high at 1969. 1939 was also the low point in input use for the Corn Belt, Northern Plains and Mountain regions. The low point for the Southeast and Delta States was 1958. For the Lake States, Appalachian and Southern Plains, the low point in input use was 1962 or 1963. The Northeast region hit a low point at 1970.

Peak input use came at 1969 or 1970 for the Northern Plains, Southeast, Mountain and Pacific regions. In the Corn Belt the maximum inputs were used in 1967. In the remaining regions peak input use came early in the period, 1951 in the Appalachian region, 1948 in the Delta, 1944 in the Northeast and 1942 in the Lake States and Southern Plains.

The range in input use was greatest in the Northeast with 34 points. The Lake States region had the least range with 13 points.

Input Use by Major Subgroup

The inputs were indexed by the major subgroups indicated by the

catalogue on appendix pages 104 through 106. These index numbers are tabulated in Tables 5 through 11.

The farm labor input group changed the most, a 179 point decline nationally. Farm labor declined the most in the Delta region, by 338 points. The least labor was used in 1970 in all regions.

The input group changing the least was farm real estate with a range nationally of only 31 points. The national peak came in 1955, the low just 7 years later in 1962. There was considerable divergence in the trends by regions. The Northeast, Lake States and Corn Belt hit peaks at 1940. The real estate input peaked in the Northern Plains and Appalachian regions in the late forties. The peak came in the early fifties in the Southeast, Delta and Southern Plains regions. In the remaining regions, the Mountain and Pacific, the real estate input is still rising with the highest observation at 1970.

For the remaining groups of inputs, there has been a general secular increase. For the three groups: Mechanical Power and Machinery; Fertilizer and Lime; and Feed, Seed and Livestock Purchases, the increase began at 1939 which was the low point for all regions. For all regions except the Pacific and Northeast, the use of inputs in these three groups peaked at either 1969 or 1970. In the Pacific region, the input of fertilizer and lime peaked at 1968.

For the Northeast region, power and machinery inputs peaked at 107 in 1942, feed, seed, and livestock purchases peaked at 113 in 1951, and the fertilizer and lime input peaked at 1966.

For all regions except the Northeast, expenditures for taxes and interest increased generally throughout the period. In the Northeast the low point was at 1966, the high at 1945. The low point for the Delta region was 1948. For the remaining regions the low point for taxes and interest expenditures fell in the period 1939-1941. The high point was 1970 for all regions except the Northeast.

The use of miscellaneous inputs was lowest generally in the early part of the period and highest in the late sixties. For the Delta region the low was 1958, for the Southern Plains, 1946. In the remaining regions the use of miscellaneous inputs was lowest in 1943 or earlier. In the Northeast region the high point came in 1963. For the remaining

(1967 = 100)

Table 5 Indices of Farm Labor Input

<u>Year</u>	<u>North- east</u>	<u>Lake States</u>	<u>Corn Belt</u>	<u>Northern Plains</u>	<u>Appala- chian</u>	<u>South- east</u>	<u>Delta States</u>	<u>Southern Plains</u>	<u>Mountain</u>	<u>Pacific</u>	<u>United States</u>
1939	306.65	279.77	282.10	236.97	262.69	309.87	432.10	356.19	204.59	176.77	269.97
1940	308.92	284.67	278.18	242.50	246.58	302.49	407.57	370.07	209.21	176.90	268.68
1941	301.92	279.51	279.57	255.13	238.57	276.58	397.83	349.01	213.82	176.50	264.52
1942	306.12	285.96	285.28	272.02	240.55	287.98	416.69	363.05	217.39	173.98	271.07
1943	298.60	281.06	282.10	269.65	245.73	288.37	395.60	346.72	215.50	174.51	267.42
1944	299.12	274.87	276.30	268.07	257.04	282.67	390.13	341.01	210.47	174.78	265.43
1945	283.54	265.97	260.30	248.02	245.45	267.38	346.94	293.34	197.88	169.73	248.69
1946	271.47	246.75	252.46	225.92	250.25	255.98	323.62	274.90	188.43	170.52	238.62
1947	247.49	223.92	228.37	209.97	238.29	250.80	325.65	286.65	182.98	162.15	226.00
1948	235.76	211.41	228.13	202.08	231.41	245.75	363.57	264.78	176.89	154.44	220.01
1949	228.59	207.92	219.88	183.61	230.37	228.52	328.69	267.06	172.49	151.52	212.19
1950	223.68	197.73	208.04	181.08	218.41	208.44	283.27	233.60	164.30	145.27	199.41
1951	213.36	192.96	204.12	180.14	223.21	218.93	288.95	243.55	161.57	148.86	199.92
1952	203.56	187.03	197.83	172.56	213.41	202.35	279.21	221.68	154.86	142.88	190.76
1953	199.18	182.51	191.14	168.45	199.09	192.38	277.19	215.64	148.36	134.50	183.69
1954	192.35	178.64	187.47	168.14	193.16	173.85	234.40	199.97	151.29	129.06	176.24
1955	183.95	172.97	180.28	159.30	180.15	172.43	227.71	195.07	143.74	126.66	169.67
1956	175.90	166.26	170.73	146.19	170.17	155.97	204.80	177.93	137.02	126.80	160.15
1957	163.82	158.00	161.58	144.28	147.84	133.90	174.45	164.00	133.39	123.12	148.99
1958	157.38	149.89	153.94	136.55	142.32	125.45	159.71	162.20	129.15	121.21	142.80
1959	147.50	144.39	149.80	125.55	141.16	128.42	165.79	156.93	121.53	120.79	138.93
1960	142.85	138.27	142.04	122.71	136.21	124.35	156.93	149.20	117.41	118.93	133.80
1961	137.67	133.75	133.43	114.71	133.25	121.18	153.90	142.27	112.93	116.66	128.71
1962	129.48	128.04	126.92	113.54	131.30	115.56	137.51	129.71	109.91	115.82	123.39
1963	122.50	122.68	122.98	110.61	128.88	115.61	139.10	125.46	106.77	115.45	120.43
1964	117.08	118.46	116.40	105.49	121.06	110.83	133.29	119.45	102.19	114.45	115.44
1965	111.04	111.46	108.38	101.21	110.20	104.68	121.47	116.81	100.05	111.23	109.30
1966	103.64	103.14	101.27	99.28	102.25	97.23	105.16	99.21	97.80	103.21	101.37
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	94.12	95.44	94.35	95.59	94.34	90.84	98.37	99.63	98.44	102.71	96.49
1969	90.40	90.10	88.59	92.93	94.01	92.25	95.78	99.74	99.62	101.42	94.18
1970	88.54	88.21	86.73	89.98	91.89	90.50	94.32	96.91	97.55	99.78	92.16

Table 6 Indices of Farm Real Estate Input (1967 = 100)

<u>Year</u>	<u>North- east</u>	<u>Lake States</u>	<u>Corn Belt</u>	<u>Northern Plains</u>	<u>Appala- chian</u>	<u>South- east</u>	<u>Delta States</u>	<u>Southern Plains</u>	<u>Mountain</u>	<u>Pacific</u>	<u>United States</u>
1939	151.33	118.66	109.66	107.68	138.88	137.60	108.07	104.10	76.55	63.93	103.68
1940	157.49	122.29	112.01	108.28	140.80	139.30	108.44	104.80	77.18	65.76	105.54
1941	154.22	114.98	108.36	105.35	138.41	136.48	108.86	104.81	76.95	66.98	103.82
1942	144.97	110.65	103.00	104.33	137.73	138.42	107.18	106.02	76.69	66.88	101.98
1943	138.65	102.24	101.67	103.18	134.92	137.74	106.99	105.94	76.65	68.10	100.65
1944	137.11	101.72	98.22	102.59	134.69	139.40	108.53	107.02	77.40	70.25	100.65
1945	126.69	98.49	95.61	102.16	139.31	144.50	111.66	107.44	79.76	73.00	101.02
1946	133.31	105.45	96.87	110.44	142.49	148.20	115.69	108.32	83.03	77.23	104.88
1947	129.11	105.47	97.47	109.75	148.15	152.78	119.42	105.69	85.39	78.59	105.85
1948	125.05	103.79	96.91	111.66	147.76	154.94	121.61	106.83	86.76	80.90	106.54
1949	132.34	107.99	102.61	101.73	140.67	157.94	122.20	106.45	91.79	81.65	107.64
1950	132.36	108.74	103.58	101.74	140.40	158.81	127.57	107.24	92.18	83.00	108.59
1951	132.24	111.82	106.18	102.43	139.57	157.20	128.13	108.40	93.17	84.79	109.86
1952	128.22	107.36	105.00	101.82	137.80	153.59	124.59	108.48	93.36	86.16	108.87
1953	125.50	107.93	104.49	102.90	136.24	154.35	127.11	109.34	93.97	87.82	109.34
1954	130.55	109.44	105.89	103.17	134.94	158.43	126.27	109.47	94.20	88.94	110.31
1955	130.56	111.60	107.91	103.56	136.64	154.18	125.64	107.38	95.31	90.11	110.93
1956	124.16	108.12	97.83	87.52	127.71	143.94	120.12	96.28	90.83	89.49	103.26
1957	121.90	104.78	98.31	70.88	120.28	128.17	108.79	91.90	86.80	88.08	98.20
1958	114.91	98.98	90.91	84.19	114.47	113.54	98.90	90.18	89.93	89.79	95.50
1959	110.98	98.19	96.96	86.86	116.04	118.05	104.28	94.43	90.32	90.24	98.06
1960	104.00	93.49	94.20	81.66	110.24	110.12	101.54	93.65	90.09	90.73	95.12
1961	96.66	81.46	66.98	64.15	95.28	98.59	95.99	85.54	89.72	91.75	83.19
1962	93.86	80.03	65.10	54.70	87.55	91.44	95.19	82.48	87.91	90.29	79.82
1963	94.28	82.81	74.06	63.71	91.31	92.86	99.06	88.02	90.28	93.26	84.77
1964	95.69	85.32	74.64	65.09	94.67	92.98	106.76	91.37	92.53	96.16	87.03
1965	98.30	85.82	75.94	72.48	95.68	93.70	109.53	94.05	94.22	98.13	89.22
1966	96.40	90.55	89.05	88.43	93.91	89.45	97.03	91.31	96.43	99.09	92.88
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	98.71	95.15	89.49	92.91	97.71	100.18	109.37	99.19	99.61	100.63	96.88
1969	98.00	93.93	87.01	91.25	99.36	113.44	122.73	102.47	98.88	99.91	97.86
1970	104.07	97.56	87.14	96.51	108.00	123.81	126.44	106.09	101.06	100.78	101.22

Table 7 Indices of Mechanical Power and Machinery Input

(1967 = 100)

<u>Year</u>	<u>North- east</u>	<u>Lake States</u>	<u>Corn Belt</u>	<u>Northern Plains</u>	<u>Appala- chian</u>	<u>South- east</u>	<u>Delta States</u>	<u>Southern Plains</u>	<u>Mountain</u>	<u>Pacific</u>	<u>United States</u>
1939	56.05	40.48	38.89	40.58	28.17	35.43	38.82	49.56	32.21	42.21	40.09
1940	58.57	42.54	40.89	42.77	29.56	36.88	40.51	52.61	34.35	44.55	42.20
1941	61.19	44.36	42.77	44.94	31.07	37.95	41.41	53.52	36.37	46.13	43.93
1942	69.37	51.87	50.26	52.69	35.57	41.52	43.92	58.37	43.26	53.66	50.48
1943	71.84	54.20	53.30	56.35	36.10	42.13	44.33	61.25	46.53	56.78	53.00
1944	74.27	56.27	55.78	59.42	36.94	42.80	44.92	63.98	49.45	59.94	55.28
1945	75.87	57.00	55.68	59.60	38.60	44.92	46.51	64.00	50.69	61.49	56.05
1946	73.91	55.08	54.48	57.61	38.66	45.46	46.93	63.51	49.81	60.52	55.00
1947	81.26	60.57	59.94	61.87	44.10	50.77	52.22	69.26	55.49	66.85	60.51
1948	92.81	67.24	66.84	69.65	50.84	57.68	59.08	74.86	63.16	76.60	67.98
1949	97.60	74.23	73.89	75.46	58.96	65.97	68.09	81.39	71.33	82.75	74.92
1950	100.90	78.72	78.93	79.47	64.75	71.59	72.87	83.62	75.06	83.55	79.03
1951	104.53	83.74	83.79	84.07	70.60	77.32	78.30	88.13	80.34	92.05	84.24
1952	106.61	88.74	88.57	89.18	75.29	82.58	83.30	92.16	85.07	92.29	88.51
1953	105.24	90.43	89.58	90.47	77.99	84.77	85.10	92.84	87.13	93.27	89.78
1954	103.07	91.22	89.77	90.84	80.23	85.96	85.89	93.18	87.33	91.79	90.06
1955	101.46	92.17	91.46	92.14	82.11	87.55	86.31	92.74	88.08	92.24	90.96
1956	100.77	92.06	91.68	91.53	83.42	88.67	86.90	92.19	88.19	93.29	91.10
1957	99.48	90.39	90.50	89.63	83.12	88.17	85.94	91.17	88.03	93.37	90.06
1958	99.21	90.75	91.09	89.88	84.99	88.33	85.90	90.77	88.68	94.52	90.53
1959	98.39	92.75	93.46	91.89	87.59	90.18	87.66	91.27	90.42	96.20	92.27
1960	97.67	91.39	91.86	90.82	86.82	88.43	86.18	89.80	89.55	94.85	90.99
1961	94.46	89.74	89.79	88.59	86.19	87.50	85.26	88.62	88.52	95.69	89.50
1962	94.69	91.63	91.43	90.28	88.97	89.15	87.42	90.11	90.47	97.43	91.23
1963	93.86	91.21	92.07	90.83	90.74	87.98	88.59	90.50	91.24	97.90	91.62
1964	93.89	92.17	93.55	92.30	92.51	90.76	89.44	90.80	95.41	98.82	93.06
1965	96.24	94.72	95.51	94.72	95.09	95.99	96.28	96.43	94.96	98.82	95.67
1966	99.41	98.94	99.87	98.82	99.72	100.11	100.58	99.97	99.64	101.92	99.76
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	101.37	101.90	101.96	102.06	101.87	101.96	102.35	102.46	102.29	101.05	101.94
1969	102.47	103.48	103.14	102.98	103.37	103.54	103.24	103.27	103.50	101.87	103.10
1970	102.57	103.37	103.05	103.03	103.34	103.39	103.14	102.83	103.42	102.29	103.05

Table 8 Indices of Fertilizer and Lime Inputs (1967 = 100)

Year	North-east	Lake States	Corn Belt	Northern Plains	Appalachian	South-east	Delta States	Southern Plains	Mountain	Pacific	United States
1939	40.50	5.69	4.81	0.46	29.44	29.52	15.61	2.23	2.14	7.08	12.25
1940	43.88	7.81	7.01	0.57	32.68	31.27	17.47	2.75	2.27	7.96	14.02
1941	49.81	9.87	7.64	0.67	33.45	33.81	20.15	3.17	2.99	9.41	15.44
1942	52.60	16.59	9.81	0.92	36.24	33.68	20.60	3.56	2.99	8.63	17.08
1943	55.66	14.25	10.53	0.93	39.93	41.89	27.68	4.92	3.69	11.28	19.28
1944	65.31	19.59	12.75	1.75	44.14	45.37	31.04	6.64	5.60	15.53	22.58
1945	66.36	18.89	12.90	2.23	44.27	44.47	29.37	6.25	5.70	16.08	22.52
1946	68.81	22.31	15.98	2.32	47.14	44.59	26.35	7.93	6.59	17.97	24.35
1947	70.26	24.81	18.64	3.75	53.50	49.67	34.28	10.29	9.32	23.20	27.89
1948	68.20	27.97	19.86	4.76	53.85	51.09	39.35	12.24	11.29	22.29	29.07
1949	70.57	30.33	22.65	5.25	59.06	53.24	45.80	13.49	10.28	20.62	31.27
1950	70.58	30.18	22.85	7.17	60.59	51.46	48.42	16.60	13.19	22.09	32.01
1951	71.36	31.06	26.14	8.76	65.66	59.07	58.27	18.71	19.87	28.97	36.12
1952	75.41	34.42	30.35	11.33	71.70	62.19	60.57	19.82	22.12	29.83	39.43
1953	77.94	37.11	34.56	15.18	70.45	64.41	58.64	19.65	25.16	32.78	41.81
1954	74.99	39.15	36.31	18.52	68.28	65.78	64.19	20.29	27.67	35.02	43.18
1955	79.76	44.44	35.74	20.54	68.91	66.39	63.88	22.55	29.55	40.24	44.70
1956	75.95	45.30	34.62	17.27	67.04	66.62	67.53	24.15	27.93	43.16	44.18
1957	77.89	49.03	35.95	19.47	67.28	68.71	66.57	26.36	33.17	47.96	46.19
1958	79.06	51.10	37.56	22.94	65.09	66.23	59.31	30.48	39.89	53.53	47.50
1959	84.62	57.66	42.90	30.78	76.26	75.42	67.86	32.90	41.81	58.81	53.90
1960	82.56	54.04	42.27	33.62	72.84	75.69	70.78	36.75	45.65	61.69	53.99
1961	82.83	59.35	43.97	44.57	74.94	80.36	72.48	41.28	54.59	63.87	57.55
1962	85.28	57.70	48.68	48.48	79.06	81.88	77.33	57.62	56.96	69.04	61.95
1963	91.78	65.33	58.87	56.87	84.61	85.05	83.17	71.01	61.66	74.48	69.84
1964	93.80	75.57	67.33	60.47	87.17	87.46	87.26	76.76	69.08	80.19	75.79
1965	94.59	78.18	72.83	65.66	86.73	87.60	91.98	83.79	75.23	86.18	79.76
1966	101.97	83.03	88.36	86.42	94.53	92.83	90.78	91.34	86.57	87.93	89.89
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	99.97	109.53	103.27	127.72	97.01	106.38	109.75	116.61	117.10	105.03	107.36
1969	97.93	125.38	101.08	122.80	101.24	112.15	113.33	138.64	132.46	99.54	110.35
1970	99.96	117.67	105.83	137.64	102.02	107.96	116.24	142.63	129.65	100.50	112.74

Table 9 Indices of Feed, Seed, and Livestock Purchases

(1967 = 100)

<u>Year</u>	<u>North- east</u>	<u>Lake States</u>	<u>Corn Belt</u>	<u>Northern Plains</u>	<u>Appala- chian</u>	<u>South- east</u>	<u>Delta States</u>	<u>Southern Plains</u>	<u>Mountain</u>	<u>Pacific</u>	<u>United States</u>
1939	68.78	45.76	46.64	35.27	37.30	20.01	25.68	49.45	38.82	34.71	41.32
1940	69.99	48.82	47.77	37.93	38.51	20.28	25.71	51.04	40.18	35.59	42.60
1941	76.14	52.61	51.99	42.50	42.12	21.41	27.11	53.36	43.26	38.69	46.07
1942	78.62	56.48	54.41	50.85	46.64	22.85	28.48	57.41	46.37	38.08	48.93
1943	82.60	60.83	60.06	56.20	50.11	23.36	30.51	60.21	53.32	41.43	52.76
1944	81.25	61.82	61.23	54.50	52.41	23.15	31.72	59.47	55.93	41.19	53.14
1945	88.44	64.55	61.38	54.99	52.90	24.49	32.18	59.51	56.72	45.63	55.00
1946	85.65	62.74	60.17	54.24	51.60	24.80	31.40	58.87	53.92	44.49	53.78
1947	91.40	62.95	61.18	55.73	54.71	27.38	33.30	63.56	56.86	47.99	56.32
1948	96.22	60.24	60.90	53.12	56.56	28.70	34.19	62.24	55.80	51.26	56.92
1949	105.82	65.45	65.34	55.88	60.84	32.19	36.68	72.55	60.72	58.99	62.38
1950	109.06	65.67	66.23	58.18	61.31	34.33	37.63	72.97	61.44	61.64	63.83
1951	112.84	69.52	70.61	62.19	65.52	38.62	41.01	78.44	65.40	68.02	68.24
1952	112.31	71.43	72.38	65.37	67.92	41.47	41.95	77.55	67.28	71.15	69.95
1953	108.50	73.38	73.25	65.65	66.55	42.85	43.12	73.01	67.50	71.04	69.75
1954	107.46	78.50	76.26	69.58	68.28	45.56	44.78	73.52	68.77	73.69	72.07
1955	102.58	81.67	79.42	72.18	69.42	47.95	44.58	73.07	71.44	74.24	73.23
1956	102.65	84.05	82.97	72.33	72.59	52.29	47.35	75.54	74.40	79.46	76.06
1957	97.09	83.07	81.99	69.26	72.33	54.57	47.52	73.66	74.66	79.86	75.05
1958	99.55	86.43	87.10	76.75	78.25	61.60	51.73	78.89	81.75	88.08	80.42
1959	94.80	89.77	91.06	86.85	80.29	65.96	58.41	87.41	86.53	93.26	84.14
1960	93.80	89.62	88.83	86.95	81.07	65.39	60.87	85.11	88.10	92.96	83.60
1961	94.05	96.55	92.59	87.32	84.41	68.43	67.17	90.09	89.62	97.91	87.16
1962	97.67	93.96	94.98	91.64	85.42	71.25	66.12	90.34	92.02	101.64	89.00
1963	97.46	93.04	96.42	92.37	87.35	71.82	69.67	88.23	95.18	95.19	89.18
1964	97.05	97.21	94.60	92.44	88.23	77.60	74.23	86.35	95.01	98.28	90.45
1965	99.66	94.32	94.05	95.08	97.01	80.73	76.23	85.49	96.80	91.83	91.37
1966	103.86	97.58	98.18	102.64	93.70	92.63	89.71	89.35	100.31	94.55	96.52
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	101.10	101.28	95.78	104.58	103.15	101.13	108.27	96.97	101.48	100.86	100.67
1969	100.99	101.96	103.37	118.36	101.66	100.48	102.17	101.76	121.07	103.64	103.90
1970	101.28	105.89	99.71	114.10	114.47	113.81	119.04	108.59	126.27	108.52	108.54

(1967 = 100)

Table 10 Taxes and Interest Indices

Year	North- east	Lake States	Corn Belt	Northern Plains	Appala- chian	South- east	Delta States	Southern Plains	Mountain	Pacific	United States
1939	112.27	75.99	66.77	57.33	85.07	57.92	83.44	67.41	66.60	42.01	67.12
1940	110.05	78.28	69.58	56.76	85.66	59.70	82.85	66.54	66.57	41.32	67.81
1941	107.90	78.87	68.17	59.40	85.71	59.42	84.40	70.68	67.96	41.25	68.25
1942	104.06	77.81	68.19	61.81	86.04	59.91	83.34	71.65	69.13	42.56	68.60
1943	107.50	81.13	71.56	68.25	90.61	62.35	86.09	74.01	73.20	43.22	72.03
1944	110.29	83.22	72.53	68.26	94.55	68.78	86.62	74.48	76.08	47.96	74.05
1945	114.25	84.89	70.38	72.56	92.34	69.82	86.98	75.87	77.46	51.02	75.08
1946	113.56	86.88	72.09	69.24	93.59	72.21	83.81	72.13	76.69	56.44	75.58
1947	110.17	85.85	74.10	73.10	92.97	68.13	79.21	74.19	75.63	54.67	75.88
1948	107.57	83.03	70.75	69.90	91.84	67.93	76.24	70.87	76.74	54.70	73.72
1949	107.41	85.23	75.81	74.73	93.63	69.03	78.87	73.72	78.75	55.10	76.66
1950	104.22	85.17	77.27	73.57	92.78	70.99	77.95	74.04	77.48	55.37	76.64
1951	101.34	84.20	77.70	77.58	91.33	70.35	79.06	74.38	84.87	54.98	77.57
1952	103.50	87.19	79.94	78.23	92.02	73.41	81.10	75.92	84.59	57.08	79.31
1953	105.71	89.48	81.43	77.44	92.06	75.82	84.68	74.57	85.57	58.80	80.36
1954	105.09	89.16	79.87	76.09	91.36	79.49	84.79	73.51	85.48	59.68	79.81
1955	104.86	91.37	83.58	79.30	90.93	78.74	84.33	74.76	85.91	63.01	81.97
1956	104.21	90.23	84.09	75.22	92.37	80.83	87.43	73.53	85.07	64.07	81.56
1957	103.09	90.98	84.38	74.79	90.51	79.54	86.34	70.79	83.08	62.64	80.81
1958	99.97	90.69	86.14	79.14	87.55	78.26	84.51	72.68	84.92	63.90	81.91
1959	100.77	92.47	90.29	84.84	89.96	78.18	84.35	81.12	88.42	68.09	85.75
1960	102.15	94.59	91.14	83.55	91.74	78.11	85.23	85.74	88.44	73.39	87.31
1961	103.25	96.85	90.85	86.81	92.28	79.37	85.33	89.32	88.87	75.60	88.75
1962	103.80	97.71	92.41	87.52	93.44	82.82	87.08	91.59	88.84	78.02	90.15
1963	101.30	98.14	93.80	91.84	94.71	83.27	88.67	92.52	93.39	80.21	91.92
1964	100.32	99.65	95.62	93.55	95.57	87.81	92.98	93.93	95.27	83.99	93.89
1965	99.37	99.38	94.76	94.29	96.03	93.05	96.32	95.76	95.56	88.43	94.81
1966	97.81	100.59	98.25	99.34	97.88	96.06	96.68	98.41	97.11	93.01	97.68
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	104.07	104.42	103.85	100.84	104.64	100.96	101.77	101.77	101.73	106.86	103.38
1969	106.04	104.56	105.51	101.72	105.62	102.16	102.97	104.60	102.54	110.99	105.08
1970	107.65	107.18	107.86	105.66	109.33	105.57	104.12	107.36	106.07	112.39	107.73

(1967 = 100)

Table 11 Indices of Miscellaneous Inputs

<u>Year</u>	<u>North- east</u>	<u>Lake States</u>	<u>Corn Belt</u>	<u>Northern Plains</u>	<u>Appala- chian</u>	<u>South- east</u>	<u>Delta States</u>	<u>Southern Plains</u>	<u>Mountain</u>	<u>Pacific</u>	<u>United States</u>
1939	64.16	49.87	45.55	41.30	47.18	42.72	60.80	59.17	49.71	47.69	50.38
1940	65.23	50.30	46.64	36.40	49.40	44.62	57.30	66.93	50.65	49.62	51.53
1941	68.97	49.78	46.02	50.81	49.65	40.69	57.76	62.05	53.61	48.62	52.11
1942	65.10	50.01	40.61	34.16	49.63	41.38	64.35	60.69	47.76	46.74	49.34
1943	65.79	49.54	44.68	61.76	48.01	41.32	60.50	58.39	51.07	48.49	51.88
1944	66.74	52.48	50.33	56.20	49.71	43.71	65.21	61.49	50.50	49.79	53.88
1945	70.10	54.45	48.65	54.22	50.27	42.55	57.06	51.60	53.03	51.02	53.03
1946	72.63	54.36	50.61	58.24	52.68	43.14	53.04	40.58	55.75	54.69	53.81
1947	68.59	53.82	50.74	60.72	50.49	42.00	54.80	56.29	56.00	51.16	54.04
1948	72.11	54.43	53.84	59.06	55.45	47.76	75.02	65.60	58.69	55.41	58.83
1949	72.64	56.03	57.67	53.25	58.49	46.53	70.05	98.30	61.32	57.06	62.19
1950	79.30	57.00	56.76	58.80	58.49	49.42	68.36	69.46	69.49	67.45	63.48
1951	80.19	60.01	58.24	57.68	61.91	56.66	76.11	82.97	74.97	68.77	67.25
1952	77.18	58.68	58.82	57.56	60.59	56.22	79.98	81.88	73.73	70.81	67.16
1953	74.44	58.83	53.50	52.85	58.98	53.94	79.90	82.24	73.45	67.79	64.87
1954	76.38	61.96	57.73	55.67	54.41	52.58	68.57	77.57	69.16	67.39	64.18
1955	80.08	64.97	64.57	59.53	63.84	58.09	76.70	76.64	71.28	70.18	68.61
1956	89.36	67.17	58.86	53.52	66.27	60.41	71.16	72.92	77.84	78.48	69.97
1957	86.78	68.45	66.88	64.28	63.92	52.94	54.94	71.31	79.20	76.39	69.38
1958	93.39	73.72	68.85	78.51	69.60	55.42	52.27	85.31	83.48	78.48	74.21
1959	96.44	74.14	72.21	73.57	73.94	63.52	68.95	87.48	89.24	83.66	78.61
1960	98.73	78.44	71.50	79.90	72.56	65.02	67.63	87.78	90.17	85.81	79.93
1961	105.16	79.64	70.79	76.22	75.34	68.99	71.41	91.63	91.70	90.39	82.39
1962	108.00	85.56	74.87	82.25	79.00	73.55	74.47	90.87	94.82	95.56	86.26
1963	111.54	85.33	77.79	82.36	83.32	76.25	83.09	90.80	95.90	97.53	88.70
1964	102.43	92.08	83.86	85.39	93.80	85.13	100.56	95.96	96.11	95.41	92.73
1965	98.80	87.10	82.75	88.42	94.16	90.35	104.52	108.48	93.32	96.05	93.72
1966	99.28	90.21	97.67	95.03	95.81	95.21	97.51	98.75	98.10	97.44	96.65
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	98.08	104.01	118.38	114.66	104.88	111.88	120.30	116.72	105.76	100.87	109.20
1969	106.55	100.05	92.65	107.95	101.67	99.19	108.05	98.52	103.76	103.04	101.36
1970	94.24	99.76	99.24	119.38	98.48	91.18	114.70	104.07	99.75	94.26	100.22

regions the high point in miscellaneous input use fell at 1968 or later.

