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Part IV. Agricultural Economic Information Systems

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M. L. U.

Developments in Agricultural Economic Data

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The Setting for Agricultural Data

Data are the raw materials of economic analysis. They lend substance to description. Properly ordered, they reveal problems and solutions to problems. It would be hard to imagine the subject of agricultural economics without data. Indeed, agricultural economists pioneered the use of quantitative analysis in the social sciences. Despite the variety and quantity of data readily available to every agricultural economist, probably no economist ever had all the data he wanted, in exactly the form or at the time that he desired.

Much of the development of present systems of agricultural economic data occurred before World War II. Beginning with the Census of 1839, and especially after the creation of the United States Department of Agriculture (USDA) in 1862, steady improvements were made in the coverage, accuracy, and scope of agricultural data. Substantial improvements were made in the 1920s and 1930s with the creation of the Bureau of Agricultural Economics. Preoccupied with the deep-seated economic problems of that period, agricultural economists everywhere demanded better data.

Given this early development, post-World War II economists and decision makers turned their attention and their pens mostly to topics other than data as such. The early postwar literature has few references dealing specifically with problems of data, as Arnold and Barlowe [1954] point out. Yet substan-

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tial improvements in the quality and coverage of some kinds of data have been made; these will be discussed later. Only recently have a few agricultural economists and statisticians raised serious questions about data.

Not long ago the agricultural statistician and the economist were frequently the same person. With increased specialization in statistical sampling, data collection, processing, and analysis, the institutional and intellectual separation of data collection and economic analysis has widened, especially since the early 1950s. This has reduced the economist's and the statistician's sense of interdependence for the design of data systems.

Specialization in farming, the increasing role of farm-related business in agriculture, and the changing role of government have altered demands for economic data. Also, integration of farming with off-farm firms providing a higher proportion of factors of production and marketing services has accentuated the difficulties of statistical estimation. The development of these interrelated trends, evident before World War II, accelerated in the postwar period and seems likely to continue.

In modern agriculture demands for data that measure economic and social phenomena associated with farming and rural living have proliferated. Most regularly reported statistics are provided by public services, including federal and state censuses, current agricultural statistical services, and market news services. Research analysts frequently acquire additional data through special surveys, often obtained under contract, for profile or cross-sectional analysis. Marketing economists depend heavily upon private survey firms for data to facilitate distribution, advertising, and sales decisions.

For decades statistical reports have provided some data on all commodities of economic significance. Demands for new or additional data pertaining to farm supplies and prices in crop and livestock estimating are usually for more detail about individual commodities involving every conceivable dimension—time, space, and, most frequently, quality.

The specialization of farm functions, accompanied by the shift of more and more functions to off-farm businesses, has engendered demands for data on factors of production. Data on fertilizer, pesticides, and custom services have consequently assumed much greater importance, especially to agribusiness. Modern technology throughout agriculture also creates demands for greater accuracy and timeliness of data. Farms and associated service businesses now require large amounts of capital and depend heavily on borrowed funds. These conditions call for more stringent controls that begin with data for planning and operating decisions.

Statistical technology has, in general, developed methods to meet these demands, but they are costly. For example, with the greater specialization of

farms the design and acquisition of representative samples, plus the strict requirements for obtaining data according to specifications, make data acquisition much more expensive and difficult. The additional resources needed often are not available. To conserve funds smaller samples are used, but this makes it more difficult to control measurement errors and raises costs for training personnel and quality control.

Objective methods are replacing subjective approaches to agricultural crop and livestock estimating. These too are expensive. Until well after World War II almost total reliance for crop estimating was placed upon the mail questionnaire for collecting data from farmers. Its great virtue was its low cost. The method was feasible because from early times the United States had literate farmers who were willing to give information to their government and had a dependable, inexpensive mail service. The system was founded on the assumption that a large response from farmers all over the country would adequately reflect year-to-year change. Changes indicated by crop reporters were tied to census and marketing data to derive estimates of totals.

Statisticians thoroughly familiar with the agriculture of their states could be relied upon to avoid gross errors and make proper allowance for unusual occurrences. Cumulative errors in nonprobability sampling estimates, projected one year after another, could be trued up every five years when an agricultural census gave a full count. Regression and other techniques were adapted for the removal of bias. The resulting agricultural estimates became the envy of the world.

This approach seemed adequate until about the beginning of World War II when changes in farm practices and structures began to accelerate. More precise and more reliable estimates were needed. Probability samples were required for estimating counts of such units as farms, acres, trees, and head of livestock. Objective measurements that fit into mathematical models were required for quantitative indications of yields previously reported in qualitative terms. These features have been introduced into crop and livestock estimates.

Specifically planned surveys based on probability samples call for greater discipline from the statistician and his respondents. Since virtually all agricultural estimates are derived from information voluntarily given, cooperation is essential. Development and maintenance of sampling frames, personal contacts to ensure response from individuals drawn in a sample, and field measurements made by trained enumerators are major elements in increasing costs because they are tasks for professional statisticians.

Farm and rural social statistics have been derived in part as products of such regular economic surveys as the agricultural census. These surveys are being devoted increasingly to the purposes of commercial agriculture. Other

rural social data have been derived from the population census and from episodic surveys. Demands for social or demographic data, however, have risen sharply in the past decade and are becoming more insistent.

The electronic computer facilitates mass data handling, statistical computations, and report preparation and dissemination. Advanced statistical techniques enhance the quality of output. Availability of the standard error computed from the sample data to indicate the degree of reliability of a probability sample is an excellent case in point. The adaptation of computer services to keep farm records and accounts illustrates the degree to which automatic data processing can assist agricultural management.

The preoccupation of economists with model building since World War II has led to some confusion regarding the relative importance of models and data. The eagerness of economists to employ models has sometimes led to questionable applications of data, and conclusions drawn from tenuous data are also tenuous, regardless of the sophistication of the model.

There is no good substitute for care in planning the acquisition of the specific data needed for an anticipated decision. The efficiency of collection can be increased by combining data needs into fewer surveys, but this is limited by the frequency and length of surveys that can be made without encountering respondent fatigue. Another limitation is the degree to which social survey questions can be integrated with established economic surveys without compromising the activity. Most economic data from individuals are now given voluntarily, through great effort is often necessary to obtain cooperation. Social data often are given very reluctantly. If respondents balk on social data questions, the economic survey suffers.

Increasing costs for acquisition of data, increasing needs for accuracy of results, and strong competition for the funding required for statistical programs present a continuing challenge to those responsible for providing agricultural economic statistics.

The World War II period brought a new demand for agricultural statistics. Special surveys by the USDA obtained the information needed to plan agricultural production and to deal with food, machinery, and manpower requirements. This work was carried out by the Bureau of Agricultural Economics (BAE), which had the responsibility for collecting basic agricultural data and for carrying out statistical analyses and economic research.

Cooperative federal-state arrangements for collection of crop and livestock data, which had been initiated in some states after World War I, were given new impetus with the passage of the Agricultural Marketing Act of 1946. A variety of agricultural data projects were initiated with matched federal-state funds under provisions of the act. The intent was to initiate marketing data services, not to support them indefinitely. An example of important statisti-

cal work that was started under such arrangements and later continued under regular appropriations was the *Pig Crop Report* for the Corn Belt states (USDA, SRS [quarterly]).

Today, cooperative federal-state agreements cover the collection of agricultural statistics in forty-seven states—with forty-one state departments of agriculture and six state agricultural colleges, universities, or experiment stations. Additional cooperative agreements cover dairy manufacturing statistics in thirty states. Market news services are also administered under federal-state sponsorship with cooperative agreements in effect in forty-three states. This joint endeavor avoids duplication of efforts, reduces reporting burdens on farmers, and provides both federal and state governments with better data covering a broader range of subjects than either could provide independently. For the fiscal year 1974, obligations for the principal agricultural statistics programs of the USDA total approximately $27.5 million. Cooperating states contribute an additional $4 million for state programs.

Demands for more accurate, more timely, and more detailed agricultural data have grown sharply over the past three decades. These three dimensions compete with each other for the resources used to produce data and, unfortunately, the support for them has been unbalanced. Occasionally there has been strong support for public funds to obtain additional data on specific items or commodities, but much less general support for the research and program modifications needed to improve accuracy or even to maintain acceptable levels of accuracy. A significant exception grew out of the experience in forecasting cotton production in 1951, described later in this chapter, which attracted the attention of Congress and the public to shortcomings in agricultural estimating techniques. This resulted in an appropriation for research on methods and led to the development of a long-range plan for shifting to probability sampling in farm surveys and to objective techniques for measurement of crop yields.

Needed improvements in agricultural data programs have had to compete for public funds with other demands on the public purse, including needed statistical improvements in other sectors. A common complaint over the years has been that more concern has been devoted to improving data about hogs than about rural people and their general welfare. There is a recognized need for more and better data about rural people, but funds for these purposes are limited. Competition for the statistical dollar has been especially keen in recent years, as the Office of Management and Budget (OMB) has exercised considerable restraint on government expenditures generally and budgets for statistical purposes in particular. However, industry groups and trade associations with specific commodity interests, often have been effective in gaining support for their data needs.

The American farmer provided the original demand for a system of current agricultural statistics as he looked to his government to provide unbiased information about crop and livestock supplies, marketing conditions, and prices. Even today, the system remains heavily oriented toward farmers' needs. Farmers are the primary respondents for much of the data provided voluntarily. They, as well as the organizations representing them, must feel that they receive something of value in return for their cooperation. It must be recognized, however, that people in agribusiness and in government use statistical data at least as much as farmers do. Altogether, it is beyond the means of any statistical system to satisfy completely the total data needs expressed by users (Simpson [1967]).

Over time, data systems for crop and livestock estimates and for market news have become largely separate from data systems relevant to economic organization and efficiency in agriculture. It has been easier to meet the needs of users of commodity statistics than to keep pace with the changing requirements for economic analyses resulting from major changes in the structure of the agricultural economy. These difficulties were succinctly summarized in a report by the American Agricultural Economic Association (AAEA) Committee on Economic Statistics (AAEA [1972]). The problem is essentially one of using outdated concepts that no longer match a greatly transformed industry.

The Census of Agriculture

For more than a century the Census of Agriculture has been a basic source of economic data about agriculture and farm people. The Census, taken every five years, has been the only nation-wide source of county data. Although some states have a local census and tax roll data, the Census has long been the authoritative source of information about crops, livestock, farms, and farm people. Most other sources of data are based on samples of varying types that provide reliable estimates only on a state, regional, or national basis. The Census itself has changed over the years in content, coverage, techniques of enumeration, and methods of summarization and publication. It is not the purpose here to dwell on these changes in detail, but a few highlights are worthy of note.

From time to time the Census definition of a farm has been changed. This has prompted questions about the comparability of data from one census period to the next. The literature of agricultural economics is sprinkled with articles by authors struggling with the reconciliation of data over time. The questions become critical when one realizes that the number of farms is used

in many ways for the allocation of federal funds among states and for estimating farm income, a vital item in policy considerations.

Some agricultural economists argue that the Census defines as farms large numbers of rural places that are not farms at all but rural residences with a bit of farming incidental to other occupations or sources of income. They contend that the number of farms and farm people is inflated for political or other reasons. On the other hand, some economists support the definition of a farm as any rural residence that is the site of agricultural enterprise, no matter how small the output. They reason that although many rural residences account for little in the way of agricultural production they contribute to the total number of people living on farms.

Arguments over the definition of a farm have become much sharper in recent years, owing in part to the changing structure of the farming sector, in part to the increasing costs of census enumeration, and in part to the changing character of the rural population. Because of increasing specialization in farming and the movement of many functions off the farm, modern farms increasingly fail to fit the traditional definitions. This is especially true in the highly specialized producing areas of California and Florida and in sectors like broiler production, beef feeding, and nursery and ornamental crops.

Traditionally, the Census of Agriculture was a full enumeration of all places or establishments that met the accepted definition. In 1945 the Census began to use sampling to obtain certain items of data. The chief motive seemed to be to reduce the cost of enumeration. But sampling raised questions of reliability of local data, and some sampled items could be reported only for large areas (to avoid disclosing information about individual farms or firms). Nevertheless, sampling continues to be used for selected items and for special surveys.

Other changes to reduce the cost of enumeration have been tried. In the 1964 Census respondents were mailed a questionnaire and were asked to fill it out before the enumerator arrived. This saved some time for the enumerator, but it introduced the possibility of greater respondent bias and increased the editing task. In 1969 and in 1974 the Census relied almost completely on mail response, using an abridged questionnaire for smaller farms. This reliance on mail response has in fact made the 1969 and 1974 censuses a sample—a sample without full knowledge of the population of farms it is supposed to represent.

Since the 1920s the Census of Agriculture has been a special source of data about farm people. This information supplemented and complemented demographic data obtained in the decennial Census of Population. While the Census of Agriculture still serves this purpose to some extent, its usefulness has

been seriously eroded. Farm people are not the unique group they once were in the United States. Instead it is found that some farmers do not live on farms, some people who live on farms are not farmers, and fewer and fewer rural families depend on farming for a livelihood. Economic and welfare policies and programs focus less on farm people as such and more on rural people as a group. Thus the sociological data from the Census of Agriculture fails to provide the information needed for many public and private decisions.

It has long been argued that the Census of Agriculture should obtain additional kinds of data. Farm machinery makers want more detail about the kind, age, and number of machines on farms; feed dealers want more information on livestock and feed supplies; government personnel want to know more about the broad characteristics of farms, the resources used, and dozens of other items. Obviously the Census cannot supply everything for everybody. The scope of the Census is limited by the amount of funds available for enumeration, summarizing, and publication and by the tolerance of respondents. Furthermore, the issue of privacy is another factor conditioning the kind and amount of information that can be gathered.

In recent years some agricultural economists have questioned the efficacy of the Census for supplying data needed by those concerned with all segments of the agricultural industry and by those interested in the welfare of rural people. For instance, the Census has been chiefly a census of "farms," not a census of "agriculture," and it has not been coordinated with other economic censuses. Thus, no consistent body of data is available for the agricultural industry. The information about farm people traditionally included in the Census is also far from adequate to serve the needs of those concerned with rural welfare and rural development. The increasing dissatisfaction among agricultural economists with the Census portends substantial change for the future.

Survey Methods

Developments in Theory

Although much mathematical theory of probability had been developed before 1900, it attracted very little interest outside the academic world before World War I. The application of probability theory required randomization and replication. Hence, experimental researchers and survey data collectors were confronted with fundamentally new techniques for acquiring and analyzing data. This resulted in inconvenience and in some cases caused additional work and cost. Resistance was encountered, especially from established investigators who had confidence in their ability to judge the representativeness of experiments or samples. Was the return from putting probability theory into practice worth the effort or cost? Many issues about the virtues of

probability sampling and statistical inference were debated during the 1930s and 1940s.

A paper published by Neyman [1934] on random versus nonrandom methods encouraged general acceptance of probability sampling for surveys. Many other papers on the subject appeared before 1950. By then the principles of sample design, founded in probability theory, had begun to appear in books on sample surveys. One of the first books on sample survey methods contained a good discussion of general principles and criteria (Hansen, Hurwitz, and Madow [1953]).

