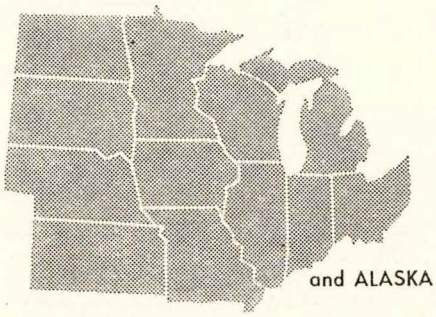
NORTH CENTRAL REGIONAL RESEARCH PUBLICATION NO. 182
MARCH 1968

Efficient Organization of the Farm Industry In the North Central Region Of the United States in 1959 and 1980

Agricultural Experiment Stations of Alaska, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin, and the U. S. Department of Agriculture cooperating.

AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION, IOWA STATE UNIVERSITY of Science and Technology, Ames, Iowa RESEARCH BULLETIN 560



Project NC-53,
Needed Adjustments in Land Tenure to Meet Changing Agricultural Conditions

Sponsored by the agricultural experiment stations of Alaska, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin, and the Cooperative State Research Service, U. S. Department of Agriculture; Agricultural Law Center, University of Iowa, and the Farm Foundation, cooperating.

Persons serving on the NC-53 Technical Committee, and their state experiment station or other affiliation, when this publication was prepared are:

Illinois:
Franklin J. Reiss
Indiana:
J. H. Atkinson
Richard Weigle
Iowa:
John F. Timmons
Donald R. Kaldor
Kansas:
Wilfred H. Pine
Kentucky:
John H. Bondurant
Minnesota:
Philip M. Raup
Missouri:
Frank Miller
Nebraska:
Lloyd Fischer
Maurice Baker
Donald Kanel
North Dakota:
Jerome Johnson
Ohio:
R. H. Baker
Robert M. Reeser
South Dakota:
Russell Berry
Arthur J. Matson
Wisconsin:
Peter Dorner
Roger Johnson
William E. Saupe

Farm Foundation:
Joseph Ackerman
James Hildreth

Agricultural Law Center
University of Iowa:
Marshall Harris

Cooperative State Research Service
U. S. Department of Agriculture:
Lloyd Halvorson and A. T. M. Lee

Director Robert J. Muckenhirn, Wisconsin, administrative advisor to NC-53

CONTENTS

SUMMARY

The Problem

The problem in this study was to estimate for 1959 and project for 1980 the resource and production characteristics of the farm industry in the North Central Region of the United States under the condition that specified requirements for economic efficiency would be satisfied. Efficient organization of the farm industry must satisfy three conditions:

a. farm output be produced at minimum factor cost,

b. aggregate farm output clear the market at prices covering the opportunity cost of the factors and

c. the product mix be geared to the relative demands for different products.

Meeting these requirements would mean that individual farm operator's income would be maximized and that the farm industry would make its maximum contribution to national income. It was specifically hypothesized that the farming industry contained an imbalance in resource cost and an imbalance in the level of farm production.

The study was a contributing project to the North Central Regional Project NC-53, "Needed Adjustments in Land Tenure to Meet Changing Agricultural Conditions." The resource and production characteristics of the efficiently organized farm industry were estimated and projected to serve as bench marks for determining needed changes in agricultural institutions

and the farming industry. The solutions specify the organizational arrangements under which the "farm problem," as it currently exists, could essentially be solved. Thus, they may be useful to legislators, organizations representing farmers' interests and formulators of agricultural policy and farm legislation.

Assumptions and Variables

Three major assumptions underlie the estimates and projections:

a. all resource owners were strict income maximizers,
b. each farm firm bought and sold in markets so large that his activities had no effect on prices and
c. the quantities of capital and labor used by the farm industry were drawn from a market so large that the farm industry demand had no effect on prices (the supplies of labor and capital were perfectly elastic to the farm industry).

The opportunity cost rates (prices) for capital and labor, the quantity of farm land available to the farm industry and the demand function for farm products were empirically estimated, but once obtained, were exogenous in the solution of the problem.

The quantity of land, labor, capital and production per farm; the value of land per acre; the level of farm product prices; and the number of farms were endogenous variables determined under the conditions specified in the study.

Observed Characteristics of the Farm Industry in 1959

The first step was to identify the characteristics of the farm industry as it existed in 1959 in each of the 71 Census of Agriculture subregions in the North Central Region. These characteristics were used to identify the existence and magnitudes of resource imbalances and as bench marks in measuring changes in the farm industry as the imbalances were adjusted.

The characteristics were developed mainly from 1959 Census of Agriculture data, supplemented by U. S. Department of Agriculture sources and farm-record-keeping association summaries. The input totals for labor, capital and land and the total production were estimated for each subregion. The number of farms in each subregion was known, and per-farm characteristics were calculated as mean values from the subregion totals. Also, gross production per farm, factor earnings and factor opportunity costs per farm were estimated.

Minimum-Cost Reorganization of Farms in 1959

The second major step was to identify and select well-organized farms in each subregion for 1959 and to reorganize the land base in the subregion into farms with the mean characteristics of the well-organized units. Farms were considered well organized if they were identified from data in individual farm records kept by farmers participating in the farm-record-keeping organizations in each state and had high factor earnings relative to factor opportunity costs. Each farmer in this selected group had organized his farm business so that he was approximating the conditions for efficient firm organization under existing market and technological conditions.

The mean resource and production characteristics of the selected group of farms were determined, and the total land in the subregion was divided into farms, each with the characteristics of the well-organized farms. Subregion totals were then calculated for the resource and production characteristics.

The selected well-organized farms had a substantially larger land base than the average commercial farms in 1959; the value of land and buildings per farm was 64 percent greater after the reorganization. With a fixed land base, this reduced farm numbers by 39 percent.

For the aggregated North Central Region, labor input was reduced by 21 percent, but capital input was increased by 32 percent. Gross production increased by 103 percent. The total cost of factors declined from $11.04 billion to $10.94 billion, while gross production increased from $10 billion to $20.39 billion. This suggested that an imbalance in resource cost existed in 1959 (the region's output was not being produced at minimum-factor cost).

Reorganization of the Industry to the Market-Clearing Level of Production in 1959

In the minimum-cost reorganization, all farms were organized at the minimum-cost level of output, but total farm production was not equated with demand at the observed price level. Total production was double the observed output level in 1959, which had exceeded the quantity that would have cleared markets at observed prices.

The purpose of the second (market-clearing) reorganization was to equate each subregion's total production with its share of market-clearing demand in 1959 within the framework of well-organized farms. The second reorganization involved changing the resource structure of farming by decreasing the input of capital and labor per land unit until aggregate total production dropped to the desired market-clearing levels.

The residual earnings of land after labor and capital had been awarded their opportunity costs were capitalized into a land value per acre. The equilibrium product price level was arrived at by equating these residual earnings of land with the marginal value product of land. This phenomenon occurred at the equilibrium market-clearing price level.

The extensification of farming to reduce gross production per land unit took place within the group of farms previously identified as being well organized. Thus, the structure of farms after the second reorganization still approximated the minimum-cost criterion, as well as the industry meeting the market-clearing conditions, at prices covering the opportunity costs of factors.

After the minimum-cost and market-clearing reorganizations for 1959, the number of farms in the North Central Region was about one-fourth the number in the observed 1959 situation. Acres per farm increased from 314 to 1,200; labor per farm increased from about 16 to 21 months, and capital increased from about $18,000 to about $40,000 per farm. Output per farm increased from $8,600 to about $30,000.

For the entire North Central Region, the land base was unchanged, labor input declined by about two-thirds and capital input by 44 percent. Total production declined by 9 percent to bring aggregate production into line with the estimated share of demand for the region (market-clearing quantity).

Minimum-Cost and Market-Clearing Reorganization in 1980

The basic procedure used to develop the minimum-cost and market-clearing projections for 1980 was the same as for the 1959 estimates. However, several data and exogenous variables, given or readily ascertained in the 1959 model, had to be projected for the 1980 model. The factors of production measured by USDA, particularly of capital and labor, had evidently become more productive per unit of input in the years preceding this study, and we assumed that their productivity would continue to increase during the 1959-1980 period. Four rates of increase in factor productivity were selected, and a set of solutions for 1980 was calculated for each.

The resource mix used in farming had also undergone change in the years preceding this study. The direction and magnitude of changes were determined, and estimates made as to the probable farm resource mix in 1980. The directions and magnitudes of changes in the opportunity cost rates for capital and labor in the past were determined, and estimates made for their values in 1980.

The projected-1980 demand for farm production was based on the 1959 market-clearing quantities by using estimated changes in population, income per capita and export demand as the demand shifters.

The acres of farm land that would be converted to nonfarm use during 1959-1980 were estimated under the assumption that the nonfarm demand for land was price inelastic and that, when filled, the supply of land to the farming industry was fixed.

Once estimated, these variables were considered exogenous to the problem, and the values of the endogenous variables were calculated as in the 1959 second reorganization. The residual to land was capitalized into a value per acre and equated with the marginal value product of land. This determined the equilibrium solution to the problem for 1980 as in 1959.

The major adjustments made in moving from the observed 1959 situation to the minimum-cost and market-clearing situation in 1980 were made in correcting the imbalances in resource cost and level of farm production that existed in 1959. The characteristics of the farm industry in equilibrium in 1959 were very similar to the industry in equilibrium in 1980, except that the per-farm labor input was much lower in 1980.

The number of commercial farms exceeded 1.1 million in the observed 1959 situation and was about 0.35 million in the 1980 projections, an annual absolute decline in farms equal to the observed annual decline during the 1949-59 period.

The necessary decline in input of all farm labor to meet the 1980 efficiency conditions would require a constant annual percentage decrease equal to that observed in the 1939-59 period. Capital input would have to decline from $21.6 billion in the observed 1959 situation to about 12.8 billion to meet the projected efficiency conditions in 1980.

Efficient Organization of the Farm Industry In the North Central Region Of the United States in 1959 and 1980[1]

by William E. Saupe and Donald R. Kaldor[2]

For the organization of the farm industry to be efficient in terms of income maximization would require that farm output be produced at minimum factor cost, that aggregate farm output clear the market at prices covering the factor opportunity costs and that the product mix be geared to the consumers' wants. Meeting these requirements would mean that the income of individual farm operators would be maximized and that the farm industry would make its maximum contribution to national income.

Implicit in conducting the research reported here was the hypothesis that existing resource and production characteristics of the farm industry were not approximations to the economic efficiency conditions. Specifically, we hypothesized that the farming industry contained two major types of resource imbalances.

First, we hypothesized that there was an imbalance in resource cost; that is, more resources than necessary were used by the farming industry to produce the observed level of farm output. Stated differently, the quantity of resources committed to the farming industry could have generated greater output. This resource imbalance prevents the farming industry from making its maximum contribution to national income. Without an imbalance in resource cost, the earning of comparable factors would be the same on all farms. A test of this hypothesis would be to compare factor earnings of selected well-organized farms with earnings of comparable factors on other farms, "well-organized" farms being those with the greatest positive (or least negative) excess of factor earnings over factor opportunity costs.

Second, we hypothesized that the amount of resources employed in farming generated greater farm production than would clear markets at prices at which the factors used on well-organized farms would earn their opportunity costs. Evidence supporting this hypothesis would be the existence of lower returns to factors of production on well-organized farms than in their nonfarm employment alternatives, at market-clearing prices. That is, the hypothesis would be supported if factor incomes did not equal factor opportunity costs on well-organized farms under market-clearing conditions. Since farm product prices have not been permitted to fall to their market-clearing levels in recent years, the comparison of factor income and factor opportunity costs on well-organized farms under the observed price relationships would not necessarily test the hypothesis.

The geographic scope of the study was the 13 states in the North Central Region and four Kentucky economic subregions (fig. 1). Analyses were made for each of the 71 Census of Agriculture subregions in the area and are reported here aggregated by states and by the entire region.

The primary objective of this study was to estimate for 1959 and to project for 1980 the resource and production characteristics of the farm industry of the North Central Region that would satisfy certain requirements for economic efficiency. Assembling evidence to support or reject the hypotheses regarding the imbalance in resource cost and the imbalance in production level were secondary objectives. Besides serving as bench marks for further research, the estimates and projections should be useful to farmer organizations, formulators of agricultural policy and farm legislation, farm credit institutions, rural institutions dependent on farm population and income, agricultural educators and professional agricultural economists.

This research was preceded by a pilot study conducted by Craft in one southern Iowa subregion.[3] The problem was the same in both studies, and the methods were similar. A model was developed that would systematically explain the structure and workings of farms and the farming industry, with sufficient specificity to provide quantitative values for the study's endogenous variables. The model had to be a simple enough version of reality so that systematic manipulation and analysis of the data could take place. The model had to be a sufficiently accurate approximation of the facts, however, for the solutions to be acceptable estimates.

Assumptions

The basic theoretical model was the conventional theory of a competitive industry made up of competitive firms, modified by particular assumptions. One critical simplifying assumption was the treatment of output. We assumed that the outputs from the farming

[1]Iowa Agriculture and Home Economics Experiment Station contributing project to Phase A, NC-53 "Needed Adjustments in Land Tenure to Meet Changing Agricultural Conditions."

[2]William Saupe is associate professor of agricultural economics, University of Wisconsin, and Donald R. Kaldor is professor of economics, Iowa State University.

[3]Craft, Rolf V. A projection of an efficient farm industry in southern Iowa, 1959, 1980. unpublished M.S. thesis. Iowa State University Library, Ames, Iowa. 1965.

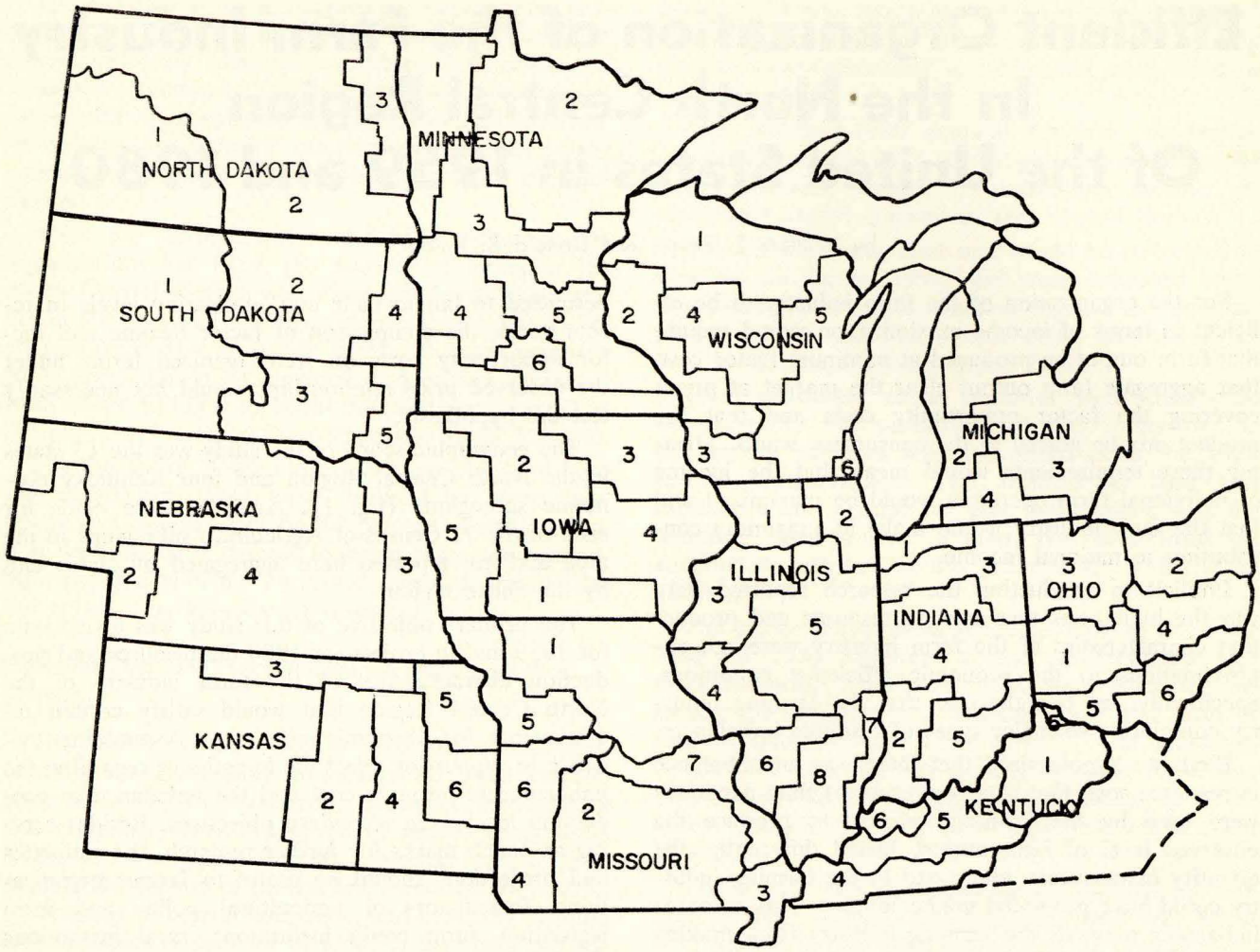


Fig. 1. Intrastate Census of Agriculture economic subregions, by states.

sector of the North Central Region could be treated as a single homogeneous product, aggregated on their 1959 relative prices. This eliminated the problems of determining the optimal product mix.

We assumed that the capital and labor used by the farming industry were drawn from markets so large that the farm industry demand had no effect on their prices. Thus, the opportunity cost of these inputs was determined outside the farming sector.

We also assumed that the 1959 land prices adequately reflected quality differences and that market value of land was a uniform measure of land input. The land supply to the commercial farming sector was considered perfectly inelastic once the requirements of noncommercial farms had been met and once the projected nonfarm uses for farmland during 1959 to 1980 had been accounted for.

Each farm firm was assumed to buy and sell on a market so large that its activities had no effect on prices. All farm operators were assumed to maximize income and to use the best production technology available.

Exogenous and Endogenous Variables in the Problem

The values of certain variables were considered known in solving the problem. These values were empirically estimated, but once obtained, were exogenous in the problem solution. They included:

a. the opportunity cost rates for capital, land and labor,

b. the quantity of farm land available to the farm industry,

c. the quantity of farm production demanded at the 1959 farm product price level, and

d. the price elasticity of demand for farm products in 1959 and 1980.

The opportunity cost prices for capital and labor were assumed to be determined outside the farm industry, and capital and labor were considered in perfectly elastic supply to the farm industry at those prices. Farm capital and labor are homogeneous with their nonfarm counterparts in the long run and make up relatively small portions of their total supply, supporting the reasonableness of this assumption.

It was assumed that nonfarm demands for farm land were price inelastic at the price level at which farm land was sold for farming purposes. That is, nonfarm demands for land would be filled from the supply of farm land; once filled, the residual supply was available exclusively for farming purposes in a fixed quantity.

The opportunity cost rate for farm land to the farm industry would be zero under these conditions. To the individual farm operator, however, the opportunity cost of investment in farm land was assumed given and was equal to the return he could earn on his capital in comparable investments. The value of land services, however, was determined within the farming sector.

It was assumed that the quantity of farm production demanded at the 1959 price level and the price elasticity of demand for production were known. It was assumed also that the input of manager-operator effort was distinguishable from other labor inputs, that the manager-operator input was available to the farm industry in a perfectly elastic supply at the nonfarm opportunity cost rate and that this input was limited to one full-time manager-operator per farm.

The value of each of the following endogenous variables was determined under specified conditions:

a. the quantity of land, labor and capital per farm,
b. the quantity of production per farm,
c. the value of land, and
d. the level of farm product prices.

Observed Characteristics of the Farm Industry in 1959

The estimates and projections of the resource and production characteristics of the farm industry in 1959 and 1980 were made in a series of steps. The first step was to identify the farm industry characteristics as they existed in each Census of Agriculture subregion in 1959. These characteristics were used to identify the existence and magnitudes of resource imbalances and as bench marks in measuring changes in farm industry characteristics as the imbalances were adjusted.

The characteristics were developed mainly from 1959 Census of Agriculture data supplemented by U. S. Department of Agriculture sources and farm-business association record summaries. The input totals for labor, capital and land and the total production were estimated for each subregion. The number of farms in each subregion was known, and per-farm characteristics were calculated as mean values from the subregion totals. Additionally, gross production per farm, factor earnings and factor opportunity costs per farm were calculated.

A later section is devoted to the sources of data, assumptions, judgments and examples for the observed situation in 1959. The characteristics are reported for the aggregated North Central Region.

Minimum-Cost Reorganization of Farms in 1959

The second step in developing the estimating procedure was to identify and select well-organized farms in each subregion for 1959 and to reorganize the land base in the subregion into farms with the mean characteristics of well-organized farms; farms were considered well organized if they had a relatively high ratio of factor earnings to factor opportunity costs.

Well-organized farms were identified from the individual farm-business records kept by farms participating in the farm-business associations in each state. The observed data in the individual farm-record summaries were adjusted to account for the effect of abnormal weather on crop production and the effect of variations from cyclical mean prices for hogs and cattle on resource earnings. Additional adjustments were made in factor opportunity cost rates to insure consistency in the differentials among subregions.