Fixed and Variable Inputs

The inputs were also indexed by fixed and variable categories. The length of run considered was one year. That is, if the input could not be varied within a production season, then it was classified as fixed. All other inputs were considered as variable. These estimates are tabulated in Tables 12 and 13 and graphed in Figure 8.

There has been considerable decline in fixed inputs since 1939. The high point in fixed input use was 1942. The decline was moderate, 12 points, from 1942 until 1955. From 1955 until 1962 the rate of decline was greater, the index dropping 25 points during this period. From 1962 until 1970, the use of fixed inputs increased by 7 points which followed the trend of the variable inputs.

The regional pattern of fixed input use was similar to the national pattern for all regions except the Mountain and Pacific. Fixed inputs were relatively constant in the Mountain region with a range of only 13 index points. In the Pacific region fixed input use was a minimum at 1939 and maximum at the end of the period.

Variable Inputs

Nationally there has been a general secular increase in the use of variable inputs. These inputs increased in 26 of the 31 years of the period. Of the five declining years, the greatest decline was only 1 index point. As indicated on Figure 8, the variable inputs are highly correlated with productivity.

Regionally the trends tend to follow the national average except for the Northeast region. The low point for use of variable inputs was 1939 for eight of the ten regions. In the Southeast the low point came in 1941, and for the Delta States the low came at 1946.

In the Northeast region, the high for use of variable inputs came at 1951. For the remaining 9 regions, the high was at 1968 or later. The range in variable inputs varied from 21 points in the Northeast to 62 points in the Northern Plains. The range for the U.S. was 42 points.

Index of Farm Output

The index of farm output is constructed as follows:²¹

In calculating farm output, two major indexes of gross production are computed--total livestock production and total crop production. Subindexes are computed for the principal commodity groups that compose total livestock production and total crop production.

The farm output, livestock production, and crop production indexes are calculated annually for each of 10 farm production regions beginning in 1939, as well as for the United States from 1910 to date. Farm output estimates are calculated at decade intervals from 1870 to 1900.

These indexes are calculated by the familiar constant price-weight method. Weighted average prices received by farmers in a given region are used as weights in constructing the indexes for the regions. The quantity-price aggregates for the 10 farm production regions are summed to obtain the quantity-price aggregates upon which the index for the United States is based. (Table 14 and Figure 9.) The reference period used for the indexes is 1967. Two weight periods are used for the regional indexes, and three weight periods for the U.S. indexes. Average 1957-59 prices received by farmers in each farm production region are used as weights for 1955 and subsequent years; average 1947-49 prices are used for 1939 to 1955. In the U.S. indexes, average 1935-39 prices are used for the years prior to 1939.

Conceptually, farm output does not include the production of producer goods. These are goods produced on farms and used in further production of farm products for human use. Producer goods include such items as seed and farm-produced power of horses and mules. These products are included in the gross farm production index, which is not published but is available for research purposes.

The current year's indexes of farm output, crop production, and livestock production are based on preliminary and sometimes incomplete data. Thus, the current year's indexes are subject to revision in the following year after all the basic data are available. A general revision of the series is made after each agricultural census for all years back to the preceding census date.

SRS calculates a preliminary index of crop production for the current year based on its monthly forecasts of crop production beginning in August of each year. The index is published in the monthly Crop Production reports. These preliminary indexes for the current year are prepared for the United States only, but they are directly comparable to the historical

²¹From USDA Agriculture Handbook No. 365, pp. 15-17.

indexes for the United States built up on a regional basis.

Limitations of Series

The indexes of farm output and the component indexes of crop and livestock production do not adequately measure changes in quality of products over time. These indexes reflect the changes in production caused by changes in quantities of individual items included. The failure of the series to measure quality change is an inherent problem in most indexes.

In theory, any crop grown for seed should not be included in farm output. Hayseed, pasture seed, and covercrop seeds are not included. Because of the lack of necessary data, no deductions are made for other types of seeds. Also, because of the lack of data, several minor products are not included in farm output or in its component series. The main item of production omitted in the farm output series is production from farm forests. This, plus other minor items omitted, probably accounts for less than 5 percent of the total farm output in recent years.

Alaska and Hawaii are not included in the current series because of the lack of data through the weight period, 1957-59. These States will be included in the farm output and component series after the next new weight period is adopted.

As more than one set of price weights is used in computing the indexes, the series are spliced at 1955 for the regions and the United States. The U.S. series is also spliced at 1939. The splicing is necessary to convert the indexes based on the various quantity-price aggregates to one final series of index numbers with 1967 as a reference base period of 100.

Official reports of SRS are the chief sources of data for crop and livestock production and prices.

Farm output includes crops produced during the crop year exclusive of hayseeds, pasture seeds, covercrop seeds, and hay and concentrates fed to horses and mules on farms. Farm output also included the "net" production of livestock other than horses and mules, and production of livestock products. Net livestock production is gross live-weight production of livestock on farms during the calendar year minus the constant-dollar farm value of hay and concentrates fed to livestock. Thus, the value of pasture consumed by livestock is included in net livestock production.

Hatching eggs for broilers and chickens raised also are excluded in calculating net livestock production. These calculations are made to avoid counting feed crops in both livestock and crop production, and to avoid counting hatching eggs as part of poultry meat production as well as egg production.

Table 12 Indices of Fixed Inputs (1967 = 100)

Year	North- east	Lake States	Corn Belt	Northern Plains	Appala- chian	South- east	Delta States	Southern Plains	Mountain	Pacific	United States
1939	174.12	140.56	124.88	110.13	148.79	163.20	161.53	142.33	94.74	84.45	127.98
1940	175.17	142.82	124.75	111.45	143.35	161.18	155.85	145.76	96.08	85.30	128.15
1941	172.61	140.76	124.67	115.13	140.38	152.10	154.21	141.85	97.53	85.62	127.22
1942	175.12	145.38	128.19	123.57	142.88	158.52	159.89	147.88	100.64	87.41	131.54
1943	171.97	143.05	127.87	124.45	144.59	158.90	155.19	144.59	101.37	88.66	131.00
1944	172.20	141.31	126.16	124.41	148.96	158.60	154.51	143.86	101.38	90.59	130.99
1945	166.28	138.23	120.83	119.84	146.13	155.35	145.80	133.52	100.10	91.64	126.84
1946	159.06	130.07	116.74	111.61	146.09	151.04	139.70	126.75	97.72	93.40	122.50
1947	151.23	123.59	112.27	108.92	144.88	151.17	142.27	130.27	98.28	92.66	120.25
1948	150.27	121.42	113.78	109.97	144.58	152.71	154.47	127.26	100.00	93.80	121.02
1949	151.64	124.14	116.28	107.33	146.55	151.62	150.67	130.43	102.97	95.32	122.31
1950	152.00	123.52	116.26	109.03	144.74	148.24	144.43	125.32	103.24	96.50	121.59
1951	149.73	124.84	118.16	111.86	148.32	153.70	148.33	129.77	105.83	98.42	123.98
1952	146.15	124.28	118.19	111.51	145.47	148.74	146.45	125.87	105.58	98.92	122.75
1953	144.57	124.56	117.98	111.62	141.03	146.74	147.84	125.29	105.50	98.29	122.07
1954	142.89	124.49	117.96	112.09	139.54	142.67	138.02	122.25	106.60	97.70	120.99
1955	139.27	123.81	117.74	111.01	135.49	141.16	136.07	121.03	105.79	98.01	119.84
1956	133.83	119.99	111.83	102.15	129.19	132.49	128.62	112.07	102.03	97.70	114.12
1957	127.26	115.44	108.94	96.36	118.05	118.68	115.58	105.57	98.59	95.21	108.33
1958	121.95	110.84	104.85	98.45	113.38	109.59	106.99	104.10	98.83	94.90	105.32
1959	118.20	109.78	107.20	98.14	114.43	112.33	110.65	106.30	98.54	95.85	106.14
1960	112.00	104.68	102.90	94.00	108.50	105.27	104.87	102.56	95.82	94.27	101.77
1961	108.73	100.98	92.05	88.04	103.39	100.57	101.92	98.46	94.98	94.93	96.75
1962	105.66	99.39	90.47	85.23	101.02	96.93	98.34	94.88	93.64	94.64	94.63
1963	101.84	97.70	92.09	87.01	100.85	95.35	99.31	95.42	94.10	95.27	94.87
1964	101.11	98.30	91.92	87.26	100.91	96.82	102.49	96.35	95.13	97.94	95.58
1965	101.09	97.69	91.44	89.78	98.78	97.74	104.14	98.50	96.31	99.88	96.16
1966	99.81	98.56	95.96	95.73	97.15	94.87	98.29	95.05	97.84	99.74	97.14
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	100.59	100.12	97.70	99.47	100.07	100.50	105.33	101.29	101.63	101.85	100.20
1969	100.21	99.21	96.77	99.09	101.99	106.00	109.72	103.56	102.01	102.68	100.83
1970	101.68	99.77	97.31	101.03	104.01	108.65	111.41	105.62	103.67	102.67	102.06

Table 13 Indices of Variable Inputs

(1967 = 100)

Year	North- east	Lake States	Corn Belt	Northern Plains	Appala- chian	South- east	Delta States	Southern Plains	Mountain	Pacific	United States
1939	89.32	54.33	42.98	46.42	60.68	58.70	80.18	76.94	61.12	70.38	61.02
1940	92.34	57.92	45.39	48.83	61.37	59.28	77.96	81.39	63.51	71.78	63.02
1941	95.58	58.97	46.86	53.09	61.95	57.21	78.10	79.66	66.24	73.09	64.15
1942	96.99	62.53	48.42	55.74	64.45	59.08	81.39	82.42	67.63	72.03	65.96
1943	98.91	63.90	51.99	61.77	66.80	61.58	80.71	83.00	70.61	74.17	68.48
1944	101.18	66.50	54.10	62.66	70.32	62.24	82.07	84.40	71.86	76.15	70.36
1945	102.44	67.04	53.40	61.78	69.97	61.26	76.42	78.05	70.79	76.37	69.27
1946	103.53	68.85	55.99	63.78	73.77	61.38	73.72	77.02	70.88	78.53	70.65
1947	103.94	69.97	58.00	65.92	75.96	63.91	77.69	83.46	73.12	78.55	72.76
1948	105.71	70.10	59.66	66.51	77.41	65.62	86.90	83.21	74.27	79.19	74.33
1949	109.23	73.63	63.68	65.51	80.06	66.11	85.49	91.61	77.71	80.30	76.95
1950	110.19	73.10	63.75	66.50	79.63	64.93	81.17	84.15	77.63	79.66	75.99
1951	110.73	74.95	66.50	68.54	83.63	70.86	86.68	89.38	81.04	85.60	79.64
1952	110.17	76.78	69.23	71.13	85.84	71.85	87.92	88.40	81.66	84.53	80.79
1953	107.60	77.36	69.37	70.88	83.70	71.88	88.18	86.25	81.06	82.56	80.00
1954	105.77	78.87	70.24	71.96	82.55	71.29	83.38	83.73	81.07	81.67	79.51
1955	104.26	81.13	71.99	73.23	83.54	73.11	83.81	82.67	80.96	82.96	80.46
1956	104.52	82.54	72.34	71.69	84.10	73.49	82.15	81.34	81.68	86.37	80.88
1957	101.84	82.98	73.23	71.82	82.09	71.80	76.65	80.38	82.71	86.46	80.21
1958	103.63	85.37	75.46	75.65	85.08	73.87	75.60	84.41	85.71	89.98	82.76
1959	101.02	87.79	79.01	79.07	88.93	78.97	82.98	86.33	86.69	92.97	85.70
1960	102.44	89.44	78.97	81.72	90.24	79.92	84.54	87.83	88.77	95.26	87.04
1961	101.21	90.35	78.39	80.99	90.54	81.45	86.63	88.52	88.53	96.64	87.34
1962	102.13	90.58	81.12	84.74	92.69	83.03	86.13	90.71	90.38	99.13	89.28
1963	103.25	92.00	85.74	87.95	96.30	85.24	91.13	93.40	92.57	100.10	92.12
1964	100.80	94.66	87.82	88.78	96.48	87.59	94.77	93.31	94.40	100.31	93.27
1965	100.45	93.15	88.59	90.25	97.64	89.14	96.02	97.54	92.98	98.11	93.70
1966	101.94	94.94	96.37	97.89	98.46	95.11	96.83	97.30	97.18	97.68	97.25
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	98.11	100.84	100.20	105.26	98.59	100.38	106.65	104.12	101.70	102.54	101.52
1969	98.25	102.69	98.73	106.33	97.87	100.46	104.03	106.43	106.84	102.05	101.72
1970	96.67	102.37	98.99	108.37	101.41	103.95	110.60	107.71	105.51	101.77	102.83

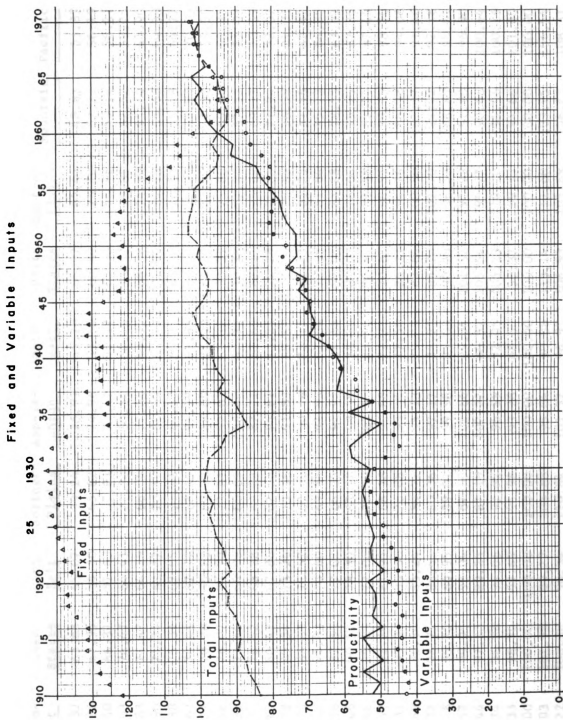


Figure 8

Table 14. Indices of Total Farm Output. (1967 = 100)

Year	North- east	Lake States	Corn Belt	Northern Plains	Appala- chian	South- east	Delta States	Southern Plains	Mountain	Pacific	United States
1939	69.32	63.88	55.07	39.24	75.91	55.28	66.27	65.44	48.67	53.87	57.58
1940	72.35	67.95	54.30	45.62	74.06	57.50	60.89	74.18	52.71	56.19	59.74
1941	72.40	66.31	57.83	57.21	72.47	51.17	63.93	70.98	59.12	58.21	61.89
1942	79.03	74.47	64.41	71.30	80.54	60.13	73.37	79.85	62.52	59.75	69.48
1943	77.83	71.42	64.19	68.04	77.84	63.35	68.58	74.96	65.64	61.90	68.43
1944	80.90	71.31	62.57	70.50	85.62	64.54	71.90	84.19	64.66	64.33	70.27
1945	80.38	75.31	62.05	71.91	84.57	64.75	65.43	70.13	63.78	64.77	69.14
1946	85.62	74.41	67.17	68.45	91.79	62.95	60.46	70.32	63.95	70.03	70.99
1947	82.21	70.78	55.83	69.13	88.09	63.32	64.79	82.84	67.31	68.55	68.62
1948	84.46	76.07	71.74	73.01	92.01	67.12	83.37	75.80	69.80	69.35	75.13
1949	86.32	77.40	68.99	60.69	88.40	62.73	70.78	97.34	67.52	71.07	73.65
1950	90.43	76.52	68.28	69.83	87.71	62.69	67.11	75.69	69.17	73.37	73.18
1951	90.85	80.47	67.86	67.33	94.62	73.21	72.29	76.66	71.94	78.07	75.47
1952	90.12	83.34	73.26	73.16	91.89	68.51	75.79	78.69	76.59	81.01	78.23
1953	92.93	83.63	71.52	67.46	90.18	76.15	82.87	81.25	81.56	82.47	78.82
1954	93.36	85.93	73.60	69.86	91.95	67.84	77.45	81.84	75.73	84.35	78.99
1955	92.18	87.56	77.02	66.35	94.91	81.63	89.08	83.28	78.55	83.91	81.61
1956	95.46	90.57	78.50	63.98	99.35	78.79	82.03	78.04	78.25	87.35	81.81
1957	90.66	89.45	77.04	72.79	84.12	69.96	70.64	81.38	82.71	87.44	80.17
1958	97.45	92.74	81.95	88.28	90.88	72.71	70.85	94.51	88.85	88.56	86.43
1959	94.31	95.30	85.56	76.08	93.41	77.50	86.21	94.76	86.38	94.08	87.71
1960	96.69	94.50	86.24	89.72	95.13	79.33	83.64	100.50	87.17	91.46	90.01
1961	98.32	98.71	86.41	80.36	97.17	83.27	89.70	102.70	86.42	92.18	90.45
1962	93.48	95.75	86.95	89.01	99.98	85.09	90.29	96.48	88.89	95.61	91.42
1963	94.57	99.95	93.04	87.95	102.66	89.04	101.32	97.99	91.90	96.80	94.84
1964	94.46	97.25	89.25	87.19	102.22	86.57	105.54	99.77	90.68	100.64	94.05
1965	96.74	96.08	94.06	92.82	96.99	92.05	105.23	110.10	94.96	100.19	97.05
1966	92.33	98.70	93.69	95.98	93.28	88.60	98.37	99.95	94.68	101.80	95.64
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	94.03	102.98	99.27	104.88	95.04	90.06	113.14	111.60	103.95	106.54	101.81
1969	97.22	100.38	98.34	110.84	101.37	96.97	106.93	105.89	106.83	108.31	102.89
1970	98.74	102.07	92.85	104.02	101.08	98.27	114.50	111.82	109.07	108.84	102.25

FARM OUTPUT

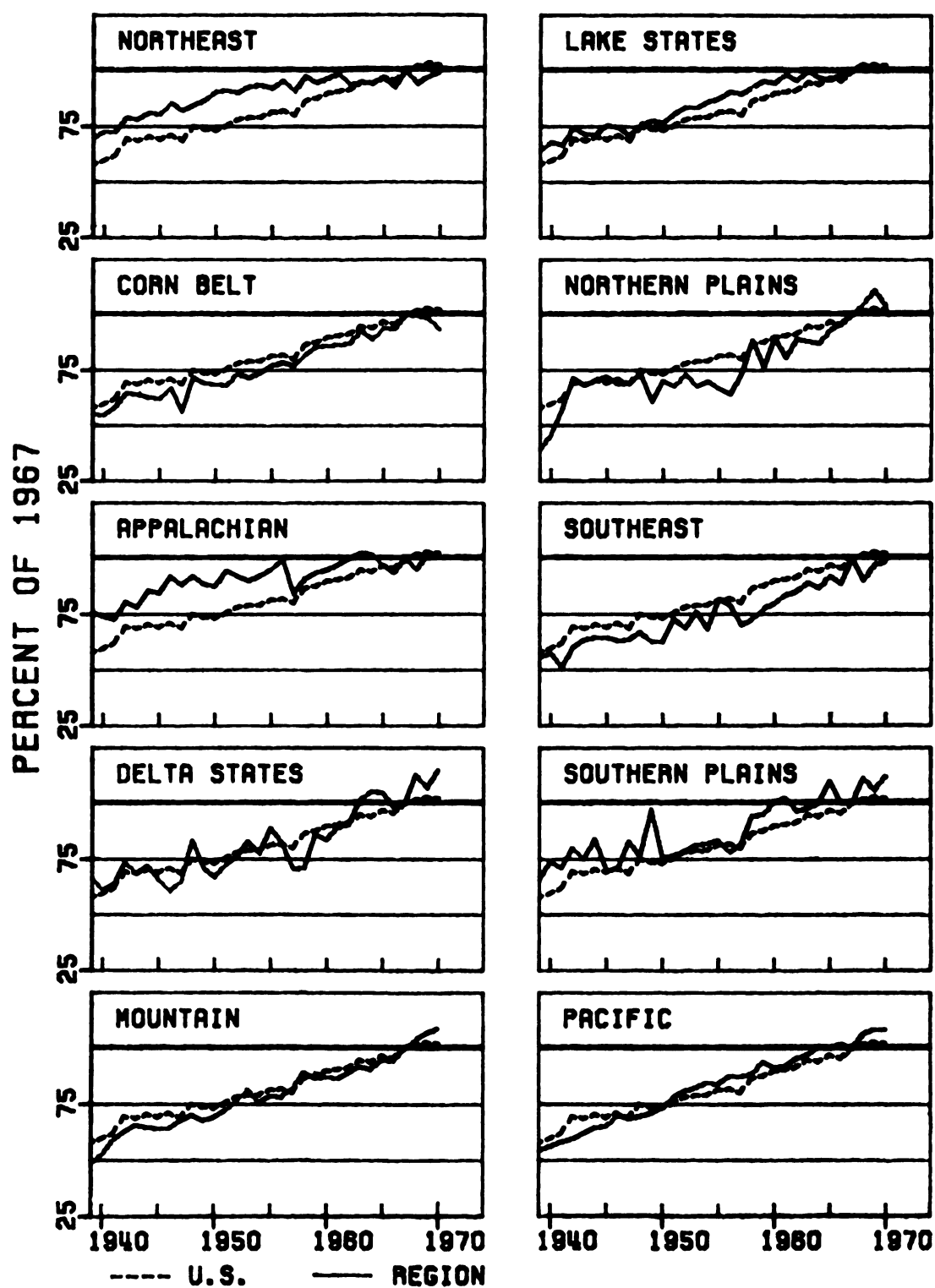


Figure 9

Feed, other than pasture, is calculated as a constant proportion of gross production of each kind of livestock or livestock product. The proportion varies among regions, and is changed each time the basic price weights are changed. The feed factors are in terms of the proportion of total value (in constant dollars) per unit of livestock production, such as per 100 pounds of beef production and per 100 eggs. Feed value excludes the nonfarm inputs such as processing and minerals that are included in the value of commercial mixed feeds. Except for broilers and turkeys, the same feed factors were used each year for each class of livestock in each region. Available data indicate that, except for broilers and turkeys, efficiency of feed use by livestock has shown little change.

Output Trends

The national trend in farm output has been upward. The low point was 1939, the high 1969. During this period output increased 45 index points or at an annual rate of 1.9 percent. The increase was fairly uniform with output increasing 22 of the 31 years.

Regional movements in output have been somewhat more erratic. In the Northern Plains region output jumped 32 points from 1939 to 1942. Output in this region then changed little for the next 15 years. Beginning in 1958, there was another surge in Northern Plains production which carried the index up another 32 points by 1968.

Poor growing conditions may have been responsible for the 15 year plateau in Northern Plains output. The Southern Plains region experienced a similar plateau from 1944 until 1957 and a similar rise of 30 points in output from 1957 until 1968. The development of hybrid sorghums may have been responsible for the beginning of the surge in production in these regions in the late 1950's.

In the Northeast and Appalachian regions output tended to follow the national average until about 1956 when output in these regions leveled out. There was a somewhat similar pattern in the Lake States region although the "leveling out" period did not begin until later, about 1961.

Year to year variations in output was greatest in the Delta States. Here the trend followed the national average until the 18 point decline from 1955 to 1958. Delta States output has increased rapidly, 44 points, since 1958.

Also somewhat erratic was output in the Southeast region although the long term trend followed along with the national average.