By 1950 workers in all disciplines using sample surveys were beginning to recognize that errors associated with causes other than sampling were often more important than sampling error. Hence, an increasing amount of research was directed toward measurement of nonsampling error and finding the means of reducing or controlling it.

The new questions which began to be asked of data in the 1930s pointed up the need for new approaches to survey sampling and estimation. An adequate means of evaluating the accuracy of one-time surveys using nonprobability methods did not exist. Also, new statistical series based on nonprobability methods could not be introduced with adequate confidence in their accuracy. The established data series based on nonprobability methods also were questioned because of the acceleration of changes in the agricultural economy. "Nonprobability methods" as used here refers mainly to the nationwide system of crop reporters who responded voluntarily to mail questionnaires.

By 1940 some researchers on survey methods felt the potential for improving nonprobability methods was too limited to be worth pursuing. They had become convinced that in the long run probability sampling should replace nonrandom methods. The prospect of greater accuracy and the advantage of having a statistical practice supported by relevant theory argued for their view.

At the same time, however, many persons expressed strong preferences for trying to find convenient and low-cost ways to improve the farm crop reporter system, the system that had been used for many years and that had served informational needs very well. Kramer and Shaffer [1954] studied the question of bias in the mail survey and concluded that mail surveys should remain as a major source of farm data.

Unfortunately, cost comparisons of various survey methods often left much to be desired. Most were simple tabulations of the cost per questionnaire or the total cost of doing a survey of a given size without regard for the scope and accuracy of the information. One principle of probability sampling was to design samples so as to minimize the sampling error per dollar of

cost, but comparison of probability and nonprobability sampling under that criterion was inadequate. The issue was not easily resolved because major changes in the method of sampling required larger appropriations.

Research projects for sample surveys in agriculture, with emphasis on the development and application of sampling theory, were established by 1940. One part of this research program dealt with methods of forecasting and estimating crop yields and another with sampling methods for farm surveys generally.

Changes in Sampling Methods

Area sampling. Complete up-to-date lists of all farms have never been available. Lists of producers of specific crops like peanuts or tobacco are sometimes available from public records; these often are useful for special surveys, but they do not serve for more general surveys of the farming sector. Prospects for obtaining reasonably complete lists, especially of large farms, have gradually improved. In the absence of a complete list frame, area sampling has been the leading approach to probability sampling. In recent years the use of multiple frame sampling, which makes joint use of area and list frames, has been increasing.

Early experience with area sampling (Jessen [1942]) led to a project for developing a master sample of agriculture (King and Jessen [1945]). The most significant output of the project was an area sampling frame that provided a convenient basis for selecting area samples; the first major use of the master sample was in the 1945 Census of Agriculture. Farmers in the sample areas were asked supplemental questions not on the regular census questionnaire.

After 1945 the area sampling frame was also used for numerous small, one-time farm surveys for agricultural economics research. Two factors favored rapid adoption of area sampling in surveys of this type: (1) the researchers generally were interested in sampling that would assure reliable results; (2) flexibility in the use of research funds permitted researchers to choose their methods of data collection. Although the cost of data was important, it was not a critical factor that limited the methods of sampling.

Agricultural economists became interested in establishing a current periodic survey of agriculture that would fill a variety of data needs outside the scope of current crop and livestock estimates. The first significant effort was the "Quarterly Survey of Agriculture in 1945," which made use of two-stage probability area sampling. After four or five quarters it failed because the sample was too small and the funds were insufficient to expand and sustain the survey. However, strong interest in an annual survey of agriculture for economic data has persisted. The needs have been only partially met by sup-

plementary sample surveys conducted as part of the quinquennial Census of Agriculture or in conjunction with it.

For established statistical series the situation was entirely different. There was a commitment to continue the existing series, thus preventing the allocation of funds for use in conjunction with the more expensive probability methods. The additional funds that were made available in this way were not sufficient to accomplish major changes in methods. Furthermore, many agricultural statisticians favored continuing and improving the convenient inexpensive methods of collecting data by mail from voluntary reporters.

A congressional investigation into the reasons for a large error in a 1951 forecast of cotton production probably was the event of most significance in helping to unify forces and to gain support for improving current agricultural statistics. The investigation led to a small appropriation in 1953 for research and development, and thereafter much progress was made. In 1957 a four-part plan for long-range improvements was presented to Congress by Newell (U.S. Congress [1957]). The highest priority was given to the first part of the plan, which was devoted to the development of better survey methods to improve accuracy, to provide a technically better foundation for present and future statistics, and to develop a more flexible system for keeping pace with the rapidly changing structure of agriculture. The second part of the plan dealt with the strengthening of price statistics. The third part focused on measures to reduce the time between data collection and the release of reports and to make possible more frequent reports during critical periods. The fourth part covered the needs for additional data and services.

Probability area sampling for crop and livestock estimates was introduced on a pilot or research basis in 1954. By 1967 the initial goal of two fully operational nationwide area surveys, one in June and one in December, had been attained. These applications of area sampling were summarized by Houseman and Trelogan [1967]. Fortunately, this period of growth in probability sampling coincided with rapid technological development in automatic data processing. Computers provided statisticians with a tool that facilitated sophisticated sample designs and made possible timely summarization and analysis of survey data.

Multiple frame sampling. With increased specialization in agriculture, and with the increase in the size of some producing units, the statistical efficiency of area sampling for many purposes has been decreasing. Since updated lists of farms with adequate control information on size and type are not available, the area frame continues to be the only complete sampling frame available. However, multiple frame sampling offers many of the advantages of both area and list sampling. The use of multiple frame sampling has been increasing since about 1965. Beginning in about 1970 a major effort has been

made to utilize multiple frame sampling for livestock surveys. This was a direct result of widespread dissatisfaction among livestock producers over a 1.9 percent revision in cattle numbers following the 1964 Census of Agriculture. The need for sampling errors of 1 percent or less was apparent and the multiple frame sample was found to be the most economical approach. The basic concepts of multiple frame sampling are quite simple, but the operating problems are difficult to master.

Methods of Crop Forecasting

The three primary sources of information for making forecasts are (1) farmers' appraisals of crop conditions, (2) measurements of environmental factors, and (3) biological or plant measurements. To forecast crop yields a forecasting model is necessary. It must be derived from past data and studies of the relationships between yields and the factors correlated with yields. The updating of the parameters in the models presents a problem because of the increasing tempo of change in cultural practices and the introduction of new crop varieties and new chemicals. Farmers' appraisals have been used since 1912 to forecast yields. The techniques are described in the "Scope and Methods" bulletin of the Statistical Reporting Service (USDA, SRS [1964, 1975]). Although this source of information is still utilized, there is increasing reliance on biological or plant measurements, particularly for certain commodities.

Much of the research on crop forecasting before 1945 focused on weather-yield relationships. This did not result in the most useful forecasting models because the spatial and temporal representation of environmental data was inadequate and because measurements over a period of years for some environmental characteristics were unavailable. Furthermore, it became increasingly clear that the relationship of yield to environment was extremely complex, involving nonlinear relationships and many interactions. This type of research was abandoned during World War II, but there has been renewed interest in it in recent years because much more complete measurements of crop environments can be obtained through the use of remote sensing technology.

Biological or plant measurements have played an increasingly important role in forecasting yield and production of a growing list of crops. In these "objective yield surveys" trained enumerators regularly visit selected fields and orchards. These are chosen on a probability basis. Enumerators make actual counts and measurements of plants and fruiting characteristics during the growing season. Observations are used to forecast yields assuming normal weather for the remainder of the growing season and to estimate production following harvest.

Current Commodity Statistics

Crop and Livestock Statistics Reports

The changes in the structure of agriculture during the past three decades would seem to call for a reexamination of the data on products, prices, supplies, and labor to ensure that the data are compatible and consistent with the concepts, models, and analytical tools utilized in agriculture today (Trelogan [1968a, 1968b]). Data users from the agricultural industry do not appear to have involved themselves in such an evaluation, however, and changes in statistical reports derive largely from in-depth analyses prepared by data suppliers.

The great demand for data on commodity inventories and supplies continues, and in specialized areas there is pressure for additional detail and greater frequency. For example, in the area of livestock production the reports have been expanded to provide quarterly data for hogs and pigs and quarterly or even monthly surveys of cattle on feed. Meanwhile, there is surprisingly little call for new kinds of data except from a few professional agricultural economists or a few specialized interest groups who want data on such commodities as popcorn, mink, cut flowers, mushrooms, and white corn. Data relating to new commodities generally get into the reporting system only when specialized interest groups help obtain additional congressional appropriations for that purpose.

Although in content the crop and livestock statistics reports closely resemble those of three decades ago, the quality has been much improved. Survey methodology and procedures have moved steadily in the direction of greater accuracy. Analytical procedures have been redirected to utilize the gains offered by such methodology. For major crop and livestock items production estimates are first established at the national level (taking advantage of the fact that the sampling errors in the national figures are much lower than those in the figures for individual states) and then are modified as necessary to establish state estimates that conform to the national total and that are consistent with a thorough evaluation of state survey data.

Current survey methodology also provides a means for evaluating the original survey results. Quality check surveys bring into focus the adequacy of each major survey, thus providing a more sophisticated means of evaluating survey results as well as giving emphasis to procedures that need to be strengthened.

Several changes applicable to broad groupings of commodities have been made in the post-World War II period. One measure has been to limit the frequency of crop forecasts or estimates for states which account for not more

than 1 percent of the national total. This concept is applied to forecasts of production for all field crops, fruits, and nuts. The goal is to provide current data only for those states that collectively account for approximately 95 percent of the national total. The number of states included in the limited group varies by commodity. Since World War II, for example, the August 1 forecast of corn production for twenty-one states is now carried forward until the end of the season in January. Hay statistics have been limited to three categories—alfalfa and alfalfa mixtures, all other hay, and total hay. The initial forecast of production for most spring planted crops is made on August 1. The April winter wheat production forecast has been discontinued. Cotton statistics are no longer published separately and instead are included in the *Monthly Crop Production Report*. Rice statistics have been refined to show acreage, yield, production, and stocks by length of grain.

Vegetable statistics have undergone major change and production forecasts have been eliminated. The statistics for most vegetables are broken down into four seasonal groups, each of which includes the intended acreage to be planted, the acreage planted, and end-of-season production.

The limited estimate concept also has been applied to livestock statistics. Inventory numbers are now shown for all states only for hogs on December 1 and for cattle and sheep on January 1. July 1 inventory data were introduced for cattle. Inventory estimates at other times provide data only for those states meeting the limited estimate criterion as outlined above. Other changes in livestock statistics include the elimination of data on the length of time cattle are on feed and the addition of inventory data by weight groups. The classification by age and sex in the cattle inventory has been discontinued, but weight groupings by sex are shown. Market hog inventories are shown by weight groups rather than by age.

The limited estimate concept is also utilized for data on monthly milk and egg production, layer numbers, milk cows, turkey breeder hens and turkeys raised. Estimates for milk and egg production are now provided only quarterly for all states.

Statistical series for farm labor are being shifted from a monthly to a quarterly basis, with survey data for both farm labor numbers and wage rates relating to the twelfth day of the quarterly month. Wage rate statistics will provide greater detail with data on piece rate wages as well as wages by kind of work performed.

In 1973 a new series of weekly statistics on the export sales of selected agricultural commodities was initiated. The series identifies the export sales volume of wheat and flour, feedgrains, rice, soybeans, and cotton and their products outstanding at the close of each week to selected geographic areas of the world.

Further improvements in the coverage and frequency of crop and livestock estimates may be expected as changes in the agricultural industry occur which require changes in data, as the needs for data in industry and government change, and as the resources and technology for data collection and reporting suggest further improvement.

Commodity Supply and Utilization Data

Most annual supply and utilization series for commodities were initiated before World War II. Subsequently, agricultural economists have modified or extrapolated from these basic series to reflect the changing data needs of government, industry, and producers. Some of these refinements are discussed below.

Dairy data. While sales of whole milk and cream declined in recent years, sales of low-fat and skim milk rose substantially. Since milk equivalent sales data did not reflect these changes, Mathis [1968] developed a series showing product weight of total fluid sales and sales of individual fluid items (whole milk, cream, and low-fat milk). Data on commercial disappearance (sales) of all milk, butter, American cheese, other cheese, nonfat dry milk, canned milk, and frozen desserts were developed to represent better the commercial market for milk and dairy products.

As dairy imports expanded sharply in the late 1960s, there was considerable pressure to extend import quotas to additional dairy products. To meet the needs of the dairy industry and the government agencies making policy decisions in this area, Mathis developed a monthly report summarizing imports of individual dairy products and of all dairy products on a milk equivalent basis. These data are used by the dairy industry, the USDA, the Tariff Commission, and other government agencies and are now published regularly in *Dairy Situation*, import data are also published in *Dairy Market News Report*.

When cheese consumption began to expand rapidly in recent years, consumption data for separate cheese varieties and for natural and processed cheese were needed. To fill this void, data were developed to show per-capita consumption of many individual cheese varieties, natural and processed cheese, and processed cheese foods and spreads (R. R. Miller [1972]).

Whey, a by-product of cheese making, pollutes water supplies when it is dumped in streams or sewer systems. With the current emphasis on solving pollution problems, more uses are being found for whey. To meet the needs of the dairy industry and government agencies for whey statistics, data on the production and utilization of whey have been developed (Mathis [1970]).

Poultry data. When poultry inspection became mandatory in 1959 for all slaughtered poultry moving in interstate commerce, information became

available which permitted development of quarterly estimates of supply and disappearance, data published in *Poultry and Egg Situation*. The supply and utilization data for broilers and turkeys were expanded in 1960. These series have been widely used in demand and price analyses as well as in short-term forecasting.

Livestock data. Supply and utilization data for edible offal have been compiled by the Economic Research Service (ERS) and its predecessor agencies since 1949 in response to industry interest. These data, published annually in *Livestock and Meat Situation*, supplement supply and utilization data for beef, veal, pork, and lamb and mutton, helping to determine both total and average consumption of high protein foods. Since offal production is not reported directly, estimates are based on research showing the average yield of edible offal per hundred pounds of dressed weight.

Foodgrain data. In the early 1960s Askew [1969] developed a historical series of privately held stocks of wheat, rice, and rye, outside government ownership or control and therefore available to the commercial market. In response to questions about returns and costs to millers, a series of relations between wheat and flour prices in Minneapolis and Kansas City was developed. This series shows changes in millers' basic costs and returns.

The USDA ceased publication of buckwheat data after a long-term decline in supply and demand. When the demand for buckwheat picked up again in the early 1970s, a series of data on buckwheat prices, supplies, and demand again became a part of *Wheat Situation* (Gomme [1972]).