The mean resource and production characteristics of the selected group of well-organized farms were calculated, and the mean value of land per farm was used to divide the total land in the subregion into farms, each of which assumed the characteristics of well-organized farms. Subregion totals were then calculated for the resource and production characteristics.

Second Reorganization to the Market-Clearing Level of Production in 1959

The first reorganization of the farm industry generated a situation in which all farms were organized at the minimum-cost level of output. Total farm industry production was not necessarily equated with demand at the observed price level, however. The purpose of the market-clearing reorganization was to equate each subregion's total production with its share of market-clearing demand in 1959 within the framework of well-organized farms.

Each subregion's share of the market-clearing level of demand in 1959 was estimated, based on a regression against time of each subregion's share of total United States farm production for each of the five preceding census enumeration years. Evaluated for 1959, the regression provided an estimate of each subregion's share of total United States farm production at the 1959 farm-product price level.

The second reorganization involved changing the resource structure of farming by decreasing the input of capital and labor per unit of land until total production dropped to the desired market-clearing levels. The device for carrying out this extensification was a regression equation developed from the group of farms previously selected as the well-organized farms. The regression used the input of capital and labor per unit of land as the independent variables regressed against gross production per unit of land as the dependent variable. Given the subregion's share of the total demand schedule for farm production and the quantity

of land in the subregion, the required production per land unit for the relevant range in product price levels was determined. The reduction of capital and labor input per land unit was carried out by using the regression equation and an iterative procedure until the desired production per land unit was reached. This was the level at which total production for the subregion would just equal the subregion's share of total demand for farm production at the product price level at which the residual to land (when labor and capital earned their opportunity costs) equaled the marginal value product of land.

The extensification of farming to reduce gross production per land unit took place within the group of farms previously identified as well organized. The structure of farms after the second reorganization met the minimum-cost criterion as well as the industry meeting the market-clearing criterion.

Minimum-Cost and Market-Clearing Reorganization in 1980

The iterative procedure by which the minimum-cost and market-clearing levels of production for 1959 were estimated was basically used to arrive at the 1980 projections. However, the values of several of the exogenous variables, which were given or readily ascertained in the 1959 model, had to be estimated for the 1980 model.

The production factors, particularly capital and labor, had become more productive per unit of input in the years preceding this study. We assumed that capital and labor would continue this trend during the 1959-1980 period. Four rates of increase in factor productivity were selected, and a set of solutions for 1980 was calculated for each.

The resource mix used in farming had also undergone change in the years preceding our study. The direction and magnitude of these changes were determined, and estimates made as to the probable farm resource mix in 1980.

The opportunity cost rates for capital and labor and the capitalization rate for capital invested in land were considered generated by the nonfarm industry. The directions and magnitudes of changes in these rates in the past were determined, and estimates made for their values in 1980.

The projected 1980 demand for farm production was estimated based on the 1959 market-clearing quantities and by using estimated changes in population and income per capita as the domestic demand shifters. Export demand estimates made by the USDA were used. Total estimated 1980 demand for farm production was allocated among subregions on the basis of the evaluated trend in their share of total United States farm production.

The quantity of farm land that would be removed from the land supply for nonfarm use during 1959-1980 was estimated. It was assumed that the nonfarm sources of land demand were price inelastic and that, when they were filled, the land supply to the farming industry was fixed.

Once estimated, these variables were considered exogenous to the problem. The values of the endogenous variables were calculated by meeting the same criteria as for the 1959 second reorganization.

In the projected solution, farms were organized at their minimum-cost level of production, capital and labor earned their opportunity costs, the capitalized residual to land equaled the marginal value product of land and the total industry production cleared the market at the indicated price level.

DETERMINING THE CHARACTERISTICS OF THE FARMING INDUSTRY IN 1959

The major data source for determining the resource and production characteristics of the farming industry in the North Central states in the base year, 1959, was the 1959 Census of Agriculture. Some USDA data and farm-business association record summaries were also used. This section reports:

a. the measurement of the 1959 volume of farm output as gross production,
b. farm operating expenses and factor earnings,
c. factor inputs and
d. factor opportunity costs.

Crop Production

Volume of production (gross production) was calculated as crop production value plus value added by livestock. Gross crop production was the sum of the observed value of crops produced in 1959 adjusted to a normal-weather basis, plus the value of government payments received by farmers for withholding land from crop production. The government payments were included because they represented the approximate returns to a cropping alternative foregone by the farmer.

The quantity of each crop produced in 1959 was available by subregions (19), and the season average price received by farmers was available by states (21, 23), from which the observed value of crop production was calculated. The observed value of production of each major crop in every subregion was adjusted by using weather indexes, to a level representing the value of production under normal weather conditions. This reduced the probability that factor productivity was distorted by unusually good or bad weather. Weather indexes were calculated for each subregion for all major crops. This recognized weather variability within as well as among states and the unequal effects of weather on different crops.

The weather index for a particular crop for a given year was calculated by dividing the observed crop yield

per acre by the normal yield, the latter being an estimate of the yield in the absence of short-run weather deviations during that crop production period. The development of weather indexes is described in Appendix A.

Value Added by Livestock Production

The value added to gross farm production by livestock was calculated by determining net livestock increase and subtracting from it the value of feed fed to livestock. Net livestock increase was the sum of livestock and livestock products sold and consumed in the home, minus livestock purchases and plus or minus livestock inventory changes.

The value of feed fed to livestock was estimated by summing the opening inventory of feeds, feed purchased and crops produced and subtracting from this total the value of closing inventory of feeds, crops sold and crops used for seed or consumed in the home. This residual was the disappearance of feed during the accounting period, plus the effect of any errors, and was considered the value of feed fed to livestock.

The value of livestock and livestock products sold in 1959 was reported by subregions by kinds of livestock (19). Hogs, pigs, cattle and calves sold were adjusted in both price and quantity to correspond to cyclical mean levels. This reduced the probability that factor productivity was affected by unusually favorable or unfavorable hog or cattle prices.

The adjustment in hog and cattle numbers made it necessary to adjust the quantity of feed fed to livestock. The concentrate-equivalent of the adjustment in quantity of feed fed was estimated, and its value added to or subtracted from livestock sales (32). This accounted for changes in quantities of feed sold, purchased and fed that would have occurred had livestock numbers actually been changed.

Livestock and livestock product sales were calculated as the sum of the observed sales with cyclical price and quantity adjustments made on the value of hog and cattle sales, plus or minus the value of the adjustment in feed fed caused by the adjustments in hog and cattle numbers. The cyclical hog and cattle adjustments and concomitant adjustment in feed use are described in Appendix B.

Home Consumption of Livestock and Livestock Products

The value of several types of livestock and livestock products consumed on the farm where produced were reported separately by states for 1959 (23). These included cattle and calves, hogs, sheep, milk and butter, chickens, eggs and turkeys. These values were summed and divided by the total number of farms in the state to determine a mean value per farm.

It was assumed that the consumption per farm was an appropriate estimator of the consumption per commercial farm. Consumption per farm was multiplied by the number of commercial farms in the subregion to estimate the total value of home-consumed livestock and livestock products for that subregion.

Livestock Purchased

The value of total livestock purchased was reported by subregions for 1959, but was not disaggregated by classes of livestock (19). It was necessary to determine the value of cattle and hogs purchased so that price adjustments could be made to approximate cyclical mean prices. These data were not readily available and were estimated in the following manner.

Cattle and hogs purchased for feeding were reported separately from cattle and hogs purchased for other uses in a 1956 study of livestock marketing in the North Central Region (7). These data were reported by states. Inshipments of cattle and hogs into states were reported by years by another source (23). It was assumed that all inshipments into states thus reported were feeder livestock and that the changes in numbers between 1956 and 1959 were entirely reflected in the numbers of feeder livestock. The changes in number were valued at mean prices per head, and this value was summed with the 1956 value for the estimated 1959 value. It was assumed that purchases of cattle and hogs for other uses did not materially change from 1956 to 1959.

The estimated numbers of cattle purchased were converted into value of cattle purchased by multiplying by mean values per head. This estimate of total value of cattle purchased was then adjusted to account for cyclical variation in cattle prices. The value of hogs purchased was estimated by using the same procedure, and total value of hogs purchased was adjusted to account for cyclical variation in hog prices. The state totals for hogs and cattle purchased were allocated among the subregions within the state on the basis of the percentage of livestock purchased in each subregion in 1959. This percentage was established from data available by subregions for 1959 (19).

Livestock Inventories

Numbers of livestock on farms during the 1959 Agricultural Census enumeration period were reported by subregions for five major classes of livestock (19): cattle and calves, hogs and pigs, sheep and lambs, horses and mules, and chickens 4 months old and older. And the portion of the state total observed in each subregion for each class was determined. These proportions were used to allocate the value of each class on Jan. 1, 1959, and on Dec. 31, 1959, among the subregions (23).

The Jan. 1 and Dec. 31, 1959, inventory values for hogs and pigs, sheep and lambs, horses and mules, and chickens 4 months old and older were estimated

by using the same procedure. The value of hog and cattle inventories was price adjusted to account for differences from cyclical mean prices. The five classes of livestock were then summed to obtain subregional inventory totals for Jan. 1 and Dec. 31, 1959.

Feed and Crop Inventories and Feed Purchased

Data concerning the stocks of feed and crops owned by farmers and held on farms on Jan. 1 of each year were available for the United States for each of the major crops (23), but had to be estimated for each subregion. Crops included corn, grain sorghum, soybeans, oats, barley, flax and wheat.

The total United States production of each of these crops was also known, and the proportion of the Jan. 1 and Dec. 31 stocks to total production was calculated for 1959. The 1959 crop production was available by subregions (19), and the quantity stored in each subregion was estimated by using the proportion just mentioned.

Value of Crops Home Consumed

The combined value of livestock, livestock products and crops home consumed was reported by states for 1959 (36). To determine the value of crops home consumed, the value of livestock and livestock products home consumed was subtracted. The difference was divided by the number of all farms in the state. This per-farm value was used as the estimator for the level of home-consumed crops per commercial farm and was multiplied by the number of commercial farms in the subregion to estimate the total value of home-consumed crops on commercial farms.

Home-raised Crops Used For Seed

Data regarding the value of home-raised crops used for seed for 10 crops were available for 1959 (30). These did not include oats or barley, which were estimated by multiplying the total acres raised by the average seeding rate. The quantity used for seed was multiplied by the average price received by farmers, giving an estimate of the total value used for this purpose. The state total was allocated among the subregions on the basis of crop acres per subregion as a percentage of the total crop acres in the state.

Crops Sold

The aggregate value of all crops sold was reported by subregions for 1959 (19). This total was adjusted to a level representing sales under conditions of normal weather by using the same weather indexes used in adjusting gross crop production.

Feed and Livestock Purchased

Expenditures for these two items were reported by subregions in the 1959 Census of Agriculture. Feed purchased included expenditures for grain, hay, millfeeds, pasture, salt, minerals, and grinding and mixing of feed. Livestock and poultry purchased included the cost of baby chicks and turkey poults. It excluded cost of livestock purchased for resale within 30 days, which was considered a dealer transaction rather than an agricultural transaction (14).

Operating Expense and Factor Earnings

In the preceding subsection, the estimation of gross production as a measure of output volume was discussed. Gross production was also a measure of total revenue since the product prices used to weight the physical units of output were also the prices received in 1959. Gross production (in the total revenue sense) minus operating expenses equaled factor earnings. Payments for hired labor, cash rent and interest on borrowed money were not included among the operating expenses in calculating factor earnings.

Operating Expenses

Several major classes of farm expenditures were reported by subregions in the 1959 Census of Agriculture (19). Of these, feed and livestock purchased were used previously in calculating gross production. The remaining classes of expenditures included in the censubregion in the census report. The proportion of the late total operating expenses. The missing expenditures were estimated from USDA data and from information contained in farm-business record summaries. The quantity of fertilizer used was reported in tons per subregion in the census report. The proportion of the state total used in each subregion was calculated from these data. Total fertilizer and lime expenditure by states was reported in USDA farm income estimate (36). The total value per state was allocated among the subregions on the basis of the subregion proportions calculated from census data.

Coefficients of correlation were calculated between the missing individual expense items, crop acres and total acres in 21 census subregions. These calculations included the records from about 2,600 farms. On the basis of the coefficients observed and their significance levels, the state totals from USDA data for machinery repairs, taxes, machinery depreciation, supplies, utilities, veterinary expense, insurance and marketing expense were allocated among subregions on a per-crop-acre basis.

Building repairs, building depreciation and farm share of auto expense were not significantly correlated with crop acres or total acres in most subregions. State totals for these categories were allocated among the subregions on a per-farm basis.

Gross production and operating expenses were so determined that their difference equaled factor earn-

ings. Factor earnings were calculated for each subregion as gross production minus operating expenses.

Factor Inputs

The total acres in commercial farms, the total land value and the number of commercial farms per subregion were reported in the Census of Agriculture data (19) and were used as reported. Farm capital was estimated in four categories: livestock, feed, machinery and the stock of capital required for production expenses.

The value of livestock on farms Jan. 1 and Dec. 31, 1959, did not necessarily reflect the mean quantity of capital held in this form during the year. The value of cattle and calves on feed was adjusted by a factor reflecting the Jan. 1 weight of cattle and calves on feed as a proportion of the mean Jan., April, July and Oct. 1 weights (25).

A month-by-month supply of hogs on farms was estimated from state data on numbers of hogs on hand Jan. 1, sows farrowed and pigs saved by months, and monthly farm and commercial slaughter (35). The Jan. 1 number, as a proportion of the mean number for the year, was determined and used to adjust the inventory values of hogs.

Feed and crop inventories, estimating procedures and the sources of data were reported in preceding sections. The mean of the Jan. 1 and Dec. 31, 1959, inventories was used as a measure of the capital held in the form of crop and feed inventories.

The value of machinery on farms by states was reported in the USDA farm-income estimates (36). Machinery value was significantly correlated with crop acres in the farm records of about 2,600 farmers located in 21 subregions. On this basis, machinery value reported by USDA was allocated among the subregions within the states on a per-crop-acre basis.

Farm operators required a stock of capital as a source of funds to pay operating expenses as they occurred during the year. The stock of capital was reduced by the outward flow of operating expenses, but was replenished by a flow of receipts. In many farming activities, it is relatively common for the flow of receipts to lag behind the corresponding flow of expense by about 6 months. On this basis, it was assumed that a stock of capital equal to 6 months' production expenses would be required to operate the farm business.

The quantities of operator, family and hired labor were estimated mainly from census data (19). The 1959 Census of Agriculture reported the number of farm operators working off their farms for specific ranges of days in 1959, but did not specify the exact number of days they worked off their farms. The estimates were made by following procedures used in 1954 Census of Agriculture (16). Farmers were assumed to have worked on their farms 11½ months, if they had not worked off their farm at all, and 10 months, if they worked 1-99 days off their farm. They were assumed to have worked 6 months if they worked 11-199 days off their farm and to have worked on their farm 2 months if they worked over 200 days off their farm.

The number of farmers reported by the census in each group was then multiplied by the estimated months worked on farms for that group. The sum was the estimated total months of operator labor.

The total input of unpaid family labor was also estimated following procedures used in the 1954 Census of Agriculture. The average man-equivalents of labor by type of farm for the United States were available for that census (16). These ranged from 0.19 man-equivalents of unpaid family labor per fruit-and-nut farm to 0.48 man-equivalents of unpaid family labor per cotton farm and were available for 12 types of farms. These coefficients were converted to months of labor by multiplying each by 12 months.

The number of farms by types for each subregion was reported in the 1959 Census of Agriculture (19). That number was multiplied by the months of unpaid family labor appropriate for that class. These products were summed to get the estimated total months of unpaid family labor.

The total cash expenditure for hired labor and the average hours worked per hired person per month were reported in the 1959 Census of Agriculture (19). The average cash wage per month was calculated by multiplying the average hours worked by hired persons per month by the composite hourly cash farm wage (24). The average cash wage per month divided into the total cash expenditure for hired labor gave the months of hired labor. This value was the estimated total months of hired labor used as an input in 1959.

Opportunity Cost of Investment in Farm Land

Opportunity cost is the amount of return foregone from alternatives when a commitment of resources is made. The capitalization rates for capital invested in farm land were estimated by using observed interest rates as guides (1). They were influenced by the cost of using funds, the risk involved in making loans, costs of negotiating and servicing loans, custom and precedent, and the presence of various degrees of credit monopoly. The investor accepted some level of risk concomitant with the use of his funds in making an investment in farm land. The appropriate opportunity cost rate would be based on the interest rate for an alternative investment with comparable risk. Also, the investor stood to gain by an increase in value of his property in certain investments. He would accept a lower observed rate of return if he expected a real increase in the value of his asset. Farm land was this kind of investment in the estimation of some land owners,

but farm mortgages did not have this characteristic (2).

Additionally, owning farm land may have provided a place of residence for the land owner or satisfied some nonincome goal. These benefits would also tend to lower the observed rate of return that he would accept for his farm land investment.

Three criteria were met in selecting alternative investments as guides to the appropriate opportunity cost rates. They were:

a. comparable level of risk between the alternatives,
b. probability of change in investment value and
c. investor possession of skills necessary to manage the alternative investment.

To reflect differences in opportunity cost rates among the states, the average interest rates received by states by all lenders on farm mortgages recorded during Jan. 1 to March 31, 1959, was used as the approximation of the opportunity cost of investment in farm land (27).

Opportunity Cost of Investment in Farm Capital Other Than Land

The opportunity cost rate appropriate for capital invested in machinery, livestock, feed inventories and stock of operating capital was higher than for investment in farm land and was based on viable alternatives in the long run. The investor in these kinds of farm capital accepted a greater risk than the investor in land. An alternative to investing in these types of farm capital was making loans to other farm operators for these same uses. These may have carried less risk than investing directly in these types of capital. This alternative did not involve any probability concerning the change in investment value other than changes in the general price level. It was an alternative that a farm operator would be aware of, and one that he would have ability to manage.

To reflect differences in opportunity cost rates among the states, the average of the interest rates charged on production loans by states, by banks and by production credit associations, excluding service fees, was used as the approximation of the opportunity cost of investment in these kinds of farm capital.

Opportunity Cost of Labor Input

The labor input on each farm was composed of hired labor, unpaid family labor and the operator's input of labor and management. Measurement of the quantity of each type of labor input was discussed in a preceding subsection.

The opportunity costs for hired labor were based on the monthly wage reported in the 1959 Census of Agriculture (19). The reported wage rates included only the cash wage paid to the laborer and did not allow for the cash value of perquisites furnished by the employer. Estimates of the value of the food and housing furnished were made and added to the reported cash wage for the estimated opportunity cost of hired farm labor.

Because of home-farm training and personal interest of family members in success of the farm business, some family labor was more productive than hired labor. Some family labor, however, was furnished by the homemaker and young children who lack the physical strength of hired labor. Family labor may also be assigned to low-productivity jobs. Considering these partly offsetting points, the cash monthly wage of hired labor, excluding the value of perquisites, was used to estimate the opportunity cost of unpaid family labor.

Several methods of evaluating the opportunity cost of the operator labor and management input were evaluated in a 1961 study by Kaldor, Beneke and Bryant (6). They estimated that, with the skills and personal resources developed from farming experience, the operators of well-organized farms would have short-run opportunities for nonfarm employment as managers of farm supply businesses or as managers of grain elevators. If the farm operators had spent the same amount of time in developing their abilities in a different kind of work instead of in farming, they could have held positions in supervisory and managerial capacities in manufacturing, wholesaling or retailing industries. These kinds of employment were studied in an attempt to estimate the opportunity cost of the farm operator's labor and management input.

In the Kaldor, Beneke and Bryant study, the quantity and type of capital managed was used to develop an index of management input (6). Capital was classified by kinds and then weighted according to the estimates of the amount of managerial ability required to manage it. Capital in land and buildings was given a weight of 1; machinery and equipment, a weight of 4; and livestock inventories, feed inventories and the stock of operating capital, a weight of 6. Observed managers' salaries were regressed on the weighted capital inputs in 22 farm supply firms in Iowa over a 2-year period, giving the following equation, which was used in our study to estimate the opportunity cost of the operator's labor and management input:

$$Y = \$3{,}721 + 0.0115X,$$

where Y is expected labor and management return in dollars and X is the sum of the weighted value of capital inputs in dollars.

Differences in wage levels existing among the states were related to the wage differences that existed in certain nonfarming occupations (17) in estimating the intercept coefficient in the regression since the $3,721 was for Iowa conditions. The nonfarming wage rates used for the comparison were the mean of the earnings of experienced male craftsmen, foremen and kindred workers and the earnings of experienced males

in professional, managerial and kindred positions. The wage rates of these two occupational groups were nearly equal. They were occupational groups requiring levels of ability similar to those that the operator-managers of well-organized farms would possess.

Characteristics of the Farming Industry in 1959

The estimation procedures for determining the observed characteristics of farming in 1959 have been described in the preceding sections. Estimates were made for each of the 71 intrastate subregions in the North Central Region. The empirical estimates for the aggregated North Central Region are reported in table 1. Similar estimates for each of the 13 states are included in a later section.