In the remaining three regions, the Corn Belt, Mountain and Pacific, output trended along close to the national average until the late 1960's. Corn Belt production has declined since 1967. In the Mountain and Pacific regions output has pushed above the national average during the same period.

Productivity

Indices of productivity appear in Table 15. Regional figures for the period 1939-1970 are graphed on Figure 10. The dashed line representing the national figure. The U.S. figures for the period 1910-1970 are graphed on Figure 8 (pg. 66).

In an effort to average the effect of weather, a three year moving average productivity for the U.S. was plotted on Figure 18 (pg. 88). This reveals three periods of productivity advance separated by brief plateaus or declines. The first period began about 1922. The rate of increase was modest and the rise ended about 1933. Productivity then declined for three years and began another advance about 1935. Between 1935 and 1947, productivity increased rapidly for a total of 21 index points. Productivity then plateaued for another three years before beginning a spectacular advance about 1950. During the period 1950-1964, productivity increased 28 points. Productivity has been on another plateau since 1964.

Regionally there has been considerable divergence in productivity trends. In the Northeast there was a general increase at a somewhat greater rate than the national average. In the Northern Plains productivity shot up 28 points in the first four years of the period. There was little change in productivity in this region for the next 14 years, from 1942 until 1956. In the next two years, from 1956 to 1958, the Northern Plains index shot up another 28 points. Since 1958, the index in this region has fluctuated around the national average. The pattern in the Southern Plains region was also somewhat erratic. Here productivity fluctuated around the national trend until 1957. In 1958 a rise began which carried the index up 23 points in 4 years. Since 1961

Table 15. Indices of Total Agricultural Productivity

(1967 = 100)

Year	North- east	Lake States	Corn Belt	Northern Plains	Appala- chian	South- east	Delta States	Southern Plains	Mountain	Pacific	United States
1939	54.48	62.89	64.63	46.94	71.77	56.27	57.14	58.26	60.18	69.42	60.37
1940	55.90	65.00	62.83	53.41	71.59	58.70	54.24	63.78	63.77	71.37	61.91
1941	55.62	63.79	66.35	63.99	70.85	54.82	57.26	62.59	69.83	73.18	64.05
1942	59.84	68.86	71.77	74.73	76.82	62.05	63.24	67.71	71.83	74.76	69.67
1943	59.04	66.40	70.17	69.02	72.79	64.12	60.34	64.36	73.97	75.84	67.90
1944	60.73	66.08	68.20	71.25	77.16	65.07	62.96	72.10	72.42	76.96	69.07
1945	61.19	70.69	69.96	74.95	77.32	66.51	61.07	64.80	72.40	76.91	69.76
1946	66.45	72.20	76.31	74.30	82.42	65.60	58.72	67.50	73.72	81.26	72.67
1947	65.42	70.67	64.28	75.53	78.70	64.74	60.87	75.88	76.47	79.87	70.26
1948	66.89	76.79	81.08	79.03	81.75	67.42	71.18	70.54	77.99	79.98	76.00
1949	66.97	75.71	75.10	67.11	76.91	63.03	61.72	85.98	72.84	80.73	73.01
1950	69.78	75.29	74.31	76.03	77.07	64.28	61.31	70.81	74.53	83.09	73.17
1951	70.47	77.93	71.96	71.36	80.39	70.64	63.16	68.58	75.12	84.64	73.20
1952	70.94	80.25	76.51	76.76	78.23	66.75	66.24	72.02	79.87	88.10	75.89
1953	74.42	80.20	74.71	70.81	79.01	74.68	71.97	75.30	85.33	90.97	77.01
1954	75.85	81.85	76.52	72.76	81.53	67.75	71.61	77.88	78.70	93.82	77.78
1955	76.41	82.82	79.41	69.15	85.27	80.89	82.79	80.14	82.07	92.50	80.42
1956	80.74	86.98	83.58	71.08	91.82	80.72	79.40	79.34	83.45	94.73	82.96
1957	79.71	87.96	83.07	84.07	83.03	76.92	74.85	86.27	89.76	96.12	84.20
1958	86.86	92.69	89.55	98.79	90.69	82.19	78.82	99.15	95.03	95.73	91.17
1959	86.47	94.86	90.62	84.03	91.08	83.69	90.20	97.30	92.16	99.61	90.79
1960	90.43	96.21	93.69	100.69	95.13	87.87	89.18	104.70	93.76	96.53	94.84
1961	93.88	102.31	100.64	94.28	99.75	93.28	95.85	109.23	93.57	96.27	97.93
1962	90.08	100.10	100.84	104.67	102.92	95.92	98.47	103.72	96.28	98.76	99.22
1963	92.18	104.90	104.29	100.65	103.98	99.64	106.82	103.67	98.31	99.17	101.34
1964	93.58	100.51	99.11	99.23	103.42	94.76	107.39	105.02	95.62	101.56	99.52
1965	96.02	100.33	104.34	103.18	98.72	99.35	105.52	112.26	100.00	101.18	102.15
1966	91.47	101.73	97.45	99.37	95.42	93.25	100.90	104.05	97.04	103.10	98.41
1967	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1968	94.72	102.54	100.44	103.05	95.64	89.67	106.68	108.82	102.25	104.26	100.98
1969	98.04	99.70	100.70	108.70	101.30	94.40	100.29	101.00	102.75	105.80	101.62
1970	99.81	101.36	95.13	100.20	98.34	92.85	103.54	105.08	104.42	106.32	100.00

FARM PRODUCTIVITY

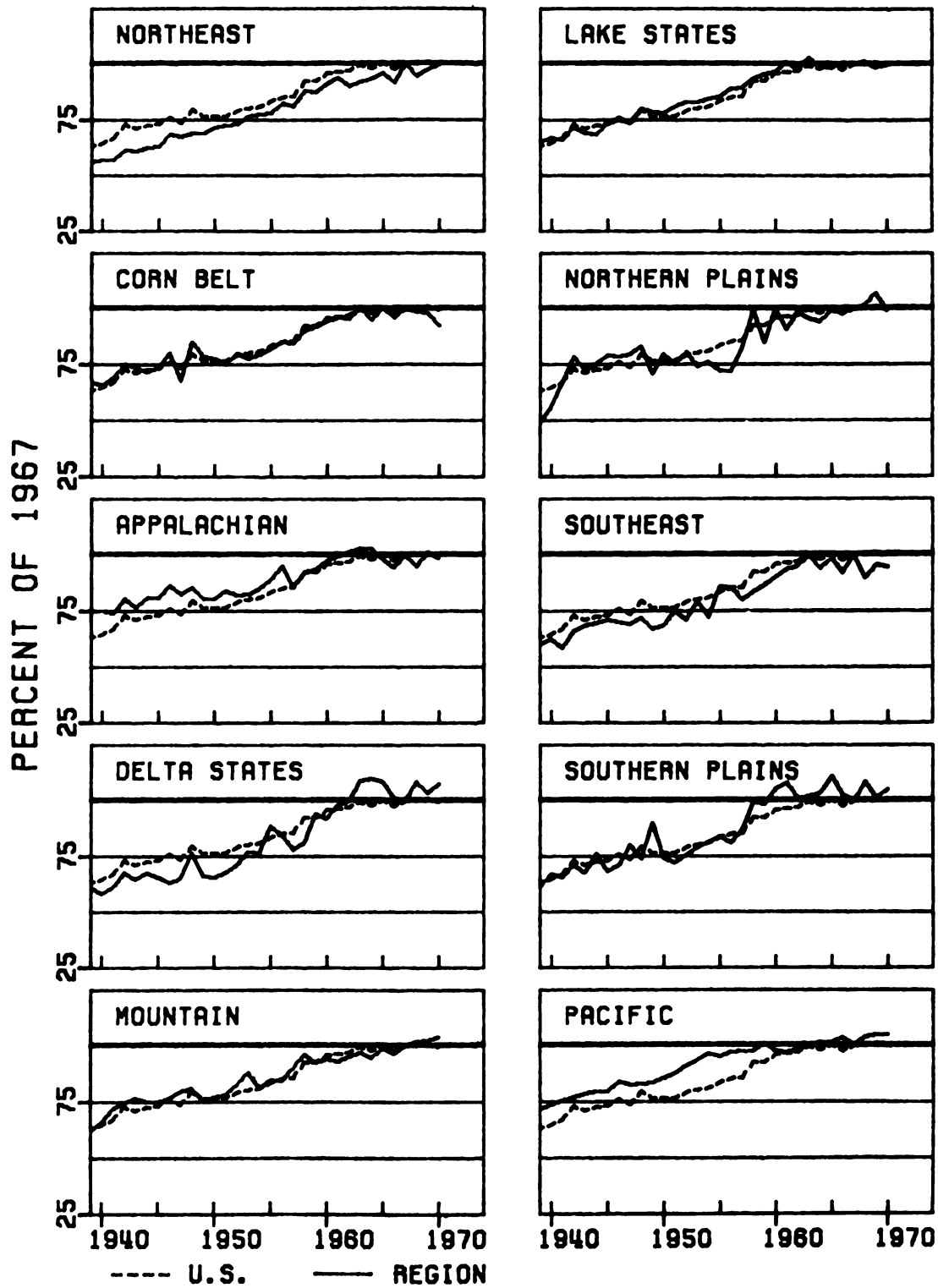


Figure 10

Southern Plains productivity has fluctuated around the 1961 level.

The pattern in the Appalachian region is rather odd. The trend followed the U.S. until 1956. In the following year Appalachian productivity dropped 9 points. After 1957, the Appalachian region again followed along with the U.S. average.

In the Southeast and Delta regions productivity advance followed a similar pattern. The trend followed the U.S. until 1957. During the period 1957-1963 productivity increased more rapidly than the national average. Since 1963 productivity has been on a declining trend in these regions. The 1957-1963 advance was greatest in the Delta States, 32 points compared to 23 for the Southeast.

In the Pacific region, productivity followed along with the national trend until 1954. After 1954 productivity in this region was still on an upward trend but it was moderate, the total change being only $12\frac{1}{2}$ points in 16 years.

In the remaining regions, the Lake States, Corn Belt, and Mountain, productivity followed along closely with the national average.

Output, Inputs, Productivity: A comparison of the three measures

A better perspective of the trends of the three measures; output, inputs, and productivity, can be gained by viewing them as displayed on Figures 11 thru 15 which appear on pages following. On these figures the dashed line indicates the national average.

On a national basis output has been steadily increasing, input use has increased very slightly resulting in a steady increase in productivity.

Looking at the regional figures, in the Northeast output lagged behind the nation but inputs were reduced drastically resulting in productivity increasing more rapidly than the U.S. In the Appalachian region output also increased less than the national average but inputs did not decrease sufficiently and productivity increased less than the U.S.

In the Lake States outputs increased slightly less than the U.S. but inputs were essentially constant resulting in productivity following closely along with the nation. In the Corn Belt outputs increased a little faster than the U.S. but it was necessary to increase input use

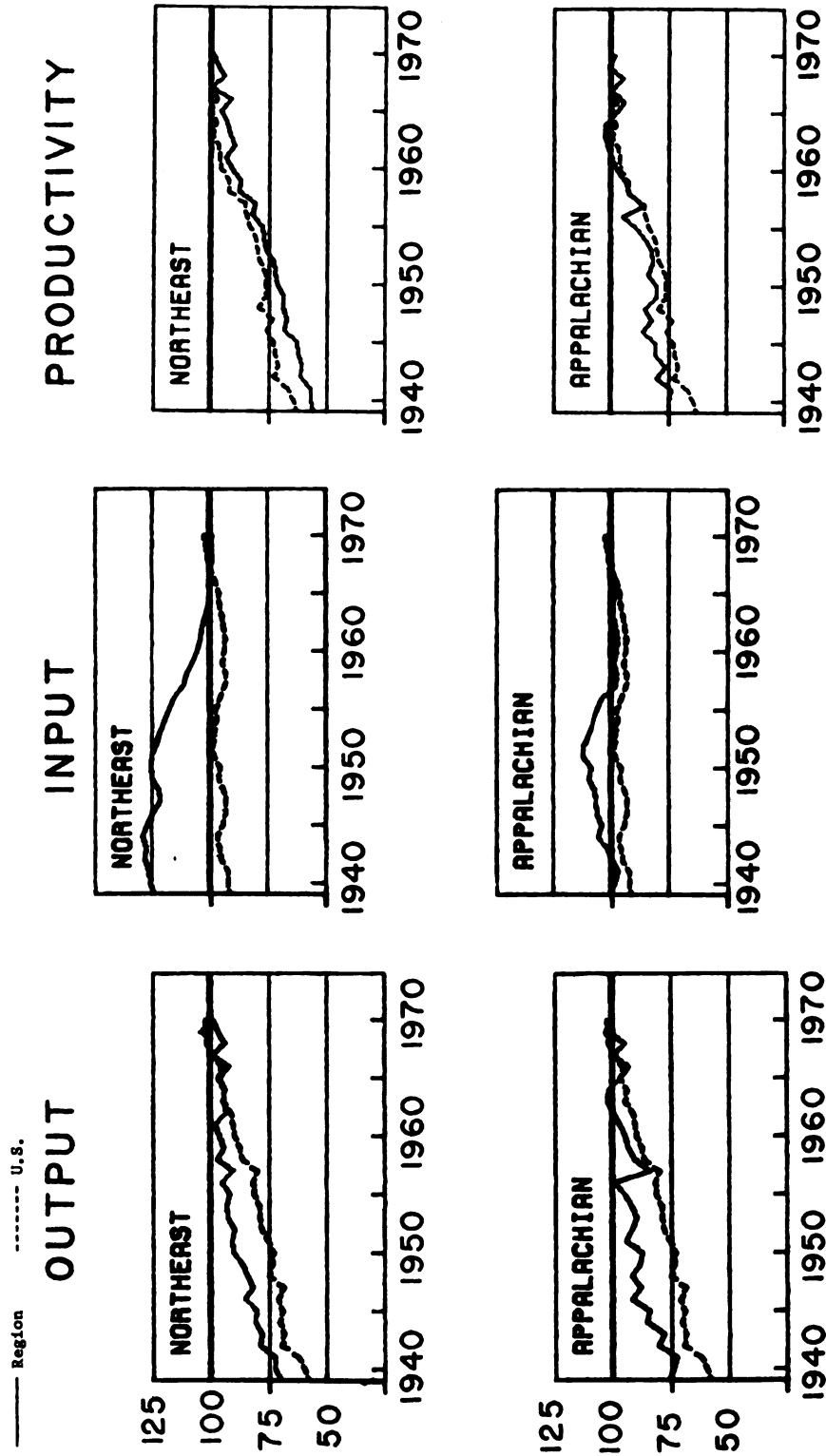


Figure 11

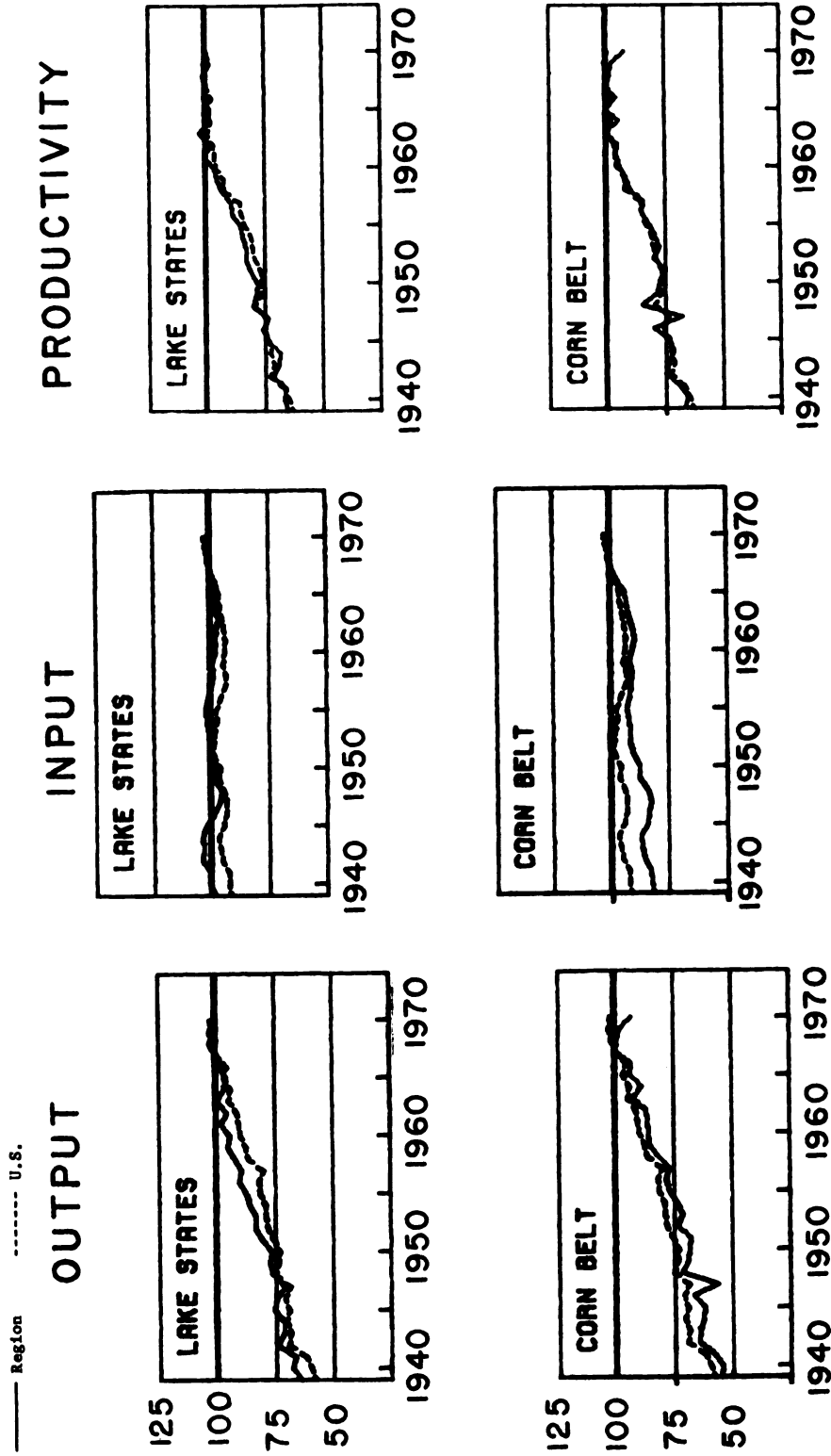


Figure 12

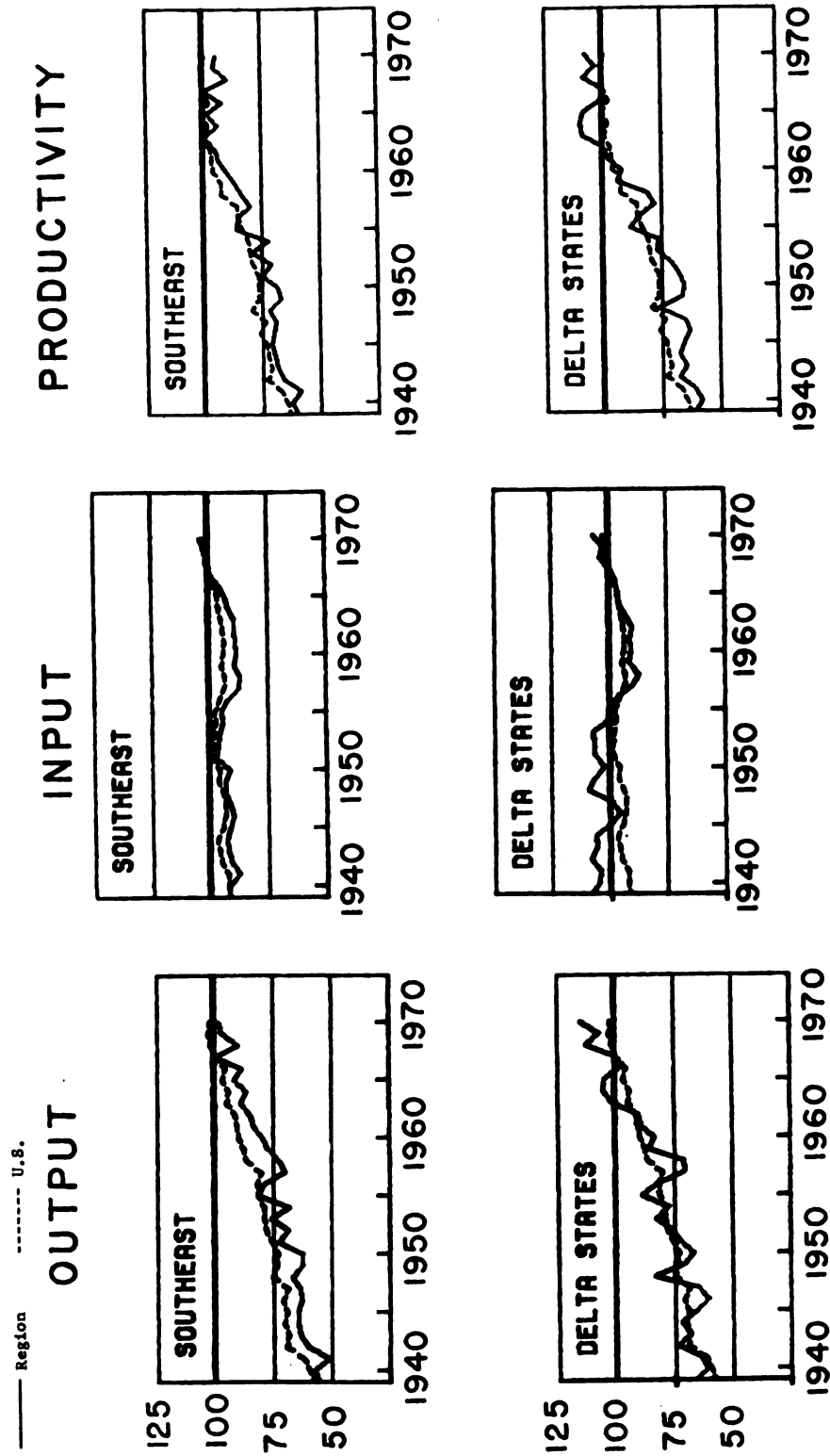


Figure 13

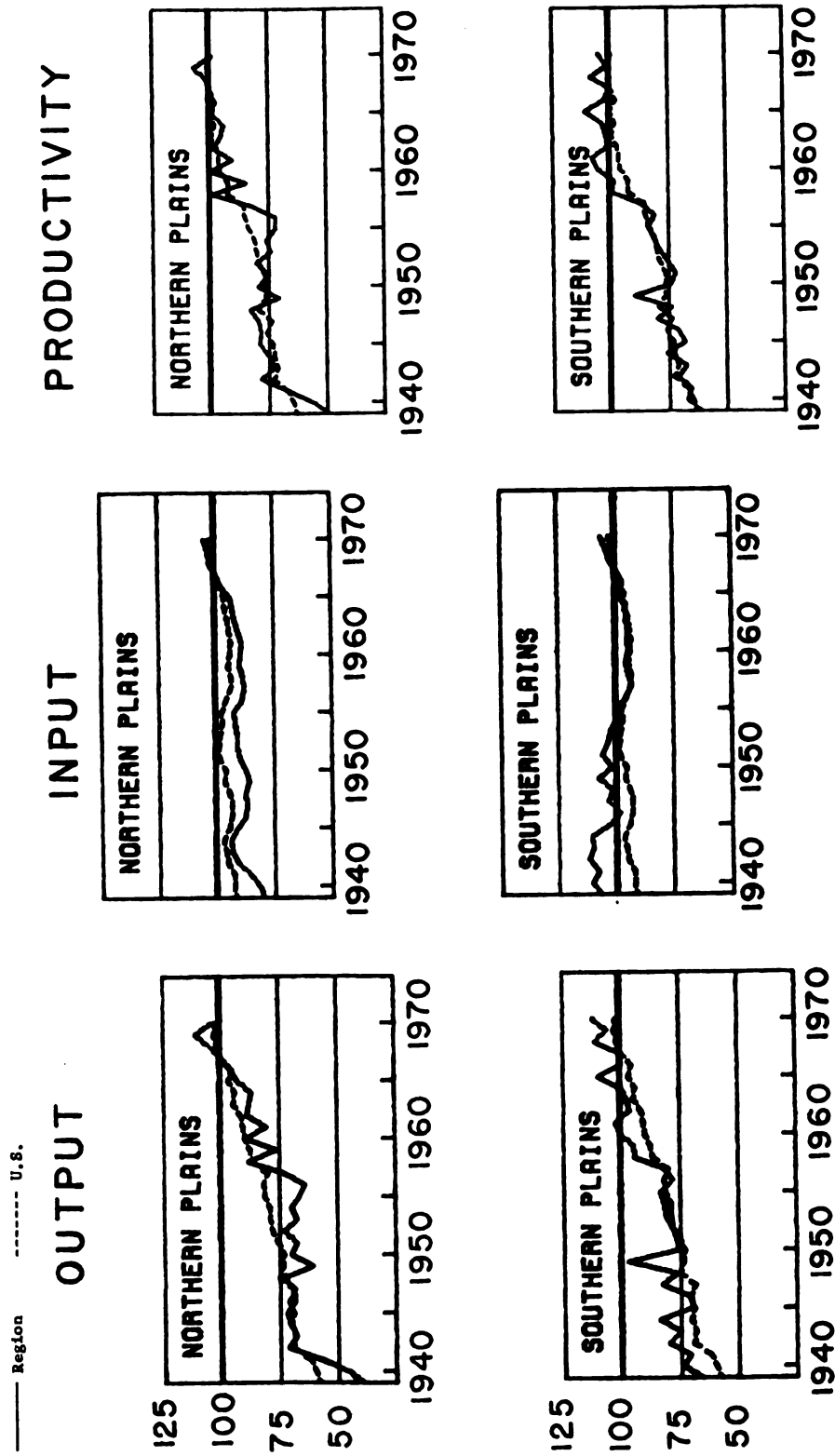


Figure 14

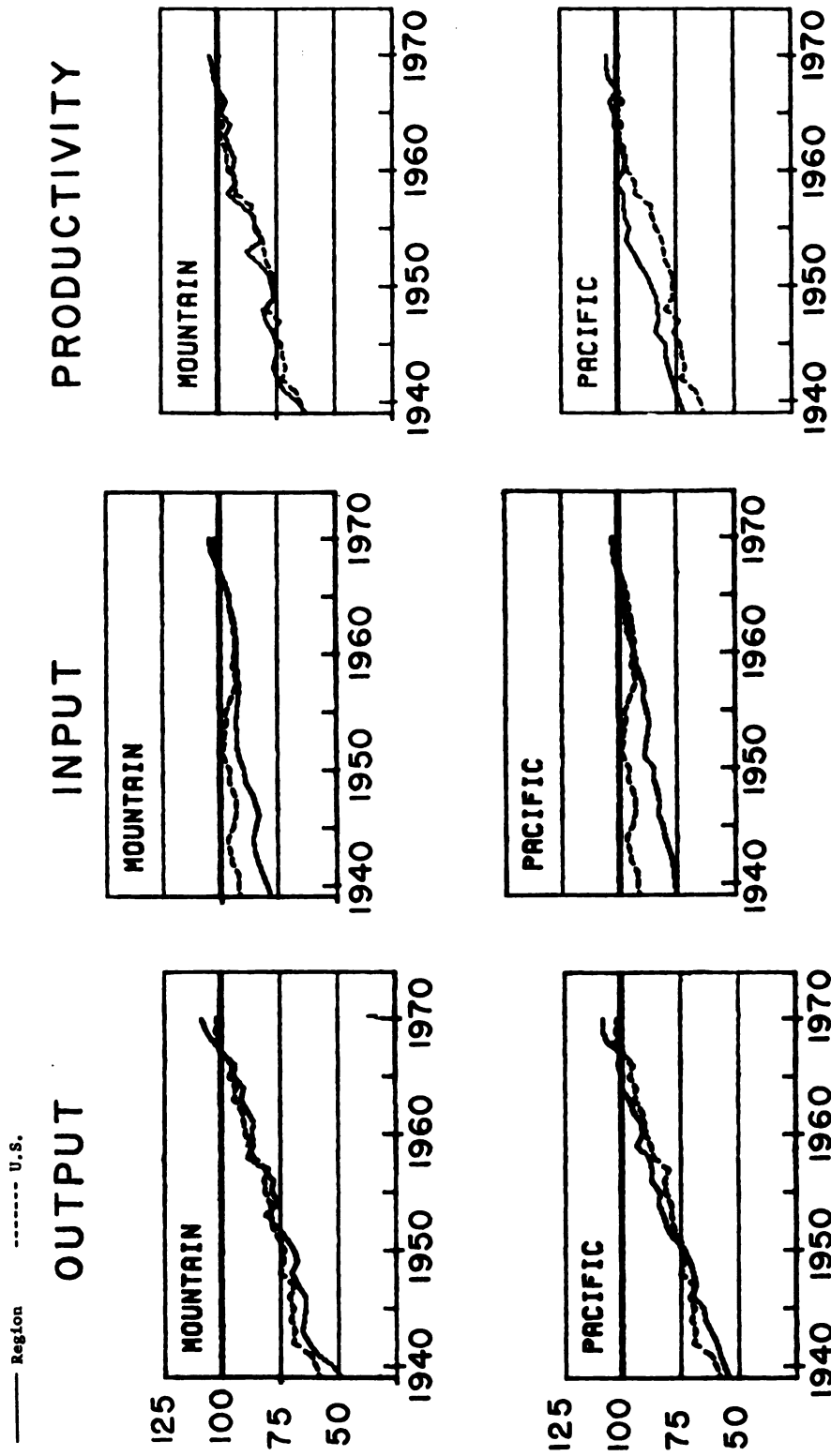


Figure 15

more rapidly resulting in productivity following closely along with the nation.