When government price supports in the form of supplemental payments to farmers were in effect, new data were needed on the average prices received by farmers, the prices to program participants including the value of the marketing certificates, and the blend prices, showing the average return per bushel of wheat sold with government payments added to the value of sales (Askew [1969]). Because of a change in the method of making certificate payments to program participants, the ERS in 1971 developed a program participant price series now published in *Wheat Situation*.

A lower price support in 1964 made wheat competitive with feedgrains. To illustrate the relative competitive position of wheat and feedgrains in different regions, the ERS developed a wheat and feedgrain price series, showing the relative price levels for grain regionally, including an adjustment for feeding value (Jennings [1958]).

Methodology for estimating domestic use directly by wheat class rather than as a residual was developed (Bitting and Rogers [1963]), resulting in a comprehensive series on the utilization of wheat for food. Export inspection by class made possible an even more complete breakdown of supply and distribution for each class of wheat; this was first published in the early 1960s.

Tobacco data. A series on annual retail expenditures on tobacco products was developed in the mid-1950s from Department of Commerce data on consumer expenditures and published semiannually in *Tobacco Situation*. It provided a breakdown for cigarettes, cigars, and other products, thus becoming a reference point for industry comparisons and margins analysis.

A series of data on tobacco used in cigarettes was begun in about 1950, published annually in *Tobacco Situation*. A similar series on a marketing year basis is published in *Annual Report on Tobacco Statistics* by the Agricultural Marketing Service (AMS). These series also include tobacco used per cigarette and show critical shifts in tobacco utilization since the early 1950s.

An output series for the production of smoking tobacco, chewing tobacco, and snuff has been issued quarterly by AMS, since 1966, following the repeal of the federal excise tax on those products. Quarterly data are summarized in *Tobacco Situation* and in industry statistical compilations.

Statistics on unmanufactured tobacco exports under government-financed or assisted programs have been compiled from program records and published in *Tobacco Situation* for calendar and fiscal years since the inception of Public Law 480 in the mid-1950s. This series summarizes export assistance programs and allows comparisons with other commodities.

United States cigarette production by length of cigarette and type (filter or nonfilter tip) was first compiled in the mid-1950s from annual surveys of leading manufacturers, with industry totals published annually in *Tobacco Situation*. This series provides a reference both on changing industry structure and on shifts in tobacco requirements.

Tobacco leaf represented in tobacco sheet stocks has been reported quarterly since 1958 by the AMS and published in *Tobacco Stocks Report*. This series offers data for each kind of tobacco and a measure of changes in the requirements for manufacturing cigars and cigarettes. Such data provided a key factor variable in explaining the sharp drop in flue-cured tobacco usage in the mid-1960s, as discussed in R. H. Miller's [1968] analysis for the 1950-66 crop years.

Oilseed data. Data series for several oilseed crops and products were developed under Kromer's leadership in the late 1950s and 1960s for price support programs and Commodity Credit Corporation activities. These provided detailed information on stocks and supplies and permitted a breakdown between government controlled and free stocks. Supply and utilization data were developed for soybeans, soybean meal, soybean oil, and soybean oil products (Kromer [1970]). These data measured the postwar growth of the industry and were valuable for making short-term and long-term forecasts of soybean supply and disposition.

Feedgrain data. Originally developed in the late 1930s, the grain-consum-

ing animal unit (GCAU) series has been updated several times with the revision by Allen and Devers [1973] reflecting more modern feeding rates of farm animals. A GCAU is simply one milk cow equivalent in terms of feed consumption based on average feeding rates during 1959-61; each class of livestock and poultry is converted into GCAU's by using the ratio of its feed consumption to the feed consumption of a milk cow. With good information on animal reproduction cycles and farmer response to change in livestock prices, animal numbers can be forecast accurately even before most feed crops are planted. As a result, the animal unit series provides the first solid basis for projecting short-run feed requirements. It is published regularly in *Feed Situation*.

Fiber data. James Donald developed several major data series related to fiber utilization and trade, including domestic fiber use (mill use adjusted for raw fiber equivalent of textile manufactures) in actual and cotton equivalent pounds. Because of sizable net imports these series presented a much more accurate picture of actual fiber use in the United States than was available earlier. They are published regularly in *Cotton Situation* and *Wool Situation*.

Price Statistics and Indexes

Price statistics of the USDA since World War II have been designed largely to satisfy the legal requirements of the Agricultural Adjustment Acts of 1948 and 1949. These required indexes of prices received and prices paid by farmers (Parity Index) on a 1910-14 base to be used in computing parity prices for farm products as the basis for a price support program.

Both indexes were revised in January 1950 (Stauber, Koffsky, and Randall [1950]). The prices paid index was revised to add 160 commodities for a total of 335 with a base weight period of 1935-39. Consumer expenditure studies in 1935-36 and again in 1941-42 provided the basis for individual commodity and group weights. Based on trial indexes using varying numbers of commodity items, those commodities which accounted for 0.5 percent or more of the group expenditure were to be represented in the group index. The increased number of commodities required under this criterion had been provided by an expansion in the collection of prices paid by farmers from about 200 commodities in 1935 to nearly 500 in 1949.

The index of prices received by farmers was revised in 1944 to add 5 commodities, bringing the total to 48, and to include 12 subgroup index numbers using marketings for 1935-39 as quantity weights. Only minor changes were made in 1950.

Although the need for periodic surveys to obtain information on changes in the pattern of farm expenditures was generally recognized, such a survey was not made until early 1956. Data from this survey were incorporated into

a revision of the Parity Index in 1959 (Stauber [1956], Stauber, Hale, and Peterson [1959]). The revised indexes were of the same general form as those that emerged from the 1950 revision, with the weighting pattern representing the average of all farms. The same major and minor commodity groups and subgroups indexes were retained. The base weight period for prices paid was 1955, the year of record for the expenditure survey. The prices received base weight period was 1953-57, thus centering on the year of the prices paid base weights. The deficiencies in coverage for prices received were relatively minor; the price series included about 93 percent of receipts from sales of farm products. For prices paid about 8.5 percent of production expenditures were not represented because of lack of price information on machine hire and custom work, marketing expenses for crops and livestock, cash rent, irrigation, and insurance. For family living about 12 percent of the expenditures remained uncovered in the Parity Index with medical, dental, and hospital expenses accounting for 7.4 percent and personal insurance and recreation accounting for the remainder. The omission of medical and dental expenditures accounts for a large portion of the difference in trend since 1959 between the Family Living Index and the Consumer Price Index of the Bureau of Labor Statistics (Houck and Soliman [1971]). The details of the series of prices received and prices paid by farmers are described in volume 1 of Agriculture Handbook 365 (USDA [1957, 1970]).

The data for the prices received and the prices paid series are based on mail surveys using nonprobability samples, which has subjected this price series to criticism. Research undertaken to establish feasibility and cost factors in collecting data by personal enumeration from a probability sample indicated significant differences between average prices as reported on the mail inquiry and from the enumerated probability sample in an Ohio study (Stauber [1964]).

The price data series of the USDA were reviewed by the National Bureau of Economic Research in 1973 and recommendations were made to the Congress (U.S. Congress [1974]). In general the Bureau found the program to be well designed and well executed and recommended only minor changes.

Market News

The Federal-State Market News Service, administered by the AMS in cooperation with state agencies, collects and disseminates market information to aid producers and marketing agencies in their daily marketing and production decisions. The procedures for gathering daily data on prices, supplies, and market conditions have changed since World War II in response to changes in marketing practices. Market news reporting has become more difficult because markets have become more decentralized, with a decline in trading at

terminal markets and an increase in direct sales from producers or packers to wholesale buyers. Wholesale buying organizations have grown larger, and their numbers have decreased. Some of these changes are described in the June 1966 reports of the National Commission on Food Marketing [1966a, 1966g] and other sources.

Other marketing changes include increased foreign sales of grain; integration of the broiler industry, with the turkey industry following a similar pattern; formula pricing of poultry and eggs; increased sales from producing areas of fruits and vegetables packaged in consumer packs; and more shipments of products by truck than by rail. Also, changes in government price support programs released more cotton, wheat, and feedgrain for free market trading, thereby requiring greater market news coverage.

The AMS has attempted to respond to these changes by establishing reporting to provide greater coverage of producing areas, collecting price and supply information at livestock auction markets and on direct sales, providing information on the relationship of carcass prices to live cattle prices, reporting on export prices of grain, and reporting prices on ready-to-cook broilers—the first point of sale—rather than on live poultry. In the fruit and vegetable market news the AMS has reported prices on consumer packages and has also attempted to collect information on the volume of supplies moving by truck.

The relocation of livestock yards and packing and processing plants from urban to rural areas meant that market news reporters had to cover more locations. In many cases the frequency of reporting is now less than daily. Special weekly reports covering national or regional markets have been introduced to provide information on market trends. New reports have been added for ornamental crops and for prices of imported produce when such data are available.

Some of the market news problems have been intensified by changes in marketing practices. One persistent problem is the difficulty of obtaining sufficient prices to report an average price when buying is concentrated in a few hands, when only a small proportion of the commodity moves through the market under observation, and when sale of a large percentage of a crop such as cotton or grain is contracted before harvest. Increased exports and containerized shipments of grain, packaging of eggs in consumer cartons at producing points, and the increased movement of agricultural supplies by truck also present challenges in obtaining accurate data on prices and supplies. Gaps remain in the data available on prices and supplies of raw fruits and vegetables used for processing.

Farm Data

Farm Income and Expenditures

Procedures for estimating farm income have not undergone radical change since World War II. In addition to basic data on gross farm income, farm production expenses, and the residual net farm income, work in this area includes outlook and situation reports and near-term forecasting. State estimates of production expenses were developed during the early 1950s, and these led to a viable series on net farm income by states.

One of the major new sources of data on farm production expense data was the 1955 Farm Expenditure Survey (USDA, AMS, and Bureau of the Census [1958]). Although this was carried down to the state level, it provided many new benchmarks for the numerous accounts making up total farm production expenses. In the early 1960s the basis for estimating the income of the farm population was changed from national income to personal income. This allowed direct comparisons of the income of farm people with the income of nonfarm people on a per-capita disposable personal income basis.

Another major undertaking since World War II has been an attempt to develop methods for estimating income parity for farmers as distinct from price parity for commodities. This work was prompted in part by the provision in the Agricultural Adjustment Act of 1938 to provide farmers with parity of income, a provision that was never put into effect because no one knew quite how to do it. Some of the outstanding work in this area was initiated by Masucci [1962], whose article broke new ground. Further work was carried out under the direction of Kyle Randall and an important study was released in 1967 (U.S. Congress [1967a]).

Another area in which considerable progress has been made is the development and annual publication of estimates of United States farm numbers by sales classes of farms, including estimates of income and expenses, and later government payments by sales classes (Grove [1939]). Koffsky provided much of the overall leadership in the postwar work on farm income estimates.

The present national data system on farm output, input, and cost was essentially established before national income accounts were developed. A move is under way to shift the conceptual emphasis in agricultural income data toward the rationale of national income and product accounts. Exploratory work on alternative additional frameworks has been provided by Weeks [1970, 1971a] and by a special task force on farm income data appointed by the ERS administrator.

Calls have been made for major changes in farm income estimates because of the feeling that the data did not reflect the rapid postwar changes in the structure of agriculture. Some agricultural economists contend that farm income estimates do not reflect accurately the present income position. Efforts to restructure farm income data are concentrated in the ERS; little is being done in the land grant colleges.

One major deficiency in the farm income estimates is believed to be the understatement of farm production expenses and the failure to distinguish between current expenses and capital stock. Statisticians and agricultural economists have pointed repeatedly to the shortage of basic data on depreciation, repairs and operations, and hired farm labor. In addition, expense accounts do not include custom work and machine hire purchased by farmers. The 1971 Production Expenditure Survey of the Statistical Reporting Service (SRS) is being used to provide new benchmarks for farm production expenses. An annual survey of production expenses should now do much to make up deficiencies in the expense accounts and contribute to a better measure of net farm income.

Farm income and expense estimates are important to policy makers and to the farm community, providing as they do the only comprehensive measure of the combined effects of changing prices, production, sales, and production costs on farm operators.

Enterprise Budgets

One basic source of data for economic analysis from the dawn of the agricultural economics profession is in enterprise budgets. Renewed interest in enterprise budgets was stimulated by legislation that provided for price supports based on costs of production, first in the 1960s for cotton and more recently for other crops. A large number of crop and livestock enterprise budgets have been prepared by the ERS and its predecessors since World War II, generally for a single period, and have been published by state experiment stations.

Enterprise budgets for major crops grown in each of six production regions have been published under the overall title of *Selected U.S. Crop Budgets, Yields, Inputs and Variable Costs* (USDA, ERS [1973b]). The budgets reflect arithmetic averages for production areas or resource situations within production areas, using expected yields for 1970. Family labor was included with hired labor, but machinery depreciation was excluded. Preharvest and harvest costs were shown separately. Many of the data for these budgets were taken from the studies of production adjustments, but data from other sources were used to update coefficients and prices when available.

A budget generator has been developed by Walker to computerize budget

preparations. The computer program consists of a routine including the title, footnote, identification number, and input-output coefficients of the budget. Subroutines include necessary internal computations for creating a budget. This program was designed with flexibility to allow users to apply additional subroutines. This computer program is now in use at several state universities.

Farm Costs and Returns Data Series

Annual time series data on farm organization, costs, and income for a number of farm types were initiated in the BAE before World War II under the direction of S. E. Johnson and W. D. Goodsell. These data were published in Statistical Bulletin 197, Agricultural Information Bulletins 158, 176, and 230, and in ERS reports 446, 478, and 480 (Goodsell [1956], Goodsell et al. [1956], USDA, ARS [1958], USDA, ARS [1960], USDA, ERS [1962-72], USDA, ERS [1970], Evans and Hughes [1971], and Weisgerber [1971]). These data provided useful illustrative material for judging the effects of policy changes on particular types of farms. The development of better procedures in recent years led to discontinuation of the series.

Agricultural Sectors of National Input-Output Models

Four national input-output models have been constructed since World War II. The Bureau of Labor Statistics (BLS) constructed the first for the 1947 economy and the Department of Commerce Office of Business Economics (OBE) published tables for 1958, 1963, and 1967.

Construction of the agricultural sector accounts in the 1947 BLS study was directed by Ritz [1955]. The basic data work was done under contract in the BAE by a group under the leadership of Fox and Norcross. The group defined agricultural sectors on a "product" basis rather than the more usual "establishment" basis, owing to the nature of the available data. Accounts for seventeen commodity sectors and one agricultural services sector were constructed. The use of a product definition for agriculture precluded the inclusion of the outputs of various activities often associated with farming, such as farm rentals and custom work for other farmers.

The second major contribution in the area was a study published in 1959 by Masucci [1959]. Based on detailed analysis of information from the 1954 Census of Agriculture and Manufactures and from the 1955 Survey of Farmers' Expenditures, this study presented estimates on the dollar volume of transactions between and among the agricultural and nonagricultural sectors. The BLS classification scheme of seventeen commodity sectors and a service sector, all classified on a product basis, was maintained. Although basically following the 1947 framework, Masucci treated by-products and waste products more explicitly.