Table 1 contains evidence supporting the hypotheses of imbalances in the farming industry. The agricultural programs of the federal government in 1959 had a price-supporting effect, and in their absence, product prices (and thus production value) would have been lower. This would also have lowered factor earnings per farm, but would not have affected labor opportunity costs. Thus, the gap between the observed factor earnings per farm ($2,800) and the factor opportunity cost ($9,400) would have been even wider in the absence of agricultural programs. It is clear from data in this table that factors used in farming did not earn as much as use in selected nonfarm alternatives.

The next research step was to reorganize all farms into well-organized farms and simultaneously balance the level of farm production and demand for farm products. This corrected the imbalances in resource cost and in production level and provided estimates of their magnitudes.

REORGANIZATION OF FARMING TO APPROXIMATE THE MINIMUM-COST AND MARKET-CLEARING CONDITIONS IN 1959

It was hypothesized that two types of resource imbalances were present among commercial farms in 1959:

a) Larger quantities of production factors were used than needed to produce the output level.
b) Aggregate farm output exceeded demand at 1959 prices.

The procedure for reorganizing the farm industry to approximate the minimum cost of production conditions in 1959 was divided into five steps:

a) A number of farms that appeared well organized were identified from farm-business records in a preliminary screening.
b) The observed farm record data were adjusted to account for influences that distorted the measurement of resource productivity, and a final group of farms was selected on the basis of largest factor earnings relative to factor opportunity costs.

Table 1. Resource and production characteristics of commercial farming in the North Central Region before reorganization in 1959, valued at 1959 prices.

Variable	Unit	Value
North Central Region totals:		
Number of farms	(thousands)	1,171
Acres of land	(thousands)	367,350
Value of land and buildings	(millions)	$ 52,720
Months of labor	(thousands)	19,002
Value of capital	(millions)	$ 21,599
Gross production	(millions)	$ 10,041
Per farm:		
Acres of land		314
Value of land and buildings		$ 45,000
Months of labor		16.2
Value of capital		$ 18,400
Gross production		$ 8,600
Factor earnings		$ 2,800
Factor opportunity cost		$ 9,400
Observed land price per acre		$ 144

c) The land base in each subregion was reorganized into minimum-cost farms, based on the mean characteristics of the selected farms. This increased total farm production over the observed 1959 levels.
d) The total demand for farm products in 1959 was estimated.
e) The minimum-cost farms were reorganized (less labor and capital were combined with land) until total output declined to give a market-clearing level of prices just high enough to equate factor earnings and factor opportunity costs.

Identification of Well-Organized Farms

It was hypothesized that there were farm operators throughout the North Central Region in the base period who had developed their observation and decision-making abilities to the degree that the organization of their farm businesses approximately met the criteria for firm efficiency. These farms would be organized in a manner that would approximately meet the factor-factor, factor-product and product-product requirements for an efficiently organized firm under the existing price and technological conditions.

Under theoretical conditions, production-function analysis, linear programming and the analysis of efficient farms would have yielded farms with approximately the same organization and production. The analysis of efficient farms had a key operational advantage since it required less data for a valid analysis. However, it required the use of rigorous selection criteria for the identification of efficiently organized farms. The criterion used was the selection of farms that earned the largest positive (or smallest negative) excess of factor earnings over factor opportunity costs. And an effective screening process for selecting the most likely farms for rigorous examination was needed.

Use of census economic classes of farms or the use of farm-business association farms for identifying the efficiently organized farms were alternatives considered. In the southern-Iowa pilot study that preceded our study, census economic classes of farms were compared, and the class with the least deficit between factor earnings and factor opportunity costs was selected. The mean characteristics of that class of farms were considered to approximate those of efficiently organized farm firms.

Census data had the advantage of being uniform for the variables reported for all the subregions in the North Central Region. However, census data did not contain all the required information and were supplemented with farm-business-record data in the pilot study. Supplementary data from farm records or other sources would have been needed had this procedure been followed. Since all operating farms were included in the census enumeration, use of census data would have had the advantage of certainty that the efficient farms were somewhere included among those studied. The reporting of census data as the mean characteristics for groups of farms, however, tended to obscure individual farm differences.

Farmers who participated in farm-business associations generally had above-average management ability, size of farm business and net farm income. This did not necessarily mean, however, that the farms that best approximated the firm efficiency conditions were included. Still, use of farm records had the advantage in allowing the comparison and selection of individual farms, not just groups of farms.

Individual farm records were available in sufficiently large numbers with generally good geographic and type of farming distribution to make this approach feasible.

Farm-business records were made available to the North Central Regional Project NC-53 through the cooperation of the agricultural economics department of the land-grant university in each state in the North Central Region. Records had been kept by farm operators in cooperation with the extension service, experiment station, farm-business association or vocational agriculture departments. Copies of the farm record summaries for individual farms were made available from each of the cooperating states in the form of individual farm worksheets, summary worksheets or computer punch cards.

The individual farm-record data were adjusted for abnormal weather and deviations from cyclical mean hog and beef prices so that they would be comparable to the observed 1959 situation. The number of farm records made available is reported in table 2.

The farm-business-record data from south-central Missouri were supplemented with results from a study exploring alternative enterprises and methods of production (9). Usable farm-business records were available for 71 of the 73 subregions in the North Central Region. Data were not available for two subregions in eastern Kentucky and these subregions were not included in the study.

Selection of Farms With Minimum-Cost Organization

In all states, the information reported in farm-business-record summaries gave the resource and production characteristics of individual farms in adequate detail for our study. When data were available on punch cards, the necessary weather and price adjustments were made on the observed data for all farms. In other cases, farm records were examined; and farms with negative factor earnings, atypical farms and farms obviously not providing full-time employment for the operator were sorted out in the preliminary examination.

Although the basic data selected from farms were similar in each state and all summaries were concerned with measures of business size, efficiency and factor earnings, there was little uniformity among states in terminology and reporting procedures. The observed data for the farms used were adjusted in several ways to make the farm data more validly comparable with the observed farm-industry characteristics in 1959. Crop yields and value of production for all major crops were adjusted to account for abnormal weather. Weather indexes, described in the section discussing the observed situation in 1959, were used in making the adjustments.

The prices of hogs and beef cattle were adjusted to their cyclical means as described in the earlier section. This affected the value of sales, purchases and inventory changes of these two livestock classes. The estimations of appropriate opportunity cost rates for land, capital and labor were described earlier. Adjusted gross production, adjusted factor earnings and factor opportunity costs were calculated for each farm.

Farms in each of the 71 subregions were arrayed in descending order on the basis of the residual when

Table 2. Number of farm records available by states.

State	Number of farm records available
Ohio	244
Indiana	565
Illinois	5,740
Michigan	812
Wisconsin	713
Minnesota	745
Iowa	1,200
Missouri	240
North Dakota	134
South Dakota	40
Nebraska	137
Kansas	1,071
Kentucky	152
Total	11,793

factor opportunity costs were subtracted from factor earnings. Farms with the largest positive (or least negative) residual were placed at the top of the array. There were farms in every subregion that had factor earnings greater than factor opportunity costs at 1959 prices. Had the price level been lower, fewer farms would have been in that situation.

The top farms in the array were selected to represent well-organized farms, the cutoff being the farm at which the accumulated sum of all factor earnings equaled the accumulated sum of the factor opportunity costs for all farms included in the array down to that point. As a group, these selected farms had factor earnings equal to factor opportunity costs. Under the income maximization assumption, there would have been no incentive for resources to either enter or leave the industry under the mean structure of these farms.

Factor returns on the farms selected as well-organized units were higher than on the typical commercial farm. Mean factor earnings were less than mean opportunity costs in each subregion under the observed 1959 conditions. This latter point supported the hypothesis that an imbalance in resource cost was widespread throughout the farm industry in the North Central Region in 1959.

Reorganization of the Subregions

The mean resource and production characteristics of well-organized farms were identified in each subregion and were used as the basis for the reorganization of the farm industry into minimum-cost farms in 1959. The per-farm characteristics estimated were gross production, capital input, man-months of labor, value of land input, factor earnings and the opportunity cost of each factor.

The rationale for the minimum-cost reorganization hinges on the farm-nonfarm returns and opportunity costs of factors and their mobility. The nonfarm demand for farm land was assumed price inelastic, and once filled, the opportunity cost of farm land to the farming industry approached zero. Farm land would be used for farming purposes as long as the marginal return to land was not negative. The land base in the subregions was not changed during this reorganization.

Labor and capital inputs, however, under the input supply assumptions have opportunity costs to the farming industry equal to their returns in nonfarm employment. In the observed 1959 farming industry, factor earnings under our assumptions were less than factor opportunity costs. Thus, pressure was generated for the more mobile labor and capital to move from farming to nonfarm industries. It was assumed that this was accomplished by farm operators taking their labor and capital resources from farming and using them where returns were equated with opportunity costs. The area of land vacated by a farm operator would be occupied by the remaining farm operators, increasing the per-farm land base. The freed labor and capital resources would be employed wherever returns equaled opportunity costs. The fixed quantity of land in a subregion was divided by the mean quantity of land per well-organized farm to estimate farm numbers. The subregion totals for value of capital input, man-months of labor and gross production were calculated by multiplying the number of farms per subregion times the mean value per farm. The total volume of production by the industry was not restricted during this step.

The variables and equations used in the first 1959 reorganization are reported in Appendix C.

Farm Production and Demand in 1959

Total net domestic utilization of farm products for food and other uses in 1959 was reported as $29,927,000,000 at 1947-49 farm prices (34, 33). Converted to 1959 farm prices, net domestic utilization was estimated to be $26,503,351,200. Estimates of effective export demand at 1959 prices were more difficult to obtain because of the complex nature of government export subsidies and programs (22, 28). The estimate of export demand totaled $3,102,176,000. (Appendix E).

Total quantity demanded of farm production in 1959, at 1959 prices, was thus estimated to be $29,605,527,200. It was the sum of net domestic utilization of $26,503,351,200 and export demand of $3,102,176,000.

Various measures of "farm production" and "farm output" were generated for calendar year 1959 to meet the criteria of various uses. In our study, "farm production" was measured as the value of crop production, plus the value added by livestock production. Farm production calculated in this manner had been reported by USDA at 1947-49 prices (29) to total $35,142,000,000. Of that total, production added by livestock was $9,984,000,000, pasture production was $2,028,000,000, and crop production was $23,130,000,000.

However, the aggregate yield-per-acre index for 28 major crops indicated that per-acre yields in 1959 were about 2 percent below the mean yields for the 7-year period in which 1959 was the median year (26). The value of production was adjusted upward to account for this and to approximate "normal" yields. Total adjusted value of production was $35,604,600,000 at 1947-49 prices and $31,531,433,760 at 1959 prices.

Total quantity demanded of United States farm production at 1959 prices had been estimated in a preceding section to be $29,605,527,200, 93.9 percent of the estimated total production of $31,531,433,760. Stated differently, the excess production at 1959 prices was 6.1 percent.

Comparability of USDA and Census of Agriculture Data

The estimate that demand for farm production equaled 93.9 percent of total farm production in 1959 was based on USDA data. Production data for agricultural subregions for 1959 were based mainly on Census of Agriculture data. In general, both the USDA and the Census of Agriculture were measuring the aggregate value of farm production for the entire farm industry. There were some differences in sources of data, timing of enumeration and prices used, however.

The major difference appeared to be in the handling of interfarm sales of feed and livestock. The cost of feed and livestock purchased by farmers was subtracted from sales and inventory increases in the calculations of farm production based on Census of Agriculture data. Although this would be an appropriate procedure in determining production for a single farm, it tended to underestimate aggregate production. The cost to the farmer buying feed or livestock would exceed the receipts to the farmers selling because of transportation, handling and other costs. When all farms were aggregated, farm production would be underestimated because receipts to farmers for interfarm sales would be less than the expenditures made by the farm buyers for the same goods.

The USDA used different procedures in estimating farm production to account for interfarm transfers of feed and livestock. This difference in procedure accounted for the major differences in values reported by the two series.

To establish the comparability of the two sources of farm-production data, farm production was calculated from census data for 1939, 1944, 1949, 1954 and 1959. These values were restated at 1959 farm prices and converted into a production index with 1949 production set equal to 100. These index values were considered the dependent variable and regressed with USDA production-index values. The r value for this regression was 0.9707, and t value was 6.9967, both significant at the 1-percent level.

This test was considered to have established the comparability between the two series of farm-production data. It was accepted that 93.9 percent of total farm production was demanded at 1959 prices, whether farm production was calculated from Census of Agriculture data or from USDA data.

Subregions' Shares of Total Demand in 1959

Total farm production in the United States was estimated to be $23,316,678,130 when calculated from Census of Agriculture data. Of this, 93.9 percent was demanded at 1959 prices, or $21,894,360,764. It was necessary to allocate this market-clearing quantity (at 1959 prices) among the subregions so that adjustments between observed production and the quantity demanded could be made at the subregional level.

To determine the changes in each subregion's percentage share of total farm production, the subregion's percentage of the total United States farm production was regressed on time. The percentages that each subregion's production was of total United States production were calculated by using Census of Agriculture data for 1939, 1944, 1949, 1954 and 1959. Based on the regression equation, the value for 1959 was calculated, giving an estimate of the percentage of total United States market-clearing farm production that would have been the subregion's share. The total market-clearing quantity of demand for United States farm production in 1959 was allocated among the subregions in this manner.

Extensification of the Farm Industry

Among other changes, the reorganization of the farm industry into minimum-cost farms in 1959 generated a 103 percent increase in aggregate output for the North Central Region (see table 3). This quantity of production greatly exceeded the share of total demand that could be allocated to the North Central Region and thus would not have cleared markets at the 1959 price level.

Had this production been placed on the open market, product prices would have declined below the 1959 level and factor earnings on farms would have dropped to some level less than equality with opportunity costs. The inequality between factor earnings in farming and their nonfarm opportunity costs would have generated pressure for the shifting of labor and capital from farm to nonfarm uses.

The rationale for shifting labor and capital rather than land from farming hinges on the assumption about the relative opportunity costs of the factors to the farm industry, which approached zero for farm land, but which were equal to returns in nonfarm employment for labor and capital. Land would not have been removed from farming until its marginal returns dropped to a level equal to its opportunity cost to the farm industry. The demand for farm land by the nonfarm industry was relatively price inelastic, and once that relatively small demand was filled, the opportunity cost of land to the farming industry would approach zero.

Had the farm-production function been known, the proportion and quantities of capital and labor leaving the farm industry and the capital, labor and land mix on the remaining farms could have been calculated with precision. Without knowledge about factor substitution rates, it was necessary to make assumptions and judgments.

We assumed that, when a farm operator responded to the discrepancies between his factor earnings and their nonfarm opportunity costs, he would shift the entire bundle of capital and labor associated with his

Table 3. Resource and production characteristics of commercial farming in the North Central Region under the observed situation, minimum-cost and market-clearing reorganization in 1959, valued at 1959 prices.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage 1959 observed situation
Subregion totals:						
Number of farms	(thousands)	1,171	714	— 39	306	— 74
Acres of land	(thousands)	367,350	367,350	0	367,350	0
Value land and buildings	(millions)	$ 52,720	$ 52,720	0	$ 52,720	0
Months of labor	(thousands)	19,002	14,949	— 21	6,420	— 66
Value of capital	(millions)	$ 21,599	$ 28,571	+ 32	$ 12,182	— 44
Gross production	(millions)	$ 10,041	$ 20,389	+103	$ 9,141	— 9
Per farm:						
Acres of land		314	515	+ 64	1,200	+282
Value land and buildings		$ 45,000	$ 74,000	+ 64	$172,000	+282
Months of labor		16.2	20.8	+ 28	20.8	+ 28
Value of capital		$ 18,400	$ 39,900	+116	$ 39,900	+116
Gross production		$ 8,600	$ 27,500	+220	$ 29,900	+248
Factor earnings		$ 2,800	$ 15,300	+446	$ 17,800	+536
Factor opportunity cost		$ 9,400	$ 15,300	+ 62	$ 17,800	+ 89
Observed land price 1959		$ 144	.....	.....	.....	.....
Residual to land capitalized into a value per acre		$ 0	$ 135	.....	$ 97	.....

farm business into nonfarm employment. The substance of this assumption was that quantities of labor and capital would be removed from the farm industry in the same ratio as they appeared on well-organized farms and that labor and capital would continue to be combined in that same ratio on the remaining farms.

The labor-capital ratio on well-organized farms would be determined by the relative prices of labor and capital. These were determined outside the farm sector and thus, their ratio would not change during reorganization. It was further assumed that the quantities of capital and labor per well-organized farm would be unchanged during the reorganization, but would be combined with more land. Because of the decrease in the number of farm operators, the aggregate demand for land would be lessened, and land price would decline, making it relatively lower cost compared with other factors. As additional land was added to the fixed input of labor and capital on the remaining farms, the marginal physical product of land would decline.

Given the fixed land base in the North Central Region, total output for the region would decline as labor and capital shifted into nonfarm employment. This is consistent with the farms being well organized —any decrease in factor inputs would result in a decrease in farm production. As a first step in the operational model used, labor and capital were removed until the total gross production in the subregion equaled the subregion share of total farm demand at 1959 price levels. This step resulted in an industry with total supply equal to total demand at the 1959 prices. The problem of determining the equilibrium price level will be discussed later.

The industry balance was attained with the concomitant minimum-cost organization of farms by an extensification procedure. The procedure was carried out by decreasing the input of capital and labor per unit of land within guidelines determined by the characteristics of the selected group of well-organized farms.

In each of the 71 subregions, an extensification regression was developed by using characteristics of the selected group of well-organized farms as observations. The capital, plus labor input per unit of land, was regressed on gross production per unit of land as the independent variable. The equation fitted was linear and of the form:

$$Y = a + bX,$$

where Y equaled the estimated gross production per unit of land and X was the capital, plus labor input per unit of land.

It was assumed that the observed price of land per acre in 1959 was a reasonable index of its relative productivity and that land, measured in dollar terms, would thus be a homogeneous factor. The unit of land used in the regression equations was worth $1. The capital plus labor input measured the services of those two factors in production. It was estimated as the sum of the opportunity costs of labor and capital, plus production expenses and depreciation. The r^2 values for the regressions ranged from 0.64 to 0.98.

Given a subregion's share of farm product demand and the land base, the value of Y was calculated as the share of demand divided by the land base. The values for the a and b variables had been estimated in the regression. The equation could then be solved for X, the input of the services of capital and labor per unit of land.

The product of X multiplied by the land base in the subregion yielded an estimate of the total capital plus labor input for the subregion. Since the per-farm

capital plus labor services input was known, the number of farms in the subregion was determined through division after the extensification procedure.

Determination of other relevant variables followed. A series of equations was developed to systematically determine the endogenous variables in the market-clearing reorganizations. Those equations and the known variables are reported in Appendix D.

Limitations of the Extensification Procedure

The regression equation used in the 1959 market-clearing reorganization facilitated the estimation of resource and production characteristics of minimum-cost farms after the second reorganization. It was a means of identifying the characteristics of farms that had extensive organization.

Extensification was accomplished within or close to the range of experience in three-fourths of the 71 subregions. In 17 subregions, however, gross production per unit of land was noticeably less than the most extensive observed farm. These subregions were widely scattered, but were mainly in the central and eastern areas of the North Central Region. There were two major implications of this development. None of the 17 subregions was in major Great Plains wheat or ranching areas but, rather, in more intensive crop- and livestock-producing areas. This suggested that, for extensification to proceed as indicated, changes in farm-product mix to crop and livestock enterprises not commonly used might have to take place. That is, alternatives in cropping systems might include such relatively extensive crops as wheat and small grains instead of corn and soybeans. Livestock alternatives might shift to cattle ranching from the relatively more intensive hog raising, dairying and cattle feeding. Thus, the extensification might be accomplished through changes in product mix.

A second implication was that new production techniques might be required that made commonly used enterprises relatively more extensive. This was the less promising of the two alternatives for the operational extensification of the farming industry.

Extensification and Product Price Decline

It was indicated previously that the data contained in the individual farm record summaries were believed to accurately reflect the nature of the farm business in most cases. Data from states that provided relatively thorough professional supervision of farm record keeping and record analysis generally had good fits in making the regression equation. In some other cases, however, meaningful relationships among the farms were not so clear. In those cases, the regression equation for a similar adjacent subregion was used, or data from farms in adjacent similar subregions were combined to develop the regression.

The extensification equation could be considered as representing a linear segment of the production surface where used within the range of observations. The quantity of farm output depended on inputs of land and a capital-plus-labor combination, which were reasonable variables for explaining farm production.

The production function was used as a guide in the extensification procedure, but because of lack of control over input measurement and homogeneity, it was not considered reliable for additional analysis. The data upon which the production function was built were not considered adequate for unqualified acceptance of the fitted function as representative of the existing physical relationships. Farm-firm demand schedules for factors or farm-firm supply schedules of products were not developed from the production functions.

Extensification is illustrated by the hypothetical example in fig. 2. Farm production and demand for a geographic area are presented under three sets of circumstances. In each part of the figure, D represents the demand for farm products and Q_3 represents the quantity demanded at the 1959 price level.