In the Southeast region outputs followed the U.S. trend. Inputs in this region also followed the national trend until about 1955 when input use slackened until the early sixties. Since that time input use increased resulting in a decline in productivity. In the Delta States output followed the national trend for the first half of the period and then increased more rapidly than the U.S. Input use declined until about 1960 and then followed the national trend for the remainder of the period. Productivity fluctuated along with the national trend until about 1960. During the decade of the 1960's, Delta States productivity has risen above the U.S. level.

In the Northern Plains region there was a large increase in outputs during the first three years of the period. This was accompanied by a moderate increase in inputs and a substantial increase in productivity. For the next 15 years there was little change in outputs, inputs or productivity in the Northern Plains region. In the Southern Plains input use decreased in the first half of the period, output increased slightly and productivity followed the national trend. In the middle of the period, from 1957 to 1970, there was a rapid increase in Southern Plains output, a 19 point increase in three years. During these three years, input use changed little resulting in a great increase in productivity. Since 1960, both output and inputs have increased at about the same rate and productivity has changed little.

In the Mountain region both outputs and inputs increased at a slightly more rapid rate than the U.S. The resulting productivity index followed along close to the national trend. In the Pacific region outputs increased a little more rapidly than the national trend but input use increased considerably and the productivity gain was less than the U.S. average.

CHAPTER V

ANALYSIS

The root cause of productivity improvement is assumed to be technological innovation. These innovations can be input reducing; output increasing; or innovations which increase inputs but which increase the value of outputs by more than the value of the added inputs.

This chapter summarizes an effort to relate productivity to the adoption of some of the more important agricultural technologies which were adopted during this century.

The Mills-Boyne Procedure

The Mills-Boyne procedure, discussed at the end of chapter I, was applied to changes in outputs to estimate changes due to change in inputs as differentiated from changes in outputs due to changes in productivity. The various time periods considered are charted in Table 16. The results point up the dramatic increase in productivity from about 1935 to 1964 and the general lack of change for the other periods, especially the period 1964-1969. This raises the question: What caused productivity to level out in the late 1960's? There is an ancillary question: What caused the dramatic increase in productivity from the mid-thirties to the mid-sixties? A backward look suggested consideration of several major technologies.

The Four Major Technologies

There have been many technological developments which fueled the productivity increase from the mid-thirties to the mid-sixties. Of these, four seem to stand out as candidates to explain part of the increase in productivity:

- 1) The replacement of the horse by tractors enabled the farmer to pull heavier loads for longer hours.
- 2) Hybrid seed produced superior yields.
- 3) Fertilizers further enhanced yields.

Allocation of changes in output using the Mills-Boyne procedure

Period	P e r c e n t C h a n g e i n O u t p u t			
	Total*	D u e t o c h a n g e i n		
		Inputs	Productivity	annual average
1911-1937	21.4	12.4	9.0	0.35
1937-1950	36.9	6.1	30.8	2.37
1950-1964	28.6	-6.5	35.1	2.51
1964-1969	7.4	7.1	0.3	0.06
1911-1922	6.9	9.4	-2.5	-0.23
1922-1932	13.3	1.4	11.9	1.19
1932-1935	-12.4	-5.8	-6.6	-2.20
1935-1950	56.7	15.4	41.3	2.75
1950-1964	28.6	-6.5	35.1	2.51
1964-1969	7.4	7.1	0.3	0.06
1922-1935	-0.7	-4.8	4.1	0.32
1935-1964	101.5	9.6	91.9	3.17
1911-1969	129.6	28.1	101.5	1.75

*Output data are three year moving averages for this analysis.

Table 16

- 4) Pesticides prevented yield decreases due to pest damages.

These four major technologies were graphed against productivity for the United States and the Corn Belt region, in Figures 16 and 17. We see a correlation between the adoption of these technologies and the change in productivity. As one would expect from theory, the technologies had their greatest effect in the early and middle stages of adoption.²²

By about 1964, all of the major technologies had been adopted by the bulk of farmers. Could this be the reason for the apparent leveling of productivity? To more accurately measure this correlation, a polynomial regression analysis was run as follows:

- Y = dependent variable: A three year moving average productivity index. A three year average was used in an effort to average out part of the weather variation.
- X_1 = interest on tractor inventory.²³
- $X_2 = X_1^2$
- X_3 = percent of corn seed which was hybrid.
- $X_4 = X_3^2$
- X_5 = percent of grain sorghum seed which was hybrid.
- $X_6 = X_5^2$
- X_7 = index of fertilizer and lime input.
- $X_8 = X_7^2$
- X_9 = index of pesticides input.
- $X_{10} = X_9^2$

The graph for the U.S. (Figure 16), indicates a strong correlation and an $\bar{R}^2$ in the neighborhood of 0.7 to 0.8 was expected. The results of the regression are labeled equation 4 in Table 17. The resulting $\bar{R}^2$, 0.994 is puzzling. Averaging productivity over three years should remove part but not all of the weather variation. Considering the myriad of data involved, we would expect measurement error alone to reduce the $\bar{R}^2$

²²As a new technology such as fertilizer approaches full exploitation, returns diminish and the gain in productivity can also be expected to diminish.

²³Regional data on tractor numbers were not available back to 1939. The index of interest on the tractor inventory was used as a proxy variable.

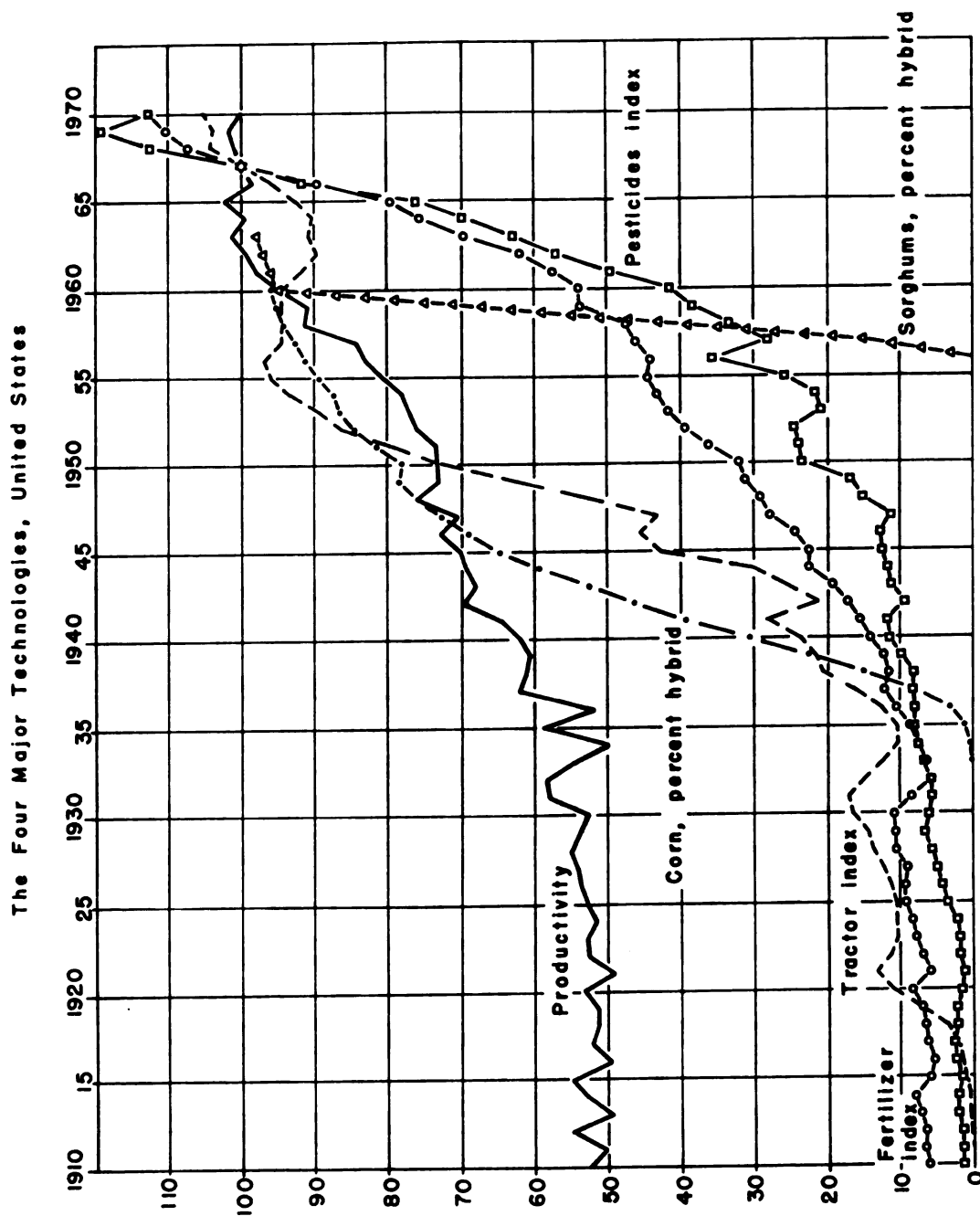


Figure 16

The Four Major Technologies, Corn Belt

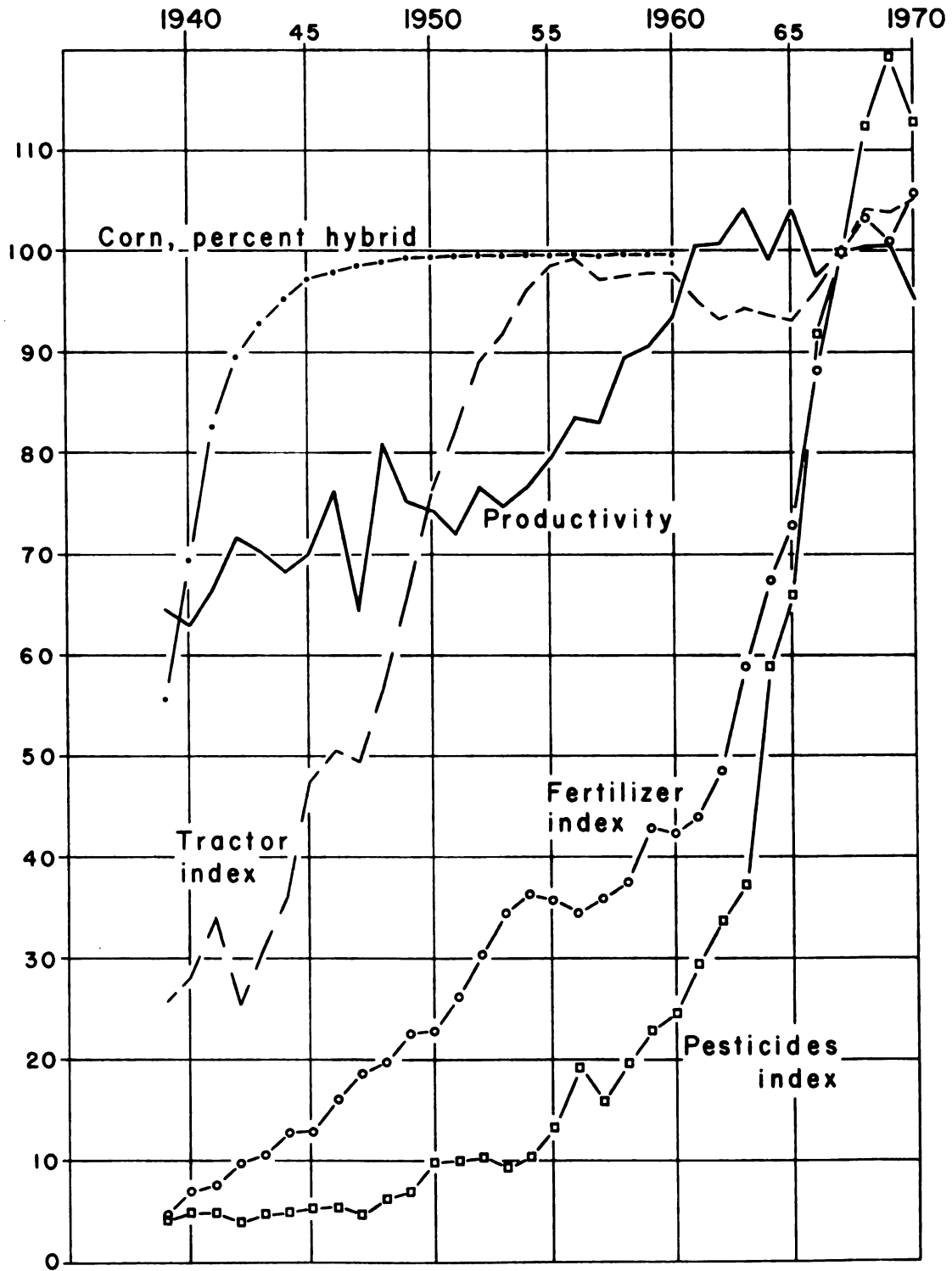


Figure 17

by more than .006. These results also leave nothing to be explained by the minor technologies unless they are highly correlated with the included variables.

In addition, the maximum of this function is 101.9. Can it be that agricultural productivity cannot rise above this level without new major technology?

It was hypothesized that the minor technologies occur more or less at random and thus could be captured with a trend variable. For this reason and to avoid the maximum ceiling, the equation was rerun with a trend variable. Three of the variables which were not significant in the first run were dropped, X_4 , X_7 , and X_8 . The results are labeled equation 5 in Table 18. A graph of Y and Y as predicted by this equation appears on Figure 18. The largest residual, -3.2 index points occurred at 1935 reflecting the poor weather for the three years contributing to the moving average output for 1935.

Similar analyses were made for three of the farm production regions, the Lake States, Corn Belt, and Northern Plains. The results of these regressions are labeled equations 6 through 8, Tables 19 through 21.

Y observed and Y estimated for these farm production regions are plotted on Figures 19 through 21. The time trend carried a higher coefficient in these regressions, probably reflecting the later time span involved.

A priori, it was believed that poor weather conditions were responsible for the flat trend in Northern Plains productivity from 1942 through 1956. The close correlation between Y and Y tends to negate this hypothesis. The correlation is so close as to lead to a suspicion that there is some feedback mechanism operating.

Table 17 Regression for the United States

Equation 4. Y = three year average productivity index, United States.

<u>Variable</u>	<u>Reg. Coef.</u>	<u>Std. Error Coef.</u>	<u>Computed t</u>	<u>Beta Coeff.</u>	
2	0.022	0.057	0.396	0.049	Interest on tractor inventory
3	0.254	0.046	5.502	0.608	Corn, percent hybrid
4	0.248	0.049	5.020	0.526	Sorghums, percent hybrid
5	0.177	0.203	0.874	0.284	Fertilizer index
6	0.349	0.100	3.495	0.574	Pesticides index
8	-0.000	0.000	-0.222	-0.024	Interest on tractor inventory squared
9	-0.001	0.001	-1.586	-0.251	Corn, percent hybrid squared
10	-0.001	0.001	-2.517	-0.267	Sorghums, percent hybrid squared
11	-0.001	0.002	-0.492	-0.176	Fertilizer index squared
12	-0.002	0.001	-1.400	-0.306	Pesticides index squared

Intercept	50.349		
Multiple correlation	0.997	(adjusted R = 0.997)	$\bar{R}^2 = 0.994$
Std. error of estimate	1.383	(adjusted SE = 1.505)	

Table 18 Regression for the United States

Equation 5. Y = three year average productivity index, United States.

<u>Variable</u>	<u>Reg. Coef.</u>	<u>Std. Error Coef.</u>	<u>Computed t</u>	<u>Beta Coef.</u>	
1	0.222	0.052	4.308	0.216	Time trend
2	-0.159	0.065	-2.435	-0.344	Interest on tractor inventory
3	0.217	0.017	12.845	0.521	Corn, percent hybrid
4	0.192	0.042	4.521	0.406	Sorghums, percent hybrid
6	0.227	0.084	2.689	0.373	Pesticides index
9	0.001	0.000	2.189	0.236	Interest on tractor inventory squared
10	-0.001	0.000	-1.440	-0.135	Sorghums, percent hybrid squared
11	-0.001	0.000	-2.677	-0.220	Pesticides index squared

Intercept	48.357		
Multiple correlation	0.998	(adjusted R = 0.998)	$\bar{R}^2 = 0.996$
Std. error of estimate	1.190	(adjusted SE = 1.269)	

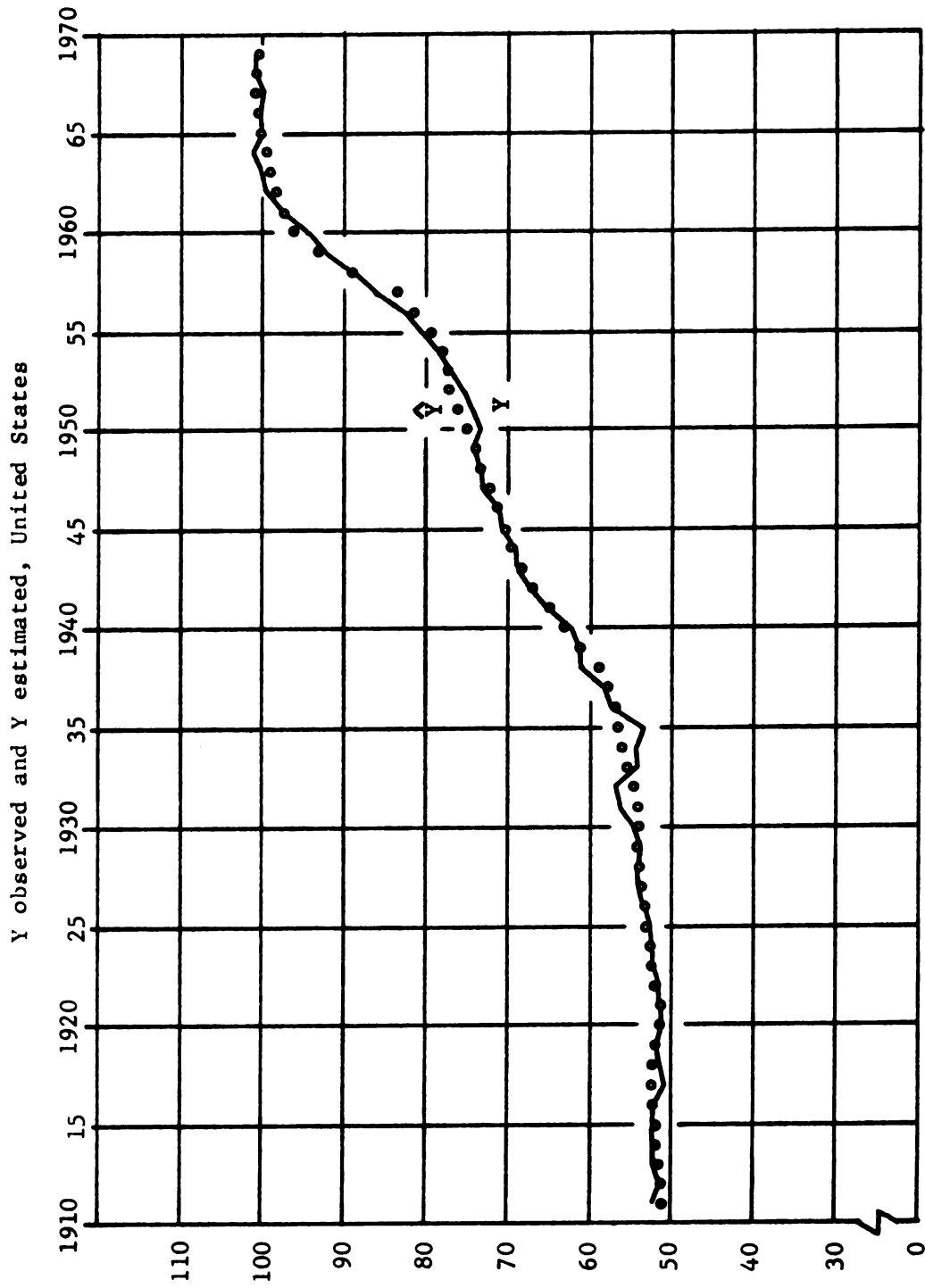


Figure 18

Table 19 Regression for the Lake States Region

Equation 6. Y = three year average productivity, Lake States Region

<u>Variable</u>	<u>Reg. Coef.</u>	<u>Std. Error Coef.</u>	<u>Computed t</u>	<u>Beta Coef.</u>	
1	2.852	0.604	4.722	1.838	Time trend
2	-0.015	0.134	-0.113	-0.030	Interest on tractor inventory
3	0.279	0.532	0.525	0.228	Corn, percent hybrid
4	-0.404	0.189	-2.138	-0.882	Fertilizer index
5	0.190	0.149	1.273	0.487	Pesticides index
7	-0.001	0.001	-1.052	-0.245	Interest on tractor inventory squared
8	-0.003	0.004	-0.636	-0.338	Corn, percent hybrid squared
9	0.002	0.001	2.441	0.678	Fertilizer index squared
10	-0.003	0.991	-3.061	-0.847	Pesticides index squared

Intercept	-54.602		
Multiple correlation	0.997	(adjusted R = 0.996)	$\bar{R}^2 = 0.993$
Std. error of estimate	1.183	(adjusted SE = 1.391)	

Table 20 Regression for the Corn Belt Region

Equation 7. Y = three year average productivity, Corn Belt Region.

<u>Variable</u>	<u>Reg. Coef.</u>	<u>Std. Error Coef.</u>	<u>Computed t</u>	<u>Beta Coef.</u>	
1	3.487	0.306	11.395	2.351	Time trend
2	-0.077	0.144	-0.533	-0.157	Interest on tractor inventory
3	2.149	1.320	1.628	1.059	Corn, percent hybrid
4	-0.462	0.208	-2.217	-1.013	Fertilizer index
6	-0.065	0.129	-0.506	-0.172	Pesticides index
7	-0.002	0.001	-1.595	-0.451	Interest on tractor inventory squared
8	-0.014	0.008	-1.740	-1.213	Corn, percent hybrid squared
9	0.003	0.002	1.761	0.729	Fertilizer index squared
10	-0.001	0.001	-1.490	-0.337	Pesticides index squared

Intercept	-148.908		
Multiple correlation	0.997	(adjusted R = 0.995)	$\bar{R}^2 = 0.991$
Std. error of estimate	1.302	(adjusted SE = 1.530)	

Table 21 Regression for the Northern Plains Region

Equation 8. Y = three year average productivity, Northern Plains Region.