The earlier classification scheme was further changed from a strict "product" classification to include secondary outputs of the agricultural sectors. Among these were gross rental value of farm operators' dwellings, gross rents paid to farm landlords, and custom work done for other farmers. The ERS also developed the estimates of agricultural sector accounts for the 1963 and 1967 tables published by the Office of Business Economics (U.S. Department of Commerce [1969, 1974]).

Modifications since the 1959 study of the input-output accounts for agriculture have been restricted to conceptual changes. Some of the data problems are unresolved. For example, input-output table construction requires estimates of total agricultural production gross of such internal transactions as home-grown feed and seed and intrastate livestock shipments, and this estimate is not regularly made. Farm income production expenditures accounts have historically omitted custom hire, because these inputs were treated as interfarmer transfers and miscellaneous business expenses; these inputs should be included in the accounts. To the extent that custom work done by nonfarmers and miscellaneous business expenses are significant, inputs to agriculture are understated because the official "gross national product originating in farming" did not include these inputs.

No surveys of farm production expenditures were made from 1955 to 1971. Information from the 1971 and later farm production expenditure surveys is being incorporated into the official farm income production expense accounts. This will correct in subsequent tables the sources of known distortions in the input structure. Commodity sector distributions of input categories must be estimated indirectly because most input data are calculated on an establishment basis. Data on trade and transportation margins for agricultural commodities are limited.

Agricultural economists have made extensive use of the national input-output tables as descriptive tools. Earl Heady and his colleagues conducted a series of studies classifying the national agricultural sectors into regional sectors while utilizing the 1947 BLS study as a resource for nonagricultural sector structures (G. A. Peterson and Heady [1955], Schnittker and Heady [1957], and Carter and Heady [1959]). Elrod and LaFerney [1970] used an updated version of the 1958 OBE table to estimate income and employment multipliers. Weeks [1970] utilized an aggregated version of the 1963 OBE table as a basis for discussing the size, structure, and pervasiveness of American agriculture. Schluter [1972] utilized the 1963 OBE table to trace out the effects of income generated in agriculture from final demand in terms of the components of the national income and product accounts. An example of the efforts made to expand the role of national input-output tables beyond that

of a descriptive tool is Weeks's version of the 1963 OBE table, which has been maintained by the ERS as a policy impact analysis model (Weeks [1970]).

Farm Output, Input, and Productivity

During World War II farmers were encouraged to produce at full capacity to meet wartime demands. After World War II there was a general concern for what might happen to the farm and nonfarm economies in the shift from wartime to peacetime.

Analysis of past changes was needed as a basis for a rational response to the peacetime problems in agriculture. The only measures of total agricultural (crop and livestock) production were the production for sale and home consumption index series. Production of individual commodities and a total crop production index were published by the Crop Reporting Board. The production for sale and home consumption series measured production volumes moving into the marketing system or used for home consumption. These measures were more closely related to changes in farm income than to changes in farm resources used in a particular year.

Barton and Cooper [1945] developed and published a farm output and gross farm production index series in the mid-1940s. Both series measured production in the year produced, even though some of the output might be sold or consumed in succeeding years. Farm output measured the volume of farm production available for eventual human use, and the gross farm production series included farm produced power. Index numbers were constructed for each of the nine census geographic regions beginning in 1919 and for the United States beginning in 1910.

Indexes for net livestock and total crops were constructed as major subgroups in the development of the output index. Thus, there were two index series within the USDA measuring total crop production—the Crop Reporting Board with a reference period of 1923-32 = 100 and this new crop index with 1935-39 = 100. Both series tend to have the same annual movement.

In 1953 a statistical review committee headed by O. C. Stine suggested that only the farm output series be published annually to avoid confusion with the gross farm production series, with the gross farm production series made available for research purposes. Only one crop production series was to be published, the Crop Reporting Board index would be published in the current year and the Barton-Cooper series would be used for the historical series. Weights were revised to make the series comparable. In 1954 the two production series were reweighted using 1947-49 for the weights and reference period. The livestock indexes were changed from net to gross indexes.

Concern was also expressed on whether data by census regions were mis-

leading chiefly because the Corn Belt was in two census regions (East North Central and West North Central). In 1959 the farm output and related series were shifted for the first time to a basis of ten farm production regions and calculated back to 1937 (Durost [1960]).

Cooper, Barton, and Brodell [1947], Jennings [1958], and others developed a series of input measures in the mid-1940s. These measures included farm workers, manhours, cropland used for crops, animal units of breeding livestock, power and machinery including and excluding horses and mules, and total inputs. These input series measured the inputs used to produce each year's production.

Partial and overall measures of input productivity were obtained by dividing the appropriate production index by the appropriate input series. These input and productivity series were published in the late 1940s (Barton and Cooper [1948], Cooper, Barton, and Brodell [1947]). Data for the power and machinery series and the total input series were not maintained after these publications appeared. Data on the animal units of breeding livestock and livestock production per breeding unit were also discontinued in 1966.

Loomis and Barton [1961] later redeveloped the total input series. This series, like the previous one, included all farm labor, real estate, and all other inputs committed to agricultural production. An overall productivity series was computed by dividing the index of farm output by the index of total inputs. They used two weighting periods, 1935-39 and 1947-49, for the period after 1950. The series was computed only by decades from 1870 to 1900 and annually beginning in 1910. This input series was further revised, and the annual data were published in *Changes in Farm Production and Efficiency* (USDA [annual]), beginning with the 1971 issue. Lambert developed the new series by building up from the ten farm production regions, using 1947-49 weights from 1939 to 1954 and 1957-59 weights from 1955 to date. His regional data start in 1939, as does the farm output series; he also developed overall productivity data for each of the farm regions.

Farm Population

The USDA began publication of annual estimates of the farm population in 1923, following the introduction of farm residence as a basis of classification in the 1920 Census of Population. Annual estimates were based on farmer responses to mail questionnaires. Historical estimates for the 1910-20 period were developed in the 1930s to provide data for parity income estimates required by legislation (Grove [1939]).

With the publication of these historical estimates a continuous series of data on farm population from 1910 has been used by the ERS and its prede-

cessor agencies. Revisions required by changes in the definition of the farm population (Banks, Beale, and Bowles [1963]) have been published from time to time (Banks and Beale [1973]). These estimates relate to the rural population living on farms, regardless of occupation. Before 1960 the farm population was determined by the respondents' answers to the survey question, "Is this house on a farm (or ranch)?" In the 1960 and 1970 censuses the farm population consisted of all those who lived in rural territory on places of ten or more acres if as much as $50 worth of agricultural products were sold from the place in the reporting year and those living on places under ten acres with at least $250 worth of agricultural products sold. The farm population series was expanded in 1944 to include such characteristics as age, sex, and labor force status. Quarterly estimates were made for 1944-49 and annual estimates were made from 1950 to date.

The ERS farm population estimates are now based on the current population surveys of the Bureau of the Census, an annual ERS survey, the decennial population census, and related data. The annual ERS report covers the farm population and components of annual change (births, deaths, and migration) by geographic regions. The ERS and the Bureau of the Census cooperatively release estimates of the farm population by age, sex, color, labor force status, and related data. The sampling error for the farm population is relatively high—about 2 percent. No measure of sampling error is available for the estimates for geographical areas.

In addition to sampling problems the farm population estimates are also subject to conceptual difficulties. Many farm operators and workers do not live on farms, and many people living on farms are employed elsewhere. The "farm population" has become less meaningful than formerly as an economic indicator of the farming sector and as a guide to the welfare of rural people.

Production Resources and Costs

Finance

Agricultural economists have been involved for many years in securing data related to farm finance. Since World War II this work has focused mainly on the financial and equity position of farmers, financing the growth of farm firms, the changing financial structure of agriculture, and future financing needs.

The main source of data has been the ERS and its predecessor agencies; the farm debt series goes back to 1910. Concern in 1944 over postwar financial adjustments in agriculture led the ERS to develop an annual series on the balance sheet of United States farms showing assets and liabilities by major

categories (Tostlebe et al. [1945]). Although largely based on existing data, estimating procedures for several additional debt and asset items were developed.

In large part the methodology for the annual balance sheet series continues as developed originally. The items most subject to error and incompleteness are noncommercial bank financial assets and debt owed to noninstitutional lenders. The underlying concepts of the series have been questioned from time to time, however, and Burroughs [1949], one of the original authors, and Irwin [1968] have discussed the concepts and the interpretation and use of the series.

The basic series on farm debt and other balance sheet items have been useful in analyzing economic growth and the changing capital structure of farming. It was found that more details were needed on flows of funds during the year and on debt and debt-asset-income relationships for different segments of the farm sector. Many agricultural economists attempted to meet these needs from surveys conducted by the Census. The 1960 Census sample survey was the first effort to obtain data both on real estate debt and on non-real estate debt, including debt to merchants, dealers, and other noninstitutional lenders. This survey also provided data on debts and assets by age of operator, income, and type and size of farm. Garlock and Allen [1964] were leaders in initiating the 1960 Census survey; Melichar (U.S. Federal Reserve System [1964]) supervised summarization of the data. The 1964 Census survey provided much the same data on debt.

The 1970 Census sample survey was broadened to include data on specific capital purchases financed by internal as opposed to external sources of funds. Data were also obtained on the off-farm and other income earned by farm operators and their families. A number of economists from the Farm Credit Administration, the Federal Reserve System, and the Bureau of the Census assisted ERS economists in designing the questionnaire and in developing and compiling the data from the 1970 survey. Many economists see a need for even more complete data to permit description and analysis of the system through which funds flow into and out of the farm sector (Penson, Lins, and Irwin [1971], Heady and Tweeten [1963], and Penson [1972]).

The rapid capitalization of agriculture during the past several decades has generated concern over the adequacy of capital. Pioneering work was done in this area by Tostlebe [1957]. More recent projections of future financing needs of the farm sector have been made in several studies by Heady and Tweeten [1963], Melichar and Doll [1969], and Melichar (U.S. Federal Reserve System [1964]).

Credit Institutions

Statistics of credit institutions and noninstitutional lenders have been used to reveal the characteristics of debt owed by farmers and the volume, adequacy, and cost of credit used by farmers. Data from credit institutions that have been used include information on loans outstanding, loans made, interest rates, loan maturities, delinquencies, and foreclosures, shown by type of lender, by area, and whether secured by farm real estate.

Many agricultural economists involved themselves in developing or improving statistics on institutional and noninstitutional creditors relating to data series or one-time studies. Much of this work was started before World War II in the former Agricultural Finance Branch of the ERS and its predecessors. Publication of the *Balance Sheet of Agriculture, 1945* was the beginning of a series of basic data on asset values and farm debt as a whole. Annual data have become an important measure of farmers' financial condition. Norman Wall and Fred Garlock guided the development of the annual *Agricultural Finance Outlook*, *Agricultural Finance Review*, and the statistical supplement to the *Review*. Data dealing specifically with farm mortgage debt have been distributed in two publications, *Farm Mortgage Debt* and *Farm Mortgage Lending*. Another publication, *Index of Deposits in Country Banks*, was developed as an important measure of the ability of rural banks to meet farm loan demands.

Much of the statistical work done on farm finance in the Federal Reserve System was developed by R. J. Doll and E. Melichar. Some of their efforts are represented in *Farm Debt, Data from the 1960 Sample Survey of Agriculture*; *Merchant and Dealer Credit in Agriculture, Data from the 1960 Sample Survey of Agriculture*; and in "Capital and Credit Requirements of Agriculture and Proposals to Increase Availability of Bank Credit" (Melichar and Doll [1969]).

The Farm Credit Administration (FCA) has been active in providing farm credit data with particular emphasis on Federal Land Bank and Production Credit Association (PCA) loans. Planting was responsible for many of the series, including reports of the sample surveys of PCA loans at five-year intervals. The annual report of the FCA contains data on its operations by states.

Several data series on farm credit extended by commercial banks and other lenders were sponsored by the American Bankers' Association (ABA) under the direction of Savage and Derr (ABA [monthly]). Regular publications such as *Agricultural Credit and Related Data* and *Agricultural Banking Developments* were the vehicles for distributing much of the data.

University and other institutional research staffs have done little in the way of compiling and distributing farm credit statistics. Rather, they have emphasized analysis of the existing farm finance procedures and programs, often recommending changes to improve the extension and use of farm credit and anticipating future farm credit needs. Numerous journal articles, circulars, and college textbooks have been produced by these institutional researchers.

Farm Real Estate

Farm real estate data have focused mostly on the prices of farm land and on the participants in farm real estate markets. Data on financing real estate transfers and on the distribution of loans for real estate purchases by type of lender were added as the percentage of sales financed at higher debt-to-value ratios increased. Although basic collection procedures remained unchanged, the type of data collected has evolved as needs have changed. Semiannual summaries of farm real estate market activity have been published in *Farm Real Estate Market Developments* by the ERS. Brief summaries also have appeared in *Balance Sheet of the Farm Sector*, *Farm Cost Situation*, and *Agricultural Finance Outlook*.

The basic challenge in real estate data collection is to sample changing real estate transfers adequately through a static group of reporters. Several attempts have been made to collect transfer data from courthouse records, but the process was too costly and the data were not sufficiently reliable. Many transfers were not recorded until years after the initial agreement, the records did not always reflect the full price or other considerations in a sale, and sampling was inadequate.

As the farm and nonfarm sectors become more and more interdependent, the impact of nonfarm factors on farm real estate values becomes increasingly important, adequate measures of this relationship have not been developed. The further separation of farming as defined by the Census of Agriculture into commercial and noncommercial sectors hampers accurate measurement of asset earnings in the commercial sector because a growing volume of farm assets contributes little to commercial production.

Research on farm real estate has historically been divided between state market studies and analyses of aggregate data for the United States. Some analysis has been done on the impact of specific institutional factors such as farm commodity programs or highway construction.

The state studies have usually attempted to determine the actual level of land values within the state, the variation in values among areas, the characteristics of the participants in the real estate market, and the influence of the various factors on real estate prices (Anderson, Loftsgard, and Erickson

[1962], Crosswhite and Vaughn [1962], Crowley [1972], Davis and Miller [1959], Dovring and Scofield [1963], Fischer, Burkholder, and Muehlbeier [1960], Gibson and Chambliss [1966], Hurlburt [1950], Murray and Reinsel [1965], and Pine and Scofield [1961]). Despite many attempts to quantify the impact of specific factors on real estate values, the data remain inadequate because of the great variation in sales prices, the small number of observations available, and the probability that the sales which occur are not representative of all rural real estate.

At the national level much of the research in the last decade has developed around an observation that land values and net farm income are not changing proportionately (Boyne [1964], Chryst [1965], Herdt and Cochrane [1966], Hurlburt [1959], Renshaw [1957], Tweeten and Martin [1966], and Tweeten and Nelson [1970]). These studies generally have assumed a national farm real estate market and have attempted to explain the observed divergence of trends in net income and land values with aggregate data. Several econometric models that predict the national average value of farmland have been developed.