In fig. 2A, S_1 represents the farm-products supply schedule, and Q_1 the quantity supplied in the observed situation at P_{59}, the 1959 price level. Q_1 is greater than Q_3, indicating excess production. Elsewhere in the present study, excess production in the United States in 1959 was estimated at about 6 percent.

S_2, in fig. 2A and subsequent figures, represents the farm-products supply schedule, and Q_2 the quantity supplied after the minimum-cost reorganization in 1959. Note that, in the minimum-cost reorganization, the total quantity of production was not restricted. Thus, the supply schedule S_2 has shifted to the right relative to S_1. Q_2 is larger than Q_3 or Q_1 and was estimated to be 103 percent greater than Q_1, the observed quantity of production in 1959 in the North Central Region. The difference between Q_3, the quantity demanded at the 1959 price level, and Q_2 measures the excess production after the minimum-cost reorganization in 1959.

In fig. 2B, extensification has taken place at the 1959 price level. The supply schedule was shifted to the left, and S_3 represents the farm-product supply schedule of the extensified farms. Extensification was pursued until the quantity produced, Q_3, was equal to the quantity demanded at the 1959 price level. However, the 1959 price level, P_{59}, was not necessarily the product price consistent with the equilibrium solution. During the extensification process, labor and capital had left farming in response to the disparities between their farm earnings and their nonfarm opportunity costs. With a fixed supply of land for the farming industry, this meant a decline in the marginal physical product and marginal value product of land. Lower marginal product of land (and lower price of land in

the competitive farm industry) would lower the cost of production for individual farm firms and thus lower product price. Thus, it appeared that the equilibrium price level would be at some level below the 1959 level.

Excess production was eliminated in fig. 2B by shifting the supply schedule through extensification. In fig. 2C, excess production had been eliminated by allowing product prices to drop to the P_4 level. At that price, Q_4 is both the quantity demanded and produced, and there would be no excess production.

The end points in the range of alternatives for eliminating excess production were thus defined. At Q_4, product-price decline accounted for the elimination of excess production. At Q_3, extensification had eliminated excess production.

S_4 represents one of the infinite number of combinations of extensification with product price decline. The decrease in production represented by the difference between S_2 and S_4 was accomplished by extensification, and the price decline from P_{59} and P_5 increased the quantity demanded sufficiently for the remainder of the quantity produced to be demanded. The problem generated here was determining which combination of extensification and product-price decline represented the consistent situation.

Estimating the Equilibrium Price Level

During the extensification process, additional land was combined with the fixed capital and labor inputs on the farms that remained in operation. This reduced the marginal physical product of land. For the farm industry, labor and capital inputs were decreased and the land base remained fixed, which was consistent in causing a reduction in the marginal physical product of land.

The lower limit on equilibrium product price level was estimated by determining the price levels at which the capitalized residual value of land was driven to zero. The latter variable was the per-acre residual when opportunity costs of labor and capital were subtracted from factor earnings, the residual being capitalized into a land value.

Subregions varied in the product price at which their residual to land was driven to zero. Generally, areas with less productive land (i.e., with a lower observed land price in 1959) were affected first. Northern Minnesota, northern Wisconsin, northern Michigan, south-central and southwestern Missouri and southeastern Kansas were the first subregions affected as product price was lowered in successive iterations.

Negative land values would have been inconsistent with economic efficiency criteria. Land value at the equilibrium would be equated with its capitalized marginal value product. If the latter were negative at positive product prices, negative marginal physical

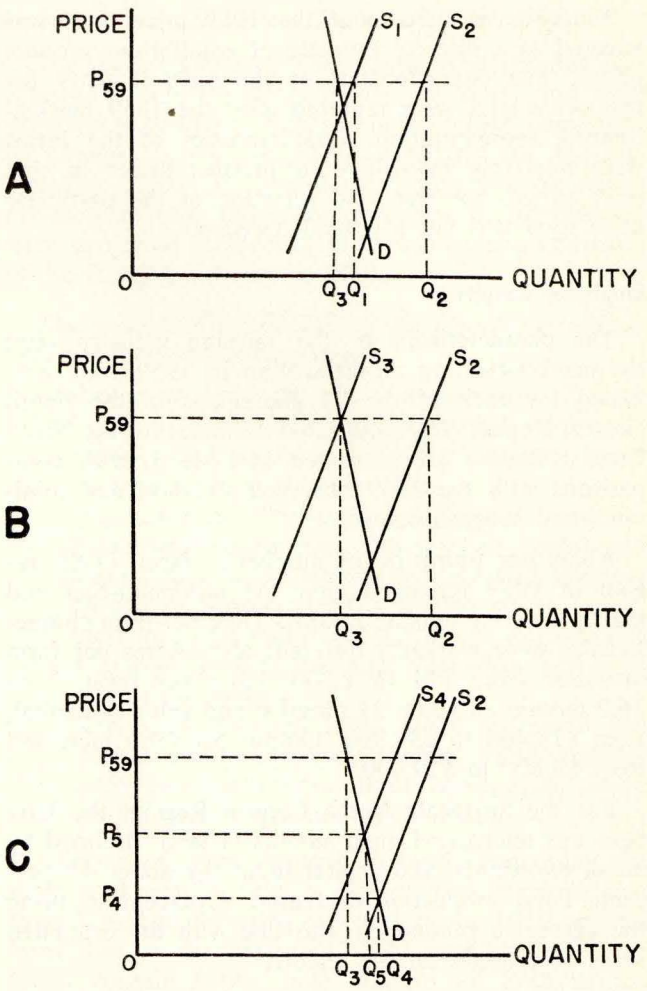


Fig. 2. Farm production and product demand illustrating extensification and price adjustments.

productivity of land would be implied and be inconsistent with the rational combination of factors.

The lower limit to which product price could be lowered appeared to be about 95 percent of the 1959 price level. At this price, negative land values would have begun to appear in some subregions.

The marginal value product of land was calculated from the regression equation and equated with the capitalized residual to land in several subregions in which the farm-record data were believed exceptionally reliable. In general, the equality occurred at product prices that were between 95 percent and 100 percent of the 1959 product price level. Although this was not conclusive, it added support to the hypothesis that the appropriate range in product prices had been determined.

A discrete estimate of equilibrium product price was needed so that the resource and production characteristics of the farm industry could be stated as single values. A range of values would not have been completely satisfactory since the characteristics were used later as inputs in the 1980 projections.

Ninety-seven percent of the 1959 price level was selected as a discrete estimate of equilibrium product prices. The characteristics of the farm industry for that price level were reported after the 1959 market-clearing reorganization. Characteristics of the farms were relatively insensitive to product prices in that price range, however, and selection of the particular price used was not a critical decision.

Empirical Results

The characteristics of the farming industry after the market-clearing reorganization in 1959 were estimated for each of the 71 subregions in the North Central Region. The aggregated estimates for the North Central Region are presented in table 3, with comparisons with the 1959 observed situation and minimum-cost reorganization[4].

About one-fourth of the number of farms in the region in 1959 remained after the minimum-cost and market-clearing reorganizations. Their per-farm characteristics were markedly different also. Acres per farm increased from 314 to 1,200; labor per farm, from 16.2 months to about 21 months; and value of capital, from $18,400 to $39,900. Output per farm increased from $8,600 to $29,900.

For the aggregate North Central Region, the land base was unchanged, man-months of labor declined by about two-thirds, and capital input, by about 44 percent. Total production decreased 9 percent to bring the aggregate production into line with the estimated share of demand for the region.

Land value was estimated to be $97 per acre, compared with $144 in the observed situation in 1959.

The combined value of investment in land and capital per farm increased from $63,400 in the observed 1959 situation to $211,900 after the minimum-cost and market-clearing reorganizations in 1959.

PROCEDURES USED FOR THE REORGANIZATION OF FARMING TO APPROXIMATE THE MINIMUM-COST AND MARKET-CLEARING CONDITIONS IN 1980

The same general procedures used in estimating the minimum-cost and market-clearing situations for the farm industry in 1959 were used for making the projections for 1980, but data, which were observed phenomena in the 1959 model, had to be projected for 1980 use. The 1980 farm industry and its reorganization is reported in four broad topics:

a. projected demand for farm products,
b. projected land supply and factor prices,
c. projected resource combination on farms, and
d. projected market-clearing industry organization.

[4]Estimates for states are included in tables 8 through 20.

Projected Demand for Farm Products

The estimated market-clearing quantity of farm production demanded at the 1959 price level had been determined by estimating directly the use of farm production at observed prices in 1959. The estimated and projected demands for farm production in both 1959 and in 1980 were allocated among the subregions on the basis of a time-series regression of each subregion's percentage share of the total United States farm production.

The projection of the 1980 total demand was based on the 1959 market-clearing quantity by using estimated changes in population, income per person and export demand as demand shifters.

The value of farm production demanded domestically in 1980 was estimated at the 1959 price level by multiplying the estimated value of the quantity demanded domestically in 1959 by two demand shifters that accounted for increases in total population and in per-capita disposable income during the 1959 to 1980 period.

The U. S. Census Bureau projected the population of the United States to be 259,584,000 by 1980 by using their Series II assumptions of fertility level continued at the 1955-57 rate (15). This would be a 46.44 percent increase over the 1959 population of 177,261,000 (18). The value of the population demand shifter would be 1.4644, based on these estimates.

USDA projected the value of the per-capita disposable income demand shifter to be 1.02 for the 1959-1980 period (29).

Domestic demand for farm production in 1980 was calculated by using the 1959 domestic demand and the two demand shifters:

($19,599,831,752) (1.4644) (1.02)
= $29,276,033,487

The USDA projected that, with an expanded Food for Peace Program, exports of farm products in 1980 would be 30 to 35 percent above the 1960 level (29). The lower of these two percentages was used in our study to estimate the 1980 export demand. If a 30-percent increase in exports was experienced from 1959-1980, the effective export demand would total $4,032,828,800 at the 1959 price level.

Total projected demand for United States farm production in 1980 was calculated as the sum of the projected 1980 domestic demand of $29,276,033,487, plus projected 1980 export demand of $4,032,828,800. In 1959 prices, the total projected 1980 demand was $33,308,862,287. The estimated demand was allocated among subregions, based on their estimated shares of total demand in 1980.

Projected Land Supply and Factor-Prices in 1980

We assumed that the nonfarm demand for land from 1959 to 1980 would be perfectly inelastic at the price levels at which land would be sold for farming purposes. That is, the nonfarm demands for land would be filled first, and all the remainder would be available for farming use. Thus, the farming industry's land supply in 1980 was considered fixed, as in the 1959 analysis. In the 1980 model, as in the 1959 model, the supplies of capital and labor were considered perfectly elastic to the farm industry at their nonfarm opportunity cost rates.

Research procedures for the projection of the supply of farm land in 1980 were developed first for Iowa conditions and then modified to fit the needs and characteristics of other states. Estimates of the supply of land available for farming in 1980 were made in other states as contributing work to the NC-53 regional project.

The projected supply of farm land for commercial farms in 1980 was 3 percent below the 1959 supply for the aggregated North Central Region. The procedures and results are presented in Appendix F.

The quantities of factors demanded and their combinations on well-organized farms depend on their productivity and their prices. Factor prices had changed relatively and absolutely in the past and could reasonably be expected to change in the future. Therefore, we projected factor prices for 1980.

Factor prices as the opportunity cost rates for labor, capital and land in 1980 were developed by Craft[5] from projections and information compiled by Denison in his study of sources of economic growth for the United States (4). The average rates of increase in earnings of labor, capital and land were projected for 1959 to 1980. These rates of increase in earnings were considered reasonable approximations of the increase in factor opportunity cost prices during the same period. The earning rates for labor, capital and land in 1980 were determined by dividing the projected share of gross national product allocated to each factor by the projected index of input of that factor. This established earnings per unit of factor input for 1980. The average rate of increase was calculated in earnings per unit of labor, capital and land input.

The projected increases in factor opportunity cost prices during the 1959 to 1980 period were 41 percent for labor and 13.5 percent for capital. The capitalization rate for land was projected to increase by 28.5 percent. The opportunity cost rates used in the 1959 analyses were increased by the percentages for the projected rates in the 1980 model. The opportunity cost rates for capital and land in 1959 and the projections for 1980 are presented in Appendix G, by states.

[5]op. cit.

Projected Farm Resource Combinations in 1980

The combinations of resources used in farming had changed during the years before our study and were expected to continue to change in the future, stimulated by changes in relative prices of factors and the differential effects of technological advances on factor productivity (8). The changes in resource combination were projected to identify the resource characteristics of the farming industry in 1980.

The procedure for projecting the resource combination was divided into four steps:

a. Project to 1980 the physical quantities of three kinds of labor, three kinds of capital stocks and capital used as farm operating expense based on time series trends.
b. Aggregate the 1980-projected physical quantities into a single labor class, one stock of capital, and capital used as operating expense and multiply by the appropriate 1980 projected prices.
c. Sum the total factor inputs from the preceding step and calculate the percentage that each class was of the total.
d. Reallocate the total labor, stock of capital and capital used as operating expense on the optimal 1959 farm into these three components based on the percentages just calculated.

These four steps resulted in farms containing the same total combined inputs (labor, stock of capital and capital used as operating expense) as the 1959 optimal farm, but in the projected 1980 proportions. These farms contained the same quantity of land as the optimal 1959 farms. This organization served only as a starting point for the required extensification or intensification for projecting the minimum-cost and market-clearing organization in 1980.

The rationale for these procedures hinged on two key assumptions:

a. that the price and technological changes that prompted the shifts in resource mix during the base period would continue to prompt similar shifts in the resource mix to 1980.
b. that the resource shifts in the base period were measured by using data from average farms, which were assumed reasonable predictors of future changes on well-organized farms as well.

In making the projections of the resource mix for 1980, a base period of years was needed that would be the best representation possible of what was likely to occur from 1959 to 1980. The period 1949 through 1963 was used in most cases. It began long enough after World War II to be free from most of that influence. A shorter period was used in estimating machinery inventories because the accumulated demand for machinery from the war period appeared to carry over until 1951 or 1952.

Projected Market-Clearing Organization in 1980

The projected resource mix described in the preceding section gave the resource characteristics of minimum-cost farms in 1980, but did not consider output or industry effects. These were used as starting points in determining the minimum-cost and market-clearing organizations in 1980. The total value of the bundle of labor, capital stock, capital consumed and land per optimally organized farm in 1959 was projected intact to the 1980 farms in value terms. However, the proportions of the first three were shifted with relatively more capital used as operating expense and less labor per farm in 1980 than in 1959, as indicated in Appendix H.

The next step was to project the quantity of production that would be generated per farm in 1980 by the new combination of resources, by multiplying the production generated per farm in 1959 by an appropriate coefficient that represented increased productivity of resources expected during the 1959 to 1980 period.

The historic trends in the index of agricultural productivity in the United States developed by the USDA were used as guides in projecting the increase in productivity. Although there are fundamental questions concerning how factor productivity changes over time, if at all, the key consideration in our study was that measured productivity had changed.

The base period used to measure productivity change influences the coefficient substantially, however. The productivity of United States agriculture displayed only a slight upward trend from 1910 until the 1930's, but since that time, a sharp upward trend has been the rule. If the trend was measured for the period of 1937 through 1958, it would have excluded major effects of unusually bad weather that immediately preceded and good weather that followed that period on crop production. It would not have included any productivity increases of the most recent 6 years. The 1.3-percent compounded rate of increase for the 1937-1958 period was considered the absolute minimum rate of increase for the base period.

The trend line in resource productivity could also be measured for the years beginning after the adjustment period following World War II. For the 13 years from 1950 through 1963, the productivity increase was 2 percent per year, compounded annually. This time period measured the productivity for the most recent period of years, but also contained years when weather was unusually favorable for crop production. The 2-percent rate of increase could be considered about the maximum rate of productivity increase. It appeared that the rate of productivity increase could have ranged from 1.3 percent to 2 percent, compounded annually. Implicit in these measurements was the assumption of linearity of the trend line, which was supported by examining the data.

The rate of productivity increase just discussed was based on data from all farms in the United States. In our study, the projected role of productivity increase on optimally organized farms from 1959 to 1980 was required. Craft estimated the inputs and outputs of the top one-third farms in the southern Iowa farm business association from the years 1948-50 to 1958-60.[6] He indicated that the productivity of inputs on these farms increased at an annual rate of about 2.5 percent.

Considering the range in productivity increases estimated for the base period, the apparent linearity of the trend line since 1930 and the productivity increase of well-organized farms in southern Iowa, we decided to project the resource and production characteristics of the farm industry for 1980 for four growth rates. The rates were 1.5 percent, 1.75 percent, 2.0 percent and 2.25 percent, compounded annually.

The analytical procedures followed in the 1980 analysis paralleled those used in the minimum-cost and the market-clearing reorganization for 1959. The total resource structures of the optimally organized 1959 farms were projected to 1980 conditions as a first approximation of minimum-cost farm organization in 1980. The nonland inputs per farm were then reproportioned according to projected trends, with their total value held constant and combined with the same quantity of land as in the optimal 1959 situation. Because of the assumed increased factor productivity during the 1959-1980 period, the per-farm level of output would have been larger than in 1959.

The number of farms per subregion would have declined during the 1959-1980 period (everything else being equal) because of the projected decline in the supply of land available for commercial farms. The subregion shares of total demand for farm production in 1980 were projected. The price elasticity of demand for farm production was assumed the same in 1980 as in 1959. Projections of relevant factor prices had been made (3).

The equations used for making the 1980 projections were similar to those used for the 1959 estimates. Modifications were introduced to account for the projected changes in resource combinations, resource productivity, commercial farm land base and product demand between 1959 and 1980. A series of 22 sequential equations were developed to systematically compute values for the unknown variables in the 1980 minimum-cost and market-clearing situation.

The variables and series of equations used are reported in Appendix I.

1980 PROJECTIONS

The empirical projections of farming in the North Central Region in 1980 describe the minimum-cost organization of farms in a farming industry whose total production clears markets at prices that just cover factor opportunity costs. They are reported in table 4 with the 1959 observed situation and estimates for

[6] op. cit.

the 1959 minimum-cost and market-clearing organizations. The 1980 projections are for the situation in which factor productivity increased at the rate of 1.75 percent, compounded annually, and farm product demand had constant elasticity.

In general, the major adjustments in the farm industry reflected in table 4 would have taken place in reorganizing the 1959 farm industry to meet income efficiency conditions. Had those major adjustments been made in 1959, relatively minor adjustments would have led to a 1980 situation in which farms would be organized at the minimum-cost level of production and the industry's output would have cleared markets at prices covering factor opportunity costs.

The number of commercial farms exceeded 1.17 million in the observed 1959 situation and totaled about 354,000 in the 1980 projections. If the percentage decline in number of commercial farms from 1949 to 1959 was continued until 1980, there would be considerably more commercial farms in 1980 than required in the 1980 projections. If the absolute rate of change was continued, however, a decrease greater than the projections would take place.

Another comparison concerning the changes required in numbers of commercial farms to reach the number indicated in the 1980 minimum-cost and market-clearing situation is presented in table 5. Under the condition that productivity increased at the rate of 1.75 percent per year, there would be 354,000 commercial farms in the 1980 minimum-cost and market-clearing situation. That total is broken down by states in the table. A projection of the number of farm operators "available" in 1980 was made by subjecting the number of commercial farm operators reported in the 1959 Census of Agriculture to projected mortality rates appropriate for their age distribution. Additionally, it was assumed that all other operators retired at age 65 and that the number of new entrants to farming equaled the number of farmers leaving operator status for all other reasons. The number of commercial farm operators that would be available in 1980 under those

Table 5. Number of income efficient farms per state compared with number of farm operators demanding farms under specified conditions, 1980.

State	Number of farms per state in the 1980 minimum-cost and market-clearing situation if factor productivity increased 1.75% per year	Farm operators available per state in 1980, assuming normal mortality, retirement at age 65 and number of entrants equaling number of quits.
Ohio	24,200	27,741
Indiana	20,300	27,226
Illinois	39,600	43,831
Michigan	18,500	20,708
Wisconsin	37,400	38,633
Minnesota	37,500	44,743
Iowa	49,100	58,967
Missouri	26,300	30,432
North Dakota	15,600	19,727
South Dakota	14,800	19,729
Nebraska	23,900	29,962
Kansas	24,200	26,595
Kentucky	22,600	27,069
Total	354,000	415,363

Table 4. Resource and production characteristics of commercial farming in the North Central Region under the observed situation and market-clearing reorganizations in 1959 and under one minimum-cost and market-clearing situation in 1980, when farm product demand has constant elasticity.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms	(thousands)	1,171	714	— 39	306	— 74	354	— 70
Acres of land	(thousands)	367,350	367,350	0	367,350	0	356,350	— 3
Value land and buildings	(millions)[a]	$ 52,720	$ 52,720	0	$ 52,720	0	$ 51,315	— 3
Months of labor	(thousands)	19,002	14,949	— 21	6,420	— 66	5,241	— 73
Value of capital	(millions)	$ 21,599	$ 28,571	+ 32	$ 12,182	— 44	$ 12,822	— 41
Gross production	(millions)	$ 10,041	$ 20,389	+103	$ 9,141	— 9	$ 14,893	+ 48
Product price level (1959 = 1.00)		1.00	1.00	.....	.97	.....	.74	— 26
Per farm:								
Acres of land		314	515	+ 64	1,200	+282	1,006	+220
Value land and buildings[a]		$ 45,000	$ 74,000	+ 64	$172,000	+282	$144,900	+220
Months of labor		16.2	20.8	+ 28	20.8	+ 28	14.8	— 9
Value of capital		$ 18,400	$ 39,900	+116	$ 39,900	+116	$ 36,200	+ 96
Gross production (total revenue)		$ 8,600	$ 27,500	+220	$ 29,900	+248	$ 31,100	+262
Factor earnings		$ 2,800	$ 15,300	+446	$ 17,800	+536	$ 16,400	+486
Factor opportunity cost		$ 9,400	$ 15,300	+ 62	$ 17,800	+ 89	$ 16,400	+ 74
Observed land price 1959		$ 144	.....	.....	.....	.....	.....	.....
Residual to land capitalized into a value per acre		$ 0	$ 135	.....	$ 97	.....	$ 94	.....