<u>Variable</u>	<u>Reg. Coef.</u>	<u>Std. Error Coef.</u>	<u>Computed t</u>	<u>Beta Coef.</u>	
1	1.601	0.841	1.904	0.976	Time trend
2	0.104	0.288	0.362	0.162	Interest on tractor inventory
3	0.732	0.182	4.017	1.097	Corn, percent hybrid
4	-0.202	0.215	-0.939	-0.516	Fertilizer index
5	0.086	0.207	0.417	0.209	Pesticides index
7	0.415	0.081	5.136	1.320	Sorghums, percent hybrid
8	-0.002	0.002	-1.167	-0.534	Interest on tractor inventory squared
9	-0.006	0.002	-2.868	-1.093	Corn, percent hybrid squared
10	0.001	0.001	1.202	0.429	Fertilizer index squared
11	-0.001	0.002	-0.589	-0.244	Pesticides index squared
12	-0.002	0.001	-3.007	-0.762	Sorghums, percent hybrid squared

Intercept -19.189

Multiple correlation 0.995 (adjusted R = 0.992) $\bar{R}^2 = 0.984$

Std. error of estimate 1.901 (adjusted SE = 2.349)

Y observed and Y estimated, Lake States Region

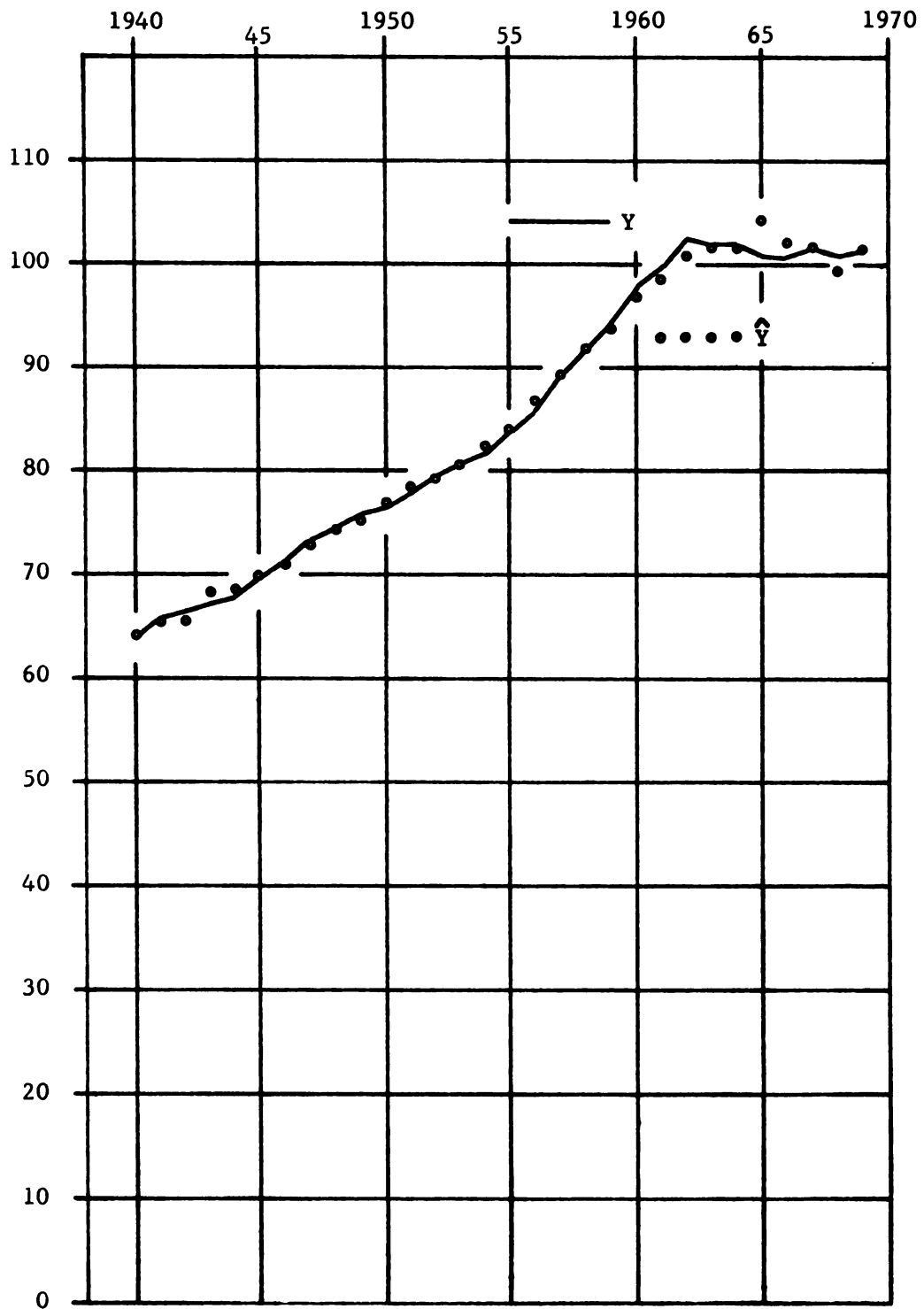


Figure 19

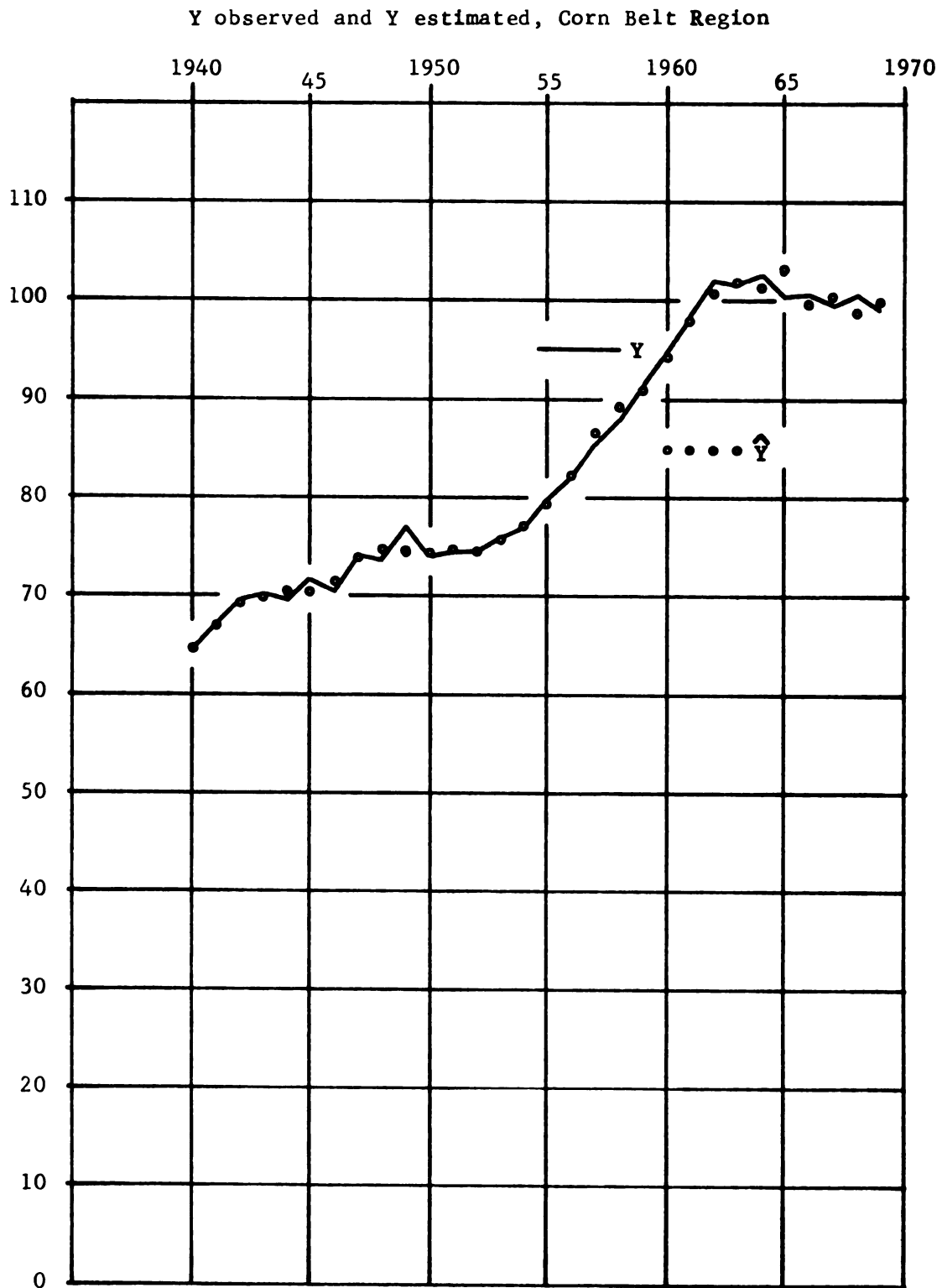


Figure 20

Y observed and Y estimated, Northern Plains Region

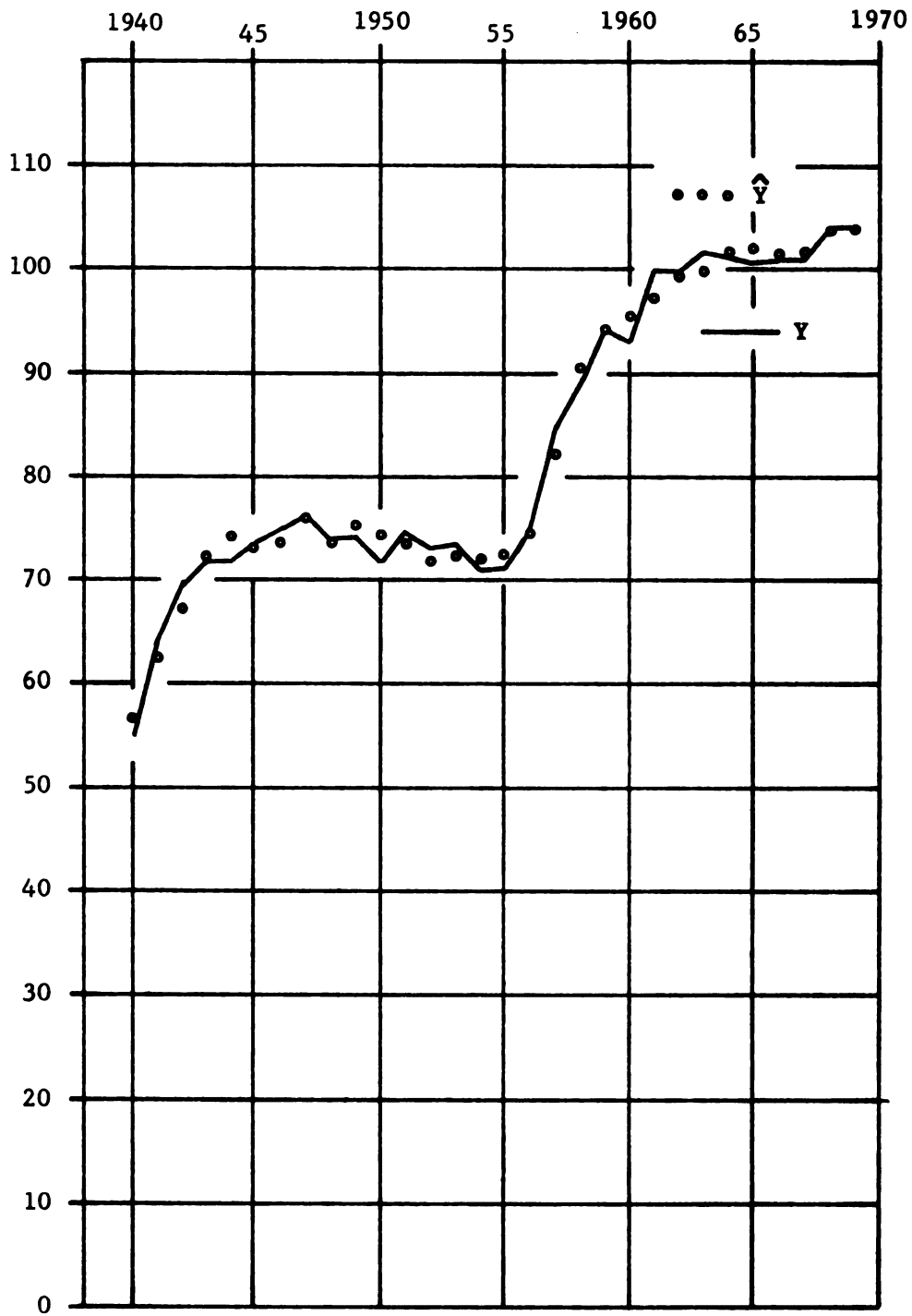


Figure 21

CHAPTER VI

SUMMARY

Productivity was defined as the ratio of total farm output to total farm inputs. The estimates are global in the sense that all productive inputs and all final products are included. Aggregation was done arithmetically using a Laspeyres weighted aggregate formula. The new series differs from the previous work of Loomis and Barton in that separate estimates were made for each of 10 farm production regions. The regional quantity-price aggregates were then summed to obtain the United States index. This procedure captures compositional difference which were missed in the earlier procedure of aggregating nationally.

Loomis and Barton computed the land input by multiplying the real estate value by the mortgage rate of interest. Their method includes investment made for speculation. The new series entered the land input at the rental cost thus excluding speculative value. Another difference between the old and new series is the adjustment for land in government programs. The older series included all land in farms. The new series was computed both with and without an adjustment for land in government programs.

On a national basis, the use of inputs, for the period 1910-1970, has remained remarkably constant. The regional input analyses, made for the period 1939-1970, indicate considerable diversity in input trends varying from a drastic reduction in the Northeast region to a steady increase in the Mountain and Pacific regions.

The analyses of input subgroups indicate a general decline in labor input, a relatively constant real estate input and general increases in the remaining input categories. The use of variable inputs increased generally from the early 1930's to the end of the period, 1970. Over this period, fixed inputs generally declined until about 1962. Fixed inputs have increased along with variable inputs since 1962.

The output indices were constructed in a manner similar to the

input indices. These indices follow an "accrual" concept in that they endeavour to measure the quantity of output produced during the calendar year even though marketing may have taken place later.

On a national basis, the trend in farm output has been a remarkably smooth increasing function since the mid-thirties. Regional trends have been similar for eight of the ten farm production regions. In the two Plains regions there were plateaus during the period 1942 through 1957.

This thesis assumed that farm operations were charged for land services at the rental cost, for other equity capital at the mortgage rate of interest, and labor was charged at the hired farm wage. Under these assumptions, management return for the weight periods, 1947-49 and 1957-59 was found to be meager. Farm owners did realize a return from appreciation but that was excluded from this analysis.

The study indicates four general trends in the productivity of American agriculture during the period 1910-1970. There was little change in productivity during the two periods: 1910-1922 and 1964-1970. There was a slight improvement in the period 1922-1935. There was a dramatic improvement in productivity in the remaining period, 1935-1964.

The regional analyses covered the period 1939-1970. During this period, the regions generally shared in the productivity increase and the recent plateau. In the Plains regions there was also an earlier plateau. In the Pacific regions the plateau was reached earlier. Only in the Northeast and Mountain regions does productivity appear to be still increasing in 1970.

The regression analyses tend to indicate that four major technologies have been responsible for most of the increase in productivity of American agriculture. These technologies were: mechanization, hybridization, fertilization and pesticides. However, these results must be interpreted carefully. It is possible that these four variables are highly correlated with other factors which were also of considerable importance. For example, it is likely that mechanization is highly correlated with economies of size. The limited evidence subsequent to 1964 indicates that if there were economies of size, then they were about exhausted by that time.



Policy Implications

At the beginning of this project, the writer was of the opinion that American agriculture was cursed with a cornucopia from which flowed ever more and better technology with productivity increasing at an exponential rate. The analyses emphatically negate this hypothesis. It indicates that, during this century, there have been, so far, four major technologies which appear to be responsible for the bulk of productivity increase. The role of the minor technologies is puzzling. Common sense and theory would indicate an enhancement of productivity, however, the statistical analyses indicate only a marginal contribution.

The major technologies began their spectacular contribution to productivity in the mid 1930's. As productivity increased, surpluses appeared, the terms of trade turned against the farming sector and a major readjustment was required in order for farmers to maintain a satisfactory level of living as compared to their urban counterpart.

In the marginal agricultural regions the adjustment came by way of a reduction in inputs. In the Northeast region the adjustment was less painful than in other regions; as the real cost of commuting declined, many farms in this area came within easy access of industrial jobs. Since the late 1940's, there has been a dramatic reduction in inputs in the Northeast and productivity increased at a greater rate than the national average.

In the Delta region, the adjustment was somewhat more painful with the sharecroppers being forced out of agriculture, many of them moving long distances to the industrial cities of the north. However, the adjustment benefited those remaining in agriculture and productivity increased at a greater rate than the national average.

Of the marginal farming regions, the Appalachian and Southeast regions have had the most difficulty adjusting inputs downward. Part of the difficulty in these regions has been the lack of mechanization of tobacco production. Restrictive government programs have compounded the problem by discouraging the consolidation which could facilitate mechanization.

The adoption of the major technologies occurred at different rates in different regions. Perhaps this is the reason productivity in the

Pacific region leveled out about 1954 compared to 1964 for the nation.

Conjecture

Although it is possible that new major technologies are "just around the corner" they are not yet visible. We can only speculate as to when and if such technology will surface. In the meantime, it might be possible to increase output to some extent by terminating or revising governmental programs. Also, it will be possible to increase output by increasing inputs. This avenue is limited to stage II of the production function, however, there is a vast amount of output which would be economically feasible providing the price were high enough.

If population continues to expand, eventually it will be necessary for the terms to trade to turn in the farmer's favor unless new major technology appears or unless the population expansion is muted to such an extent that minor technologies can supply the additional productivity needed.

Suggestions for Further Study

In an expanding economy, there is a tendency for all the variables to expand together giving rise to spurious correlations. This multicollinearity might explain the close correlations between productivity and the major technologies for the U.S., and the Corn Belt and Lake States regions. However, in the Northern Plains region the irregular pattern of productivity change is such as to rule out multicollinearity as an explanation for the high correlation with the major technologies. A more extensive analysis of this region might reveal more about the impact of scale on productivity. Another hypothesis which might be tested on this region is that of feedback. Can it be that productivity in year $t-1$ affects input use in year t ? It might be possible that only certain inputs are affected, such as the four major technologies. The Northern Plains region would also be a good prospect for studying weather effects since rainfall is seldom in surplus.

Similar analyses of the remaining seven farm production regions might give a clue to the reason for the high correlations between productivity and the major technologies. There was a long plateau in

productivity in the Southern Plains region. Was there an equally high correlation with the major technologies? In the Delta region will Y predicted follow the cyclical productivity pattern? The Northeast is another region which promises to shed further light on this correlation. Did the drastic reduction in inputs upset the correlation with the major technologies?

The four major technologies do not account for changes in the efficiency of livestock production. Further study might reveal the role of changing feed conversion rates, artificial insemination, bulk milk handling, and other animal related technologies.

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APPENDIX TO THESIS

INPUT INDEX CATALOGUEFARM LABOR

Hired labor (including perquisites).

Operator labor.

Unpaid family labor.

FARM REAL ESTATE

Interest on equity in land and service buildings.

Interest on real estate mortgages.

Land services leased to Government on "voluntary" basis.

Depreciation on service buildings and other structures.

Accidental damage to service buildings and machinery.

Repairs on service buildings and other structures and land improvements.

Grazing fees, State forests.

Grazing fees, National forests.

Grazing fees, Public Domain.

Grazing fees, Military lands.

Grazing fees, Indian Reservations.

MECHANICAL POWER AND MACHINERY

Automobile depreciation, farm share.

Interest on automobile inventory, farm share.

Automobile repairs, parts, and tires, farm share.

Automobile licenses, farm share.

Automobile insurance, farm share.

Tractor depreciation.

Interest on tractor inventory.

Tractor repairs, parts, and tires.

Truck depreciation.

Interest on truck inventory.

Truck repairs, parts, and tires.

Truck licenses.

Truck insurance.

Depreciation on other farm machinery.

Interest on inventory of other farm machines.

MECHANICAL POWER AND MACHINERY Continued:

Other farm machines: Repairs, parts, and tires.

Fuel and oil.

Electricity, farm share.

Blacksmithing and hardware.

Harness and saddling.

Small hand tools.

Custom work.

FERTILIZER AND LIME

Fertilizer mixing cost.

Nitrogen fertilizer.

Superphosphate fertilizer.

Rock phosphate fertilizer.

Potassium fertilizer.

Limestone.

FEED, SEED, AND LIVESTOCK PURCHASES (Non-Farm Value Added)

Seed: Corn, hybrid.

Seed: Corn, open pollinated.

Seed: Oats, spring.

Seed: Wheat, spring.

Seed: Soybeans.

Seed: Barley, spring.

Seed: Cottonseed.

Seed: Minor grains plus all seeds other than grains. (Includes greenhouse and nursery supplies.)

Feed: Grain handling by local elevators on grains fed as such.

Feed: By-product processing cost.

Feed: Marketing cost on by-products fed as such.

Feed: Formula feed formulating and marketing cost.

Hired trucking, freight and express.

Milk hauling.

Livestock marketing.

Baby chickens purchased, broiler type.

Baby chickens purchased, layer type.

FEED, SEED, AND LIVESTOCK PURCHASES Continued:

Baby turkeys purchased, heavy breeds.

Baby turkeys purchased, light breeds.

TAXES AND INTEREST

Taxes: Real estate.

Taxes: Personal property.

Interest on inventory of all cattle and calves.

Interest on inventory of hogs and pigs.

Interest on inventory of all sheep and lambs.

Interest on inventory of all chickens.

Interest on inventory of all turkeys.

Interest on corn inventory.

Interest on oats inventory.

Interest on barley inventory.

Interest on grain sorghum inventory.

Interest on wheat inventory.

Interest on soybean inventory.

Interest on hay inventory.

Interest on forage inventory.

Interest on operating capital.

Interest added by non-real estate debt.

MISCELLANEOUS INPUTS

Insurance: fire, and wind. (net).

Insurance: crop-hail (net).

Insurance: Federal crop (net).

Containers.

Binding materials.

Dairy supplies.

Pesticides.

Irrigation operating and maintenance charges.

Veterinary.

Telephone (farm share).

Ginning charges.

Interest on horse and mule inventory.

LABOR INPUT

Labor Quantity

Of the three Federal sources of independent estimates available on the quantity of labor used in agriculture, none are entirely suited to our purpose:

- a. The Bureau of Labor Statistics of the Department of Labor reports monthly the hours worked by people who work the majority of their hours in agriculture; i.e., workers are classified fish or fowl, depending on where they work the most hours. Thus, many hours of off-farm work are included as agricultural labor since it is worked by part time farmers who work more hours on their farm than in off-farm employment. Also, many hours of farm labor is excluded since it is worked by people who work off the farm more hours than on the farm.

The BLS man-hours series began (on a U.S. basis) in 1947. Since 1956 the series has been refined by splitting the hours into the three classes: hired, operator, and unpaid family labor.

- b. The Economic Research Service, USDA, publishes a series on man-hours used in agriculture. This series is based on an engineering study of labor requirements and is thus a man-hours used rather than a man-hours available figure. These figures are published, on a regional basis, back to 1919; however, they are not broken down by class of worker, i.e., hired, operator, and unpaid family labor.
- c. The Statistical Reporting Service, USDA, reports employment of farm workers by the following categories:

Farm employment represents number of family and hired labor working during the survey week. Family labor includes farm operators working on farms one hour or more plus other family members working 15 hours or more without receiving cash wages during

1

survey week. Hired workers include all persons working one hour or more for cash wages during the survey week. The SRS has also collected data for several years on the average length of workday; however, these figures cannot be accurately expanded to a man-hours total since we have no way of knowing how many days per week the respondent had in mind when he reported the length of workday.

Beginning in 1965, the SRS collected data on the number of hours worked per week for one week in each month. Thus, it is possible to multiply the average hours worked per week by the average number of workers on farms to obtain an aggregate measure of hours worked. It is possible from published data to break this figure down into regions and into hired and total family labor. The SRS has available, but does not publish, figures on the proportion of family labor which is operator labor. By special request, the SRS released confidential data, since 1965, on the number of unpaid family members working. Since these data are compiled by states, it is possible to compute a man-hours used broken down both by regions and by the three classes of labor, hired, operator and unpaid family members:

1. From the data on the number of operators working per farm and the number of unpaid family members working per farm, take the ratio of operators working to all family members working.
2. Multiply this ratio by the number of all family members working

(from Farm Labor) to get the number of operators working. Multiply the number of operators working by the average hours which they worked (Farm Labor) to get aggregate operator hours by regions.

Do the same for other family labor and hired labor. This gives aggregate hours broken down both by regions and by operator, hired and other family labor.

Also, beginning in 1965, the SRS in the June Enumerative Survey, collected data directly on the number of hours worked for one week in May broken down by:

1. Farm operators.
2. Hired workers.
3. Unpaid family members (other than operator).
 - a. Working 15 or more hours during the week.
 - b. Working less than 15 hours per week.

However, these data have not been published.

For hired labor, it is possible to estimate hours worked by dividing the wage bill by the hired farm wage.

By making a seasonality adjustment, it is possible to blow up the SRS June Enumerative Survey data into an annual figure.

Below is a comparison of hired labor hours for 1965 computed by the various methods:

	<u>Hours</u>
June Enumerative Survey (seasonally adjusted)	2,175,834,000
(SRS average hours/week) (52) (SRS employment)	2,580,100,000
Wage bill $\div$ composite wage rate	2,689,754,000
BLS	3,092,000,000

A comparison of total labor hours for 1965 follows:

	<u>Hours</u>
ERS (labor used approach)	7,904,000,000
BLS (labor force approach)	10,515,000,000
SRS (employment approach)	11,319,705,600

The procedure used to compile the labor input follows:

- a. From the 1965 SRS data, compute regional breakdown between hired, operator, and other family members on a percentage basis. Compute percentage deviations from U.S. average. Assume the regional deviations from U.S. averages can be projected backward through time.
- b. Apply SRS regional deviations from U.S. average to BLS breakdown percentages back in time to 1956. This gives regional breakdown percentages.
- c. Apply these regional breakdown percentages to the ERS regional man-hours to get ERS man-hours broken down both by regions and by class of worker.

The composite hired wage rate was adjusted for the value of perquisites by taking the percentage difference between F.I.B. figures on labor expenditures with and without perquisites. This is the wage used for family labor. For hired labor, it was determined that six percent should be added to the quantity to account for "stand-by" time. To facilitate computation, this six percent was added to the wage rather than to the quantity.

REAL ESTATE INPUT

Land Classification

A problem arose in measuring the quantity of land in that the Census classifications have changed slightly during the period involved. There has been a general trend to carry through the sub-classifications

with additional refinements and with changes in the headings and groupings of some classes. The change in land classification did not have a serious effect on the valuation procedure except, in 1939, other pasture was grouped together with all other land. An arbitrary separation was made by assuming that the acreage of all other land was constant from 1939 until 1944. The way in which the Census classifications were grouped into value classes appears on the following pages.

The Value of the Stock of Land

In order to develop the constant dollar value of the stock of land, it was necessary to develop land classifications which were consistent with the per unit values, and for the 17 Western states, also consistent with the rent/value ratios which were used to convert the stock to an annual flow of input.