A model developed by Tweeten and Martin [1966] is typical of recent national studies. A unique study by Boyne [1964] examined the impact of changes in the value of all assets, including real estate, on the wealth position of farm operators. In general, research at the national level illustrates the differences of opinion that exist among economists about the cause of the upward trend in land values.

Most commodity studies have focused on the effect of price support and production control programs on the value of land used for specific crops. These studies have shown that allotments do have a capitalized value and that the long-term average capitalization rate is in the neighborhood of 15 percent. In general, the commodity studies indicate that farm program benefits have been capitalized into land values and that the implied capitalization rates are considerably higher than the market rate of interest.

Machinery and Equipment

A national inventory of principal machines on farms is published annually in *Changes in Farm Production and Efficiency* (USDA, ERS [1972a]). Tractors, trucks, and automobiles were enumerated by the Census in 1920. The annual series based on census counts, shipments by manufacturers of machines for farm use, survey data, trends in census data, and estimated annual discard rates began in about 1939.

The early data included mainly counts of major machines on farms and trends from year to year. Initially, the machines were small, and those on farms were relatively new; the discards were low and the numbers increased at

a rapid rate. As mechanization progressed, additional data on age, size, and annual use of machines were collected. Annual collections of data were largely confined to the inventory of machines on farms. Periodical mail surveys and occasional enumerative surveys were made to assess age, size, and annual use. Data involving inventories of machines were used in series on farmers' purchases of machines, repair costs, and depreciation, and in *Balance Sheet of the Farming Sector.*

A contract study on use, depreciation, and replacement of machines and custom operations was made in 1956 (Parsons, Robinson, and Strickler [1960]). This one-time nationwide survey was a stratified multistage probability sample of 80 county sampling units and 541 segments. Data from this survey made possible the first calculations of the average age and the average service life of machines. Later data involving sales of principal machines to farmers have been useful in computations of discard rates, tractor horsepower, average age, average useful life, and other relationships.

More information is needed on work-related farm accidents and pollution to serve as a base from which to assess progress in muffling sound, equipping machines with roll-over protection, educating drivers to operate and maintain machines in a safe manner, and minimizing emissions. Further information is needed on long-range purchase patterns for major machines.

Fertilizer

A boom in the production of synthetic anhydrous ammonia came out of World War II. Used for munitions during the war, ammonia is the basic stock for virtually all nitrogen fertilizers. Ammonia producers sought an outlet for their product by wooing farmers in the Midwest as prospective users of fertilizers. This helped to shift the center of fertilizer consumption from the cotton and tobacco production areas in the Southeast to the Corn Belt.

Much of the post-World War II economic research into the use of commercial fertilizer was inaugurated by Ibach and Adams. Donald Ibach and others who worked with him in the ERS and in the ARS. Although their work was largely agronomic, it provided a foundation for the study of the economics of fertilizer use. One major contribution was the development of a method for estimating crop response to various levels of application of primary plant nutrients. Ibach devised a method for estimating the use of fertilizer by crops and by states, based upon data obtained from the agricultural censuses.

From 1969 to 1973 the fertilizer industry underwent a reversal from excess production capacity and low prices to tight supply and record high prices for primary plant nutrients. Because the domestic economy and agriculture depend heavily on the fertilizer industry—about a third of domestic crop production is attributed to fertilizer—the USDA has expanded its research

into the structure of the industry. The ERS monitors the supply and demand situation annually in *Fertilizer Situation*. Other departmental publications about fertilizer are the SRS *Fertilizer Consumption Report* and the Agricultural Stabilization and Conservation Service *Fertilizer Supply*, each published yearly. Nevertheless, gaps remain in the fertilizer data, especially in the areas of nonfarm use of fertilizer, fertilizer production and consumption in foreign countries, transportation of fertilizers from producing points to farms, and production and use of secondary nutrients and micronutrients—growing segments of the fertilizer industry.

Feed

Principal changes in feed-livestock data have come from intensive efforts to make indexes of relationships more useful. Current index series make use of basic nutritional standards developed by the National Academy of Science, Council of Animal Nutrition. Daily minimum nutrient requirements with allowance for waste and shrinkage by type and kind of livestock are used to develop feeding rates for a specific base period. All feedstuffs are measured in feed units which facilitate measurement by nutrient source such as concentrates, harvested roughage, and pasture. Index series are now available by state and by specific type and class of livestock and poultry. These include (1) grain-consuming animal units, (2) roughage-consuming animal units, (3) grain-and-roughage-consuming animal units, (4) livestock production units based on concentrates, and (5) livestock production units based on all feeds. In response to the need for a measure of feedgrain use by states, an annual balance showing feedgrain surplus and deficit was developed for each state, using grain-consuming animal units and SRS feedgrain crop estimates.

In addition to the five index series mentioned above, a high-protein animal unit series at the national level is maintained to identify end-use by individual livestock species. For the 1973-74 feeding year, estimates of nonagriculturally produced feedstuff fed to livestock and poultry were initiated. The three major items added were urea, salt, and mineral mixtures.

Two one-time surveys were completed, one in 1966 on consumption of urea as a feed ingredient for cattle (Allen and Mighell [1969]) and the second in 1970 on the formula feed industry. Each covered an area for which adequate data were lacking. Before 1965 the source of urea data was the Tariff Commission, which indentified the share of urea used for feed. The 1966 survey showed much more urea being fed to cattle than was reported to be manufactured under the 42 percent label. Apparently a considerable quantity of fertilizer urea containing 46 percent nitrogen was being mixed in feeds. As far as livestock feeding is concerned, the two kinds of urea are almost perfect substitutes.

In addition to the conventional uses for which they were designed, feed-livestock index data have been used by business firms to determine the market potential and the possibilities of market penetration. In a landmark case involving freight rates of the Southern Railway, the grain-consuming animal unit series was used by the U.S. Interstate Commerce Commission [1963] to estimate the consumption of feed grains in the nine southeastern states. The case was appealed through the federal court system to the Supreme Court, which held that the methodology and the results were logical and acceptable.

Major gaps still exist in the livestock-feed data with respect to (1) the movements of feed ingredients from production to consumption, in both the quantity moved and the method of transportation, to determine impacts on regional production patterns, (2) the quantities used and the characteristics of recently developed commercial byproduct feeds, (3) the kind and amount of microingredient feed additives fed to different kinds of livestock and poultry, (4) determination and evaluation of the net gain obtained by additions of microingredients to livestock and poultry feeds, and (5) the kind and amount of feed going to nonfarm livestock.

Pesticides

At the end of World War II most of the pesticides in general use were inorganic materials. With the development of the new synthetic organic pesticides it became economically feasible to control many pests more effectively. By the early 1960s more than 10,000 commercial pesticide formulations were available. They have helped to make possible increased specialization and more intensive farming. The demand for pesticides increased sharply during the postwar years, but so did public concern over the use of pesticides and their side effects.

In 1964 Congress authorized an expanded program of research on the agricultural use of pesticides. The Agricultural Appropriations Act of 1965 provided funds to the USDA to undertake an intensified program of research, education, and regulation, recognizing that pest control is an economic problem as well as a biological and physical problem. The data available at the time were inadequate to evaluate the economic implications of pesticide use. The ERS with the help of the SRS was authorized to conduct nationwide enumerative farm surveys to collect and analyze the needed data. Three nationwide enumerative surveys were conducted to get detailed data on farm use of pesticides for 1964, 1966, and 1971 (Andrelenas, Eichers, and Fox [1967], Fox et al. [1968], Andrelenas [1974]). These surveys provided the basis for at least twenty publications and numerous staff and administrative reports showing quantities of pesticides, expenditures for pesticides, and

types and forms of pesticides used by farmers on specified crops and livestock.

The data obtained in these surveys were also used to estimate the effects of pesticides on productivity and the consequences of restricting or prohibiting the use of certain pesticides. Such economic impact studies represent an important application of the data in recent years, and they have been used in Environmental Protection Agency (EPA) advisory hearings and pesticide registration reviews and in public hearings on proposed pesticide restrictions. Other studies based on data from the surveys were prepared for the Congress, the President's Office of Science and Technology, the Council on Environmental Quality, and the EPA. In addition, government agencies, researchers at various agricultural experiment stations and universities, and many others have used the data. Entomologists, weed scientists, and other researchers have contributed technical information to the economic evaluations.

The 1971 survey filled gaps in earlier data and provided more recent information. In addition to recording types, quantities, and costs of pesticides used, this survey collected information on the pesticide containers used and their disposal, the hazards to human beings from the use of pesticides, the methods of pesticide application on row crops, and the reasons for using specific pesticides and their effectiveness against major pests. These data helped appraise the potential for using alternative methods of pest control and for making adjustments in agriculture to reduce the need for chemical pesticides.

Farm Labor

National statistics on farm labor are obtained from continuing household and establishment surveys and from special surveys. The major household surveys are the decennial Census of Population and the monthly Current Population Survey. The reports appearing in *Occupation by Industry* PC(2)-7C are prepared from the decennial census. Both *Employment and Earnings*, a BLS monthly bulletin, and *Hired Farm Working Force*, an ERS annual series with ancillary reports, are derived from the Current Population Survey.

The major establishment surveys include the Census of Agriculture, which is taken every five years, and the quarterly Agricultural Labor Survey by the USDA, SRS. The Census of Agriculture reports for each state and the nation as a whole are published from the five-year survey although they contain little data on farm labor. Additional data obtained in conjunction with the quarterly Agricultural Labor Survey have been published by the Department of Labor in reports transmitted to Congress. These reports, entitled *Hired Farm Workers*, present data relative to the effects of minimum wage legislation on the supply and demand for hired farm workers.

Estimates of agricultural employment are issued quarterly by SRS and are published in *Farm Labor*. Data are included on family workers, hired workers, total workers, and hours worked, covering the United States, all standard federal regions, and all contiguous states except those in Region 1.

Since January 1974 estimates have been based on a probability survey using the multiple frame concept. Before January 1974 monthly estimates were based on a nonprobability mail survey. The necessity for the change to probability sampling became apparent as farms grew more specialized and the mail survey lists no longer represented the large or seasonal labor users. The sample survey covers the week of the twelfth day of January, April, July, and October and records the actual payrolls of about 18,000 scientifically selected farms for these weeks—timing that matches the week specified in employment and wage series constructed by other government agencies. The current survey requires that workers must have been employed on the farm during the survey week. They may be counted as farm workers more than once if they worked that week on two or more farms in the sample; the number of hours worked and the wages earned are not counted twice.

Wage rates are obtained for different types of work and methods of pay. Wages by method of pay include wages per hour for piece rate, wages other than piece rate, wages per hour only (perquisites also received), cash wages only (any method of pay but no perquisites received), and cash wages per hour only (no perquisites). Wages by type of work include wages per hour for field and livestock work, packinghouse work, machine operation, maintenance and bookkeeping, supervision, and other agricultural work. Although some workers do more than one job, the respondent classifies the worker according to what he did most of the time during the survey week.

The results of a special survey of farm enterprises, conducted by the Census of Agriculture in 1972 on 1971 farming operations, were published in nine parts as volume 5, Special Reports. A large volume of labor data for the nine major farm enterprises was obtained. A supplementary census of agricultural services was conducted in 1969 and published as volume 3 in 1972. It presents numbers of employees and payrolls for businesses serving agriculture as defined in the population of the survey.

Since World War II the need for farm labor statistics has increased in part because of more urgent policy issues affecting labor (minimum wage, unemployment insurance, safety, and others), in part because of the increased cost of labor, in part because of growing concern over the welfare of hired workers, and for other reasons. This prompted the SRS to drop the mail survey and turn to the enumerated multiple frame approach worked out by Stokstad and Garrett (Small [1975]).

Labor statistics are used by the ERS to construct a series on man-hours of

labor used in farming. Estimates are developed for individual farm enterprises by applying average man-hour labor requirements to the official estimates of acreage and yield reported in SRS *Crop Production* reports. With data from the agricultural censuses benchmark estimates of man-hours per acre are developed for farm enterprises in each state. *Trends in Output Per Man-Hour in the Private Economy, 1909-58* (U.S. Department of Labor, BLS [1954]) and subsequent BLS releases present indexes of production per man-hour, but only for all of agriculture.

Some labor information gaps were filled by data collected in the 1964 and 1966 "ERS Pesticide Surveys" (Andrelenas, Eichers, and Fox [1967], Fox et al. [1968]). These surveys obtained data on labor input, the value of perquisites furnished workers, and pay levels of workers by job classification. Other noncontinuing surveys such as the cotton cost survey, cling peach survey, and the flue-cured tobacco survey by governmental, academic, and other organizations have also helped to fill voids in labor data. More detail on the number and kind of workers in the farm labor force, the types of jobs they perform, and the skill requirements of those farm jobs are needed on a national basis.

Insurance

Crop insurance coverage, premiums, and indemnities have been included in an annual data series prepared by the ERS and its predecessors since before World War II. Originally data were collected from insurance companies, but now they are obtained mainly from several insurance statistical associations. Data on crop losses and the cost of insurance protection are important in the financial management of farms, in the operations of concerns supplying capital to agriculture, in planning and operation of the USDA crop insurance program, and for other purposes.

An earlier series on farm property insurance premiums and indemnities of farm mutual insurance companies was discontinued because of the nonfarm trend in the business of mutual insurance companies. A series of indemnities and premiums more representative of farms has been expanding since 1960. A one-time study of this development was made by W. R. Bailey and Jones [1970], with data furnished by insurance company statistical associations. Insurance data are regularly published in the ERS *Agricultural Finance Review*.

Marketing

Agricultural marketing research was expanded with enactment of the Research and Marketing Act of 1946. Since then, researchers in the USDA and

in the state experiment stations have added greatly to the knowledge and understanding of agricultural marketing. Bibliographies of USDA reports from 1950 through 1969 list over a thousand publications for marketing economics research.

Marketing research studies over the past twenty-five years have dealt with a variety of subjects including market development, merchandising and promotion, transportation, food distribution, costs and margins, and public programs. Some examples are the effect of the pilot food stamp program on retail food store sales (Frye [1962]), the food service industry (Van Dress [1971]), the agricultural exemption in interstate trucking (Miklius [1969]), the comparative cost to consumers of convenience foods and home-prepared foods (Harp and Dunham [1963]) and potato flakes (Dwoskin and Jacobs [1957]). These analyses were one-time studies based largely on primary data. These and hundreds of other marketing studies carried out in the land-grant universities and other state and federal institutions developed a great volume of data on marketing functions and the marketing of special commodities.

A comprehensive report, *Agricultural Markets in Change* (USDA, ERS [1966]), summarized past and prospective changes in markets and marketing functions for agricultural products, with chapters on innovations, market development, transportation, and commodity marketing systems. Also in 1966 the ERS prepared several studies for the National Commission on Food Marketing [1966b-1966g] including a special analysis of cost and profit components of farm-retail spreads for farm-originated foods.

In addition to one-time marketing studies, agricultural economists of the USDA have developed several major data series on agricultural marketing costs and charges. Two major series are now maintained by the ERS to meet current and continuing needs for information on food marketing costs and the farmer's share of the consumer's food dollar; these are "market basket" and "marketing bill" statistics and appear regularly in *Marketing and Transportation Situation* and other situation reports.