[a]Valued at observed 1959 land price.

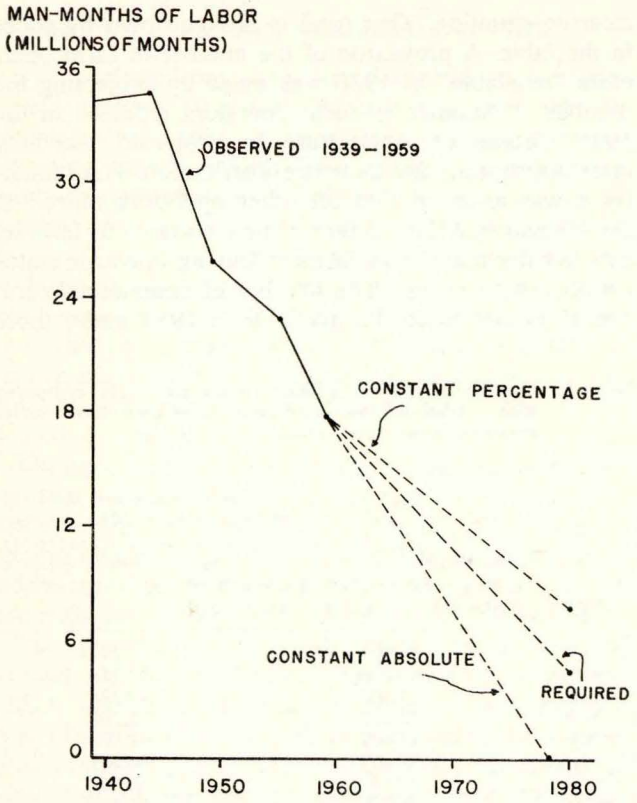


Fig. 3. Project man-months of labor on commercial farms in the North Central Region in 1980, based on required change to meet income efficiency conditions.

conditions totaled 415,363, which exceeds the projected farming opportunities by about 17 percent.

Man-months of labor on commercial farms declined from 19 million in the 1959 observed situation to about 5.2 million in the 1980 minimum-cost and market-clearing situations. The observed changes in man-months of labor on commercial farms in the North Central Region are represented by a solid line in fig. 3 for 1939-59. When that base period was projected at a constant percentage change to 1980, the value was slightly greater than the man-months of labor projected for the 1980 minimum-cost and market-clearing situations. However, projecting the rate of change during the base period at a constant absolute change would have reduced the labor supply on farms to zero before 1980, an unrealistic supposition.

The market-clearing 1959 reorganization was accomplished by reallocating the regional land base into farms organized with relatively low capital and labor inputs per unit of land. This resulted in a sizeable decrease in labor and capital input in the region. The value of the capital input declined from about $21.6 billion in the observed 1959 situation to about $12 billion after the market-clearing reorganization in 1959 and was $12.8 billion in the 1980 market-clearing situation. Nonland capital was an aggregation of the value of machinery, feed inventories, livestock inventories and the value of the stock of liquidity required to furnish a flow to pay operating expenses. The observed aggregated level trended upward during the 1949-62 period. The value of machinery input during that period was about constant, but there was a fairly substantial, continuous increase in the stock of capital required for operating expenses. Livestock and feed inventories trended generally, but irregularly, upward during that period. Thus, the decline in capital inputs in the aggregate (they increased per farm) would be a reversal of observed trends.

Characteristics in 1980 for Four Rates of Factor Productivity Increase

In a preceding section, it was indicated that estimates of the rate of increase in factor productivity varied with the period of years selected as a base. A range, within which the true value of measured annual factor productivity increase would likely fall, was estimated, and the 1980 minimum-cost and market-clearing solutions for each of four rates in that range were projected.

The minimum-cost and market-clearing characteristics of the farm industry in 1980 under those four rates are presented in table 6. Factor productivity increase at the rate of 1.75 percent had also been included in table 4, where it was compared with various 1959 situations.

In general, when resource productivity was assumed to increase at relatively high rates, less labor and capital would be required in the aggregate North Central Region. There would also be a greater volume of production generated, product prices would be lower, and total value of production would be lower.

There would be more acres per farm at the higher rates of productivity increase. The value of land would be lower.

Alternative Assumption Concerning Elasticity of Demand

The preceding discussion and the projections reported in tables 4, 5 and 6 were based on a demand function for farm products assumed linear in logarithms. The demand equation was expressed as:

$$Q + aP^{-0.23}, \text{ or}$$
$$\log Q = \log a - 0.23 \log P$$

where Q = quantity of farm products demanded, P = price of farm products, a = a constant and −0.23 = projected price elasticity of demand for farm products in 1980.

Empirical evidence was not available that could be used to establish the price elasticity of demand for farm products at the price levels considered in our study. It could reasonably be assumed, however, that, as farm product prices declined from the 1959 level, United States farm production would become more

Table 6. Characteristics of the commercial farm sector of the North Central states, 1959 observed organization and projected 1980 income efficient organization under alternative factor productivity assumptions.

Characteristics	Unit	1959 observed organization	1980 income efficient organization: Factor productivity increase per year 1.5 percent	1.75 percent	2.0 percent	2.25 percent
Regional values:						
Number of farms	(thousands)	1,171	370.8	354.0	338.3	323.1
Value of land and buildings	(millions)	$52,720	$51,315	$51,315	$51,315	$51,315
Months of labor	(thousands)	19,002	5,489	5,241	5,007	4,782
Value of capital	(millions)	$21,599	$13,425	$12,822	$12,246	$11,696
Gross production	(millions)	$10,041	$14,671	$14,893	$15,135	$15,344
Product price level	(1959=1.00)	1.00	0.79	0.74	0.69	0.65
Per farm values:						
Acres of land		314	961	1,006	1,053	1,103
Value of land and buildings	(thousands)	$ 45	$ 138	$ 145	$ 152	$ 159
Months of labor		16.2	14.8	14.8	14.8	14.8
Value of capital	(thousands)	$ 18.4	$ 36.2	$ 36.2	$ 36.2	$ 36.2
Gross production	(thousands)	$ 8.6	$ 31.3	$ 31.1	$ 30.9	$ 30.6
Factor earnings	(thousands)	$ 2.8	$ 16.6	$ 16.4	$ 16.2	$ 15.9
Factor opportunity costs	(thousands)	$ 9.4	$ 16.6	$ 16.4	$ 16.2	$ 15.9
Residual to land capitalized into a value per acre			$ 102	$ 94	$ 89	$ 83

Table 7. Characteristics of the minimum-cost and market-clearing farm industry in the North Central Region in 1980 with four rates of resource productivity increase, linear arithmetic demand function.

Item	Unit	Factor productivity increase per year, compounded: 1.5 percent	1.75 percent	2.00 percent	2.25 percent
North Central Region totals:					
Number of farms	(thousands)	340	322	305	288
Acres of land	(thousands)	356,350	356,350	356,350	356,350
Value of land and buildings	(millions)	$ 51,315	$ 51,315	$ 51,315	$ 51,315
Months of labor	(thousands)	5,033	4,767	4,508	4,267
Value of capital	(millions)	$ 12,312	$ 11,662	$ 11,028	$ 10,438
Gross production	(millions)	$ 14,827	$ 15,986	$ 15,114	$ 15,242
Product price level (1959 prices = 1.00)		.71	.66	.62	.58
Per farm:					
Acres of land		1,048	1,106	1,170	.1,236
Value of land and buildings		$151,000	$159,000	$168,000	$178,000
Months of labor		14.8	14.8	14.8	14.8
Value of capital		$ 36,200	$ 36,200	$ 36,200	$ 36,200
Gross production (total revenue)		$ 31,000	$ 31,000	$ 31,000	$ 31,000
Factor earnings		$ 16,200	$ 16,000	$ 16,000	$ 15,900
Factor opportunity costs		$ 16,200	$ 16,000	$ 16,000	$ 15,900
Residual to land capitalized into a value per acre		$ 102	$ 94	$ 89	$ 84

competitive in world markets. Additionally, as farm product prices declined, price relationships would shift so that it would be economically feasible to use some farm products as industrial inputs in production processes not presently in widespread use. These two demand components would tend to make the assumption that the demand function was linear in logarithms appear reasonable.

However, since the projections pertain to product price levels beyond empirical experience, an alternative assumption concerning elasticity of demand for farm products was considered.

Table 7 reports the characteristics of the minimum-cost and market-clearing farm industry in the North Central Region in 1980 under four rates of resource productivity increase, with an arithmetically linear demand function. Data are directly comparable to those, presented in table 6, that represent the same conditions, except that the demand function was linear in logarithms (had constant price elasticity) instead of being arithmetically linear. At any given product-price level the quantity of production demanded would be relatively less under the assumption of an arithmetically linear demand function. Thus, in table 7, the level of aggregate production is less than the level presented in table 6 for any price level. With a lower level of production, less labor and capital would be required in the aggregate, and there would be fewer, more extensively organized farms.

Characteristics by States

The resource and production characteristics of the farming industry are presented by states in tables 8-20. The observed situation, minimum-cost reorganization and market-clearing reorganization for 1959 are included, as well as the 1980 minimum-cost and market-clearing situation with 1.75-percent productivity increase and with farm product demand characterized by constant elasticity.

Table 8. Ohio resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		85,008	72,234	—15	19,983	—76	24,183	—72
Acres of land	(thousands)	14,914	14,914	0	14,914	0	13,777	— 8
Value of land and buildings	(millions)	$ 3,770.7	3,770.7	0	3,770.7	0	3,469	— 8
Months of labor	(thousands)	1,412	1,528	8	426.7	—70	357	—75
Value of capital	(millions)	$ 1,387	2,632.6	90	742.9	—46	733.6	—47
Gross production	(millions)	$ 626.7	1,877	200	620.3	— 1	1,018.8	63
Per farm:								
Acres of land		175	206	18	746	326	570	226
Value of land and buildings		$ 44,357	52,202	18	188,961	326	144,604	226
Months of labor		16.6	21.2	28	21.4	29	14.8	—11
Value of capital		$ 16,317	36,446	123	37,176	128	30,334	86
Gross production		$ 7,372	25,988	253	31,041	321	31,175	323
Factor earnings		$ 1,663	14,571	776	19,212	1,055	16,075	867
Factor opportunity costs		$ 9,493	14,571	53	19,212	102	16,075	69
Residual to land capitalized into value per acre		.....	240	— 5	176	—30	179	—29
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 9. Indiana resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		83,931	47,098	—44	16,471	—80	20,330	—76
Acres of land	(thousands)	16,262	16,262	0	16,262	0	15,145	— 7
Value of land and buildings	(millions)	4,402	4,402	0	4,402	0	4,078.8	— 7
Months of labor	(thousands)	1,294	1,082	—16	384.8	—70	290.7	—78
Value of capital	(millions)	1,427.9	2,480	74	869.9	—39	839.9	—41
Gross production	(millions)	733.7	1,679.8	129	686.6	— 6	1,104.7	51
Per farm:								
Acres of land		194	345	78	987	409	745	284
Value of land and buildings		52,452	93,472	78	266,981	409	201,416	284
Months of labor		15.4	23.0	49	23.4	52	14.3	— 7
Value of capital		17,014	52,661	210	52,814	210	41,315	143
Gross production		8,742	35,666	308	41,687	377	40,210	360
Factor earnings		2,925	19,618	571	25,656	777	19,449	565
Factor opportunity costs		9,591	19,618	105	25,656	168	19,449	103
Residual to land capitalized into value per acre		.....	262	— 2	207	—22	186	—30
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 10. Illinois resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		123,328	83,631	—32	30,981	—75	39,580	—68
Acres of land	(thousands)	28,625	28,625	0	28,625	0	27,849	— 3
Value of land and buildings	(millions)	9,154	9,154	0	9,154	0	8,879	— 3
Months of labor	(thousands)	2,023	1,704	—16	653	—68	571.9	—72
Value of capital	(millions)	2,588	3,926	52	1,509	—42	1,597	—38
Gross production	(millions)	1,426	3,056	114	1,285	—10	2,103.6	47
Per farm:								
Acres of land		232	342	47	924	298	704	203
Value of land and buildings		74,229	109,462	47	295,487	298	224,914	203
Months of labor		16.4	21.1	29	21.1	29	14.4	—12
Value of capital		20,985	46,976	124	48,723	132	40,354	92
Gross production		11,566	34,820	201	41,472	259	39,311	240
Factor earnings		4,904	18,833	284	25,263	415	19,677	301
Factor opportunity costs		12,240	18,833	54	25,263	106	19,677	61
Residual to land capitalized into value per acre		.....	314	— 2	242	—24	205	—36
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 11. Michigan resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		65,042	41,320	—36	16,435	—75	18,524	—72
Acres of land	(thousands)	11,385	11,385	0	11,385	0	10,199	—10
Value of land and buildings	(millions)	2,184	2,184	0	2,184	0	1,967	—10
Months of labor	(thousands)	1,112	957	—14	390	—65	269	—76
Value of capital	(millions)	891.8	1,382.7	—55	550.5	—38	480.4	—46
Gross production	(millions)	470.6	1,022	117	445.3	— 5	721	53
Per farm:								
Acres of land		175	276	58	693	296	551	215
Value of land and buildings		33,574	53,047	58	132,869	296	105,758	215
Months of labor		17.1	23.2	36	23.7	39	14.5	—15
Value of capital		13,712	33,463	144	33,494	144	25,932	89
Gross production		7,235	24,740	242	27,094	275	28,804	298
Factor earnings		1,789	14,560	714	16,826	841	14,398	705
Factor opportunity costs		8,880	14,560	64	16,826	89	14,398	62
Residual to land capitalized into value per acre		.....	172	—11	127	—35	166	—14
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 12. Wisconsin resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		106,691	79,077	—26	33,486	—69	37,426	—65
Acres of land	(thousands)	19,079	19,079	0	19,079	0	17,882	— 6
Value of land and buildings	(millions)	2,511	2,511	0	2,511	0	2,360	— 6
Months of labor	(thousands)	1,787	1,739	— 3	732.5	—59	650.8	—64
Value of capital	(millions)	1,967	2,430	24	1,033	—47	1,092	—44
Gross production	(millions)	768.8	1,556.6	102	717.5	— 7	1,167	52
Per farm:								
Acres of land		179	241	35	570	218	478	167
Value of land and buildings		23,538	31,758	35	74,851	218	62,846	167
Months of labor		16.7	22.0	32	21.9	31	17.4	4
Value of capital		18,440	30,732	67	30,875	67	29,199	58
Gross production		7,206	19,684	173	21,425	197	23,075	220
Factor earnings		1,524	11,114	629	12,807	740	12,989	752
Factor opportunity costs		8,205	11,114	35	12,807	56	12,989	58
Residual to land capitalized into value per acre		.....	129	— 2	111	—16	156	18
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 13. Minnesota resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		120,301	71,370	—41	33,339	—72	37,534	—69
Acres of land	(thousands)	28,318	28,318	0	28,318	0	27,561	— 3
Value of land and buildings	(millions)	4,471	4,471	0	4,471	0	4,337	— 3
Months of labor	(thousands)	1,953	1,345	—31	621.4	—68	512.3	—74
Value of capital	(millions)	1,996	2,549	28	1,165	—42	1,106	—45
Gross production	(millions)	1,028	2,298	123	841.7	—18	1,373	34
Per farm:								
Acres of land		235	397	69	849	261	734	212
Value of land and buildings		37,172	62,657	69	134,133	261	115,977	212
Months of labor		16.2	18.8	16	18.6	15	13.6	—16
Value of capital		16,592	35,871	116	34,947	111	29,464	78
Gross production		8,546	23,319	173	25,246	195	27,074	217
Factor earnings		2,961	12,924	336	15,044	408	14,401	386
Factor opportunity costs		8,483	12,924	52	15,044	77	14,401	70
Residual to land capitalized into value per acre		.....	150	— 5	103	—35	128	—19
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 14. Iowa resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		154,329	91,368	—41	41,046	—73	49,086	—68
Acres of land	(thousands)	32,894	32,894	0	32,894	0	32,369	— 2
Value of land and buildings	(millions)	8,415	8,415	0	8,415	0	8,247	— 2
Months of labor	(thousands)	2,431	1,824	—25	819.7	—66	714.9	—71
Value of capital	(millions)	3,597	4,163	16	1,853	—49	1,682	—53
Gross production	(millions)	1,394	2,613	87	1,293	— 7	2,109	51
Per farm:								
Acres of land		213	360	69	801	276	659	209
Value of land and buildings		54,526	92,100	69	205,013	276	168,485	209
Months of labor		15.8	20.0	27	20.0	27	14.6	— 8
Value of capital		23,309	45,565	95	45,134	94	34,262	47
Gross production		9,030	28,596	217	31,492	249	31,794	252
Factor earnings		3,160	16,660	427	19,647	522	16,896	435
Factor opportunity costs		10,403	16,660	60	19,647	89	16,896	62
Residual to land capitalized into value per acre		.....	243	— 4	188	—26	181	—29
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 15. Missouri resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		106,678	53,757	—50	24,259	—77	26,262	—75
Acres of land	(thousands)	27,399	27,399	0	27,399	0	26,511	— 3
Value of land and buildings	(millions)	3,147	3,147	0	3,147	0	3,053	— 3
Months of labor	(thousands)	1,699	1,107	—35	546.8	—68	484.7	—71
Value of capital	(millions)	1,722	1,693	— 2	770	—55	847.7	—51
Gross production	(millions)	721.3	1,272	76	621.2	—14	1,011	40
Per farm:								
Acres of land		257	510	98	1,129	339	1,010	293
Value of land and buildings		29,504	58,548	98	129,523	339	115,951	293
Months of labor		15.9	20.6	30	22.5	42	18.5	16
Value of capital		16,139	31,503	95	31,749	97	32,279	100
Gross production		6,726	23,666	250	25,606	279	28,507	322
Factor earnings		2,227	12,845	477	14,080	532	15,849	612
Factor opportunity costs		8,167	12,845	57	14,080	72	15,849	94
Residual to land capitalized into value per acre		.....	96	—17	55	—53	91	—22
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 16. North Dakota resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		50,407	23,805	—53	14,522	—71	15,595	—69
Acres of land	(thousands)	40,312	40,312	0	40,312	0	39,855	— 1
Value of land and buildings	(millions)	2,099	2,099	0	2,099	0	2,068.9	— 1
Months of labor	(thousands)	809.5	501.9	—38	305.9	—62	201.9	—75
Value of capital	(millions)	813.9	933.4	15	567.6	—30	821.8	1
Gross production	(millions)	424.1	712.7	68	433.4	2	705.6	66
Per farm:								
Acres of land		800	1,693	112	2,776	247	2,556	220
Value of land and buildings		41,649	88,192	112	144,567	247	133,277	220
Months of labor		16.1	21.1	31	21.1	31	13.0	—19
Value of capital		16,147	39,210	143	39,087	142	52,698	226
Gross production		8,414	29,939	256	29,845	255	33,483	298
Factor earnings		2,019	16,480	716	16,396	712	17,484	766
Factor opportunity costs		8,751	16,480	88	16,396	87	17,484	100
Residual to land capitalized into value per acre		.....	45	—13	27	—48	45	—13
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 17. South Dakota resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		49,681	26,446	—47	13,527	—73	14,829	—70
Acres of land	(thousands)	43,256	43,256	0	43,256	0	42,331	— 2
Value of land and buildings	(millions)	2,198	2,198	0	2,198	0	2,152	— 2
Months of labor	(thousands)	796.5	511	—36	264.6	67	189.4	—76
Value of capital	(millions)	1,013	1,193	18	621.7	—39	786.1	—22
Gross production	(millions)	417.8	733.9	76	392.4	— 6	638.2	53
Per farm:								
Acres of land		871	1,636	88	3,198	267	2,855	228
Value of land and buildings		44,261	83,149	88	162,560	267	145,132	228
Months of labor		16.0	19.3	21	19.6	22	12.8	—20
Value of capital		20,395	45,121	121	45,967	125	53,010	160
Gross production		8,411	27,751	230	29,007	245	31,845	279
Factor earnings		2,727	15,541	470	16,631	510	17,220	531
Factor opportunity costs		9,119	15,541	70	16,631	82	17,220	89
Residual to land capitalized into value per acre		.....	43	—16	28	—45	40	—22
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 18. Nebraska resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		80,847	37,386	—54	21,992	—73	23,949	—70
Acres of land	(thousands)	46,978	46,978	0	46,978	0	46,586	— 1
Value of land and buildings	(millions)	4,120	4,120	0	4,120	0	4,079	— 1
Months of labor	(thousands)	1,284.8	771.4	—40	450.7	—65	349.6	—63
Value of capital	(millions)	2,107.8	1,993.9	— 5	1,163.5	—45	1,178.8	—44
Gross production	(millions)	764.6	1,290.2	69	750.6	— 2	1,224.5	60
Per farm:								
Acres of land		581	1,257	116	2,136	268	1,945	235
Value of land and buildings		50,967	110,215	116	187,364	268	170,739	235
Months of labor		15.9	20.6	30	20.5	29	14.6	— 8
Value of capital		26,071	53,334	105	52,907	103	49,221	89
Gross production		9,458	34,511	265	34,130	261	37,835	300
Factor earnings		2,233	18,753	740	18,286	719	19,240	762
Factor opportunity costs		10,364	18,753	81	18,286	76	19,240	86
Residual to land capitalized into value per acre		.....	84	— 5	46	—48	69	—22
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 19. Kansas resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		83,096	58,027	—30	21,305	—74	24,228	—71
Acres of land	(thousands)	48,092	48,092	0	48,092	0	47,151	— 2
Value of land and buildings	(millions)	4,756	4,756	0	4,756	0	4,655	— 2
Months of labor	(thousands)	1,249	1,230	— 2	448.4	—64	296	—76
Value of capital	(millions)	1,486	2,402	62	905.6	—39	965.8	—35
Gross production	(millions)	762.1	1,859.8	144	749.7	— 2	1,219	60
Per farm:								
Acres of land		579	829	43	2,257	290	1,946	236
Value of land and buildings		57,235	81,962	43	223,235	290	192,143	236
Months of labor		15.0	21.2	41	21.0	40	12.2	—19
Value of capital		17,890	41,395	131	42,511	138	39,865	123
Gross production		9,171	32,051	249	35,191	284	37,242	306
Factor earnings		2,865	16,666	482	19,892	594	17,495	511
Factor opportunity costs		9,873	16,666	69	19,892	101	17,495	77
Residual to land capitalized into value per acre		.....	91	— 8	60	—39	67	—32
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Table 20. Kentucky resource and production characteristics of farming in 1959 and projected for 1980.