The only annual source of land valuations is a series by the Statistical Reporting Service based on a random sample of crop reporting districts. The Farm Real Estate section, FPED, ERS, has compiled a series of per acre values from these data. Their breakdown by land quality follows:

- I. For the humid states:
 - 1. Plowland
 - 2. Pasture
 - 3. Other land
- II. For the mountain and Pacific regions:
 - 1. Irrigated land
 - 2. Non-irrigated land
 - 3. Grazing land
 - 4. Other land

The crop report questionnaire asked for values typical for the locality as differentiated from land owned by the respondent. There is a discrepancy of approximately 15 percent between the values reported on the SRS survey and the Census report. The Census asked the question as follows:

About how much would the land and the buildings sell for?

- a. Land and buildings owned by you?
- b. Land and buildings rented from others?
- c. Land and buildings managed for others?

LAND INPUT

1959 CENSUS CLASSIFICATION, Humid States

Value Classification

I. LAND IN FARMS

A. Cropland harvested:-----	
1. Includes hay and wild hay.-----	Plowland
2. Small fruits, orchards (whether harvested or not in current season) vineyards, nurseries and greenhouses.-----	
B. Cropland used only for pasture:-----	
1. Land used for past, or grazing that could have been used for crops w/o additional improvement.-----	Pasture
2. Crops hogged off, pastured or grazed before reaching maturity.-----	
C. Cropland not harvested and not pastured:-----	
1. Other cropland not harvested and not pastured:-----	Plowland
a. Acreage on which crops failed because of:-----	
Drought, floods, insects, etc.-----	
b. Acreage not harvested because of low prices or labor shortage.-----	
c. Acreage not harvested but occupied by growing crops intended for harvesting in later years.-----	
d. Acreage which had been plowed and could be plowed again w/o first clearing away brush, but which had been idle for one or more years.-----	
This classification also includes abandoned orchards.-----	
2. Cropland used only for soil improvement crops.-----	
E. Woodland pasture.-----	Other Land
F. Woodland not pastured, includes soil bank land planted to trees.-----	

1959 CENSUS CLASSIFICATION, Humid States, Continued Value Classification

- | | | |
|----|--|------------|
| G. | Other pasture:----- | } |
| | 1. Improved pasture: A pasture that had been limed, fertilized, seeded, irrigated, drained, or cleared of weeds or brush.----- | } |
| | | Pasture |
| H. | All other land: Land under buildings, farmstead, lanes, roads, ditches, ponds and wasteland.----- | } |
| | | Other Land |

1959 CENSUS CLASSIFICATION, 17 Western States

Value Classification

I. LAND IN FARMS

	Irrigated or Non-irrigated	Other Land
A. Cropland harvested:-----		
1. Includes hay and wild hay.-----		
2. Small fruits, orchards (whether harvested or not in current season) vineyards, nurseries and greenhouses.-----		
B. Cropland used only for pasture:-----		
1. Land used for past or grazing that could have been used for crops w/o additional improvement.-----		
2. Crops hogged off, pastured or grazed before reaching maturity.-----		
C. Cropland not harvested and not pastured:-----		
1. Other cropland not harvested and not pastured:-----		
a. Acreage on which crops failed because of: Drought, floods, insects, etc.-----		
b. Acreage not harvested because of low prices or labor shortage.-----		
c. Acreage not harvested but occupied by growing crops intended for harvest in later years.-----		
d. Acreage which had been plowed and could be plowed again w/o first clearing away brush, but which had been idle for one or more years. This classification also includes abandoned orchards.-----		
2. Cultivated summer fallow.-----		
3. Cropland used only for soil improvement crops.-----		
E. Woodland pasture.-----		
F. Woodland not pastured, includes soil bank land planted to trees. -----		

1959 CENSUS CLASSIFICATION, 17 Western States Value Classification

- | | | |
|---|--|------------|
| G. Other pasture: ----- | | |
| 1. Improved pasture: A pasture that had been limed, fertilized, seeded, irrigated, drained, or cleared of weeds or brush. ----- | | Grazing |
| H. All other land: Land under buildings, farmstead, lanes, roads, ditches, ponds and wasteland. ----- | | Other Land |

d. Land and buildings rented to others?

It is hypothesized that the discrepancy is due partially to:

1. The Census asked for total value of the farm in dollars, thus the respondent may have given a book valuation, rather than a present market valuation.
2. The wording of the Census question might lead the respondent to report a value no higher than the assessed valuation. He might believe that reporting a higher value could conceivably result in an increase in taxation. The SRS question asked for the valuation of other peoples land, thus there would be no incentive to under report.
3. It is possible that the SRS report covered the more commercialized farms compared to the Census Report. Complete data on land classified by qualities was available only from the 5 year Census benchmark. There are annual reports which give partial data as follows:
 - a. The Statistical Reporting Service reports the acreage harvested of 59 crops. These data are by states.
 - b. The Natural Resource Economics Division, ERS, has data on acreage of cropland used for crops by regions.

It is hypothesized that the values reported to the SRS survey did not change abruptly with changes in distribution of land between cropland and pasture. Thus a precise annual break-down between cropland, pasture land and other land did not seem necessary. Therefore, a decision was made to base the land quantity entirely on Census benchmarks. Alternatives considered for interpolating between Census years follows:

1. A straight line interpolation between Census years.
2. A 6th degree polynomial equation which would give a smooth curve passing through each Census point.
3. A polynomial curve of less than 6 degrees.

Although the curvilinear regression has certain theoretical advantages, it suffers in that subsequent up-dating of the series might change the regression line. For this reason a decision was made to use a straight line interpolation.

The Value of Buildings

In order to build up total land values by classes, it was necessary to use weight period per acre values which excluded buildings. The operator's dwelling was not considered to be a production item, thus it was desired that it be excluded. However, the remainder of the farm buildings are production items and should be included as an input. Service building values were available which could be deflated to obtain a constant dollar value. However, annual regional data were also available on the value of buildings as a proportion of total real estate value, also the value of dwellings as a proportion of total building value. These ratios permitted the calculation of a constant dollar value for land plus service buildings. An illustration of the equation used for this calculation appears on page 118.

Data Sources for rent/value ratios

1. The Census reports the ratios of cash rent/value.
These figures were rejected for this study since in the 17 Western States public grazing land is included; the rental rate in many cases is less than the market rate on this land.
2. The Crop Reporting Service has, for several years, collected data on cash rents, together with estimated values for the farms so rented. These figures were considered to be superior for this study even though there were a limited number of observations in some states.

In order to estimate net rents, it was necessary to estimate Landlord expenses. Data for these costs came from:

1. The 1955 Survey of Farmer's Expenditures, compiled jointly by the Census Bureau and the USDA, published as USDA, AMS-354 December, 1959.
2. The 1956 Survey of Landlord's Expenses, an unpublished small sample survey of expenditures by landlords on tenant-operated farms.

Building maintenance was estimated from both sources and averaged.

Payment for insurance premiums was estimated from the 1956 survey, and insurance claims collected from the 1955 survey. Accidental damage and maintenance of land and water improvements was estimated from the 1955 survey. Building depreciation and obsolescence was assumed to be $1\frac{1}{2}$ percent of building value, and management was assumed at 2 percent of the gross rent.

Building depreciation and management costs were assumed at the same rates for the 48 states. Other expenses were estimated separately for each of the ten farm production regions.

The net-rent-value ratios calculated are tabulated on page 119 along with a 1959 comparison to the mortgage rate of interest.

Procedure Used for Land Compilations

The weight period per acre values, from the farm real estate section, are for bare land. These values were applied to the interpolated census quantity figures to obtain the PQ for the stock of bare land. Annual figures on the value of dwellings as a proportion of buildings and buildings as a proportion of land plus buildings were obtained from the Farm Real Estate section. The following equation was derived to obtain the value of land plus service buildings:

Procedure for converting land value to land + service building value (Using 1939 Northeast region figures as an example) (in \$1,000)

Land as a proportion of land + buildings = 1 - buildings as a proportion of land + buildings = 1 - .555 = .445

Then $\frac{\text{land}}{.445} = \text{value of land + buildings} = \frac{2,745,463}{.445} = 6,169,580$

and (.555) (6,169,580) = value of buildings = 3,424,117

(.531) (3,424,117) = value of dwellings = 1,818,206

subtract to get value of service buildings 1,605,911

value of land + service buildings = 4,351,374

$\frac{(2,745,463)}{(1 - .555)}$ (.555) (.531) = value of residence

$\frac{(2,745,463)}{(1 - .555)}$ = value of land + buildings

$$\left(\frac{\frac{L}{1 - .555}}{d} \right) - \left[\left(\frac{\frac{L}{1 - .555}}{d} \right) \left(\frac{.555}{d} \right) \left(\frac{.531}{e} \right) \right] = \overbrace{\text{value of land + service buildings } 4,351,374}^x$$

Letting:

L = Value of bare land,

d = buildings as a proportion of land plus buildings,

e = dwellings as a proportion of buildings,

x = value of land plus service buildings,

$$\left(\frac{L}{1-d} \right) - \left[\left(\frac{L}{1-d} \right) de \right] = \left(\frac{L}{1-d} \right) (1-de) = x$$

Comparison: Net rent/value vs. mortgage rate of interest
(cash rented farms)

Region	<u>Ratio: Net rent/value</u>				Mortgage Interest Rate, 1959 ²⁴
	<u>1947-49</u> Percent	<u>1957</u> Percent	<u>1958</u> Percent	<u>1959</u> Percent	
Northeast	3.2	3.5	2.7	3.1	5.40
Lake States	3.1	3.9	3.8	3.9	5.10
Corn Belt	2.9	4.0	3.8	3.7	5.17
Northern Plains	3.9	4.0	3.9	3.7	5.03
Appalachian	6.8	7.0	6.7	6.0	5.59
Southeast	7.9	6.8	6.6	7.0	5.96
Delta States	9.7	9.0	8.6	7.8	5.63
Southern Plains	5.5	4.9	4.6	4.5	5.38
Mountain	5.8	5.2	5.6	4.7	5.36
Irrigated	8.6	7.6	6.8	5.9	-
Nonirrigated	12.9	6.8	6.8	6.0	-
Grazing	3.1	3.3	4.7	3.7	-
Pacific	7.3	4.9	5.1	4.7	5.65
Irrigated	8.2	5.2	5.2	4.8	-
Nonirrigated	7.4	4.6	6.0	5.7	-
Grazing	5.7	4.5	4.7	4.2	-
U.S. Average	5.3	5.0	5.0	4.7	5.35

²⁴Eitel, Van E., "Farm Mortgages Recorded in 1959," USDA, ERS-61, April 1962.

DEPRECIATION

Current dollar estimates of depreciation were obtained from the Farm Income Branch. These estimates are compiled as follows:²⁵

"Depreciation.--Depreciation covers. . . service buildings and other farm structures, motor vehicles, and farm machinery and equipment, plus accidental damage to farm buildings. It is the estimated outlay, in current prices, which would be required if farmers were to replace the plant and equipment used up during the year. The estimates are based on a "declining balance method" in which a constant percentage representing the annual rate of depreciation of each type of capital is applied to its estimated value at the beginning of each year. Depreciation rates are applied separately to the various forms of capital equipment on farms, but only 40 percent of automobile depreciation and 78 percent of farm truck depreciation is charged as a production expense. The assumed rates of depreciation result in a total chargeoff of approximately 95 percent of total value over the period of years estimated as the useful life of the capital item, with the remaining 5 percent representing scrap value.

For each of the capital items, the appropriate rate is applied to the sum of its total value in constant dollars at the beginning of the year and half the value in constant dollars of purchases during the current year, because purchases are assumed to be distributed evenly over the year. Constant dollar values are employed for these calculations to measure the real consumption of capital. An index of prices paid by farmers is used to convert from a current to a constant dollar basis or from a constant to a current dollar basis.

Estimates of accidental damage to farm buildings from fire, wind, and hail are based chiefly on loss reports to insurance companies.

State estimates of depreciation for each category are derived by allocating the U.S. totals among the States on the basis of the best information available. For example, depreciation on buildings is distributed in proportion to the estimated value of buildings on farms in each State. Depreciation of motor vehicles and other farm machinery is

²⁵From Agriculture Handbook No. 365, Vol. 3, "Gross and Net Farm Income," pg. 10f, U.S. Department of Agriculture, 1969.

allocated in proportion to numbers of each type of vehicle on farms, or other relevant information such as State totals of the cost of repairs to farm machinery."

MAINTENANCE OF SERVICE BUILDINGS AND MACHINERY

Current dollar estimates were obtained from the Farm Income Branch, ESAD. These estimates were compiled as follows:²⁶

"Repairs and operation."--This covers repairs and maintenance of farm buildings, repairs and other operating expenses for motor vehicles and farm machinery, and expenses for petroleum, fuel, and oil used in the farm business (net of refunds or tax credits).

Expenditures for building repairs and maintenance are estimated separately for dwellings and other farm buildings. In general, U.S. totals are derived by applying to total expenditures for construction, estimated ratios of repairs to total construction outlays. State totals are derived by allocating the U.S. totals among the States in proportion to the value of buildings on farms.

U.S. expenditures for petroleum, fuel and oil used in the farm business are from the quinquennial Census of Agriculture. Estimates for other years are projected from the census year on the basis of changes in prices of petroleum products, numbers of motor vehicles on farms, and average consumption of fuel and oil for each type of motor vehicle.

Repairs and other operating costs of motor vehicles and machinery are estimated separately for farm autos, trucks, tractors and other farm machinery. They include such items as the cost of repairs, tires and tubes, registration fees, and insurance. Only 40 percent of the total cost of auto repairs and operations is charged to farm production and 78 percent for trucks. State totals of repair and other operating costs of motor vehicles and farm machinery and equipment are derived in general by distributing the U.S. total expenses for each type of vehicle among the States in proportion to the number of vehicles on farms, the number of tractors on farms, and other measures such as the estimated retail value of farm machinery parts shipped and an index representing changes in labor costs. Changes in prices for such items as tires, and services

²⁶From Agriculture Handbook No. 365, Vol. 3, op. cit., pg. A-19.

such as insurance premiums, are utilized in constructing this account."

INTEREST ADDED BY NON-REAL ESTATE DEBT

Data were obtained from the Farm Income Branch for current dollar expenditures for interest on chattel mortgages. Their accounts are made up of the following components:

- a) Interest paid to all commercial banks, obtained from Carson Evans, Agricultural Finance Branch, adjusted for interest paid on non-farm credit.
- b) Interest paid to all federal agencies except the CCC, also obtained from the Agricultural Finance Branch.
- c) Interest paid to the CCC, obtained from the ASCS.
- d) Interest paid to dealers and others.

Since most short term debt is incurred to finance inventory, and since we are charging interest on inventory at the mortgage rate, it would be double counting to include all of the interest paid on short term debt. Thus, the weight period difference between the short term rate and the mortgage interest rate was calculated reasoning that this is the added cost to the farmer of borrowing short term credit rather than using his own capital.

Thus, the short term principal was multiplied by the weight period difference between the short-term and mortgage rates and the resulting interest added figure was deflated with the SRS index of Production Costs. Intuitively this may seem like erroneous double deflation but consider the example:

Assume a farmer borrows the money to buy a grain drill in the weight period. The drill cost \$400. The interest rate was 6%. Assume the loan was for one year. The loan cost was \$24. Suppose in 1970 the farmer buys an identical grain drill but the price is now \$600 and the interest rate is 8%. The loan cost is \$48.

We wish to deflate in such a manner that the two loans have equal constant dollar cost. To do this we have to both deflate the price of the machine and use a weight period interest rate.

This input was entered in the computer program as follows:

Let t = the current year

$t-1$ = the current year minus one, in other words, last year

P = amount of short term money borrowed

S_c = current short term interest rate

$S_o = S_c(t-1)$ = interest rate on short term credit outstanding, assuming the current rate lagged one year approximates the rate on loans outstanding

S_w = the weight period interest rate on short term credit outstanding

L = the weight period long term interest rate (use the mortgage rate of interest as a proxy)

I = the index of production costs

Want $P/I(S_w-L)$

knowns: S_oP , S_c , S_w , L , I .

$$S_oP \cdot \frac{S_w}{S_o} = S_wP$$

$$\text{and } L \left(\frac{S_oP}{S_o} \right) = LP$$

$$S_oP \cdot \frac{S_w}{S_o} - \left[L \left(\frac{S_oP}{S_o} \right) \right] = PS_w - PL = P(S_w-L)$$

divide by I to deflate:

$$\begin{aligned} \left(\frac{1}{I} \right) \left\{ S_oP \cdot \frac{S_w}{S_o} - \left[L \left(\frac{S_oP}{S_o} \right) \right] \right\} &= \left(\frac{1}{I} \right) \frac{S_oP}{S_o} (S_w - L) = \frac{S_oP (S_w - L)}{IS_o} \\ &= \frac{\frac{S_oP}{IS_o}}{\frac{S_w-L}{S_o}} = \frac{S_oP}{S_o \left(\frac{I}{S_w-L} \right)} \end{aligned}$$

PETROLEUM, FUEL AND OIL

It was necessary to construct price indices for this input since none existed on a regional basis. The indices constructed were based on the tank truck price of regular gasoline. These price figures were available by regions since 1959. The Agricultural Estimates Division supplied confidential data for the years 1957 and 1958, although these figures were subsequently published in the December 30, 1966 Agricultural Prices.

For the years prior to 1957, regional data were not available for tank truck gasoline. Data for these years were manufactured by the following procedures:

- A. For the years 1948 through 1956, it was assumed that the national percentage variation between tank truck prices and filling station prices could be applied to each region. Thus, filling station prices were computed by regions and decreased by this percentage difference to derive tank truck prices.
- B. No expenditure measurements were made between the years 1939 and 1947. Thus the F.I.B. expenditure figures are a straight line interpolation for this period. To derive a tank truck price for this period, the regional tank truck price was computed by procedure A for the years 1939 and 1947. Then the regional variation from the United States average price was computed for these two years and this variation was interpolated for the other years in the interval. These interpolated variations were then applied to the annual United States tank truck prices to obtain regional tank truck prices for the period.

CUSTOM WORK

The Farm Income Branch keeps accounts on cotton ginning but for no other custom work.

A decision was made to handle ginning separately and assume that it is all done by non-farmers.

The 1955 survey of farmers expenditures has entries for both custom work expenditures and income from custom work. This would supposedly enable a calculation of value added by non-farmers which came out:

Proportion of Custom Work Done by Non-farmers

	<u>Percent</u>
North	70.8
South	71.9
West	61.0

Since these figures were obviously too high, Paul Strickler, Production Resources Branch, FPED, was asked for an educated estimate which was 35 percent for the Pacific Region and the Plains States and 20 percent for the remaining regions.

A subsequent conference with Grady Crowe, Production Adjustments Branch, FPED, indicated that this estimate was low for cotton regions since aircraft are customarily used for insecticide application. Thus a decision was made to raise the Delta and Southeast regions to 35 percent.

The first census measure on custom work was in 1949. The wording on the 1949 and subsequent census questionnaires appears on a following page. At first it was believed that ginning could be subtracted from the census figure to obtain a figure for custom work other than ginning. The results indicate that if the Farm Income Branch's figure on ginning is subtracted from the census expenditure for custom work the rate per acre comes out negative for the Delta states in 1949 and only 15 cents in 1954.

Conferences with Rudie Slaughter and Herbert Brown, Production Adjustments Branch, FPED, indicated that most farmers consider ginning to be a processing cost rather than custom work. The changes in the wording of the census question and comparison with the 1955 figure from the survey of farmers expenditures indicates that the 1959 census figure probably included most of the ginning with custom work.

In order to estimate a 1954 figure comparable with the non-cotton regions, the percentage change from 1954 to 1955 for the non-cotton regions was projected from 1955 back to 1954 for the cotton regions. (Much of this change was likely sample bias rather than a change in per acre rates.) For the cotton regions; the Delta states, the Southeast, Southern Plains, Appalachian, and Mountain, these 1954 rates were used for all years from 1939 to 1954.

For the non-cotton regions, the 1949 rates per acre were used for all years from 1939 to 1949.

The 1964 census excluded ginning but included contract work. Since much of the Bracero labor was contracted, an effort was made to separate this out of the 1964 census figure by:

- a. Calculating the change in custom work expenditures from

1959 to 1964 for the United States, excluding the states of: California, Texas, Florida, and Michigan²⁷ since these states use most of the Bracero labor (ERS Ag. Econ. Report #77).

- b. Applying the rate of change calculated in (a) for these four states to the 1959 census expenditure.

This assumes that the rate of change 1959-64 for the remainder of the nation can be applied to these four states.

To move between census benchmarks, the custom rate per acre of cropland harvested was interpolated. This figure was applied to the annual cropland harvested acreages to obtain the PQ in current dollars. The 1964 custom rate/acre was used for subsequent years.

The deflater used was an average of the indices of prices paid for:

- a. Motor supplies.
- b. Farm machinery.
- c. Wage rates.

Wording of census questions regarding expenditures for machine hire and custom work:

The question was first asked in 1949:

How much was spent last year for machine hire?

(Include tractor hire, threshing, combining, silo filling, baling, plowing, and spraying.)

1954: How much was or will be spent this year for machine hire? (Include custom work such as tractor hire, threshing, combining, silo filling, baling, ginning, plowing, and spraying.)

1959: (Question 276) How much was or will be spent this year for machine hire? (Include custom work such as tractor hire, threshing, combining, cotton picking, cotton ginning, silo filling, corn picking, baling, plowing, fruit picking, spraying and dusting.) (Question 277) How much was or will be spent this year for hired labor? (Do not include housework,

²⁷ Since this procedure increased rather than decreased the 1964 Michigan Expenditures for custom work, a decision was made to use the 1964 census figure for Michigan without adjustment for contract labor.

custom work, or contract construction work. Include cash payments only.)

1964: (Question 345) How much was or will be spent for machine hire, custom work, and contract work in 1964? (Include expenses for the hire of farm machinery and equipment; and custom work such as grinding and mixing feed, plowing, combining, corn picking, silo filling, spraying, dusting, and contract work such as fruit picking, berry picking, fruit harvesting, etc. performed by a contractor, crew leader, a cooperative, etc. Do not include expenses for cotton ginning.)

(Question 346) How much was or will be paid in cash for hired labor in 1964? (Include payments to members of the family and payments made or to be made for Social Security taxes. Do not include payments for housework, custom work, or contract work.)

VEHICLE LICENSES

The cost of licensing farm vehicles can be considered a farm input in so far as the expenditure represents a payment for road construction and maintenance. Data on the current dollar expenditures for the production share of this item were obtained from the Farm Income Branch, ESAD. The SRS index of prices paid by farmers, including interest, taxes, and wage rates was used as a deflator.

VEHICLE INSURANCE

The production share of the cost of insuring motor vehicles was derived similar to vehicle licenses. Data on current dollar expenditures, net of loss adjustments, were obtained from the Farm Income Branch. The index of motor vehicle prices was used as a deflator.

BLACKSMITHING, HARDWARE, AND SMALL HAND TOOLS

Current dollar expenditures data for these items were obtained from the Farm Income Branch, and deflated with the SRS index of prices paid for farm supplies.

ELECTRICITY

Regional data for expenditures on electricity were not available prior to 1949. An assumption was made that there was no change in the regional distribution for the period 1939-1948. Data for this period and regional data for subsequent years were obtained from the Farm Income Branch.

These current dollar expenditures were deflated with an index based on the price per KWH paid by farmers for electricity.

HARNESS AND SADDLING

Current dollar expenditure data for these items were obtained from the Farm Income Branch. These figures were deflated with a price index constructed from the price of horse collars reported in Agricultural prices.

FERTILIZER

The fertilizer input was compiled as follows:

The composite fertilizer grade was calculated for each region, then a grade as nearly the same as possible was found for which a price was available. Mixing cost was then assumed to be the difference between what farmers paid for this grade and what they would have paid if they had purchased the equivalent quantity of nutrients at straight material prices.

Quantities and prices for the early period (1939-54) were based on oxides. That is, P_2O_5 for phosphorus and K_2O for potash. For the late period (1955 to 1970) prices and quantities were on an elemental basis. For the late period, anhydrous ammonia was priced separately from other forms of nitrogen. For both periods rock phosphate was priced separately

from other forms of phosphate. For everything except rock phosphate, prices were derived on a nutrient basis. Rock phosphate was priced as a straight material.

Non-farm use was then estimated and subtracted from the total. The procedure used to estimate non-farm use follows:

Procedure for determining non-farm use of fertilizer

There are three sources of data on non-farm use of fertilizer:

1. Article by Scholl and Wallace in Vol. 5, #2 of Agricultural Chemicals, NAL #381 Ag8, June 1947-June 1948 Data.
2. USDA Bulletin 216, Bottom of Table 2, 1947, 1950, 1954, data.
3. USDA Bulletin 348, 1959, data.

Only the sources underlined were used because:

- a. There was no significant difference between 1 and 2 for 1947 and source 2 lacked data for the Lake States and the Corn Belt regions.
- b. The 1950 data from source 2 was judged to be very rough estimates by Don Ibach, FPED, ERS, and did a very poor job of fitting the trend.

The three sources underlined were used as follows:

1. For the years prior to 1948 the 1948 ratio of non-farm/total was applied to the total figures.
2. For the years 1948-54 and 1954-59 a straight line interpolation was used.
3. For the years subsequent to 1959, the rate of increase from 1954 to 1959 was cut in half and continued. In regions where non-farm use decreased from 1954-59, the 1959 rate was continued.

Limestone

I. Quantity:

The 1954 and 1959 census tonnage figures were adjusted for under-enumeration using the adjustment figures for acres of cropland

harvested.²⁸

Then:

- A. For the Mountain Region, census data were interpolated between census years from 1939 to 1959. Lime Institute data were not used since there were no reports for several mountain states during this period. For the Mountain Region, the census did not report lime tonnages in 1964. Thus for 1964 and subsequent years, for the Mountain Region, the Lime Institute figures were used. For the period 1959 to 1964, an interpolation was made between the 1959 census tonnage and the 1964 Lime Institute tonnage.
- B. For the other regions:
 1. For the period 1939 to 1954:
 - a. For the Pacific Region a straight line interpolation was made between census benchmarks.
 - b. For the humid states, the lime association and/or institute figures were wedged to fit the census data.
 2. For the period 1954 to 1964, the Lime Institute figures were wedged to fit census data for all regions except the Mountain Region.
 3. For the period 1964 to date, the 1964 wedge factors were applied to the Lime Institute figures for all regions except the Mountain Region.

II. Price:

- A. For the 1957-59 weight period, SRS spring and fall prices were averaged.
- B. For 1947 and 1948, spring SRS prices were used.
For 1949, spring and fall SRS prices were averaged.

THE SEED INPUT

Two basic approaches are available to estimate constant dollar

²⁸ Underenumeration figures were not available by states from the Census bureau as of 1 December 1968. The figures on page 59 of ERS Agricultural Economics Report #149 imply a correction of only 1½ percent. Thus a decision was made to use the 1964 census data without an adjustment for underenumeration.

expenditures for seed.