Development of these statistical series was prompted by the widespread belief that marketing costs too much. Consumers felt that marketing costs were pushing retail food prices up, and farmers felt that they were holding commodity prices down. Periodically the ERS evaluates and revises the procedures used to estimate the market basket and marketing bill data. Procedures and methods are also regularly reviewed by the USDA Statistical Review Board.

Market Basket Statistics

Waugh and Been originated the farm-food market basket statistics in 1936

in response to a widespread interest in farm-retail price spreads. Data sources and methods have been refined and improved many times since 1936. Market basket data show changes in the marketing charges for domestic farm-originated foods. They also show the relation between changes in prices paid by consumers and returns to farmers. This series has been published in *Marketing and Transportation Situation* since May 1942; a monthly supplement, *Price Spreads for Farm Food*, has been published since May 1971.

The market basket represents the average quantities of sixty-five domestic farm-originated foods purchased annually per household in retail stores in 1960-61 by families of urban wage earners and clerical workers and by single persons living alone. It does not include foods consumed away from home, imported foods, seafoods, or other foods not of domestic farm origin. Quantities are held constant so that changes in the value of the market basket will give accurate estimates of price changes. Prices of these sixty-five foods are used to estimate the market basket retail cost, the returns received by farmers, and the farm-retail spread, with data published for forty-six individual foods.

The primary sources of price data for the market basket series are the retail prices reported by the BLS and the prices received by farmers reported by the SRS. Market basket quantity weights are obtained from BLS expenditure studies at approximately ten-year intervals in order to obtain weights for the Consumer Price Index.

Marketing Bill Data

The other major USDA series on marketing costs is the "marketing bill," first published in 1945. This series reports total charges made by marketing firms for transporting, processing, and distributing domestic farm-originated foods purchased by civilian consumers in this country. It is the difference between civilian expenditures for these foods and farm value, which is an estimate of gross returns to farmers for products equivalent to those purchased by consumers.

Civilian expenditures for farm foods include expenditures for food bought in retail stores, restaurants, and other away-from-home eating establishments and directly from farmers, processors, and wholesalers. Expenditures for imported foods, fish, and other foods not originating on domestic farms are excluded.

The early development of marketing bill data was done by Been et al. [1945]. Initial estimates were based on the assumption that all food was sold through retail stores. Separate estimates of labor costs for marketing, of intercity rail and truck transportation costs, and of marketing firm profits were

introduced in the mid-1950s. In 1957 the procedures were revised to include the additional cost incurred on food purchased in eating places and to exclude the cost of food sold at less than retail prices (Hiemstra [1968]).

In 1967 the marketing bill statistics were reestimated by Scott, Gale, and Findlay, using the commodity flow method which had been recommended by Waldorf (Gale [1967]). For census years benchmark estimates are made of the commodity volumes flowing through the different marketing agencies (assemblers, processors, wholesalers, retailers) and the marketing charges added at each stage in the process. These estimates are based on data from the censuses of manufactures and of business and on published data from the USDA, the Office of Business Economics of the Department of Commerce, the Interstate Commerce Commission, the Internal Revenue Service, trade publications, and other sources. Annual estimates derived from less extensive data are used to interpolate between census years and extrapolate beyond the last benchmark.

The commodity flow method used for census years is conceptually superior because it incorporates the effects of changes in marketing channels, in gross margins for specific agencies, and in services offered and allows the introduction of new products. The price-quantity method provides an alternative estimate in benchmark years and an interpolating series for other years.

Several major cost components have been estimated since 1959. The procedures for making these estimates from Internal Revenue Service data were developed by Wesson, who established series for advertising, rent, depreciation, interest, taxes, business, and other cost components. Estimates of the cost of container packing materials were added by Eley [1971]. By 1972 about 90 percent of the total marketing bill was allocated to specific cost components. The rest of the bill was unallocated among fuel and power, intracity transportation, institutional costs, and miscellaneous items.

Recently, Crawford [1974] made several refinements in the marketing bill data, including separate estimates for foods consumed at home and in public eating places, hospitals, and in-plant food service establishments from 1963 on. The refinement of the marketing bill data was facilitated by the availability of benchmark data from an ERS survey of eating establishments (Van Dress [1971]). Estimates were also made for noncensus years for agency components (wholesaler, processor, retailer, public eating places). These estimates showed the labor costs and profits separately. Additional work is under way to disaggregate the marketing bill further.

Related Statistical Series

The ERS publishes several statistical series that are useful in analyzing changes in the marketing bill and market basket statistics. These include

(1) Indexes of Labor Costs per Hour and per Unit of Product Marketed, (2) Output per Man-Hour in Factories Processing Farm Foods, (3) Prices of Intermediate Goods and Services, and (4) Indexes of Railroad Freight Rates for Farm Products. A description of most of these series is given in the eleven-volume *Major Statistical Series of the U.S. Department of Agriculture: How They Are Constructed and Used* (USDA [1957-72]).

Data on Farm-Related Business

As nonfarm businesses have become increasingly important in the agricultural industry, economists have sought data beyond the traditional USDA and Census of Agriculture sources. The Census of Manufactures and the Census of Business have become useful sources of data, particularly with revisions in the standard industrial classification that permit identification of farm-related businesses.

The USDA has been represented on committees responsible for periodically reviewing and improving the *Standard Industrial Classification Manual* (U.S. Office of Management and Budget [1974]). As industry-related information is aggregated and published according to "SIC" codes, they implicitly limit the economic interpretations that can be made from the series. Over the years numerous changes have been made in the codes and, consequently, in the data, making them more useful to agricultural economists. In 1972 one of several improvements was to exclude garden tractors and implements from the farm machinery and equipment category, making that category represent more accurately the establishments producing machinery and implements for commercial farming operations. A separate category was created for garden tractors and implements. New categories also have been developed for establishments which provide soil preparation services, crop services and protection, crop harvesting and preparation for market, as well as for establishments primarily engaged in furnishing complete farm management services.

Since World War II major changes in farm-related business data include (1) the transfer of fats and oils from the chemical sector to the foods sector, (2) the transfer of fluid milk processing from wholesale trade to manufacturing, (3) the development of the *Annual Survey of Manufactures*, which annually presents many of the data provided by the Census, (4) periodic computation and publication of concentration ratios by all four-digit industries (as listed in the SIC Manual) for the largest four, eight, and twenty firms, composed of establishments of same four-digit classification aggregated to their parent firm but including only establishments for that industry alone, (5) the computation of specialization, coverage, and other ratios (for example, value added per man-hour of production worker, value added per

employee, and cost of materials and payroll per dollar of shipments), and (6) the development of enterprise statistics which aggregate on a company basis rather than an establishment basis.

Although the economic censuses provide a statistical image of the food and kindred product industries in terms of numbers, size, location of establishments, and some efficiency measures, they do not include such data as profits, advertising expenditures, and fringe benefits, which are relevant to analyses of conduct and performance of the industry. Such data are provided in *Internal Revenue Service Source Book* and *Statistics of Income*, publications issued eighteen months or more after data collection, and are not compatible with economic census data.

Data relating to public storage facilities are reported by the Census of Business, under SIC "Farm Product Warehousing and Storage" and "Refrigerated Warehousing." Some warehousing is included for wholesale establishments which primarily sell cotton and grain; some uncertainty exists about the completeness of coverage of "captive" warehouses owned and operated by some of the largest processors.

The USDA conducts periodic cost analyses of grain and cotton storage, with projections for two to three years between studies. It also maintains a data file of public warehouse facilities in operation; these data include measures of capacity.

In addition to the sources just mentioned, *Current Industrial Reports* from the Bureau of the Census regularly provide product sales for numerous lines of agricultural inputs both by quantity and value, such as tractors specified by horsepower of units purchased and feeds by kind.

The USDA also has maintained up-to-date information on marketing and supply service cooperatives since World War II. These series report the number, size, location, activities, and tabulations by types of product, largely in *Statistics of Farmer Cooperatives*. Some data are also reported in other USDA series such as *Agricultural Statistics* and *Balance Sheet of Agriculture* and in cooperative firm house organs. The Farmer Cooperative Service (FCS) prepares technical reports which are released intermittently. These focus on such issues as vertical and horizontal integration and on particular kinds of cooperatives such as dairy herd improvement or rural electrification.

Food Consumption and Nutrition

Food Consumption and Related Data

The development of food consumption data has a long and complicated history involving several USDA and other federal agencies and the work of scores of individuals. Only a few highlights can be mentioned here.

Inadequate consumption by many families during the Great Depression brought proposals for raising nutritional levels and expanding the demand for food. About one-third of the 1939 Yearbook of Agriculture, *Food and Life* (USDA [1939]) dealt with human nutrition and food consumption. Other subjects were farm legislation and programs. Although the initial focus of the Agricultural Adjustment Act of 1933 and later legislation was to improve the incomes of farmers, there was an immediate need to supply food to hungry people.

Specific efforts were made to increase the consumption of surplus foods under the Food Stamp Plan of 1939. The idea was to increase the demand for food by what amounted to stratified pricing, an idea developed by Fred Waugh and promoted by Milo Perkins. In that same year came the School Lunch Program, followed by the School Milk Program in 1940. Each of these programs was temporarily suspended during World War II.

The war required a marked sharp expansion of American farm output accompanied by allocation of available supplies, not only to the military forces and the civilian population but also to the United Kingdom, the Soviet Union, France, and other Allied nations. This decreased domestic civilian supplies of a number of commodities well below the levels of market demand and brought on consumer rationing. The rationing program made evident the need for more information on the price and income elasticities of food demand and on the nutritive content of food.

The food supply continued to be a problem in the postwar years, owing to the need for food relief abroad and the renewed interest in the Food Stamp Plan and related programs. Finally, the need for better planning in food and agricultural programs stimulated long-range projections of desirable consumption levels and production goals. Meanwhile the need for better data on food consumption and demand, nutritional objectives, and production potentials continued to increase.

One of the earliest statistical estimates of domestic food consumption was O. E. Baker's "Changes in Production and Consumption of Farm Products and the Trend in Population," published in 1925 (Baker [1929]). Some years later, although the BAE did not regularly publish estimates of domestic food consumption, it collected and compiled a considerable amount of consumption data and published a series of special reports on the effects of the droughts of 1934 and 1936 on consumption. In the meantime a comprehensive set of per-capita food consumption estimates was developed in the Program Planning Division of the Agricultural Adjustment Administration by Wells, Nelson, Cavin, and Elliott, utilizing much of the data already available in the BAE. This set of estimates was used by Stiebeling and Coons [1939] in the 1939 Yearbook of Agriculture and for other purposes (Stillman [1949]).

In anticipation of wartime needs the BAE issued in March 1941 an appraisal of the current food situation entitled "Consumption of Agricultural Products" (Anderson [1941]). At about this time the program planning group of the Agricultural Adjustment Agency was transferred to the BAE, where the consumption series was completed. These efforts were merged with other BAE work in this field, all of which was placed under the direction of O. C. Stine, who established a food consumption section within the Division of Statistical and Historical Research.

The gifted young statistician Meyer Girshick was brought into the division to improve the statistical competence of that group and the statistical work throughout the BAE. Although he had to devote considerable time to work on certain critical wartime problems with the Statistical Research Group at Columbia University, he and his small staff succeeded in improving and coordinating the food consumption activities within the department. Beginning in 1942 consumption estimates for the major foods were regularly issued in a new publication, *The National Food Situation*, together with an evaluation of the supply-price outlook and reports of significant actions taken by the War Food Administration.

Among the other accomplishments were coordination and standardization of major food series on a calendar-year basis and the development of adequate waste and loss factors which made it possible to express per-capita consumption in comparable retail weight equivalents. These advances also made possible the construction of a meaningful price-weighted index of per-capita consumption of all foods and provided the Bureau of Human Nutrition and Home Economics with a much improved basis for determining the nutritive value of annual food supplies. One notable addition to the consumption series was the inclusion of the data on fish consumption which had been compiled in the course of a very extensive research effort (Sherr, Power, and Kahn [1948]).

For more than a decade after World War II Marguerite Burk [1956] was the primary force in the development of food consumption and related data. The data and methodology are contained in *Consumption of Food in the United States, 1909-48*, which was revised and brought up to date in 1953 (USDA, BAE [1949, 1953]). In addition, Burk's reports contained detailed descriptions of the structure of the data system, the data sources, and the major limitations of the estimates. All this was further supplemented by valuable material on such topics as income, prices, and expenditures related to food consumption.

The 1953 report also contained an innovative set of estimates designated as "Supply-Distribution Indexes" (largely compiled by Marguerite Burk and Martin Gerra) and designed to provide a comprehensive view of the national

food sector. Essentially they were a series of index numbers which for any given year indicated the proportion of United States food supplies derived from domestic production, stock changes, and imports; they also indicated the proportions of these supplies distributed for civilian and military consumption, nonfood uses, commercial exports, USDA deliveries for such purposes as lend-lease and relief, and year-end stock changes. In addition, the series permitted simultaneous analysis of changes over time among the various sources of supply and the channels of utilization. Eventually the quantities being used for domestic feed and seed were eliminated.

Hiemstra succeeded Burk as head of the Food Consumption Section for the period 1963-69, during which two additional handbooks were published, *U.S. Food Consumption in 1965* (USDA, ERS [1965]) and *Food—Consumption, Prices and Expenditures* (Hiemstra [1968]). These publications extended and improved the work of Burk and her associates and also made important additions. Quarterly consumption estimates were published for meats, poultry, eggs, and fats and oils. Estimates for Alaska and Hawaii were incorporated into the national totals. Food donated by the USDA was reported as a separate component of civilian consumption, four separate measures of per-capita food consumption were calculated and compared, and a substantial volume of significant new material on food prices and expenditures was added.

Although many specialized research projects and their authors cannot be included in this general survey, the contributions of a number of the commodity specialists with responsibilities in the consumption field are mentioned in the section on Commodity Supply and Utilization Data. Special mention should be made of the work of Frederick V. Waugh. Though his research covered an extremely wide range of topics, he devoted a considerable amount of attention to the demand for food. This is especially evident in his outstanding bulletin, *Demand and Price Analysis* (Waugh [1964]), which was selected for the Publication of Enduring Quality Award in 1974 by the AAEA.

Near the end of World War II economists began to speculate on the nature and possibilities of full employment under peacetime conditions. Many economists developed long-range projections to provide perspective on the structure of the economy under alternative assumptions with respect to population, employment, productivity, income, and related factors. Between May and December 1945 the USDA published four interbureau reports under the title *What Peace Can Mean to American Farmers* (USDA, Interbureau Coordinating Committee on Postwar Planning [1945a-1945d]). The long-term USDA series on per-capita food consumption, together with related information on price and income elasticities, were important elements in making

these projections realistic and useful. Later projections were published in "Prospective Demands for Food and Fiber" (Daly [1957]) and "Potential Demand for Farm Products over the Next Quarter Century" (Koffsky [1960]), which had been presented to a seminar group at Iowa State University.