Item	Unit	Observed 1959 situation	Minimum-cost reorganization 1959	Percentage change from 1959 observed situation	Market-clearing reorganization 1959	Percentage change from 1959 observed situation	1980 minimum-cost and market-clearing situation with productivity increase 1.75 percent compounded annually	Percentage change from 1959 observed situation
Subregion totals:								
Number of farms		61,750	24,825	—60	18,837	—69	22,666	—63
Acres of land	(thousands)	9,832	9,832	0	9,832	0	9,130	— 7
Value of land and buildings	(millions)	1,487.8	1,487.8	0	1,487.8	0	1,383.6	— 7
Months of labor	(thousands)	1,150.8	498.5	—57	375.5	—67	291.8	—75
Value of capital	(millions)	600.2	594.7	— 1	429.4	—28	400.8	—33
Gross production	(millions)	503.2	417.4	—17	305.1	—39	497.5	— 1
Per farm:								
Acres of land		159	396	149	522	228	403	153
Value of land and buildings		24,094	59,933	149	78,985	228	60,958	153
Months of labor		18.6	20.1	8	19.9	7	12.9	—31
Value of capital		9,721	23,958	146	22,800	135	17,686	82
Gross production		8,150	16,815	106	16,201	99	16,242	99
Factor earnings		4,563	11,631	155	11,713	157	9,275	103
Factor opportunity costs		6,684	11,631	74	11,713	75	9,275	39
Residual to land capitalized into value per acre		.....	146	— 8	122	—23	131	—18
Farm product price (1959 = 1.00)		1.00	1.00	.....	.97	— 3	.74	—26

Limitations of the Study

It is important to consider the estimates and projections only in light of the purpose for which they were developed, the assumptions underlying them and the data sources. In several cases, alternative sets of estimates or projections were made where an *a-priori* basis for a unique value was lacking. For example, four projected rates of increase in factor productivity were explored. The problem of farm product mix was not considered. It was indicated previously that the farm industry has a greater internal capacity to deal with this type of problem than with imbalances in resource cost or level-of-industry production. It was thus considered a problem of lesser importance. It was also indicated that, as the ratio of capital plus labor inputs per unit of land was decreased in reducing total volume of output, change in product mix was likely to occur. Thus, intensive livestock or cropping systems would give way to more extensively organized activities. This seemed a reasonable hypothesis. The problem was complicated, however, by relative product prices being implicitly held at their base period relationships. Beef cattle and hog prices were adjusted to their cyclical mean levels, but other product prices held the same relationships to each other as existed in 1959. Had the price of some major product deviated more widely from its long-run equilibrium price than other product prices, then some distortion may have entered the study. The distortion would occur in an intrastate subregion if the product whose price was out of line was the only major production activity in that area. For a hypothetical example, wheat might have been priced "high" relative to a more extensively organized production activity; for example, beef cow herds. Under those hypothetical conditions, a subregion specializing in wheat production but suitable for beef cow herds would have experienced more reorganization and extensification than was estimated. As a result, the study would have underestimated the magnitude of the adjustments.

Two alternatives concerning the demand schedule for farm products in 1959 and 1980 were explored. Sets of estimates and projections were made for a demand schedule that was arithmetically linear and for a schedule with constant price elasticity (linear in logarithms). A third alternative, elasticity being an increasing absolute negative value as farm product prices fell, was not included. Although there may have been an intuitive basis for including this kind of a function, there was little empirical basis for establishing a projected value for elasticity in the 1980 situation.

The 1959 Census of Agriculture was the major source of data in making the estimates concerning the observed situation in the farming industry in 1959. They were supplemented with USDA and farm-business-record data, particularly in estimating farm operating expenses and value of machinery. If the adjustments made to the various data to make them comparable were not adequate, then the estimates presented in the study may not reflect the true situation in the farm industry in 1959.

Data from individual farm records were examined, and those farms with the largest positive excess of factor earnings over factor opportunity costs (or least negative residual) were selected to represent farms ap-

proximating the economic efficiency conditions. The professional supervision given the farm operators in their accounting efforts was generally adequate to insure over-all reliability of the farm record data. However, farm record data from areas that lacked supervision might have lacked reliability. Also, only a few farm records were available from some intrastate subregions, which was a limitation of this source of data. And there was no assurance that the farms with the largest excess of factor earnings over factor opportunity costs had been included in the record-keeping groups.

An extensification regression was developed from farm record data in most intrastate subregions, but where numbers of farms were lacking, interstate data were used. Generally, the data fit linear functions well, but since the regression equation could be interpreted to be a production function, it would have been untenable to assume that the linearity could be extrapolated indefinitely beyond the range of observations. In some subregions, it was necessary, however, to extrapolate beyond the range of experience toward the origin, which could have raised questions concerning the realism of the farms so defined if there had not been more extensive types of farming alternatives for that area.

The proportions of nonland inputs on well-organized farms in 1980 were projected by extrapolating the changes in input mix that had taken place on all farms in the base period. Insofar as the changes in prices and technology that caused shifting among inputs on all farms in the base periods would not cause similar shifting among inputs on well-organized farms between the base period and 1980, the nonland resource mix projected for 1980 farms would contain an element of error. A set of projections for each of four rates of increase in factor productivity were made, selected from the range of values that appeared reasonable after observing trends in the base period. There was no empirical basis for selecting one rate as the true rate.

It was assumed that the observed price of land per acre in 1959 adequately reflected differentials in productivity and that a dollar's worth of land was homogeneous in respect to its ability to produce. Input of land was measured in value terms throughout the analysis. Since the unit of land in the analysis was basically 1 dollar's worth of land, the marginal physical product and marginal value product of land were directly related to the observed price of land per acre in 1959. The equilibrium product price in each subregion in the 1980 projections was determined by equating the capitalized marginal value product of land per acre with the capitalized residual per acre derived when nonland factors were paid their opportunity costs. Thus, equilibrium product price reflected observed land price per acre, and if observed land price did not accurately measure land productivity, there would be inconsistencies generated between subregions.

This may partly explain why equilibruim product price varied slightly among the 71 intrastate subregions. Also, it was implicitly assumed that the opportunity cost rates for nonland inputs approximated their marginal value products. Any deviations in reality from this assumption would be reflected in the residual allocated to land and thus affect the equilibrium product price. Thus, there were opportunities for the equilibrium product price in the individual subregions to contain an error component. This tended to limit the precision of the projections on a subregion basis and would suggest that relatively small differences among the subregions or states in characteristics might be more apparent than real.

APPENDIX A: WEATHER INDEXES

In calculating the quantity of farm production in 1959 and other years, consideration was given to the effects of abnormal weather on per-acre yields and total crop production. The productivity of resources employed would not have been accurately measured if weather was particularly favorable or unfavorable for crop production.

Weather indexes were calculated for each subregion for all major crops. This recognized weather variability within, as well as among, states and the unequal effect of weather on different crops. The weather index for a particular crop for a given year was calculated by dividing the observed crop yield per acre by the normal yield per acre, the normal yield being an estimate of the yield in the absence of short-run weather deviations during that crop production period.

Normal crop yield can be represented by a trend line in per-acre yields over time with the weather index measuring the magnitude of the observed yield deviations from the trend line. The slope of the trend line represents the combined effect of all variables influencing crop yields per acre over time. These include the changing form and level of capital and labor inputs on land, as well as weather cycles or trends, if any.

The slope of the trend line was estimated on a state basis, and one point on the trend line was estimated for each subregion from aggregated county yield data. Given these two variables the trend line was estimated.

Slope of the trend line

It was assumed that the variables affecting the slope of the trend line would have a relatively uniform impact within a state, but might vary over larger geographical areas; i.e., between states. A linear trend

line was fitted to state yield data for a series of years by using the least-squares regression technique. The b-value obtained by using state data was used as the slope of the trend lines for that crop in all subregions in that state.

The b-value was very sensitive to the time period selected. For example, Iowa experienced unusually low state average corn yields of 23 and 18 bushels per acre in 1934 and 1936 and high yields of 76, 77 and 80 bushels per acre in 1961, 1962 and 1963. The mean yield for that 30-year period was 53 bushels per acre. A linear regression fitted to Iowa corn-yield data from 1934 through 1963 included these five unusual years and had a slope of 1.13 bushels per year. However, a regression fitted to the years 1937 through 1960 yielded a trend line with a slope of only 0.495. Thus, removing two years of low yields from the beginning of the period and three years of high yields from the end of the period resulted in a function with less than half the slope. Similar situations in crop yields also existed elsewhere in the region.

Since the purpose in developing the trend line was to estimate yields produced with normal weather, a period relatively free of years with unusual yields was selected. The 24 years from 1937 through 1960 were selected, and the b-values were obtained from linear regressions fitted to yield data for those years.

Locating a point on the yield trend line

Points on the yield trend line were estimated for every major crop in each subregion. The mean yield per acre for the 5 years, 1956 through 1960, was determined. It was assumed that this mean was the normal yield for the median year 1958 and that this was a point on the linear trend line. By using the b-value for the state, normal yield for any other year could then be estimated.

Crop yields were available by subregions only for the census years. Annual yields were reported for the state crop-reporting districts used by the USDA Statistical Reporting Service, but they did not correspond well with census subregions. It was necessary to develop subregion mean yields by aggregating county yield data. The calculation of b-values by states was based on state yield data.

To illustrate the procedure followed, the point on the trend line for corn for Iowa Subregion 1 was estimated in the following manner. The mean yield for 1956 through 1960 was determined by summing total corn production in the counties included in Subregion 1 and dividing by the total acres. The counties included were Guthrie, Adair, Adams, Taylor, Wapello, Jefferson, Davis, Van Buren and all the counties in the South Central Crop Reporting District. This weighted mean was 52.4 bushels per acre. This was assumed the normal yield for the median year of this series, 1958.

In general form, normal yield was estimated by:

$$\hat{Y} = a + bX,$$

where $\hat{Y}$ was the estimated normal yield of a given year, a was the 1958 normal yield, b was the slope coefficient and X was the time interval in years between 1958 and the year for which the estimate was being made. In the following examples, $X = 1$ when estimating the 1959 normal yield, and $X = 4$ when estimating the 1962 normal yield. For years preceding 1958, negative values would be used.

Since the b-value represents the annual bushel increment in yield per acre, the 1959 normal yield was estimated by summing the 1958 normal yield, plus one times the b-value:

$$52.4 + 1\ (0.495) = 52.895 \text{ bushels}$$

Normal yield for 1962 was estimated as:

$$52.4 + 4\ (0.495) = 54.38 \text{ bushels}$$

APPENDIX B: CYCLICAL ADJUSTMENTS IN OBSERVED HOG AND CATTLE NUMBERS AND PRICES AND RELATED ADJUSTMENTS IN FEED USE

Hogs and cattle sold were included in determining value added by livestock production, a component of gross production and factor earnings. The number of both hogs and cattle tend to fluctuate cyclically over time. For hogs, the complete cycle from peak to peak last from 3 to 5 years; for cattle the cycle is longer.

Sales of hogs and cattle were adjusted in both price and quantity to correspond to cyclical mean levels. This reduced the probability that measured factor productivity was affected by unusually favorable or unfavorable prices.

The adjustment in livestock numbers required a related adjustment in the concentrate-equivalent feed fed, the value of which was added to or subtracted from livestock sales.

Cyclical hog adjustments

The first step was to identify the hog cycle. Data for hog Jan. 1 inventories on United States farms were published each year (21, 23), and hog cycles were identified by the fluctuations in the Jan. 1 numbers. The 7 years beginning Jan. 1, 1956, and ending Dec. 31, 1963, represented two successive hog cycles. Jan. 1, 1956, was the peak in a hog cycle, with hog numbers exceeding 55 million head; 1956 was a year of de-

clining hog numbers, and the valley in the hog cycle was reached Jan. 1, 1958, with about 51½ million head. The second peak, representing the end of the first cycle, was reached on Jan. 1, 1960, with over 59 million head reported. The valley on this second cycle was recorded Jan. 1, 1961, and the final peak was reached on Dec. 31, 1962, when hog numbers exceeded 56.9 million head. The base year in our study, 1959, was the median year in these two successive hog cycles, 1956-1963.

Mean United States hog prices held a nearly constant relationship with the prices of other farm products during this 7-year period. The ratio of the index of farm prices received by farmers for all farm products to the mean United States price for hogs remained about constant. Hog prices did not need adjusting to compensate for a trend in the index of all farm prices received.

The mean price received per hundredweight for all hogs sold in the United States during the 1956-63 hog cycle was $16.32. The observed price received for all hogs in the United States in the base year, 1959, was $14.10. The price difference was $2.20 per hundredweight. Dividing $2.20 by $14.10 equals 0.156; that is, a 15.6-percent price rise was needed to raise the 1959 observed price to the mean cyclical hog price.

To calculate the decrease in hog production that would have been required to raise prices 15.6 percent, the estimate of price elasticity of farm level demand for hogs, -0.4578, developed by Brandow was used (3). The product of 0.156 multiplied by -0.4578 equals -0.071417. This decrease, 7.14 percent, was the decrease in hog numbers that would have been required to accomplish the $2.20 per hundredweight price rise in 1959.

Cyclical beef cattle adjustments

The cattle cycle was typically longer than the hog cycle. The two most recently completed cattle cycles each took 6 years from the valley to the following peak in cattle numbers. With Jan. 1 inventories, cattle on farms and ranches were low on Jan. 1, 1938. The following high was recorded 6 years later on Jan. 1, 1944. The next low, Jan. 1, 1949, was followed by a peak 6 years later on Jan. 1, 1955. The most recent low was Jan. 1, 1958. The inventory on Jan. 1 of each succeeding year since then increased over the immediately preceding year, including Jan. 1, 1964, the last available data used in this study.

The mean price received per hundredweight for all beef cattle sold during the 1955-1963 period was $19.38 per hundredweight. The observed price received for all beef cattle sold in the United States in the base year, 1959, was $22.60. The price difference was $3.22 above the cyclical mean price level. This was 14.25 percent and indicated the decline from 1959 prices necessary to reach the cyclical mean level. To calculate the increase in beef cattle production required to depress prices 14.25 percent, the price elasticity of farm level of demand for cattle was used. In the Brandow publication (3), this price elasticity is -0.6836.

The price elasticity, -0.6836, multiplied by the percentage decrease in prices needed, -0.1425, equals 0.0974, the increase in beef cattle sold that would have caused the 14.25-percent price decline.

Concomitant adjustments in feed use

In calculating the value of total livestock and livestock products sold, price and quantity adjusters were used to adjust the observed values of hog and cattle sales. This took into account both the price change required for the 1959 price to equal the cyclical mean price and the associated quantity changes required to bring about that price change. The effect of the changes in hog and cattle numbers on the quantity of feed consumed also was estimated. The required changes in numbers of hogs and cattle were estimated and converted into uniform grain-consuming animal units to facilitate estimating the net change in corn-equivalent consumption (32). The value of the change in consumption was determined and included as a positive or negative value in calculating the total value of livestock and livestock products sold.

The value of the change in concentrate consumption was greatest in central and southern Nebraska, where a net increase of $9.7 million in concentrate cost was estimated. Total adjusted value of livestock sales exceeded $343 million in that subregion. Central Indiana experienced the largest decrease in concentrate cost, resulting from a relatively large hog decrease and small cattle decrease. The decrease in feed cost was $3.4 million, compared with a total adjusted value of livestock sales of $267 million. The changes in concentrate cost generally were small percentages of the total livestock sales in their respective subregions.

Table B-1. Adjusted value of livestock and livestock products sold in Iowa Subregion 1 in 1959.

Class of livestock	Value of sales	
Hogs and pigs observed	$58,431,780	
Hogs and pigs (price & quantity adjusted)		$ 62,726,516
Cattle and calves (observed)	73,236,294	
Cattle and calves (price & quantity adjusted)		68,915,353
Sheep and lambs		5,227,935
Milk sold		12,592,493
Chickens including broilers		565,213
Chicken eggs		5,532,823
Miscellaneous poultry products		2,684,651
Horses and mules sold alive		310,404
Goats and kids sold alive		0
Wool short		1,174,186
Mohair		0
Feed adjustment		—36,929
Total adjusted value of livestock & livestock products sold		$159,692,645

To illustrate the adjustment procedures used, the data for Iowa Subregion 1 (southern Iowa) are presented in table B-1.

To account for cyclical effects, there was an estimated reduction in the number of hogs sold in Iowa Subregion 1 of 139,068 and an increase of 42,205 cattle sold. This shift resulted in a net increase in the quantity of corn equivalent fed of about 38,873 bushels. At the average price received by farmers of $0.95 per bushel, this corn equivalent would have cost $36,929, and this value was subtracted from livestock sales as the value of feed adjustment.

The total adjusted value of livestock and livestock product sales in Iowa Subregion 1 was $159,692,645 in 1959, after the adjustments in prices and quantities of hogs and cattle sales and concomitant feed adjustments were made.

APPENDIX C: VARIABLES AND EQUATIONS USED IN THE MINIMUM-COST 1959 REORGANIZATION (FIRST REORGANIZATION)

Known variables for 1959 used in the minimum-cost reorganization and the market-clearing reorganization for 1959 were:

X_1 = acres in commercial farms in the subregion
X_2 = value of farm real estate in commercial farms in the subregion
X_3 = opportunity cost rate for land
X_4 = opportunity cost rate for capital
X_5 = mean land value per well-organized farm
X_6 = mean man-months of labor per well-organized farm
X_7 = mean capital input per well-organized farm
X_8 = gross production per well-organized farm
X_9 = factor earnings per well-organized farm
X_{10} = total opportunity cost of factors per well-organized farm

A series of nine equations was solved independently for each subregion by using the variables to specify the characteristics of the farm industry after the minimum-cost reorganization in 1959. The equations represented a simplified approximation of the relevant relationships believed to exist in the farming industry.