1. The quantity planted for some of the major grains is published in Agricultural Statistics. For some of the remaining grains, the quantity planted can be estimated by multiplying acres planted by the seeding rates from Agricultural Statistics. These quantities have been computed, for most seeds for which prices are available, by the Farm Income Branch. These quantities can then be multiplied by the proportion purchased²⁹ and the weight period value added to obtain the value added in constant dollars.
2. Expenditures in current dollars, available from the Farm Income Branch, can be deflated with the index of seed prices. This gives expenditures in constant dollars which can then be multiplied by the weight period marketing margin to obtain value added in constant dollars.

The first approach is more accurate for those crops for which price data are available, however, prices are not available for many of the minor crops. Thus, the first approach was used for the major grains and the second approach for the remainder of the seed input. The grains treated as major grains were:

Corn hybrid	Soybeans
Corn, open pollinated	Barley, spring
Oats, spring	Cottonseed
Wheat, spring	

This is the way F.I.B. classifies the grains (plus a misc. class). It was necessary to use their classification system since prices were not available for all of the minor grains, thus prohibiting them from being

²⁹ An unsuccessful attempt was made to run down the source of F.I.B.'s figures on the fraction of seed purchased. Neither George Tucker nor Jim Kendall, SRS, could recall making these estimates and had no knowledge of published figures. An estimate could be derived from the series "Field and Seed Crops" (Statistical Bulletin 386, and its predecessors, NAL library number 1 Ag 84 St) by subtracting the seed used on farms where grown from the seed planted. The difference represents the quantity purchased, however a portion of this comes from neighboring farms and does not move through commercial channels.

treated physically.

The second approach, i.e., deflating current expenditures, was used for all seeds except the major grains. Since F.I.B. expenditures are adjusted to the Census after being totaled, the data had to be manipulated as outlined in Procedure a (which follows below) in order to remove the major grains from expenditures. Considerable difficulty was experienced in locating data for estimating the weight period marketing margin to apply to the deflated expenditures. To estimate this marketing margin the following state or regional data are needed:

1. The price paid by farmers.
2. The price received by farmers.
3. The quantities planted by states if both 1 and 2 are not quoted by Farm Production Regions. This is to enable the state prices to be weighted into regional averages.

After removing the major grains from expenditures, the more important seeds remaining are: Alfalfa, red clover, and potatoes in the Northern regions; winter wheat and alfalfa in the Plains states (plus grain sorghums in the late period); and lespedeza in the South. It was not possible to compute the weight period marketing margin for alfalfa seed since the prices paid are quoted by common and certified, and data on the proportion certified were not available. (On a quantity planted basis, i.e., we know where the certified seed was produced but not where it was "consumed" for seed.) For potatoes, the price received by farmers for potato seed was not available.

Thus, a decision was made to base the marketing margin (for the deflated portion of the seed input) on the three seeds: Winter wheat, red clover, and lespedeza. However, even these data were not "clean". The price paid for lespedeza seed is quoted only by four varieties. The quantities produced of each variety were used to weight the prices into an average for all lespedeza seed. There were no data available on the quantity of red clover seed planted. The state prices paid were weighted to regions with the acres harvested of clover and timothy hay. Of the wheat seed purchased, a large portion is bought from neighbors but data is very skimpy on this. Except for the grain sorghum regions, fragmentary data was used as a basis to estimate 55 percent purchased from

neighbors. For the grain sorghum regions, for the 1957-59 weight period, this proportion was dropped to 45 percent to reflect the increasing use of hybrid sorghums which were assumed to be purchased through commercial channels.

Procedure a

Unadjusted expenditures for all grain seeds were subtracted from the unadjusted expenditures for all seeds. Then, unadjusted expenditures for the minor grains was added to this figure to obtain total unadjusted expenditures for all seeds except the major grains. This total was adjusted to Census using the F.I.B.'s adjustment factors and the result was deflated with the index of seed prices from the Farm Cost Situation.

Procedure b (which follows below) was used to account for both the neighbors and the processors margins as a proportion of expenditures. An arbitrary assumption was made that farmers paid 10 percent over the grain price for open pollinated corn and wheat seed which they purchased from neighbors.

These procedures resulted in marketing margins for:

wheat in all regions,

red clover and/or lespedeza in all regions.

Based on 1955 data from the F.I.B., expenditures for seeds other than major grains were divided into two classes:

Highly processed: grass seeds, vegetables seeds, greenhouse and nursery supplies.

Lowly processed: minor field seeds and potato seed (including winter wheat).

A weighted overall marketing margin was then calculated by weighting the red clover marketing margin with the proportion of highly processed seeds and weighting the wheat marketing margin with the proportion of lowly processed seeds.

This overall marketing margin for all seeds other than major grains was then applied to the deflated expenditures to obtain the constant dollar value added by non-farmers.

Procedure b - Procedure for determining seed processing margin

Let a = commodity grain price

k = bu. of seed purchased

F_n = fraction of purchased seed bought from neighbors

F_p = fraction of purchased seed bought from processors

P_f = price paid to farmer for seed

P_r = price farmer pays processor for seed

Procedure b (continued)

Assume neighbor gets 10 percent markup from elevator price. Then:

$$\underbrace{\text{Expenditures to neighbors}}_{\substack{\text{Price pd. to} \\ \text{neighbor}}} \underbrace{\text{Expenditures to processors}}_{\substack{\text{Q bot. from} \\ \text{processors}}} \\ \left[\underbrace{(a)(1.1)}_a + \underbrace{(k)(F_n)}_{k \ b} \right] + \left[\underbrace{(P_r)}_d + \underbrace{(k)(F_p)}_{k \ c} \right] = \text{F.I.B. expenditures} \\ \text{simplified notation}$$

$$(k) [(1.\text{lab}) + (dc)] = \text{F.I.B. expenditures} = j$$

$$\begin{aligned} & \$ \text{ markup to neighbors} \quad \underbrace{\text{per bu. margin to neighbor}}_{(a)(o.1)} \quad \underbrace{\text{Q bot. from neighbor}}_{(k)(F_n)} \quad + \quad \underbrace{\text{per bu. margin to processor}}_{(P_r - P_f)} \quad \underbrace{\text{Q bot. from processor}}_{(k)(F_p)} \\ & \quad \quad \quad a \quad \quad \quad k \ b \quad \quad \quad d \ e \quad \quad \quad k \ c \quad \quad \quad \text{Value added by neighbors and processors} \end{aligned}$$

$$(k) [(o.\text{lab}) + (d-e)(c)] = \text{value added by neighbors and processors} = i$$

$$\frac{(k)(o.\text{lab})}{(k)(1.\text{lab})} + \frac{(d-e)c}{(dc)} = i/j = \text{value added as a proportion of F.I.B. expenditures}$$

Details for Major Grain Seeds

The details concerning the tabulation of major grain seeds are discussed in procedures f to m which follow below.

Except for hybrid corn, there were no data available on the price paid to farmers for grain seeds. An arbitrary 10 percent was added to the grain price for open pollinated corn and wheat. The commodity price was used for the remaining grain seeds.

Procedure f: Hybrid corn seed

Purdue Research Progress Report 272 indicates that the retail price figures in Mr. Funk's letter³⁰ are list rather than sale prices. To adjust for discounts, find Funk's weighted average price and adjust it down to the U.S. average price shown in the June 1965 Agricultural Prices. (The Agricultural Prices figure is for regular flats, whether for double cross or all types was not stipulated on the questionnaire, per Mr. Stoksted, SRS.)

Est. Bu.
Planted, U.S.

Single X	2,553,200	@\$22.00 = \$ 56,170,400
Double X	8,297,900	@\$13.70 = 113,681,230
Triple X	1,914,000	@\$15.50 = 29,667,000
	<u>12,765,100</u>	<u>\$199,518,630</u>

$$\text{Weighted average} = \frac{199,518,630}{12,765,100} = \$15.63$$

Thus, the average discount = $15.63 - 12.20 = 3.43$ or as a percent $\frac{3.43}{15.63} = 21.945\%$ ($100 - 21.945 = 78.055$)

Thus Funk's sale price becomes:
 Single cross (\$22.00) (78.055%) = \$17.172
 Double cross (\$13.70) (78.055%) = \$10.694
 Triple cross (\$15.50) (78.055%) = \$12.099
 and Funk's value added per bushel becomes:
 Single cross \$17.172 - \$3.47 = \$13.702
 Double cross \$10.694 - \$1.41 = \$ 9.284
 Triple cross \$12.099 - \$1.43 = \$10.669

³⁰ Letter from Thomas F. Funk, Graduate Research Assistant, Department of Agricultural Economics, Purdue University, dated May 25, 1967.

Procedure f (continued)

These values added weighted by the quantities planted:

	<u>Bushel</u>	
Single x	2,553,200	@ \$13.702 = \$ 34,983,946
Double x	8,297,900	@ 9.284 = 77,037,704
Triple x	<u>1,914,000</u>	@ 10.669 = <u>20,420,466</u>
	12,765,100	\$132,442,116

$$\frac{\$132,442,116}{12,765,100 \text{ bu.}} = \$10.375 = \text{average value added per bushel.}$$

$$\text{Value added as a proportion of the sale price} = \frac{\$10.375}{12.20} = .85041 = 85\%$$

Therefore use 85% of sale price as value added by non-farmers.

The average weight period sale prices were derived from F.I.B. records by dividing expenditures by quantity purchased to obtain a price per 1,000 pounds. This average sale price was multiplied by 85% to obtain the value added per 1,000 pounds.

This value added per 1,000 pounds was then applied to the Farm Income Branch's quantity purchased to obtain the expenditure in constant dollars.

Procedure g: Open pollinated corn seed

F.I.B. assumes that $\frac{1}{2}$ of the open pollinated corn planted is purchased. To obtain the Q of open pollinated planted they multiply the acreage planted by the seeding rate and subtract the Q of hybrid corn planted.

F.I.B. expenditures were divided by the Q purchased to obtain a weight period price paid for open pollinated corn seed.

The price received by farmers for open pollinated seed was assumed to be 10 percent above the commodity prices which were obtained from Don Durost, FPED, ERS. (Statistical Bulletin 273.) The difference between the price paid and the price received was calculated and this weight period marketing margin was multiplied by the quantity purchased to obtain the value added in constant dollars.

Procedure h: Spring oats seed

The F.I.B. computes quantities planted by multiplying seeding rates (from Ag statistics) by acres planted (from

Procedure h (continued)

the crop report). They then, multiply by the fraction purchased and prices paid for oat seed from the June Ag. prices to obtain expenditures.

To obtain weight period average prices, F.I.B. expenditures were divided by the quantity purchased. To obtain the processors marketing margin, the grain price was subtracted from the price paid by farmers for oat seed. This weight period value added per bushel was then multiplied by the bushels of spring oats purchased to obtain the expenditure in constant dollars.

Procedure i: Spring wheat seed

The quantity of spring wheat seed purchased was obtained from the F.I.B. Their expenditures were divided by the quantity purchased to obtain the weight period prices paid. The price received was assumed to be 10% above the commodity price obtained from Durost.

The difference between the price paid and received was calculated and this weight period processing margin was applied to the quantities purchased to obtain the expenditure in constant dollars.

Procedure j: Soybean seed

F.I.B. expenditures were divided by the quantity of soybean seed purchased to obtain the weight period price paid by farmers. Durost's commodity prices (Statistical Bulletin 273) were assumed to be the prices received by farmers. The difference is the weight period value added processors.

These factors were applied to F.I.B.'s quantity purchased to obtain PQ's in constant dollars.

Procedure k: Cottonseed for seed

F.I.B. expenditures were divided by F.I.B.'s quantity purchased to obtain weight period average prices paid by farmers. The commodity price received by farmers was assumed to be the price received for cottonseed for seed.

The weight period value added per 1,000T was computed, then applied to the Farm Income Branch's quantity purchased

Procedure k (continued)

to obtain expenditures in constant dollars.

Procedure m: Barley seed

The bushels of seed planted and the proportion purchased were obtained from the F.I.B. They obtain bushels planted by multiplying acres planted by the seeding rates from Agricultural Statistics.

Weight period prices paid were taken from the June issue of Agricultural Prices and weighted into regional averages.

Durost's commodity prices (Bulletin 273) were assumed to be the prices received by farmers for barley seed.

THE FEED INPUT

Feed Grains, proportion going through commercial channels

An abortive attempt was made to estimate these proportions by starting with the following procedure:

Let q = Feed grains fed (from Production Resources Branch, FPED, Statistical Bulletin 337 and unpublished worksheets).

w = Feed grains fed on farms where grown (from SRS, Statistical Bulletins 115, 208, 311 and 404).

Then $q - w$ = Feed grains purchased from all sources.

However, this procedure produced negative purchases for the 1957-59 period for two regions, the Lake States and the Northern Plains.

In an effort to pinpoint the source of the discrepancy, a tabulation by states was made for the 1964 crop year. This resulted in negative purchases for the states of Michigan and North Dakota and positive purchases which were obviously too small for many remaining states. A conference with the Feed Grains Branch, SRS, indicated that the figures for "Feed grains fed on farms where grown" were obtained by subtracting what farmers report as sold from what they report as produced. These data were obtained from questionnaire C.E. 2-308, a copy of which appears on the page following.

Labeling this residual as "Feed fed on farms where grown" is suspect for the following reasons:

PLEASE MAIL BY
MARCH 1, 1968

FARM REPORT
U. S. DEPARTMENT OF AGRICULTURE
Statistical Reporting Service



Please make necessary corrections in name and address

It's about that time...

when the busy Spring season keeps us jumping. Your report will help us give you up-to-date information which will in turn help you in planning and marketing your crops.

This service is possible only with your valuable help, so thanks a lot.

Please remember to:

1. Read the special instructions.
2. Mail your report promptly in the enclosed envelope which needs no stamp.

Respectfully,

G. D. Simpson

G. D. Simpson
Chairman, Crop Reporting Board

P. S. Individual reports are kept confidential.

"Farm With Facts"

SPECIAL INSTRUCTIONS

- Enter dash (-) for the questions that do not apply to your locality. On questions relating to your operations, enter 0 when zero or none is the answer.

C.E. 2-308

N.J., Ohio, Ind., Ill., Minn., Iowa,
N. Dak., S. Dak., Kans., W. Va.

Please Answer These Questions For The Farm or Ranch You Operate	Answer here ↓
FIELD CROPS	
CORN produced on this farm or ranch last year (1967 crop) - 70 lb. ear or 56 lb. shelled BUSHELS	
CORN of 1967 crop sold and to be sold - 70 lb. ear or 56 lb. shelled BUSHELS	
OATS produced on this farm or ranch last year (1967 crop) - 32 pound BUSHELS	
OATS of 1967 crop sold and to be sold - 32 pound BUSHELS	
BARLEY produced on this farm or ranch last year (1967 crop) - 48 pound BUSHELS	
BARLEY of 1967 crop sold and to be sold - 48 pound BUSHELS	
SORGHUM GRAIN produced on this farm or ranch last year (1967 crop) - 56 pound BUSHELS	
SORGHUM GRAIN of 1967 crop sold and to be sold - 56 pound BUSHELS	
HAY of all kinds harvested on this farm or ranch last year (1967 crop) - TONS	
HAY of 1967 crop sold and to be sold - TONS	
DAIRY	
COWS MILKED on this farm or ranch yesterday - NUMBER	
ALL MILK COWS on this farm or ranch yesterday (both dry and in milk) - NUMBER	
MILK PRODUCED on this farm or ranch yesterday (Report only one day's production) Report in either POUNDS or GALLONS	
POULTRY	
EGGS produced by your flock yesterday - NUMBER	
HENS and PULLETS of laying age in your flock yesterday (include birds being forced molted) - NUMBER	
CHICKENS EATEN during the past month that were produced on your farm or ranch NUMBER TOTAL POUNDS liveweight	
EGGS EATEN and used for cooking during the last 7 days that were produced on your farm or ranch - NUMBER	
HENS and PULLETS of laying age that died during the past month due to disease, accident, exposure, etc. - NUMBER	

- I. No account is taken of change in stocks.
- II. There is an implicit assumption that farmers report grains under CCC loan or purchase agreement as "sold or to be sold". The discrepancy suggests that this assumption is unwarranted. Legally, liquidation of grains under CCC loan is a foreclosure of chattel mortgage rather than a sale. Purchase agreements also lack one of the two requirements of a legal sale contract: The CCC offers to buy but the farmer does not accept the offer at the time the purchase agreement is signed. Thus the purchase agreement resembles an option to sell rather than a sales contract.
- III. If a cash grain farmer is asked "How much grain was sold or will be sold", this is tantamount to asking him "How much will your income be?" If this question is asked by the USDA, a Federal agency, how is the farmer to know that the Internal Revenue Service, another Federal agency, will not review his report? Thus it is prudent to expect some grain farmers to make a conservative report, especially as to their anticipated future sales.

Statistical Bulletin 268, "Grain Transportation Statistics for the North Central Region" estimated the sales of feed grains by country elevators to farmers for the calendar year 1958. Thus this year was chosen to attempt an adjustment that would arrive at a plausible estimate of feed grains used for feed on farms where grown. (Sheets θ_1 .) Unfortunately, this study was regionalized in such a manner that data on complete states were available only for the states of: Iowa, North Dakota, South Dakota, Nebraska, and Kansas. Following the bottom half of sheets θ_1 (on the pages following)

q = total grains fed

t = feed grain purchases from local elevators by farmers

$q-t = u$ = grains fed on farms where grown plus purchases from neighbors.

Sheet 91

FED OMAHA DATA ADJUSTMENT

State IOWA

Data source	Field & Seed Crops, Stat. Bull. 311, Mar. May, 1962	Stat. Bulletin 504	Change in inventory on farm	Data Operations Branch, AECB											
				Sold	Adjusted inventory	Used for seed on farm where grown	Received under loan repaid	Farm stored	Purchase Agreement "retained"	Loans delivered to stored	Purchase Agreement to OCS	Feed grains used for feed on farm where grown	Factor	1000 tons	
		a	c	1000 bushels											
				4	6/2**	f	g	h	i	j	k	ac+efg	ac+g+km	n	m+p
1957 CORN crop	611,320	215,962	-10,825	-9542				35,628	6297	45,196	4990	314,099	.028	8794	
1957 SOYBEAN crop	13,860	5,244	74	37		53		132	471	1,129	166	6,328	.028	177	
1958 OAT crop	219,401	50,462	342	171	10,591	1953						156,234	.016	2900	
1958 BARLEY crop	1,178	412	-75	-58	47							797	.024	18	
Total														11,489	

Data source	Production Branch, FED	Grain Transportation Statistics Division, Statistical Bulletin 265									
		Grain purchased from local elevators by farmers, 1 Jan. '58 to 31 Dec. '58									
		Total grain	Factor	Feed grains fed on farm where grown							
				purchased from neighbors							
				1000 tons							
				Factor							
1957 CORN crop	q	F	n	re = t	q - t = n	n - p = v					
		58,976	.028	1451							
1957 SOYBEAN crop		828	.028	23							
1958 OAT crop		15,983	.016	296							
1958 BARLEY crop		7	.024								
Total	34,450			1930	12,530	1031					

Sheet 2.

FEED GRAIN DATA ADJUSTMENT

STATE NORTH DAKOTA

Data source	Field & Seed Count, Stat. Bull. 311, Rev. May, 1962	Stat. Bulletin 504	Change in production including illage	Sold on farm	Adjusted inventory from where grain	Used for feed on farm where grain	Branch, ERS	Data Operations Branch, ASGS	Loans de- livered to CCC, farm stored	Purchase from CCC, farm delivered to CCC	Feed grains used for feed on farm where stored, also factor	1000 tons
	a	c	d	e	f	g	h	i	j	k	l	m
1957 ODM crop	14,964	3797	628	314	32		214	350	955	269	8,645	262
1957 SORGHUM crop											.028	
1958 OAT crop	75,738	28,508	8,783	4,392	2,694						36,138	579
1958 BARLEY crop	109,704	86,666	7,319	3,660	4,464	12,145					2,469	99
Total												880

Data source	Production Resources Branch, FRED	Grain Transportation Statistics for the North Central Region, Statistical Bulletin 268	Total grains purchased from local elevators by farmers, 31 Mar. 58 1957 to 30 Sept. 1958	Conversion factor	1000 tons	Feed grains fed on farm plus purchase from neighbors	Feed grains purchased from neighbors	1000 tons
	q	r	s	t	u	v	w	x
1957 ODM crop		805	.028	22				
1957 SORGHUM crop			.028					
1958 OAT crop		2,712	.016	43				
1958 BARLEY crop		2,006	.024	48				
Total	1,005			113	892			12

Sheet 9.

FIELD GRAIN DATA ADJUSTMENT

State: KANAS

Data source	Field & Seed Crops, Stat. Bull. 311, Mar. May, 1962	Stat. Bulletin 304	Data Operations Branch, AUCI												
			Production change in storage	Sold on farm	Adjusted inventory on farm	Used for inventory farm where grain were stored	Released for use on farm where grain were stored	Feed stored on farm	Purchase "redman" feed	Loans delivered to CCC, farm stored	Purchase delivered to CCC	Feed grains used for feed on farm where grain were stored			
													1 0 0 0 bushels		
			1 0 0 0 bushels				1 0 0 0 bushels				1000 tons				
			a	b	c	d	e	f	g	h	i	j	k	m-c-f-g m-b-j-f-g	m + p
1957 CORN crop	36,180	16,643	1679	840	7	7	849	293	2778	378	14,592	403			
1957 SOYBEAN crop	127,491	94,343	1696	848	441	441	849	293	3097	3680	19,904	597			
1958 OAT crop	13,416	2,549	-3937	-2968	982	26	26	26	26	26	12,839	205			
1958 BARLEY crop	18,535	2,970	-446	-233	773	162	162	162	162	162	9,863	237			
Total												1402			

Data source	Production Resources Branch, FYED	Grain Transportation Statistics for the North Central Region, Statistical Bulletin 285	Feed grains fed on farms where grain is purchased from neighbors																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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1957 CORN crop			9,431	-0.26	264																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																

Grain purchased from local elevators
by farmers, 1957 to 1958
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Grain purchased from local elevators
by farmers, 1957 to 1958
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Grain purchased from local elevators
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Grain purchased from local elevators
by farmers, 1957 to 1958
factor

Grain purchased from local elevators
by farmers, 1957 to 1958
factor

We can logically expect a substantial proportion of purchased grains to come from neighboring farms in regions that have grain surpluses because:

1. The feeder can avoid the local elevator's handling charge of about 10¢ per bushel.
2. The neighboring grain farmer can avoid the cost of delivering the grain to the local elevator.

The feeder can be expected to purchase a larger proportion from the elevator:

- a. In grain deficit areas,
- b. Shortly before harvest since the neighboring grain farmer would not normally have grain on hand at this time.

Typically the feeder can be expected to line up his anticipated needs at harvest-time and purchase as much as possible from neighboring grain farmers. Two factors limiting this activity are likely to be:

1. The feeder will be conservative in estimating his needs in order not to purchase an excess.
2. The feeder and the neighboring grain farmer may not have sufficient storage to handle inventory for the entire feed year.

Thus we can expect substantial purchases from neighboring grain farmers in the post harvest season and purchases from the elevator in the preharvest season.

We would expect the preharvest or evening-up purchases to run fairly constant in relation to total feed fed. For some of the North Central States, we can obtain this relationship from the two publications indicating the sales of feed grains by country elevators to farmers:

1. "Grain Transportation Statistics for the North Central States", by Kenneth R. Farrell, June 1958, Data for the calendar year, 1954. NAL #280.359 F24.
2. "Grain Transportation Statistics for the North Central Region", USDA Statistical Bulletin 268, August 1960, Data for the calendar year 1958. NAL #1Ag84St

These purchases from country elevators as a percentage of total feed grains fed are:

<u>State</u>	<u>Percent purchased from elevator</u>	
	<u>1954</u>	<u>1958</u>
Minnesota	9	
Ohio	6	
Indiana	4	
Illinois	9	
Iowa	11	13
Missouri	13	
North Dakota	4	11
South Dakota	11	19
Nebraska	24	19
Kansas	29	32

Based on the foregoing logic, (following worksheets θ_1) the residual "feed grains fed on farms where grown" was estimated for 1958 as follows:

1. The crop report questionnaire asked farmers to report only on the previous year's crop. Thus, the change in inventory from one year to the next is not accounted for. If data were available it would be desired to adjust for change in inventory of non-government stocks on farms. Since data for 1958 were not available to make a separation, an assumption was made that one-half the change in inventory was "free" stocks.
2. An adjustment was made for feed grains used for seed on farms where grown.
3. Concerning CCC activities, since the crop report was made on March 1st, logic indicates that the corn and sorghum crops should be treated differently from oats and barley. At the time the crop report survey is taken, the previous year's oats and barley crops have been mostly disposed of except for CCC resale. Much of the sorghum crop is either sold or under CCC loan. Much of the corn crop is still uncommitted and can either be sold, fed, or put under CCC loan. To obtain a reasonable residual for "feed grains fed on farms where grown" trial and error indicated that CCC activities should be handled as follows:

For corn and sorghums: Deduct the farm stored portion under loan or purchase agreement.

For oats and barley: Deduct only that resealed under CCC loan.

Referring to sheets Θ_i , by subtracting p from u , we obtain the quantity of feed grains purchased from neighbors. Comparing states, the residual p for 1958 appears plausible for the states of Iowa and Nebraska and low for the Dakotas and Kansas. The causes of this divergence is believed to lie in:

1. the questionable change in inventory figures,
2. differences in time periods being compared:
 - a. 1 October 1957 to 1 October 1958 feed year
 - b. 1) 1957 corn and sorghum crops
2) 1958 oats and barley crops
 - c. change in inventory:
 - 1) for corn and sorghums - 1 October 57 - 1 October 58
 - 2) for oats and barley - 1 July 58 - 1 July 59
 - d. purchases of grain from country elevators, 1 January 58 - 31 December 58.

Except for change in inventory, the same adjustments were applied to the 1964 figures for all states. Data for CCC stocks on farms were available for 1964 allowing an accurate estimate of change in inventory of free stocks.

Although some of the state estimates were obviously inaccurate, the regional averages fell in the range which would be expected.