Though most of the work on food consumption has been in terms of national aggregates, there has been great interest in and need for more detailed breakdowns. In 1959 Burk and Lavell compiled per-capita food consumption indexes for households by region, urbanization, and household income based on the 1955 USDA Household Food Consumption Survey (Lavell [1959]). A study by Price [1967], also based on these data, indicated that variations in household consumption were due to the age and sex composition of its members. Regional studies have been of special interest to groups such as marketing firms. Perhaps the most intensive effort in this direction has been that of Raunikar, Purcell, and Elrod [1969], who compiled regional, state, and market area data for a number of commodities.

Despite the impressive accomplishments in the compilation of data on food consumption, much important work remains. At present the principal requirements are for (1) more data on food used by restaurants and institutions, (2) more accurate estimates of waste and losses in marketing, (3) estimates of waste in the home, (4) more data on the distribution of consumption among household members, and (5) food consumption by major subgroups of the population both within and among households. Consumption data for bakery products and other highly processed products, more adequate data for estimating quarterly consumption, more frequent and smaller cross-sectional surveys between the traditional larger surveys, and continuing information on methods and data from other countries are also needed.

The Index of Supply and Utilization

The development of supply-utilization balance sheets for individual commodities and groups of commodities was a major accomplishment in understanding the structure of supply and demand for agricultural products, inadequate as they were for analysis of the agricultural sector. The index of supply and utilization was developed, primarily by Burk and Gerra, to fill this gap (USDA, AMS [1955]). The development of this series permits simultaneous analysis of changes over time and among utilization channels and supply sources. The categories of utilization are food, feed, seed, other nonfood, and exports. Commodities and channels can be combined or disaggregated at will by the investigator. The scarcity of literature using this data system suggests that the profession has failed to exploit it fully (Egbert [1969]).

The supply-utilization index is based on value aggregates with constant farm prices and annual quantities of farm commodities. Gross production and

utilization were published at first, but the indexes were later changed to a net concept to eliminate the double counting of feed used for livestock production and seed used for producing new crops. Indexes for all commodities, food commodities, livestock commodities, and crop commodities are published regularly in ERS *Situation* reports. In addition, the component value aggregates by major commodity group are available from the ERS.

The long-term goal is to integrate this system with other agricultural and nonagricultural sector accounts. Such integration would make possible more accurate estimation of the structural supply-demand relationships at various stages in the food and fiber production, supply, and marketing systems. Data on farm receipts and expenses, consumer expenditures, value added in marketing, value of exports and imports of agricultural commodities, and others would be involved.

The Nutritive Value of Diets in the United States

During World War II administrators with responsibilities for production and distribution of food needed basic information on family food consumption. Inadequate data stimulated two lines of research—namely, the calculation of the nutritive value of food available annually for consumption by the domestic civilian population and a national survey of household food consumption which included calculation of the nutritive value of the household food supplies by urbanization and income level. A national survey of urban families was made in 1948 (USDA, Bureau of Human Nutrition and Home Economics [1949]), and of all urban and rural families by region in 1955 (USDA, ARS [1957a]); data for four seasons were collected in 1965-66 (USDA, ARS [1972]). Numerous smaller surveys of selected groups of households were made by the USDA between the large national surveys of 1955 and 1965. The survey data have also been compared over time (LeBovit et al. [1961], USDA, ARS [1957a, 1969]).

Annual estimates of the nutritive value of the food supply can be used to assess the national availability of nutrients and to estimate changes in availability over time. The estimates are derived by applying nutrients per unit to per-capita consumption of various commodities (USDA, ERS [1968]).

Most household surveys do not measure the nutritive values of diets of individual household members. Surveys of individual diets were undertaken in a series of studies from 1947 through 1958 at state agricultural experiment stations in cooperation with the USDA and several state departments of public health. The first nationwide survey of individual diets was made in spring 1965 in connection with the 1965-66 household survey (USDA, ARS [1972]).

One of the problems in estimating nutrition levels is assigning nutritive

value factors to reported food quantities. It is often difficult for survey respondents to describe accurately the foods used. The proliferation of processed foods makes it more difficult to determine the basic food ingredients and the nutrient content of each. In the annual time series on food supply it is almost impossible to allow for shifts within product groupings—from leaner to fatter beef or from stewing or roasting chicken to fryers. To supplement the basic food composition factors, several surveys of manufacturers of vitamin and mineral preparations were undertaken to obtain information on the contribution of enrichment and fortification of foods for inclusion in the time series data (Friend [1963]).

Another problem is the estimation of waste and losses of food in homes, institutions, and public eating places and the destruction of nutrients in cooking and preparation. Some estimates of the value of the vitamins lost in cooking have been incorporated into survey calculations for 1955 and later years. Very little is known about the amount of food wasted in the home and other eating places.

A major problem in interpreting the nutritive value of diets is the lack of a suitable standard for adequacy. The usual yardstick is the Recommended Dietary Allowances of the Food and Nutrition Board of the National Research Council. These are the allowances recommended to provide for the nutritional health of the majority of the population with the margin over the minimal requirements varying widely among nutrients. Diets containing less than the recommended allowances of nutrients are not necessarily deficient. Although the allowances are not a precise tool for rating the diets of individuals or households, they are fairly satisfactory for evaluating the diets of the population as a whole and of major population groupings based on geographic location, age, ethnic origin, and other factors.

Natural Resource Economic Data

Land Use

Data on land use were first shown in land records as a basis for assessment, and surveyors of the public domain recorded descriptions for sales purposes. Questions on land use were first included in the Census of Agriculture in 1840. Over the years questions in the Census gradually increased in detail and were given special attention in the Census of 1925. The closing of the frontier plus World War I demands for farm products resulted in concern about the man-land ratio. In 1920 the USDA prepared its first estimates of the amount of land in various major uses, and the totals were published in the 1923 *Yearbook of Agriculture* (USDA [1924]).

During the next twenty years various agencies, states, counties, and plan-

ning and zoning jurisdictions developed land use data and land inventory maps as land use problems arose because of the drought and agricultural depression. By the end of World War II, however, there was still no comprehensive system for collection, analysis, and publication of land use data. Since then, the needs for land use data for problem definition, analysis, and planning have risen sharply because of conflicts in land use resulting from the expanding population and accelerated economic growth.

In 1947 the USDA developed major land use data by states from census data and from records of state and farm agencies. This series has been updated periodically (see, for example, Wooten and Anderson [1957]). Dozens of local, state, and regional studies during the late 1940s and 1950s reported data on land use. Few of these studies developed much new data, however, and none was continued to provide data over time for the same universe.

The SRS has developed an area-segment sampling program for the United States which periodically provides data on land in crop production. At present, land not in crops is not accounted for, but the crop production sample could become the basis for acquiring data on other land uses.

The demand for data on the use of land for recreation has been increasing, but the collection of much data is complicated because much of the land used for recreation is also used for other purposes. Selected outdoor recreation statistics from various sources have been compiled by the United States Department of the Interior, Bureau of Outdoor Recreation [1971], but articulation is a problem because of differences in definition, timing of data collection, and geographical coverage of different sources of data.

The USDA has done several studies by comparative airphoto analysis to show the nature of land use changes in the rural-urban fringe and to develop population and land coefficients. It has also made a comparative airphoto analysis of land reclamation and abandonment by tract with illustrations of "before" and "after" use (Dill [1967], Dill and Otte [1970, 1971]).

Analytical studies of land planning programs are difficult because of differences in detail, timing, definitions, and geographical indexing of the various independent series of data. For many purposes it is necessary to analyze land use changes on the basis of individual tracts and to correlate socioeconomic data with the data on the physical attributes. Data published as county totals do not reveal the land use changes actually occurring on a tract basis, such as cropland reclamation and abandonment or urbanization. Data on specific tracts now must be acquired by specialized field surveys.

A comprehensive unified land data system on a tract basis (CULDATA) has been proposed (Cook and Kennedy [1966]). The initial proposal to automate all legal land records has been extended to include other land use and socioeconomic data. From this basis a standard land use coding manual could

be developed which would provide digital equivalents for types of land use in great detail. This program would be a first step toward building a data bank for land use analyses within the total systems concept. Automated data capabilities make such a system feasible. At present, however, land use data remain either on a very generalized basis, such as the work of Wooten and Anderson [1957], or are available piecemeal in specialized studies.

Land Tenure

Throughout most of the nineteenth century the problems and issues of land tenure in the United States revolved around the management and disposal of the public domain. Toward the latter part of the century a few people became concerned about the rising rate of tenancy among farmers and especially with the high incidence of tenancy and sharecropping in the South. When Francis A. Walker was director of the Census of 1880, he initiated a special statistical study of land ownership and tenancy (Walker [1883]). The census of 1890 and each census since then have developed data on the tenure status of farms.

Following some initial work by H. C. Taylor, B. H. Hibbard, and a few others early in this century, several studies of tenancy and tenure were made during the 1920s and 1930s, prompted mostly by concern for the low estate of tenants, especially sharecroppers in the cotton and tobacco regions. Several New Deal programs in the Rural Resettlement Administration and its successor agencies sparked a demand for data on land tenure, tenancy, and related characteristics of the rural economy. Agricultural economists in the BAE and in most of the land-grant colleges responded with studies of both local and national import.

In addition to the detailed Census data on tenure obtained in 1934 and 1939, substantial volumes of data were developed by special studies. Works Progress Administration projects in some states produced very detailed data on tenure, including maps of every tract of land in the state classified by tenure status. This work was discontinued with the approach of World War II and has not been resumed on anything like the scale evident in the 1930s.

After World War II the attention of agricultural economists to questions of tenancy waned considerably. The improved economic situation in agriculture during and after the war, the rapid decline of the cropper system in cotton production, and growing public concern over other problems turned attention to other issues, with a few outstanding exceptions. In the West a group of economists became involved in tenure issues on public lands. In the South the Southwest Land Tenure Research Committee, sponsored by the Farm Foundation and the agricultural experiment stations, remained active and made a number of outstanding studies (Bertrand and Corty [1962]).

The Southern Land Economics Research Committee, which succeeded the old "Tenure" committees, continued to sponsor outstanding work on land problems including tenure. The results of this work appeared, for example, in *Farmland Tenure and Farmland Use in the Tennessee Valley* (Southern Land Economics Research Committee [1970]). Most of the work on land tenure and tenancy since 1960 resulted in little new data. Census data and such public records as tax rolls, the files of the ASCS (USDA), and the work of the Farmers Home Administration provided most of the information for these studies.

Inventory of Conservation Needs

A National Inventory of Soil and Water Conservation Needs (CNI) was first conducted in 1958 under the leadership of the Soil Conservation Service (SCS) with the data updated and expanded in 1967 (USDA, SCS [1958, 1967]). Eight USDA agencies, the Bureau of Indian Affairs, and the Department of the Interior cooperated. In addition, land-grant universities and other federal, state, and local agencies interested in water, forest, range, and wildlife conservation also participated at state and county levels.

Information on land use and treatment needs was obtained for every county from sample areas, with more than 160,000 samples inspected (basic sampling rate, 2 percent; size, 40 to 640 acres). Detailed soil surveys were made of the sample areas to determine the land capability class and subclass before the field inspections. Sample area data were processed and expanded to the inventory acreage in each county. This information was analyzed by county CNI committees and adjusted if it differed substantially from known values. Land use and treatment estimates for forest lands were closely correlated with data supplied by the Forest Service experiment stations. Information was also obtained for some 19,000 small watersheds on the nature and extent of flood prevention and water management problems that could be solved only through project action; this information led to feasibility estimates for project developments. The national inventory has produced the most comprehensive data hitherto available on the nation's land resources.

Soil Surveys

The National Cooperative Soil Survey was initiated in 1899 as a joint effort of several federal and state agencies. The SCS now has the primary responsibility, with the cooperation of the Forest Service, the Bureau of Indian Affairs, the Bureau of Reclamation, and the Bureau of Land Management. The land-grant colleges and universities (departments of soils, natural resources, conservation, or others) and other state agencies also cooperated. The major objectives of the survey were (1) to prepare soil maps, (2) to de-

scribe the characteristics of the different kinds of soil, (3) to classify the different kinds of soil into the nationwide classification system, (4) to interpret the soils for alternative uses and treatment, and (5) to publish this information.

About 40 percent of the 1.8 billion acres of land in the United States and the Caribbean area is now mapped. Soil mapping of some 45 million acres is done annually by 1,200 soil scientists in the field with the support of 200 additional scientists. Some 80,000 different kinds of soil are now recognized in the United States, and each has a unique set of physical and chemical properties and other characteristics such as depth, slope, and extent of flooding and erosion.

Soil surveys published at the county level provide soil maps, descriptions, and classifications. The estimated yields of the common agricultural soils are given for specified levels of management. Since 1957 interpretations of each of the mapped soils have been made for use in engineering, community planning, drainage and irrigation projects, and recreation and wildlife conservation programs.

Water

Data on the characteristics and uses of the nation's water resources became available somewhat later than farm and land use data. The first Census of Irrigation in 1890 was designed to provide information on the role of water in the agriculture of the West. Although this produced some information on water uses, little general information was developed on water supplies. Special studies in connection with reclamation project planning occasionally developed data on water supply, but even here the information was often not reliable. The early work of such men as Mead [1926, 1931] and Teele [1927] on the economics of reclamation and irrigation failed to develop either the funds or the capacity for collection of comprehensive data on water. The National Resources Board of the 1930s made a serious effort to inventory the nation's water resources, but much basic information simply did not exist. Even today the information for many areas of the country is far from adequate.

Water resource information was not collected in any consistent way before 1950. Water management and allocation problems were recognized in general land economics studies, but few researchers isolated the water variable. Water management was largely an undefined subset of reclamation, land drainage, flood control, or soil conservation activities. Such water data as existed were likely to be the product of experimental work in agronomy and forest management.

Agricultural economists made little use of this information although they

conducted numerous studies related to irrigation, soils and soil conservation, and especially water conservation. Before 1950 both the basic science of hydrology for measuring water movement and use and precise quantitative work in farm management were still evolving. Quantitative analyses in resource economics were not emphasized, perhaps partly because of the heritage of the Commons/Dewey/Veblen school in resource economics (Commons [1924], Dewey [1938], Veblen [1914]).

During the 1950s the science of hydrology advanced considerably and farm management became "production economics" with quantitative firm theory applied to agriculture. Toward the end of the decade natural resource economists were catching up with production economists in quantification. A major turning point in the utilization of specific water data for agricultural economics studies was marked in a report by Beringer [1961], who showed both the conceptual fallacy and the lack of empirical basis for assuming water resources to be an inseparable complement of land.

In the 1960s many econometric water studies were completed that either derived or employed production-function relationships in which water appears as an independent variable or as an analytical proxy, such as a drought-day or an atmosphere of soil moisture stress. More important, a capability was developed for cataloguing the sources and characteristics of basic data that could be used for both farm economic studies and meso and macro area water planning studies. Some pioneering work in this direction was carried out by Gertel [1962a, 1962b]. The United States Water Resources Council produced one national assessment [1968]. Although the Council continues to sponsor work on water resources, the Bureau of the Census and the United States Geological Survey remain the chief producers of current macroinformation on water resources, uses, and supplies.