The number of commercial farms per subregion was determined by dividing the value of farm real estate in the subregion by the mean value of land per well-organized farm. This was designated as Y_1:

$$Y_1 = X_2/X_5.$$

The total man-months of labor employed in the subregion was calculated by multiplying the number of farms times the mean man-months per well-organized farm. This variable was Y_2:

$$Y_2 = (Y_1)\ (X_6).$$

The total capital employed in the subregion was calculated by multiplying the number of farms times the mean capital input per well-organized farm. This variable was Y_3:

$$Y_3 = (Y_1)\ (X_7).$$

The total gross production of farms in the subregion was determined by multiplying the number of farms times the mean gross production per well-organized farm. This variable was Y_4:

$$Y_4 = (Y_1)\ (X_8).$$

The mean acres per farm was calculated by dividing the total acres in the subregion by the number of farms and was identified as Y_5:

$$Y_5 = X_1/Y_1.$$

The opportunity cost of the land used per farm was calculated by multiplying the opportunity cost rate for land times the mean value of land per well-organized farm. This variable was Y_6:

$$Y_6 = (X_3)\ (X_5).$$

The opportunity cost of capital used per farm was calculated by multiplying the opportunity cost rate for capital times the mean capital input per well-organized farm, and was identified as Y_7:

$$Y_7 = (X_4)\ (X_7).$$

The total opportunity cost of labor used per farm was calculated by subtracting the opportunity costs of capital and land from the total opportunity cost of factors per well-organized farm. This variable was Y_8:

$$Y_8 = X_{10} - Y_7 - Y_6.$$

The opportunity cost of labor and capital per farm were subtracted from factor earnings per farm. This residual, on a per-acre basis, was capitalized into a land value per acre. This variable was Y_9:

$$Y_9 = X_9 - X_{10} + Y_6/(Y_5)\ (X_3).$$

APPENDIX D: VARIABLES AND EQUATIONS USED IN THE MINIMUM-COST AND MARKET-CLEARING 1959 REORGANIZATION (SECOND REORGANIZATION)

A series of equations was developed to systematically determine the endogenous variables in the market-clearing reorganization. Several variables were considered known in the market-clearing reorganization, including the 10 exogenous variables identified as X_1, $X_2, \ldots, X_{10}$ in the minimum-cost reorganization, re-

ported in Appendix C. Three additional exogenous variables were used:

X_{11} = a-value in the regression equation.
X_{12} = b-value in the regression equation.
X_{13} = quantity of production demanded from commercial farms in the subregion at 1959 product price level.

The nine endogenous variables estimated in the minimum-cost reorganization, identified as Y_1, Y_2, . . . , Y_9, were considered known values for the market-clearing reorganization. Three additional Y variables were estimated and used as known values.

Farm operating expense, plus depreciation, was identified as capital consumed in the production process on the well-organized farms. This variable was identified as Y_{10} and was estimated as gross production minus factor earnings:

$$Y_{10} = X_8 - X_9.$$

Gross production per unit of land in the industry equilibrium situation was designated as Y_{11}. This was the value of $\hat{Y}$ in the extensification equation and was estimated by dividing the subregion share of demand at 1959 product prices by the land input per subregion:

$$Y_{11} = X_{13}/X_2.$$

The X variable in the extensification equation, capital plus labor services per unit of land, was identified as Y_{12}. It was estimated by inserting the values for $\hat{Y}$, a and b into the regression equation and solving for X:

$$Y_{12} = Y_{11} - X_{11}/X_{12}.$$

It was indicated in preceding sections that total farm production could be equated with demand through extensification, product price decline or some combination of the two. Since no criterion was available to *a priori* specify the industry equilibrium output and product price, a range of equilibrium prices was estimated with a high probability that they encompased the true value. The midpoint of that range was assumed the equilibrium product price in 1959.

It was necessary, however, to first calculate the industry production and resource characteristics for a series of product price-extensification combinations to identify that possible range of equilibrium prices. Estimates were calculated for the 1959 product price level (i.e., extensification with no price drop) and several other combinations with a product price drop and extensification. These solutions were examined to estimate the equilibrium price level.

Independent estimates were calculated for each of the 71 subregions for each selected price level. The series of equations that were used are described in the following. Values for each of the Z variables were calculated for a given price level; the price level was then lowered, and another set of solutions estimated in an iterative procedure.

The superscript i on the Z variable identifies the price level. The i = 1, 2, . . . , n, where n equals the number of product price-extensification combinations examined.

The subregion share of farm product demand at the 1959 price level and the price elasticity of demand for farm products were used to estimate the share of demand at a series of product price levels. The subregion share of demand at the i-th price level was identified as $Z_1{}^i$. The physical quantity demanded was multiplied by 1959 prices. The equation used was:

$$Z_1{}^i = (1.23 - 0.23\ P_i)\ (X_{13}).$$

Gross production per dollar of land was calculated by dividing the quantity of farm production by the value of farm real estate in the subregion. This variable was $Z_2{}^i$:

$$Z_2{}^i = Z_1{}^i/X_2.$$

The regression equation was of the form $Y = a + b\ X$, with X the input of capital and labor per dollar of farm land. It was identified as $Z_3{}^i$ and was calculated by solving the regression equation for the X variable:

$$Z_3{}^i = (Z_2{}^i) - (X_{11})/X_{12}.$$

The number of farms in the subregion was calculated by first determining the total input of capital and labor in the subregion. Multiplying the input of capital and labor per dollar of farm land times the total value of farm land in the subregion gave this value. The total capital and labor input in the subregion was divided by the input of capital and labor per farm in the first reorganization to determine the number of farms in the subregion. This variable is identified as $Z_4{}^i$:

$$Z_4{}^i = (Z_3{}^i)\ (X_2)/Y_8 + Y_7 + Y_{10}.$$

The total man-months of labor used in the subregion after the second reorganization was determined by multiplying the number of farms in the subregion by the man-months of labor per farm as estimated in the first reorganization. This variable was $Z_5{}^i$:

$$Z_5{}^i = (Z_4{}^i)\ (X_6).$$

The total capital input in the subregion was estimated by multiplying the number of farms in the subregion by the capital input per farm after the first reorganization. This variable was called $Z_6{}^i$:

$$Z_6{}^i = (Z_4{}^i)\ (X_7).$$

The acres per farm after the second reorganization was determined by dividing the total acres in commercial farms in the subregion in 1959 by the number of farms after the second reorganization. This variable was $Z_7{}^i$:

$$Z_7{}^i = X_1/Z_4{}^i.$$

The value of land and buildings per farm after the second reorganization was calculated by dividing the total value of farm real estate in the subregion in 1959 by the number of farms in the subregion after the second reorganization. This variable was $Z_8{}^i$:

$$Z_8{}^i = X_2/Z_4{}^i.$$

The total revenue per farm was equal to the physical units of production produced per farm multiplied by the price level at which aggregate production would have cleared the market. This variable was $Z_9{}^i$:

$$Z_9{}^i = (Z_1{}^i)\ (P_i)/Z_4{}^i.$$

Factor earnings per farm after the second reorganization were calculated by subtracting the operating expenses and depreciation from the total revenue, as calculated in the preceding equation. This variable was identified as $Z_{10}{}^{i}$:

$$Z_{10}{}^{i} = Z_{9}{}^{i} - Y_{10}.$$

The opportunity cost of land per farm after the second reorganization was calculated by multiplying the value of land and buildings per farm times the opportunity cost rate for land. This variable was $Z_{11}{}^{i}$:

$$Z_{11}{}^{i} = (Z_{8}{}^{i})\ (X_{3}).$$

Total factor opportunity costs per farm after the second reorganization were determined by summing the opportunity cost of land per farm with labor and capital opportunity costs per farm after the first reorganization. This variable was identified as $Z_{12}{}^{i}$:

$$Z_{12}{}^{i} = Z_{11}{}^{i} + Y_{8} + Y_{7}.$$

The residual to land was calculated by subtracting the opportunity cost of labor and capital from factor earnings and dividing by the number of acres per farm to get the land residual on a per-acre basis. This residual was capitalized into a value of land per acre by dividing it by the opportunity cost rate of land. The variable was identified by $Z_{13}{}^{i}$:

$$Z_{13}{}^{i} = Z_{10}{}^{i} - Z_{12}{}^{i} + Z_{11}{}^{i}/(Z_{7}{}^{i})\ (X_{3}).$$

APPENDIX E: ESTIMATION OF EFFECTIVE EXPORT DEMAND FOR UNITED STATES FARM PRODUCTS IN 1959

Exports of farm production in 1959

United States exports of farm production in 1959 dollars were estimated by using two major data sources. Exports under specified government-financed programs and exports outside specified government-financed programs, but including some government subsidization, were reported for calendar year 1959 by the Economic Research Service of the USDA (28). Disposition of Commodity Credit Corporation price-support program commodities as exports was reported by fiscal years by the Agricultural Stabilization and Conservation Services of the USDA (22). The reported CCC dispositions through exports were used in estimating level of exports under various government programs. Total agricultural exports estimated in this manner are reported in table 13.

The total value of agricultural exports was included in the USDA supply-use series, from which the estimate of domestic use was taken, but no allocation was made among government programs and commercial transactions (33, 34). The total reported in the USDA supply-utilization series, however, was similar to the summed total of all agricultural exports in table E-1. It was assumed that the data were comparable and that domestic use reported in the USDA supply-use series could be combined with the itemized estimates of exports to represent the total demand for United States agricultural production in 1959.

Exports as a component of demand in 1959

Takings of farm products that originated from domestic use and unassisted commercial export transactions were components of demand at observed market prices in 1959. Government-assisted exports and exports under government programs, however, could not be considered entirely as parts of the market-clearing demand.

In our study, government export activities were classified into two categories on the basis of the activity objectives. One objective was the reduction of surplus agricultural commodities from storage and markets in the United States. A second objective was to further other goals of the government, such as fostering good will, promoting economic growth and political stability in developing countries, developing stock-piles of strategic materials, and humanitarian goals.

Where the second objective seemed clearly the case, the takings of the government were considered a component of demand. That is, the government agencies exporting farm production for objectives other than surplus disposal were considered demanders of farm production comparable to domestic demanders and unsubsidized commercial exporters.

In table E-1, the donations and barter for strategic materials and overseas services under Title III of Public Law 480 were considered in this category, and their observed values were included at 1959 prices.

Disaster relief under Title II of Public Law 480 was also considered in this category, but was not included at the observed value since that represented CCC costs, not market price. It was assumed that the quantity of commodities involved could have been obtained at market prices and that the ratio of "CCC sales proceeds value" to "CCC cost value" in fiscal 1959 and fiscal 1960 could be used to estimate approximately the market value of the Title III donations in 1959. The value of this ratio was 0.696. Thus, $38,976,000 was considered a component of export demand out of the total observed $56,000,000 when valued at "CCC cost value."

Additionally, exports made with credit extended by the government for short periods were considered entirely a component of demand, implying there would have been no significant change in this value if other sources of credit had been used.

Table E-1. United States exports under specified government-financed programs, and estimated export component of total demand for United States farm production, 1959 (in 1959 dollars).

Government programs or conditions for exporting	Observed values of exports in calendar year 1959	Estimated component of total demand for U.S. farm production[a]
Public Law 480:		
Title I, sales for foreign currency	$ 732,000,000	$ 183,000,000
Title II, disaster relief (value stated as CCC cost)	56,000,000	38,976,000
Title III, donations (value stated as export value)	107,000,000	107,000,000
Title III, barter for strategic materials and overseas services	176,000,000	176,000,000
Mutual Security (AID), Sections 402 and 350, sales for foreign currency and economic aid (value shown is the disbursements for exports)	158,000,000	39,500,000
Total exports outside specified government-financed programs (sales for dollars) including unassisted commercial transactions and shipments of some commodities with government assistance in the form of the following:		
(a) Extension of credit for relatively short periods	30,000,000	30,000,000
(b) Sales of Government owned commodities at less than domestic market prices	123,300,000	30,825,000
(c) Export payments in cash or its kind	101,100,000	25,275,000
Unassisted commercial transactions	2,471,600,000	2,471,600,000
Total agricultural exports, 1959	$3,955,000,000	
Total estimated component of total demand for U.S. farm production, 1959		$3,102,176,000

[a]The estimation of these values was discussed in the text.

The four remaining categories in table E-1 were considered mainly devices for removing surplus agricultural production from United States storage and markets while concomitantly meeting other objectives. Among the remaining categories were sales of government-owned commodities at less-than-domestic market prices. These were valued at $123,300,000 at market prices. Also included were export subsidy payments in cash or kind totaling $101,100,000 at market prices. Also, there were sales for foreign currency under Title 1 of Public Law 480 valued at $732,000,000 and sales for foreign currency and economic aid under Mutual Security (AID), sections 402 and 550, which totaled $158,000,000.

The part of these exports that represented the extent to which they were used to meet nonagricultural objectives of the government were components of demand in the same way that donations and barter for strategic materials under Title III of Public Law 480 were included. The quantity purchased at market price by the recipients in the absence of these programs would also have been a component of demand.

APPENDIX F: LAND IN COMMERCIAL FARMS IN 1959 AND PROJECTED SUPPLY IN 1980

It was necessary to estimate the quantity of farm land that would be available for agricultural uses in 1980 to estimate resource characteristics of the farming industry. The basic procedure was to consider the land supply in 1959 as a base and to subtract from that base the estimated amounts of farm land converted permanently to nonagricultural uses during 1959 to 1980. The residual was considered farm land available for use in 1980. Estimates were prepared in each state by members of the NC-53 committee, guided by procedure developed in Iowa.

Supply of farm land in 1959

The total supply of farm land in 1959 was reported in the Census of Agriculture by commercial and noncommercial farms (19). The quantities of farm land permanently converted to nonagricultural uses during 1959 to 1980 were projected by types of use and for each of the 71 census subregions.

Urban expansion

Organizations responsible for city planning in larger urban places were surveyed concerning their projected requirements for additional farm land by 1980. The organizations included planning and zoning commissions, chambers of commerce and city governments.

Projected land requirements for smaller urban places were determined by multiplying projected population increases by an estimated acreage requirement per person. It was estimated that 0.2 acre of farm land would be required for each person added to the urban population of towns with less than 10,000 population in Iowa, for example. Observed and estimated acres per person in several Iowa towns of different sizes supported use of this rate.

There was some variation among the states in the quantity of farm land estimated as required per person added to the urban population. It was estimated in

Table F-1. Land in commercial farms in 1959 and projected supply in 1980, by states.

State	Land in commercial farms 1959 (acres)	Land in commercial farms 1980 (acres)	Percentage decrease in supply 1959-1980
Ohio	14,914,392	13,776,992	7.6
Indiana	16,261,780	15,145,285	6.9
Illinois	28,625,797	27,849,555	2.8
Michigan	11,385,170	10,198,823	10.5
Wisconsin	19,079,877	17,882,385	6.3
Minnesota	28,318,827	27,561,964	2.7
Iowa	32,894,114	32,369,242	1.6
Missouri	27,399,281	26,511,405	3.3
North Dakota	40,312,669	39,855,123	1.1
South Dakota	43,256,083	42,331,420	2.1
Nebraska	46,978,575	46,586,830	.8
Kansas	48,092,200	47,151,854	2.0
Kentucky	9,832,769	9,130,901	7.2
Total for North Central Region	367,351,534	356,351,779	3.0

Illinois and Michigan that 0.25 acre would be required. In Indiana, it was estimated that 0.16 acre would be needed, and 0.083 acre was estimated in Minnesota. The rest of the states used the value of 0.2 acre per person.

Airport facilities

The Federal Aviation Agency annually prepared a National Airport Plan, which included development considered necessary to provide a system of airports adequate to meet the need of civil aviation (5). The most recent revision of the plan was based on requirements for 1963 to 1967, and estimates by the Federal Aviation Agency had not been made beyond that period. It was assumed that airport development would be carried out as indicated by the National Airport Plan and that a linear extrapolation of the five years included in the 1963 to 1967 plan would accurately project the amount of land required for airport expansion from 1959 to 1980.

Highway expansion

A central highway authority in each state provided data concerning past acquisitions and future requirements for farm land. Land acquired for the interstate and defense system of highways was included, as well as acquisitions by counties for road improvement.

Public recreation areas

Public recreation areas included federal reservoir projects, wet-lands projects, state parks and county recreation areas. The agencies or groups with authority provided data concerning recent expansion of facilities and projected requirements for farm land.

Private recreation areas

The development of privately owned recreation areas was not organized, supervised or regulated by a central planning group or common authority. Little information about its past growth was available, and projections concerning future development of privately owned recreation areas were made with difficulty in all states.

County extension staffs in selected Iowa counties furnished information concerning these recreation areas in their counties. They also reported plans for future projects, including lake developments, church camps, other camps, golf courses and vacation ranches. There was wide variation reported among Iowa counties in the private development of recreation areas. Future acquisition of farm land for this use would likely be influenced by federal reservoir and other projects, state park expansion and county park activities. Projections of land requirements per county were based on mean recent and known future acquisitions.

In Illinois, it was indicated that there would be considerable multiple use of land in private recreation areas, with little if any reduction in farm land. In another state, it was indicated that there was sizable overcapacity in some types of privately owned recreation facilities, even during peak usage periods.

Total nonfarm demand for land 1949-80

The preceding categories covered the major expected sources of nonfarm demand or farm land from 1959 to 1980. In Kansas, the total land in agricultural use had been declining in eastern areas, increasing in western areas and increasing for the state as a whole in every recent census period. For this reason, subregion estimates of total farm land converted to nonagricultural uses during 1959 to 1980 were projected by using a different procedure. The percentage change in agricultural land was regressed with total land area to provide an aggregated projection of farm land converted to nonfarm uses. This procedure gave estimated totals by subregions, but did not provide a breakdown by types of uses.

Demand for land by noncommercial farms

The resource and production characteristics of noncommercial farms had differed historically from commercial farms. Procedures for projecting their 1980 characteristics also were different. For this reason, the demand for land by the three kinds of noncommercial farms was projected separately from the commercial farms. It was assumed that, under Iowa conditions, the number of part-time farms was directly related to the urban employment opportunities available. Thus, the increase in part-time farming opportunities during 1959 to 1980 and the land required by part-time farmers were a direct function of urban expansion. The

rationale for this assumption was that the farm operators could not work off the farm 100 or more days if the jobs were not available and that the increases in number of nonfarm employment opportunities were closely related to increases in urban population.

In Michigan, off-farm employment opportunities were believed related to the location of industries around the state rather than to urban expansion *per se*. Other Michigan studies were used as the basis for estimating a 20-percent increase in part-time farming during the 1959 to 1980 period in the state.

There had been a decline in both part-time and small farms in Illinois before this study. No change in numbers of part-time farms during the 1959 to 1980 period, with the possibility of a decline taking place, was indicated for Illinois.

It was also indicated that a decline in part-time farming might take place in southern Indiana.

It was estimated that no change would occur in the acres held in semiretired farms in Iowa during 1960 to 1980. Data indicated that the percentage of farm operators age 65 and over had been relatively stable from 1940 to 1959, making up about 11 percent of the total farm operators in Iowa (13, 19). Assuming that this percentage remained at 11 percent during 1960 to 1980 and that the relative size of the holdings of farm operators age 65 and over held constant its relationship to the holdings of the remainder of the farm operators, no change would occur in the holdings of semiretired farmers.

It was assumed that the holdings of abnormal farms in Iowa would not change significantly during 1960 to 1980.

An upward trend in numbers of semiretired farmers had been observed in Kansas. The numbers of farmers aged 45-54 years in 1959 supported projected increased numbers of semiretired farmers for 1980.

It was assumed that the demands for land for urban expansion, airport facilities and the other kinds of uses would be filled from land in commercial farms in 1959 in the proportion that land in commercial farms was to total land in farms. This implied that there was no selectivity for either category of farm land for the uses. The increased holdings of part-time, semiretired and abnormal farms, however, all required land that had been in commercial farms in 1959.

APPENDIX G: OPPORTUNITY COST PRICES FOR CAPITAL AND INVESTMENT IN LAND IN 1959 AND PROJECTED PRICES FOR 1980, BY STATES

The opportunity cost rates were based on the average return paid "comparable" resources in the nonfarm economy, and we assumed that these rates reflected the average earnings of roughly comparable resources in their alternative uses. For 1959 the price for capital was measured by the average rate paid on production loans extended by commercial banks and the production credit associations. The rate for investment in land was based on state average rates received by all farm mortgage lenders in 1959.

Rates for 1980 were based on Denison's (4) projections of increased returns to capital investments by 1980.

Table G-1. Opportunity cost rates for capital and investment in land in 1959 and projected for 1980, by states.

State	Capital		Investment in land	
	1959	1980	1959	1980
Ohio	0.0630	0.0715	0.0542	0.0696
Indiana	0.0641	0.0728	0.0525	0.0675
Illinois	0.0622	0.0706	0.0507	0.0651
Michigan	0.0664	0.0754	0.0534	0.0686
Wisconsin	0.0634	0.0720	0.0499	0.0641
Minnesota	0.0665	0.0755	0.0504	0.0648
Iowa	0.0636	0.0722	0.0486	0.0625
Missouri	0.0660	0.0749	0.0537	0.0690
North Dakota	0.0657	0.0746	0.0503	0.0646
South Dakota	0.0673	0.0764	0.0494	0.0635
Nebraska	0.0593	0.0679	0.0494	0.0635
Kansas	0.0621	0.0705	0.0519	0.0667
Kentucky	0.0600	0.0681	0.0551	0.0681

APPENDIX H: PROJECTED FARM RESOURCE COMBINATIONS IN 1980

Projection of physical quantities of inputs

Projections of physical quantities of inputs were made for three classes of labor, three classes of capital and for capital consumption for 1980 based on time-series data. Projections were made by states.