Feed Grains: Price charged for local handling

Costs of storing and handling grains by local elevators was reported in ERS-288, "Costs of Storing and Handling Grain in Commercial Elevators, 1964-65", by Allen Schienbein. These figures do not allow for profit, however, they include more storage than is required for inventory. Thus the two factors were believed to counterbalance. Although the study is partially regionalized, the charges vary little from 10¢ per bushel and a decision was made to use this figure for all regions. Conferences with Schienbein and with Frances Yeager (Farmers Cooperative Service) indicated that this figure is applicable to both 1947-49 and 1957-59. The following counterbalancing effects are believed to have been operating: labor costs have increased, mechanical efficiency has increased, competition has increased, with a net effect of no change in the charge to farmers.

By-Product Feeds

Before proceeding further some definitions are in order:

- Supplement:** Materials used to supplement grains to improve the balance of the ration.
- Processor:** Buys oilseeds, fish, copra, etc., through the wholesale market, processes these into the various by-products such as millfeeds, tankage, etc. These by-products are sold to either the formulator or through a jobber for eventual retailing to the farmer for feeding as such.
- Formulator:** Buys various ingredients on the wholesale market and mixes them into a livestock feed. These can be further divided into:
- Formulated supplements:** These feeds may contain grains but are intended to be fed as supplements to grains rather than as complete feeds. Most state laws require the formulator to tag these feeds indicating the analysis.
- Complete feeds:** A mixture of grains and supplements which forms a complete balanced ration.

Reasonably good data on the quantity of supplements fed were available on a national basis. The remainder of the data required varying degrees of "manufacturing" before they could be utilized.

The available data indicated that the feeds should be divided for analysis as indicated in Figure 22. Fragmentary data on the value added by formulators was available from the Census of Manufacturers. However, these data required considerable processing before they could be used. Oakley Ray's³¹ discussion of double counting in the census figures appears on the following page.

The 1961 relationship between tons produced and tons of ingredients used was utilized to make regional adjustments for this double counting. Referring to Figure 22, the Census of Manufacturing supplies the value

³¹Oakley M. Ray, Director of Market Research, American Feed Manufacturers Association.

WHAT ABOUT THE CENSUS REPORT ON FEED TONNAGE?

OAKLEY M. RAY
Director of Market Research

The Census Bureau recently published the results of a survey of 1961 formula feed production. The table indicates the statistics by states. Total production reported was about 50 million tons.

All of the larger feed manufacturers were included in the survey. A sample of the dealer-mixers and smaller manufacturers was contacted. Estimates for the smaller operations were developed from the sample.

The Census Bureau statistics cannot be directly compared with AFMA estimates of formula feed production, because the Census estimates include the tonnage of dealers who mix supplements and concentrates into complete feeds. AFMA statistics include only the output of those who manufacture feed from basic ingredients or with the help of a highly concentrated premix.

Limitations of Data

The tonnages listed in the table include an undetermined amount of double counting because the supplement and concentrate tonnage of the feed manufacturer is included, as well as estimates of the complete feed tonnage of the dealer-mixer. This double counting would likely be greatest in the Corn Belt where an estimated 60 to 65% of the tonnage sold by feed manufacturers is high protein concentrates and supplements.

The Census Bureau survey did not include the tonnage of concentrates and supplements produced by small manufacturers. This has been added to the questionnaire for 1962 feed production.

The data listed in the table include 0.5 million tons of custom milling reported by large manufacturers and 8.4 million tons produced by the smaller operators. The report indicated that the coverage of mobile mills is believed to be low.

The questionnaires returned indicated the production of 2.9 million tons of complete feeds "for own feeding operations" in addition to the tonnage listed in the table. The 2.9 million tons was not included because it appeared that many of the mills producing feed for their own

animals were not contacted on this survey.

The discussion above indicates some of the limitations of the data. This is the first feed census which has attempted to include feed produced by small companies where feed is only a sideline such as elevators, hatcheries, machinery dealers, etc.

Industry Census Will Be Improved

The Census Bureau recognizes the weaknesses in this survey and expects to eliminate some of them in future years. The questionnaire for the 1962 survey has been substantially revised. The size, diversity, and the rapid changes which are occurring in the formula feed industry make it impossible to have a completely accurate census at a reasonable cost.

A number of feed manufacturers complained to AFMA about the time required to complete the 1961 questionnaire. A substantial portion of the total time was needed to answer the questions concerning quantities of the various feed ingredients which were used. AFMA discussed the problem with Census Bureau representatives. They agreed that it is not necessary to collect ingredient data each year. The questionnaires for 1962 production have been mailed by the Census

Bureau, and ingredient questions have been omitted.

Complete Report Available

The Census Bureau report also includes the following estimates for 1961 feed production:

1. Tonnage of complete feeds produced in each state by all manufacturers and dealer-mixers.
2. Tonnage of total formula feeds produced in each state by large manufacturers.
3. Tonnage of complete poultry feeds by type produced by large manufacturers, by state.
4. Tonnage of complete livestock feeds by type produced by large manufacturers, by state.
5. Tonnage of poultry supplements and concentrates by type produced by large manufacturers, by state.
6. Tonnage of livestock supplements and concentrates by type produced by large manufacturers, by state.

If you wish one or more copies of the complete eight page report, send 10 cents per copy to the Bureau of the Census, Washington 25, D.C. Ask for Current Industrial Reports, Series: M20E(61)-1, entitled *Poultry and Livestock Feed Production, 1961*.

Formula Feed Produced in 1961 by Large Manufacturers Plus Complete Feed Produced by Small Manufacturers and Dealer-Mixers, As Estimated by the Census Bureau

State	Thousand Tons	State	Thousand Tons
Texas	4,269	Kentucky	760
Iowa	3,513	Florida	726
Illinois	3,198	New Jersey	635
California	3,050	Delaware	579
New York	2,877	Maryland	441
Ohio	2,387	Oregon	441 ¹
Tennessee	2,261	Utah	437
Missouri	2,199	Colorado	349
Indiana	1,980	South Dakota	339
Minnesota	1,675	Louisiana	309
Georgia	1,644	Massachusetts	210
Pennsylvania	1,533	Idaho	158
North Carolina	1,426	Montana	152
Wisconsin	1,244	New Hampshire	135
Nebraska	1,108	North Dakota	118
Virginia	1,083	South Carolina	118 ¹
Mississippi	973	Maine	116 ¹
Alabama	966	Connecticut	85 ¹
Oklahoma	918	Arizona	80 ¹
Kansas	916	Wyoming	32
Washington	893	West Virginia	32 ¹
Arkansas	845	Nevada	5
Michigan	820	New Mexico	4 ¹
Vermont	767	Rhode Island	2 ¹
		U.S. TOTAL	49,819

¹This tonnage includes only production by large manufacturers. Production by small manufacturers and dealer-mixers was not published.

²This tonnage includes only production by small manufacturers and dealer-mixers. Production by large manufacturers was not published.

FEED MARKETING SEMINAR

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added for the proportion: $(c)(a + b)$ i.e., the feeds fed as formula feeds. The quantity figures for total supplements can be approximated from protein supplement requirements. These are not published but can be developed from unpublished data as outlined in procedure d which follows:

Procedure d: Supplement requirements

The Production Resources Branch takes Mr. Clough's³² national total supplement fed figure and breaks it down by classes of livestock. They also have unpublished figures on animal numbers by states. Thus the total supplements required can be obtained by multiplying the U. S. average supplement requirement by the number of animals fed and summing over all classes of livestock as illustrated below:

Let h = Year: 19(59), 60, . . . , 68.

i = class of livestock: 0110 for milk cows, 0201 for heifers, etc.

k = state: 1 for Maine, 2 for New Hampshire, etc.

A = number of livestock in class i in thousand head.

Ex. $A_{hik} = A(59)(0110)(2)$ = number of milk cows in New Hampshire in 1959.

Let B = Annual U. S. Protein supplement requirement in thousand tons.

Ex. $B_{hi} = B(59)(0110)$ = 1000 tons of protein supplement fed to all milk cows in the U. S. in 1959.

then:

11

$\sum_{i=1} B_{hi}$ = national total protein supplement fed to farm livestock, year h .

$\sum_k A_{hik}$ = national total number of livestock, class i , year h .

B_{hi} = national total protein supplement fed to class of livestock i , year h .

³²Malcolm Clough, Head, Feed Section, Economic and Statistical Analysis Division, Economic Research Service.

$$\frac{B_{hi}}{\sum_k A_{hik}} = \text{tons of protein supplement fed per head, class of livestock } i, \text{ year } h.$$

$$A_{hik} \cdot \frac{B_{hi}}{\sum_k A_{hik}} = \text{tons of protein supplement fed to class of livestock } i, \text{ state } k, \text{ year } h.$$

$$\sum_{i=1}^{11} \left(A_{hik} \cdot \frac{B_{hi}}{\sum_k A_{hik}} \right) = \text{tons of protein supplement fed to all farm livestock, state } k, \text{ year } h.$$

$$\sum_{k=1}^{11} \sum_{i=1}^{11} \left(A_{hik} \cdot \frac{B_{hi}}{\sum_k A_{hik}} \right) = \text{tons of protein supplement fed to all farm livestock, Northeast region, year } h.$$

This method would be too time consuming if it were necessary to start from scratch. However, the Production Resources Branch had the animal numbers on data cards for the period 1 October 1959-60 through 1 October 1967-68.

Subdivision of the Livestock Feed Input

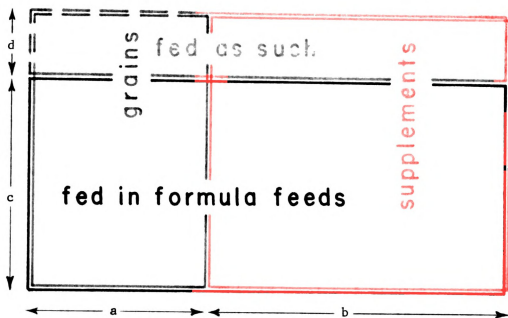


Figure 22

Method of Compilation

An outline of the general approach used follows:

I. Estimation of U. S. Totals:

- A. Total supplements fed: Mr. Clough made calendar year estimates for the Farm Income Branch for the period 1949 to date. For the period 1939-48 it was necessary to use feed year estimates from Statistical Bulletin 159, Revised June 1962.
- B. Supplements formulated: Mr. Clough also made calendar year estimates for supplements formulated for the Farm Income Branch for the period 1949-date. For the period 1939-48, the ratio: supplements fed in formula feeds as a proportion of total formula feeds fed, was interpolated through the benchmark years, 1939, 1947, and 1949.
- C. Formula feeds formulated: For the period 1949-date, Mr. Clough made estimates of grains formulated which added to B above sums to total feeds formulated. For the period 1939-1948, see procedure c on page 157 following.
- D. Supplements fed as such: This is equal to A minus B. Since the marketing margin on supplements fed as such is computed separately for each ingredient, it was necessary to have the tonnage of each ingredient fed as such. Mr. Clough estimated these figures for the Farm Income Branch for the period 1949-date. For the period 1939-1948, the ingredient tonnages were computed by subtracting the quantity formulated from the total quantity fed. The quantity formulated was estimated by interpolating the composite formula feed formula through the benchmark years: 1939, 1947, 1949.

II. Regional Distribution:

- F. Feed grains purchased: The general approach is discussed previously, pages 139 to 149. The tonnages of feed grains were multiplied by the proportion going through commercial channels to obtain the tons of feed grains fed going through commercial channels.
- G. Formula feeds fed:
 - a. For the period 1939-1958:

Regional percentage distributions were interpolated through the benchmark years, 1939, 1941, 1942, 1950, 1958, 1959.

- b. 1) For the period 1959-1968 the percentage difference between the regional distribution of the quantity produced and the quantity fed was interpolated. These adjusters were applied to the distribution of production for the intervening years to obtain the regional percentage distribution of the quantity fed.
- 2) The percentages derived from 1) above were applied to the U. S. formula feed fed figures to obtain the regional tonnages of formula feeds fed.

H. Grains fed in formula feeds:

Percentage distributions were interpolated through the benchmark years, 1939, 1950, 1968. These distributions were applied to the U. S. quantity of grains formulated to obtain regional tonnages of grains fed in formula feeds.

I. Total supplements fed:

- a. For the period 1960-68:
 - 1) A regional percentage distribution was made from the computer print out of supplements required. (See procedure d on page 152 for a discussion of the computer procedure.)
 - 2) The percentage distributions derived in 1) above were applied to the U. S. tonnages of supplements fed to obtain regional tonnages.
- b. For the period 1939-1959:
 - 1) A calculation was made of the regional percentage difference between the regional percentage distributions of:
 - (a) supplements fed
 - (b) grain consuming animal units fed for the benchmark years: 1942, 1944, 1950, 1960.

Interpolations were made through these

benchmark years to obtain the regional percentage difference for the intervening years.

- 2) These regional percentage differences were applied to the regional percentage distribution of grain consuming animal units to obtain the regional percentage distribution of supplements fed.
- 3) These regional percentage differences from 2) above were applied to the U. S. tonnages of supplements fed to obtain the regional tonnages of supplements fed.

J. The tonnage of supplements fed as such was calculated by subtracting H from I above.

Procedure c: Procedure for determining the quantity of feeds formulated, 1939-48.

A conference with Mr. Clough indicated that unpublished data were not available. Various sources of data and the estimates are listed on sheet **8** on the page following. The estimates underlined were considered to be the most reliable and were used as benchmarks. An abortive attempt was made to move the intervening years with trade estimates from the publication "The 3.5 Billion Formula Feed Industry", NAL # 389.7F325. This publication indicates an increase in formula feed production from 20 million tons in 1942 to 29 million tons in 1943 and a reduction in production from 30 million tons in 1945 to 25.5 million tons in 1946. These industry statistics are believed to include inter-plant transfers and, at least in the early years, some by-products fed as such. However, there are no supporting data and little theory to justify this drastic increase and subsequent fall in production. There are no data supporting a similar movement in total supplements fed. Thus, for formula feeds to rise and subsequently fall, there must have been a rise and fall in the proportion of supplements fed in formula feeds or else a rise and fall in the quantity of grains fed in formula feeds, or both.

Attempts at distributing the residual, "Supplements fed as such" resulted in negative figures for one or more regions during this period. Thus a decision was made to reject the industry data for this period,

and formula feed production was moved with total supplements fed.

To obtain the ingredients formulated, for 1939, the 1939 quantity formulated was distributed with the 1940 average formulas from Cir. 836. This resulted in negative quantities fed as such for some ingredients. This is believed to be caused by changes in composition. Thus, the negative quantities were "borrowed" from other ingredients to leave zero or positive quantities fed as such.

By-Product Processing Margins

Using soybeans as an example, suppose a farmer sells soybeans to a processing plant and purchases soybean meal from his local feed dealer. There is non-farm value added not only by the feed dealer but also by the processor. To estimate the value added by processing the wholesale value of the meal as a proportion of the value of both oil and meal was applied to the price received by the farmer for soybeans to approximate the farm value of meal. The difference between the farm value and the wholesale value represents the value added by the processor.

This processing cost is incurred regardless of whether the feed is mixed and sold as a formula feed or sold as an ingredient to be fed as such. Thus the processing cost was applied to the total quantity of ingredients fed and the formulating and marketing costs were picked up at the wholesale pricing point.

Feed Marketing Margins

Supplements Fed as Such

It was possible to estimate accurately the marketing margin on supplements fed as such by ingredient on a national basis since both the wholesale price and the price paid by farmers were available. However, there were no data available to distribute the individual ingredients to regions. Thus, the national total ingredient tonnage was multiplied by the ingredient marketing margin to obtain a national total marketing cost for all ingredients fed as such. This national total expenditure was then distributed to regions with the tonnages of supplements fed as such in each region.

Formula Feeds

Although prices paid by farmers for some formula feeds were available,

Formula Feeds: U.S. production (or consumption) 1939-1949 1000 tons

Sheet 8

Source	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
The 3.5 Billion \$ Formula Feed Industry	(17,000)	18,000	19,000	20,000	29,000	29,500	30,000	25,500	26,000	25,500	28,500
Fg. 10, June 1949 Feed Situation	<u>10,749</u>								22,298*		
Form E (Farm Income Branch)											<u>25,900</u>
The Prod. & Distribution of Specified Feed Ingredients and of Commercial Mixed Feeds, 1949-43. (R. D. Jennings)			15,000	20,000	29,000						
1947 Census of Manufacturers	12,363†								20,150‡		
Fg. 8, USDA Cir. 836	13,000			20,000	29,000				22,300		

* Total shipments plus interplant transfers.

† This figure may include some dog food and by products fed as such

‡ 18,941 divided by 91% enumeration = 20,150 thousand tons of materials consumed

|| A preliminary Census report.

The underlined figures are believed to be the more accurate.

there were no data for effecting a breakdown of the tonnages to match the price categories. Neither are wholesale prices quoted for formula feeds. However, they can be estimated with procedure e (on the page following).

There are little published regional data on retailing margins for livestock feeds. 1939 estimates for farmer's supply stores are published in Standard Ratios for Retailing, by Dun and Bradstreet, Inc. NAL # 386.2 M69. Brensike and Vosloh³³ analyzed the Illinois price spreads for poultry feeds for the period 1953-58. Askew and Brensike³⁴ discussed the 1947 value added by manufacturers. However, their conclusions are suspect because they did not adjust for double counting in the production tonnages.

Rickey³⁵ made an accounting report based on a survey of several co-operative feed mills. Phillips³⁶ made a similar study of the 1955 costs of operation of selected Iowa feed manufacturing companies. The latter two studies excluded profits.

A conference with Carl Voslow indicated that this retailing margin is somewhere in the neighborhood of \$10 to 14 dollars in the Delmarvia area. The formula feed retailing margin should be less than the marketing margin on supplements fed as such since this figure includes transportation from the wholesale pricing point to the point of purchase by farmers. Application of the Dun and Bradstreet ratios resulted in margins approaching the fed as such margins. However, livestock feeds are more competitive and move faster than most farm supply items, thus, the Dun and Bradstreet regional ratios were cut by one-half to bring them in line with the levels indicated by the studies by Brensike, Vosloh, Askew, Rickey, and Phillips (see footnotes 33 thru 36).

³³ V. John Brensike and Carl J. Vosloh, Jr., "Price Spreads for Formulated Poultry Feeds in Illinois," USDA Marketing Research Report No. 378, December, 1960.

³⁴ William R. Askew and V. John Brensike, "The Mixed-Feeds Industry," USDA, Marketing Research Report No. 38, May, 1959. NAL # 1 Ag84Mr.

³⁵ Lacey F. Rickey, "Operating Costs of Selected Cooperative Feed Mills and Distributors," USDA Farm Credit Administration Bulletin No. 56, November, 1949, NAL # 166.2 B87.

³⁶ Richard Phillips, "Costs of Procuring, Manufacturing, and Distributing Mixed Feeds in the Midwest," USDA Marketing Research Report No. 388, April, 1960, NAL # 1Ag 84Mr.

A charge for bags, tags and twine was also added since the value added by manufacturing does not include the cost of these materials added.

Procedure e: The wholesale price of formula feeds

For 1961, the Census of Manufacturers current industrial reports indicate the tonnages of production of formula feeds and the tonnages of ingredients used by states. These data provide a means for removing the double counting in the production tonnages:

$$\frac{\text{ingredients}_{1961}}{\text{production}_{1961}} \cdot \text{production}_{1958} = \text{ingredients}_{1958}$$

This procedure, of course, assumes a constant degree of double counting.

To find the wholesale price, adjust the value of products shipped for double counting and divide this by the tons of ingredients used in the manufacture of formula feeds.

HIRED TRUCKING, FREIGHT AND EXPRESS

The Farm Income Branch had a series of expenditures for hauling milk but did not have series on hauling other items. It was assumed that the 1955 relationship between hired transportation and the value of farm output was a constant that could be applied to all years.

This constant was derived in the following manner:

The value of farm output (obtained from Don Durost, FPED, ERS) for 1955 (in 1957-59 dollars) was divided between livestock and crops and deflated back to 1955 current dollars:

	<u>Billion Dollars</u>
a. Productive livestock	8,562.0
Index of livestock and livestock product values (May 1962 Ag prices)	<u>.90</u>
	7,705.8
b. Crops	17,966.2
	<u>1,664.1</u>
	19,630.3
Less feed for horses and mules	<u>228.4</u>
	19,401.9
Index of crop values (May 62 Ag prices)	<u>1.04</u>
	20,177.976

Thus the 1955 current dollar value of farm output is:

<u>Billion Dollars</u>
7,705.8
<u>20,177.976</u>
= 27,883,776,000

From the 1955 survey of farmer expenditures the cost of transporting items other than milk was derived as follows:

Hired trucking	375,136,000
Trucking costs not included elsewhere	<u>33,551,000</u>
	408,687,000
Less income from trucking and hauling	<u>65,485,000</u>
	343,202,000
Plus other transportation	<u>36,199,000</u>
	379,401,000
Less milk hauling (by truck)	<u>185,153,000</u>
	194,248,000

Thus if we exclude milk hauling, transportation as a proportion of the value of farm output was in 1955:

$$\frac{194,248,000}{27,883,776,000} = 0.006,966,3$$

This proportion was applied to the constant dollar value of farm output for all years to estimate transportation excluding milk hauling by regions.

BABY CHICKENS PURCHASED

The number of baby chickens purchased was obtained from the Farm Income Branch by the two categories: Broiler type and Layer type. The average weight period price paid was obtained by dividing expenditures by the quantity purchased.

Confidential data on the price received for hatching eggs were obtained from the Ag Price Statistics & Farm Labor Branch of SRS. Since these data were not complete for all states, it was believed to be more accurate to tabulate the difference in price or the premium paid for hatching eggs over table eggs. The states, for which weight period figures were available, were weighted to regional averages with the

volume of chicks hatched in commercial hatcheries. This premium was then added to Durost's weight period average price of table eggs to obtain the hatching egg price. A hatchability adjustment was made and the difference between the price paid for the chick and the value of the hatching eggs required to produce one chick gave the value added by hatcheries.

The hatchability figures were obtained from the Poultry and Egg Section, ERS. These figures were:

1947	68.4%
1948	68.7
1949	<u>69.0</u>
	3/ <u>206.1</u>
	68.7
1957	71.4
1958	71.7
1959	<u>72.0</u>
	3/ <u>215.1</u>
	71.17

Since k is constant for all years at 1.818

$$m = i - ij(1.818) \\ = i(1 - 1.818j)$$

For the early period, j was weighted with the 1957 split between light and heavy:

$$j = \frac{(12313)(73,350) + (.10335)(13,301)}{86,657} = \frac{18341}{86,651} = .21167$$

BABY TURKEYS PURCHASED

The Farm Income Branch had quantity figures separated into light and heavy breeds since 1955. Thus a decision was made to split the account at that year.

Weight Period Prices were obtained by dividing expenditures by the number purchased.

The only data available on the hatchability and price of turkey hatching eggs was from the Income Section of the Farm Income Branch. They estimate, for both weight periods, that 1.818 eggs were required to hatch one turkey poult.

Prices of hatching eggs were available only for the late period. Since these prices were estimated as a proportion of the price of a

turkey poult, they provide a means of estimating the early period prices.

MILK HAULING

Current dollar expenditures were obtained from the Farm Income Branch and deflated with the average of the two indices:

Farm Wage Rates (SRS)

Truck Repairs, Parts and Tires

The latter index is a composite made up of:

0.91 times the BLS index of prices paid for Auto repair and maintenance plus 0.09 times the BLS Truck and Bus tire price index.

LIVESTOCK MARKETING

The Farm Income Branch keeps an account on livestock marketing expenses which they obtain by:

- a. For livestock going through commission markets: They multiply the average cost per head for commission and yardage (which they obtain from Ken Potter, Packers and Stockyards Division) by the number of animals marketed.
- b. For livestock going through auction markets: They multiply the value marketed by the average cost of marketing per dollar value of livestock sold through auction markets. This rate is also obtained from Mr. Potter, Packers and Stockyards Division.

These current dollar expenditures were deflated with the SRS index: Production, Interest, Taxes & Wage Rates.

REAL ESTATE TAXES

Tax figures were obtained from the following data sources:

1939	Statistical Bulletin 189
1940 RET-9	Farm Real Estate Taxes (an ERS publication)
1941-44	Statistical Bulletin 189
1945	RET-9
1946-49	Statistical Bulletin 189
1950-67	Statistical Bulletin 441
1968	RET-9

PESTICIDES

Dr. Shepard, ASCS, was consulted regarding the construction of a price index. For the period 1939-55 he recommended that lead arsenate, nicotine sulphate and cube be used as a basis. Prices for the early period came from Agricultural Statistics. Wholesale prices were used since farm prices were not available. Weight period quantities were estimated by Dr. Shepard for nicotine sulphate. Quantities for the other two materials were computed by subtracting exports from production. Weight period quantities for lead arsenate were in Agricultural Statistics. Quantities for cube Dr. Shepard took from a book which he authored.

For the period 1955 to date, copper sulphate, 2,4-D and DDT were used as a basis. Wholesale prices came from a workbook Dr. Shepard furnished in which he had summarized into annual averages (from 1949) the weekly wholesale price quotations from the "Oil, Paint and Drug Reporter" (NAL #306.8 015). Weight period quantities came from the pesticide situation.

IRRIGATION OPERATION AND MAINTENANCE COST

The following indices were used as deflators:

- a. For the period 1939-48: The Engineering News Record index of construction costs: Page 144 in the March 23, 1950, issue; NAL #290.8 En 34.
- b. For the period 1949-63: Figure 2 in the unnumbered publication "Irrigation Operation and Maintenance Cost Trends" U. S. Department of Interior, Bureau of Reclamation, 1964.
- c. For the years 1964 to 1970, the same index as b, figures obtained from the Economic and Statistical Branch, Division of Irrigation and Land Use, Bureau of Reclamation.

CROP INSURANCE

The bulk of this insurance is against hail damage. Current dollar expenditures net of loss adjustments were obtained from the Farm Income Branch. Discussions with Edward Reinsel, Agricultural Finance Branch, and Don Durost led to the conclusion that the index of crop values was

the best deflator for this expenditure, reasoning that a farmer insures the potential value of the crop.

CONTAINERS

Current dollar expenditures for containers was obtained from the Farm Income Branch. These were deflated with an index of prices of selected items obtained from Agricultural Prices. For the period 1955 to date, the items included were: stave baskets, burlap bags, open mesh bags, fruit box shook, lug box shook, vegetable crate shook, and hampers.

BINDING MATERIALS

An index constructed from the cost of baler twine as published in Agricultural Prices was used as a deflator for binding materials.

VETERINARY AND TELEPHONE

Estimates in current dollars for these expenditures were obtained from the Farm Income Branch. The telephone estimates were prorated to represent a production share.

Veterinary expenditures were deflated with the SRS index of prices paid for farm supplies. For deflating telephone expenditures, an index was constructed from the price paid for local service as published in Agricultural Prices.

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