HIRED LABOR

Hours of hired labor input were projected to 1980 from the 1949-through-1963 base period. The state totals for cash wages, perquisites and employers' share of social security taxes (36) were converted into constant dollars (23) and divided by the composite hourly wage (20) to generate an estimate of hours of hired labor in the base period. A downward trend was observed, and the projections for 1980 were made by using a constant percentage decline. Although the data also fit a linear arithmetic function satisfactorily, a linear function would have implied the eventual elimination of hired labor as an input over time.

FAMILY LABOR

The total number of operators plus other family workers also displayed a downward trend in the 1949-through-1963 base period (20). Projections to 1980 were also made by using a constant percentage decline.

The projected number of total operators plus other family workers in 1980 was multiplied by the months of labor per operator plus other family workers in 1959 to estimate total months of operator plus other family labor in 1980. This total was allocated between operators and other family workers in the same proportions that they were of the total in 1959. The months of labor per operator and other family workers in 1959 and the proportions of total months furnished by operator labor and by nonoperator family labor in 1959 were developed from 1959 Census of Agriculture data (19).

Projections by Denison (4) indicated that the work year in nonfarm industries would be about 10.3 months by 1980, and this figure was used as the minimum labor input per well-organized farm in 1980. It was assumed that the proportion of operator labor to other family labor remained constant from 1959 to 1980. Since nonoperator family labor was furnished by the operator's wife and children, to assume a change in the proportion would imply changes in family structure or changes in the willingness or need for the family to provide labor. There was no obvious basis for the latter changes.

LIVESTOCK AND CROP INVENTORIES

Livestock and crop inventories were estimated by states for the base period 1949 through 1963. The sum of the Jan. 1 values of cattle, hogs, sheep and chickens on farms in each year of the base period were considered to make up total livestock inventories on farms (31). Crop inventories for corn, wheat, soybeans, oats and barley were assembled in quantity terms for Jan. 1 of each year (37, 38) and valued in terms of Jan. 15 prices (21). Jan. 1 inventories of hay were estimated to be 68.1 percent of the production of the preceding year, the mean percentage that Jan. 1 United States hay stocks were of the preceding year's production during 1955 through 1960 (23).

Jan. 1 values of livestock and crops were summed for each year, converted to constant dollars, and a linear time series regression was fitted. The regression was evaluated for 1980, yielding the projected livestock and crop inventories.

Estimates were made for each year in the 1949-through-1963 base period, converted to constant dollars and regressed against time in a linear regression. The evaluation of the regression for 1980 served as the projected value for 1980.

CAPITAL CONSUMPTION

The term, capital consumption, in our study represents total production expenses, plus depreciation. Besides production expenses, estimated in projecting the stock of operating capital, we projected depreciation (36). Production expense and depreciation were summed, converted to constant dollars and regressed against time in a linear regression. The years 1949 through 1963 were used for the base period. The 1980 projected values were determined by evaluating the regression for that year.

Aggregation of inputs

The projection to 1980 of physical quantities of several kinds of nonland farm inputs by states was described in the preceding sections. At this stage, the inputs were physical units priced at 1959 prices. An immediate objective was to sum the three kinds of labor inputs into one labor input, the three kinds of capital inventory items into one capital input, and to aggregate these two broader categories with capital consumption. A set of factor prices was needed to make the aggregation.

Also, it was necessary to determine the percentage that each broad category was of the total to project the farm-resource mix in 1980. However, since relative prices of the inputs varied over time, the percent-

Table H-1. Proportions of nonland inputs in Ohio in 1959 and comparisons with five price weighting systems for 1980 projections.

Item	1959 observed proportions	1980 Projected Proportions				
		1949 prices	1963 prices	Geometric mean of 1949 and 1963 prices	1959 prices	1980 prices
Value of labor input	0.414	0.207	0.265	0.235	0.249	0.282
Opportunity cost of capital	0.098	0.099	0.093	0.096	0.094	0.090
Production expense plus depreciation	0.488	0.694	0.642	0.669	0.657	0.628
Total	1.000	1.000	1.000	1.000	1.000	1.000

Table H-2. Individual factor inputs as percentages of total nonland inputs on optimal farms in 1959 and 1980, by states, in constant prices.

State	Optimal farm - 1959			Optimal farm - 1980		
	Value of labor input	Opportunity cost of capital	Capital consumption[a]	Value of labor input	Opportunity cost of capital	Capital consumption[a]
Ohio	0.414	0.098	0.488	0.282	0.090	0.628
Indiana	0.379	0.103	0.512	0.230	0.037	0.673
Illinois	0.365	0.098	0.537	0.249	0.905	0.656
Michigan	0.459	0.098	0.443	0.274	0.037	0.640
Wisconsin	0.424	0.105	0.471	0.334	0.115	0.551
Minnesota	0.413	0.109	0.478	0.289	0.105	0.604
Iowa	0.394	0.116	0.490	0.286	0.102	0.613
Missouri	0.379	0.090	0.531	0.320	0.109	0.571
North Dakota	0.394	0.105	0.501	0.236	0.151	0.613
South Dakota	0.377	0.127	0.496	0.241	0.165	0.594
Nebraska	0.363	0.115	0.522	0.250	0.114	0.635
Kansas	0.366	0.099	0.535	0.209	0.099	0.692
Kentucky	0.475	0.106	0.419	0.354	0.095	0.551
Mean	0.400	0.106	0.494	0.273	0.110	0.617

[a]Capital consumption was the sum of production expenses plus depreciation.

age would vary with whatever set of input prices were used. The observed proportion of nonland inputs in 1959 for Ohio, with comparisons among five possible price-weighting systems for the 1980 projections, are presented in table H-1 as an example of the alternatives available.

It seemed most appropriate to use the projected 1980 input prices since later stages of the analysis would be in terms of that year.

Individual inputs as percentages of total inputs

The projected physical quantities of nonland inputs in 1980 were multiplied by their respective 1980 projected prices and summed. This aggregated total was used as the denominator in calculating the percentage that each major category of nonland input was of total inputs. The three major categories were value of labor, the opportunity cost of capital and capital consumption; i.e., production expense plus depreciation.

A comparison between the nonland factor mix on the optimally organized farms in 1959 and 1980 is presented by states in table H-2. For the North Central Region as a whole, the labor input was projected to decline from about 40 percent of the mix in 1959 to less than 30 percent in 1980. Opportunity cost of capital maintained about a constant share during the period, while capital consumption increased from about 50 percent in 1959 to 60 percent in 1980.

Recombination of inputs on well-organized farms in 1980

As a first approximation for 1980, the resource and product characteristics of the optimally organized farms in the 1959 minimum-cost and market-clearing reorganization were used. The total value of labor, opportunity cost of capital and capital consumption per farm were held constant, but they were recombined in the proportions projected. The aggregated production of farms was calculated by using projected increases in resource productivity for 1980 and compared with the projected demand as a basis for further farm adjustment.

APPENDIX I: VARIABLES AND EQUATIONS USED IN THE 1980 MINIMUM-COST AND MARKET-CLEARING REORGANIZATION

Exogenous variables

The text discussed how values for certain exogenous variables were empirically projected for use in the 1980 model. Additional information from the observed and optimal 1959 situations were used. The 15 known variables were:

X_1 = price of land per acre in 1959.
X_2 = gross production per acre on noncommercial farms in 1959.
X_3 = projected acres in noncommercial farms in 1980.
X_4 = subregion share of total 1980 demand for farm production.
X_5 = supply of land available for commercial farms in 1980.
X_6 = percentage of aggregated nonland inputs that was opportunity cost of capital in 1980, per farm.
X_7 = percentage of aggregated nonland inputs that was value of labor input in 1980, per farm.
X_8 = percentage of aggregated nonland inputs that was capital consumption in 1980, per farm.
X_9 = aggregated nonland inputs per optimally organized farm in 1959.
X_{10} = opportunity cost rate for capital in 1980.
X_{11} = opportunity cost rate for land in 1980.
X_{12} = man-months of labor per optimally organized farm in 1959.
X_{13} = value of labor input per optimally organized farm in 1959.
X_{14} = value of land per optimally organized farm in 1959.
X_{15} = gross production per unit of land on optimally organized farms in 1959.

It was indicated that four separate projections of the characteristics of the farm industry in 1980 were made for each of the four projected rates of increase in resource productivity. The rates of increase in resource productivity were indicated by G_j, where $j = 1, 2, \ldots, 4$ rates of increase.

The values of eight additional variables were determined independently of the increase in factor productivity and the product price level. That is, their values remained constant for all levels of G_j. They were designated as Y variables, and the equations used to compute their values are described in the following paragraphs.

It was assumed that noncommercial farms operated outside the realm of economic efficiency and income maximization and that their level of output would be independent of the product price in 1980. Additionally, their rate of resource productivity increase was assumed lower than for commercial farms. In support of these assumptions was the large differential in gross production per acre between commercial and noncommercial farms in 1959. In the 71 subregions of the North Central Region, the former averaged $74 per acre, but noncommercial farms generated about one-fifth as much, $16 per acre.

Total gross production by noncommercial farms in 1980 was projected by multiplying the product of gross production per acre in 1959 and projected acres in noncommercial farms in 1980 times a coefficient representing an increase in resource productivity of 1.5 percent, compounded annually. This variable was Y_1:

$$Y_1 = (X_2)\ (X_3)\ (1.367058).$$

The subregion share of total 1980 demand for farm products minus the production generated by the noncommercial farms yielded the subregion share of 1980 demand that had to be met by commercial farms. This variable was designated as Y_2:

$$Y_2 = (X_4) - (Y_1).$$

The projected acres of farm land expected to be available for commercial farms in 1980 were multiplied times the observed land price per acre in 1959 to provide a measure of the total land input consistent with land input in the 1959 analyses:

$$Y_3 = (X_1)\ (X_5).$$

The opportunity cost of capital per farm, Y_4, was estimated as the product of aggregated value of nonland inputs per organized farm in 1959 multiplied by the projected proportion of the aggregated value of inputs that the opportunity cost of capital would be in 1980:

$$Y_4 = (X_9)\ (X_6).$$

The input of capital per farm was obtained by dividing the opportunity cost of capital per farm by the projected 1980 opportunity cost rate. This variable was Y_5:

$$Y_5 = Y_4/Y_{10}.$$

Value of labor input per farm in 1980 was designated as Y_6. It was the product of aggregated nonland input per organized farm in 1959 times the projected proportion of the aggregated input that value of labor input would be in 1980:

$$Y_6 = (X_9)\ (X_7).$$

The capital consumption per farm in 1980 was projected in a similar manner by using the projected proportion of the aggregated input that capital consumption per farm would be in 1980:

$$Y_7 = (X_9)\ (X_8).$$

Man-months of labor per farm in 1980 was projected by multiplying the ratio of the projected value of labor input per farm in 1980 to the value of labor per organized farm in 1959 times the man-months of labor per organized farm in 1959. This variable was identified as Y_8:

$$Y_8 = (Y_6)\ (X_{12})/X_{13}.$$

Endogenous variables

The values of two additional variables were dependent upon product price level, P_i, but were independent of the rate of factor productivity increase. $P_i = 1, 2, \ldots, n$, where n is the number of different price levels used. The physical quantity of farm production demanded from a subregion at the P_i price level was a function of the quantity that would have been demanded at the 1959 product price level and the projected price elasticity of demand for farm products. Farm production was identified and calculated as follows, where the demand for farm production was assumed arithmetically linear:

$$Z_1{}^i = (1.23 - 0.23\ P_i)\ (Y_2).$$

When the demand for farm production was assumed linear in logarithms (i.e., had constant price elasticity), farm production was calculated as follows:

$$Z_1{}^i = \text{antilog of } (\log Y_6 - 0.23 \log P_i).$$

The dependent variable in the extensification regression, $\hat{Y}$, was designated as $Z_2{}^i$. It referred to gross production per unit of land and was calculated by dividing the quantity of production demanded in 1980 by the value of the land input:

$$Z_2{}^i = Z_1{}^i/Y_3.$$

The rest of the endogenous variables were dependent on both the product price level and rate of increase in resource productivity. $Z_3{}^{ij}$ represented the X variable in the extensification regression, capital plus labor input per unit of land. It was projected as follows:

$$\frac{Z_3{}^{ij} = Z_2{}^i - (X_{11})\ (X_9)/X_{14}.}{(X_{15})\ (G_j) - X_{11}}$$

The number of farms in a subregion was determined by multiplying the capital plus labor input per unit of land times the quantity of land available and then dividing that product by the capital plus labor input per optimally organized farm in 1959. The number of farms was indicated by $Z_4{}^{ij}$:

$$Z_4{}^{ij} = (Z_3{}^{ij})\ (Y_3)/X_9.$$

$Z_5{}^{ij}$ was the total capital input per subregion, the product of capital input per farm times the number of farms:

$$Z_5{}^{ij} = (Y_5)\ (Z_4{}^{ij}).$$

The acres per farm, $Z_6{}^{ij}$, were determined by dividing the acres of land available for commercial farms by the projected number of farms:

$$Z_6{}^{ij} = (X_5)/Z_4{}^{ij}.$$

The value of land and buildings per farm was calculated by dividing the value of land and buildings available by the number of farms. This variable was $Z_7{}^{ij}$:

$$Z_7{}^{ij} = (Y_3)/Z_4{}^{ij}.$$

Total revenue to the farm industry was the product that resulted from multiplying the physical quantity produced times the price level at which that quantity would have cleared the markets. Dividing by the number of farms gave the total revenue per farm, $Z_8{}^{ij}$:

$$Z_8{}^{ij} = (Z_1{}^i)\ (P_i)/Z_4{}^{ij}.$$

Factor earnings per farm, $Z_9{}^{ij}$, were determined by subtracting production expenses and depreciation from total revenue:

$$Z_9{}^{ij} = Z_8{}^{ij} - Y_7.$$

Opportunity cost of land per farm was the value of land times the projected 1980 opportunity cost rate:

$$Z_{10}{}^{ij} = (Z_7{}^{ij})\ (X_{11}).$$

Total opportunity cost per farm was the sum of the opportunity costs of land, labor and capital per farm and was designated as $Z_{11}{}^{ij}$:

$$Z_{11}{}^{ij} = Z_{10}{}^{ij} + Y_6 + Y_4.$$

Total man-months of labor per subregion was calculated by multiplying the man-months per farm times the number of farms:

$$Z_{12}{}^{ij} = (Y_8)\ (Z_4{}^{ij}).$$

The residual to land when nonland opportunity costs were subtracted from factor earnings was capitalized into a value per acre by dividing by the opportunity cost rate for land. The value of land per acre thus determined was designated $Z_{13}{}^{ij}$:

$$Z_{13}{}^{ij} = Z_9{}^{ij} - Z_{11}{}^{ij} + Z_{10}{}^{ij}/(Z_6{}^{ij})\ (X_{11}).$$

The marginal value product of land capitalized into a value per acre was designated as $Z_{14}{}^{ij}$. It was calculated by multiplying the marginal physical product of land by the product price level and dividing by the opportunity cost rate for land:

$$Z_{14}{}^{ij} = \frac{(Z_8{}^{1.0}) - \dfrac{Z_1{}^{0.5}}{Z_4{}^{0.5}} \div (Z_6{}^{1.0}) - (Z_6{}^{0.5})\ P_i}{(X_{11})}$$

where superscripts 1.0 and 0.5 refer to specific values of P_i.

In the discussion of the 1959 extensification regression as an interfarm production function in a preceding section, it was indicated that the relevant segment of the production surface appeared linear. That is, among the selected group of well-organized farms, the relationship between inputs of capital plus labor per unit of land and gross production per unit of land appeared linear. It would be untenable to assert that this phenomenon existed over the entire production surface.

This relationship was assumed to hold only within or near the range of experience of the regression. The marginal physical product of land would be constant, which simplified the determination of $Z_{14}{}^{ij}$.

REFERENCES

1. Agricultural finance review. Vol. 24. 1963.

2. Agricultural finance review. Farm real estate market developments. U. S. Dept. Agr., Econ. Res. Serv. Pub. CD-64. 1963.

3. Brandow, G. E. Interrelations among demands for farm products and implications for control of market supply. Pa. Agr. Exp. Sta. Bul. 680. 1961.

4. Denison, Edward F. The sources of economic growth in the United States and the alternative before us. Committee for Economic Development Supplementary Paper No. 13. 1962.

5. Federal Aviation Agency. National airport plan, 1963-67. Lincoln, Nebraska. 1962.

6. Kaldor, Donald, Raymond Beneke and Russell Bryant. Comparison of resource returns of well-organized farms with selected nonfarm opportunities. Iowa Agr. and Home Econ. Exp. Sta. Res. Bul. 491. 1961.

7. Livestock marketing in the North Central Region. Ohio Agr. Exp. Sta. Res. Bul. 846. 1959.

8. Loomis, Ralph A., and Glen T. Burton. Productivity of agriculture. U. S. Dept. of Agr. Tech. Bul. 1238. 1961.

9. Miller, Frank, and Ronald Bird. Profitable adjustments on farms in the Eastern Ozarks of Missouri. Mo. Agr. Exp. Sta. Res. Bul. 745. 1960.

10. Rudd, R. W., chairman. Policy for United States agricultural export surplus disposal. Ariz. Agr. Exp. Sta. Tech. Bul. 150. 1962.

11. Schultz, Theodore W. Value of United States farm surpluses to underdeveloped countries. Jour. Farm Econ. 42: 1019-1030. 1960.

12. Tyner, Fred H., and Luther G. Tweeten. Excess capacity in United States agriculture. Agr. Econ. Res. 16:23-31. 1964.

13. U. S. Census Bureau. Census of Agriculture, 1954. Vol. 1. Part 9. 1955.

14. U. S. Census Bureau. Census of Agriculture, 1959. Vol 1. County Reports. 1960.

15. U. S. Census Bureau. Current population reports, Series P-25, No. 251. [from U. S. 18th Census, 1960]. Washington, D. C. 1962.

16. U. S. Census Bureau. Farmers and farm production in the United States: special report [from U. S. Census of Agriculture, 1954]. Washington, D. C. 1956.

17. U. S. Census Bureau. General social and economic characteristics, U. S. summary: Final Report PC1-IC [from U. S. 18th Census, 1960]. Washington, D. C. 1962.

18. U. S. Census Bureau. Statistical abstract of the United States. 82nd edition. Washington, D. C. 1961.

19. U. S. Census Bureau. Worksheets for State Table 17 [for U. S. Census of Agriculture, 1959]. Washington, D. C. 1960.

20. U. S. Department of Agriculture, Agricultural Marketing Service. Farm labor. Washington, D. C. 1964.

21. U. S. Department of Agriculture. Agricultural prices annual summary, 1961. Washington, D. C. 1962.

22. U. S. Department of Agriculture. Agricultural Stabilization and Conservation Service. Charts providing a graphic summary of CCC operations. Washington, D. C. 1963.

23. U. S. Department of Agriculture. Agricultural statistics, 1962. 1963.

24. U. S. Department of Agriculture. Area variations in wages of agricultural labor in the United States. U. S. Dept. of Agr. Tech. Bul. 1177. 1958.

25. U. S. Department of Agriculture. Cattle and calves on feed, selected states by quarters, 1955-59. U. S. Dept. Agr., Agr. Market. Serv. Bul. 277. 1961.

26. U. S. Department of Agriculture. Crop production annual summaries. 1960-1963.

27. U. S. Department of Agriculture. Economic Research Service. Farm mortgages recorded in 1959: interest rates, terms, and sizes with historic data, 1949-59. Washington, D. C. 1961.

28. U. S. Department of Agriculture. Foreign agricultural trade of the United States. U. S. Dept. Agr. Econ. Res. Serv. Washington, D. C. 1964.

29. U. S. Department of Agriculture. Land and water resources: a policy guide. U. S. Dept. Agr. Econ. Res. Serv. Washington, D. C. 1962.

30. U. S. Department of Agriculture. Field and seed crops-production, farm use, sales, value. U. S. Dept. Agr. Stat. Rptg. Serv. Bul. 311. 1962.

31. U. S. Department of Agriculture. Livestock and poultry inventories. U. S. Dept. Agr. Stat. Rptg. Serv. Bul. 177. 1963.

32. U. S. Department of Agriculture. Livestock-feed relationships, 1909-1963. U. S. Dept. Agr. Econ. Res. Serv. Bul. 337. 1963.

33. U. S. Department of Agriculture. Measuring the supply and utilization of farm commodities. U. S. Dept. Agr. Agr. Market. Serv. Handbook 91. 1955.

34. U. S. Department of Agriculture. Measuring the supply and utilization of farm commodities, 1959 supplement. Washington, D. C. U. S. Dept. Agr. Agr. Market. Serv. 1960.

35. U. S. Department of Agriculture. The pig crop. U. S. Dept. Agr. Market. Serv. Washington, D. C. 1961.

36. U. S. Department of Agriculture. State estimates of farm income, 1949-62. U. S. Dept. Agr. Econ. Res. Serv. Publication FIS-191, supplement. 1963.

37. U. S. Department of Agriculture. Stocks of grains in all positions. U. S. Dept. Agr. Stat. Rptg. Serv. Bul. Washington, D. C. 1963.

38. U. S. Department of Agriculture. Stocks of grains, oilseeds, and hay, by states, 1949-60. U. S. Dept. Agr. Stat. Rptg. Serv. Bul. 304. 1962.