Forests

The prime compiler of data on forest resources is the Forest Service, which conducts a continuing survey in cooperation with different state agencies and private groups, as authorized by the McSweeney-McNary Forest Research Act of 1928. Its objective is to inventory periodically all forest lands, their extent, condition, and volume of timber and to ascertain rates of growth and depletion. State surveys of timber resources are completed each year for 10 percent of the states, and individual state reports are published as completed. About every ten years a national report is prepared providing estimates of timber resources for all states for one common year. The national reports since World War II are *Timber Resources for America's Future* (USDA, Forest Service [1958]), and *Timber Trends in the United States* (USDA, Forest Service [1965]). A later report uses 1970 as the base year (USDA, Forest Ser-

vice [1974]). These reports appraise current forest land and timber resources, analyze the demand outlook for timber, and project future supplies. Survey procedures involve a combination of airphoto interpretation and ground measurements on samples of points and plots drawn for each county. Basic inventory data include acreages and volumes of standing timber by class and current rates of utilization, replacement, and growth.

The Forest Service also publishes annual reports on the demand and price situation for forest products. Quarterly reports are published on the production of major forest products, prices employment, and on trade in the forest industries of the Pacific Northwest.

Weather Indexes

For many years agricultural economists have sought ways to improve the reliability of production projections. This led to inquiry into the relationships between weather and crop yields. Historically most weather studies had been done on small plots, but in the 1950s and 1960s concern for improving policy decisions required more aggregate analysis. A number of studies dealt with the relative impact of weather and technology on aggregate crop yields.

Three general approaches were used. The first used regression analysis to relate meteorological variables and a time trend to yields. The technology trend was predetermined by the time trend. The second approach used phenological data from test plots to determine the weather impact. The residual was the technology impact. The third approach used simultaneous equations where the weather and technology variables were included in the model at the same time to determine the impact of each.

In several studies of aggregate wheat, grain sorghum, corn, and soybean yields over 1962-65, Thompson [1962, 1963a, 1963b] initially used a linear time trend to express the effects of technology on yields. Later Thompson [1966] introduced two subjective technology variables for corn, using monthly temperature and rainfall data, separately and in combinations, as weather variables. Together the weather variables explained more variation in yield than did the technology variable, leading Thompson to conclude that recent yield increases were due primarily to good weather. Hence, he expected yields to decline with more normal weather.

Oury [1965] also used a time trend as his technology variable, combining rainfall and temperature data into one weather variable to explain changes in aggregate corn yields from 1890-1927 and 1928-1956.

Phenological weather variables measure weather indirectly by observing its apparent effects on yield. The basic method for constructing the index is to use linear time trends to represent the effects of technological change on

small plots (usually experimental check plots or variety tests). The ratio of observed check plot yields to trend check plot yields for a given year is then used as an index of the net impact of weather that year. The technology used on the check plot is held constant, making yield variation due largely to weather. This method was used by G. L. Johnson [1952] in a study of burley tobacco yields, by Hathaway [1955] in a study of the Michigan dry bean industry, and by Stallings [1961] in computing phenological weather indexes by crops of the United States from the early 1900s to the 1950s. Heady and Auer [1966] derived phenological indexes for a large number of field crops in most of the major producing areas. Their indexes were based on data obtained from crop nursery variety tests and hybrid test plots. The aggregated indexes were then used in a regression of state yields, adjusted for the effects of fertilizer application and variety improvement, acreage planted, weather, and time.

Shaw and Durost [1962, 1965] constructed weather indexes for corn crop reporting districts in the Corn Belt from state hybrid test data in each district. These were aggregated to state levels and used to regress the state corn yield on the index with three technological variables. The investigators concluded that most of the recent yield increase could be imputed to technological innovation rather than to generally good weather, in contrast to the conclusions of Thompson.

Perrin [1968] regressed yields simultaneously on a small number of technological variables and on a similar number of meteorological variables. All variables were measured independently. The resulting regression equations allow the imputation of historic yield changes to various weather and technological variables and provides the basis for predicting future yields if normal weather is assumed. Perrin's study included corn in Iowa and Illinois, grain sorghum in Kansas and Nebraska, and spring wheat in North Dakota. The contribution of weather and technological changes was estimated through a procedure involving derivation of aggregate production functions in which grain yield, fertilizer applied, and genetic and cultural practices were the variables for each subregion of each state. The weather variable was a modification of the drought index developed by Palmer [1962]. It is a single variable which incorporates several meteorological variables relevant to moisture stress. His results also suggested that increases in yields came mostly from improved technology, not from good weather.

The SRS has adopted phenological methods for estimating and forecasting yields in its crop estimating program. Bruce Kelly and his associates developed a variety of models to forecast yields for the major grains, potatoes, and a number of tree fruits (USDA, SRS [1964, 1975]).

Airphotos

Progress in the use of airphotos as a source of data in land utilization research has been rapid in recent years. Airphoto analysis has been especially useful in obtaining data for studies of river basins, watersheds, or other natural areas where data collected by political subdivisions may not apply and for studies of changing land use in areas where acreage information is not collected on a regular basis. Three techniques for using airphotos include direct identification, airphoto comparison analysis, and use of small-scale airphotos or airphoto index sheets to study large areas.

In direct interpretation a natural body of land such as a river floodplain is studied to identify and quantify land use by flood frequency zones and by modified frequency zones with control measures (Dill [1955]).

The use of airphoto comparison analysis of recent pictures compared with earlier coverage can provide data on changes that have taken place in land use by clearing and draining forest land, urbanization, or reversion of land to forest (Dill and Otte [1971]). This technique is particularly useful in disclosing land use changes where conflicting trends are not revealed by traditional data.

Data on land use in large areas can be obtained from small-scale airphotos in a relatively short time with a minimum of personnel and expense. A study of the entire Mississippi alluvial basin covering about 24 million acres was made by two people in six months (Frey and Dill [1971]).

The use of airphoto analysis and other sophisticated sensor devices now under development to obtain data for economic analysis is expected to increase in the United States and elsewhere (Dill [1967]). Earth resources satellites now in operation have the capability of collecting data on a wide variety of subjects including land use, plant diseases, temperatures, and pollution. The challenge in exploiting this capability lies mostly in developing techniques for interpretation and for handling the large volume of observations that are potentially possible.

Remote Sensing

As a result of three streams of technology, remote sensing has emerged as a potential source of data for agricultural economics research. First, the space program has developed vehicles to carry sensors and permit frequent or even continuous observation of crop production and land use phenomena. The Earth Resources Technology Satellite, launched by NASA in 1972, covers any given spot on the earth's surface approximately every eighteen days but permits observation only when the site is free from cloud cover. The frequency of coverage can be increased marginally by modification of the orbit and sensor design or infinitely by increasing the number of satellites. An orbit

that permits a satellite to hover over a given area of the earth is possible, but the corresponding increase in altitude severely attentuates sensor capability.

The second development is in sensors. Airphoto interpretation has been used to obtain land use, forestry, and crop data of specific types and in limited situations for many years. Improved resolution, specialized narrow-band imagery, and expanded use of the infrared range of the electromagnetic spectrum have made possible many new applications of photo interpretation for data acquisition. For many types of data, use of these sensors provides real savings over acquisition by ground survey or other conventional methods. However, so long as human interpretation is required, time and labor costs will place definite economic limiations on these uses.

The third area of technology useful in remote sensing is the computer. Sensors, particuarly those operating continuously from orbiting spacecraft, produce overwhelming quantities of raw observations. Using these observations to develop signatures for specific crops or other target phenomena requires considerable computer capacity. In addition, observations on each small area of the earth's surface must be codified so that it can either be displayed on a map or tabulated by country, river basin, or other desired geographic entity. This involves recording, storage, and retrieval of very large quantities of data which are expensive for the computers operating today.

Automated crop identification and measurement have been achieved experimentally and even applied on a pilot basis. The Laboratory for Applications of Remote Sensing at Purdue has used the output from a multiband spectral sensor to develop and utilize unique signatures for wheat and other selected crops in automated recognition.

Comprehensive programs for obtaining data by remote sensing are probably some years away. All the technology needed has not been developed fully, even at the research level. Beyond that is the need for development of operational programs integrated with, complementing, and supplementing present data-gathering procedures. Selected applications of remote sensing using conventional aircraft have been used for data collection, and further use of these methods seems likely in the near future. The ultimate development of remote sensing with satellites will come when one type of instrument package aboard one or more vehicles can give continuous worldwide coverage to record information for a number of purposes at the same time.

International Data

Agricultural economists elsewhere in the world have the same data interests as those in the United States. Although substantial gaps and deficiencies exist in the domestic data, much greater data gaps occur in most other countries of

the world, especially in the so-called developing nations. There data of any kind are scarce, reliable data are even scarcer, and the small number of trained statisticians and economists available to gather and use good data suggests that improvements will be slow and costly.

For many years efforts have been made to gather and publish agricultural economic data for all countries of the world. The old International Institute of Agriculture made its major contribution as a collector and publisher of information about the agricultural economies of the world, but it had neither the authority nor the resources to overcome deficiencies of basic data within participating countries. Economic data relevant to international affairs are foremost among the statistical areas in need of development and refinement. Statistics on trade in agricultural commodities have improved markedly since World War II, but much less progress has been made with other types of data.

International agencies, notably the United Nations Food and Agriculture Organization (FAO), have worked diligently to acquire and improve world agricultural statistics. Symbolic of these efforts has been the decennial World Census of Agriculture.

The World Census of Agriculture

The first concerted effort toward achieving a world census of agriculture was undertaken for 1930 by the International Institute of Agriculture. It was not very successful because many countries lacked the resources and the will to conduct a census. A second attempt to get a world census was completely disrupted by World War II.

The FAO directed its initial work toward a world census of agriculture in 1950. It made a good start toward the resolution of many problems encountered in striving for comparability of data among nations and regions. These problems, which often loom large within a developed country, are even more formidable in an international setting. The preparation of definitions for units of measure and for such commonplace terms as "heifer" and "fowl" that can be understood throughout the world is very difficult. Uniform measures of land and products do not exist. Other characteristics of agriculture such as mechanical power can be quantified only in such classification terms as incidence or nonincidence. In addition, the effectiveness of the programs may be limited by uncooperative national regimes or by the lack of trained personnel in undeveloped nations. Nevertheless, patient and persistent staff work, aided and abetted by foreign aid programs of developed nations, achieved a little progress toward better world censuses in 1960 and 1970 and toward a projected census for 1980.

The FAO staff assistance, devoted to improving the standards of statistical performance in member countries, is supplemented by specialized training

schools and conferences. For example, training schools up to nine months in length are regularly conducted in the United States, France, and India to train foreign nationals in census taking and administration.

Annual Country Statistics

In addition to its persistent and continuous efforts to encourage and introduce standardized census data country by country, the FAO endeavors to assist in the development of current data services useful for policy and management decisions. The results, however, have not been uniform, and the data are often not timely enough to meet intranational or international planning needs.

The FAO is not the only agency concerned with worldwide agricultural data. Other international organizations, both private and governmental, strive from time to time to improve the collection and availability of statistics. Individual countries, especially the developed countries, strive to acquire relevant data on food production, food demand, food trade, and such supplementary data as precipitation and temperature indicative of crop prospects. Remote sensing has been hailed as a solution in this regard, but much more research must be done before the potentials of space technology can be realized in statistical data gathering.

The Agency for International Development (AID) training and research programs often include a component for data gathering, analysis and dissemination. These contribute to wider recognition of the usefulness of data, especially if government leaders find that information systems can be included in applications for assistance and that data can be helpful in applications for grants, loans, or emergency assistance.

With the assumption of leadership in managing food stocks and promoting the expansion of production, the United States has had to acquire at least a modicum of a statistical base for decision making. One result of this was the *World Food Budget to 1970* (USDA, ERS [1964]); indigenous secondary data were supplemented with observations obtained through agricultural attachés. The attachés seldom had the opportunity or the resources for systematic collection of data, and their observations were often highly subjective. Nevertheless, their carefully edited data represented one of the most reliable sources of comprehensive data on the world food situation. Subsequent efforts by the ERS to quantify world food production, consumption, and trade have developed much more reliable data on world agriculture.

World Food Data

Trends in population and in food supplies throughout the world since World War II have stimulated the interest of agricultural economists and

many others in information about food supplies, food demand, and trade in food commodities. Lester Brown's classic bulletin, *Man, Land and Food* (USDA, ERS [1963]), served to heighten concern over the world food situation and to focus on the relationship between world food needs and agricultural policy in the United States. Many studies and conferences since that time have altered appraisals of the world food problem, but they all served to emphasize the need for more complete and precise information. Concerns about the adequacy of relevant data have never been more urgent.

Several developments point toward much greater attention to the improvement of worldwide information on food supplies. The proliferation of publicly supported financial institutions, private foundations, and national assistance programs directed toward economic growth and the alleviation of poverty and hunger calls for better information on existing conditions. The tightening of margins between food supplies and food needs such as occurred in the mid-1960s and again in the early 1970s plus the growing concern over restraints on international trade in food further emphasize the need for better data. Each of several "world food conferences" demonstrated the need for information.

Studies of the world food situation by international agencies and others number in the hundreds. These sometimes focus on individual countries or areas and sometimes on specific commodities or problems; they sometimes try to be all inclusive and comprehensive. To try to list, summarize, or appraise such work here would be a digression. Suffice it to say that most of such work develops little new data and most suffers from incomplete, inaccurate, or inadequate data.

Rural Area Development

Rural Poverty

Socioeconomic data on the rural population received relatively little attention from agricultural economists until the mid-1950s. The data in the early studies were concerned with low-production farms (Martin [1970]) and low income in agriculture (Hendrix [1955]) with little attention to rural nonfarm data. Later studies in the 1950s and the early 1960s collected some rural nonfarm data on small scattered areas (Southern and Hendrix [1959], Henderson [1960], and Crecink and Hoover [1960]), but there was still a general dearth of data on rural poverty at the time the Economic Opportunity Act of 1964 was passed.

With the availability of the socioeconomic data from the 1960 Census of Population, efforts among agricultural economists to describe rural poverty problems increased considerably. The "poverty threshold" first developed for

use by the Council of Economic Advisers had no residence or family-size differentials (A. R. Bird [1964]). The improved thresholds developed by the Social Security Administration provided agricultural economists with an opportunity to make a significant research input into policy decisions. Initially poverty thresholds included a farm differential of 40 percent on the premise that food and other farm amenities were produced on the farm at no cost. The data developed by agricultural economists to show the inequity of the differential were instrumental in the eventual reduction of the differential to 15 percent in 1969 (Bonnen [1966], Hoover and Green [1970], Madden et al. [1968]).

Other recent studies by agricultural economists have continued to add to the expanding rural poverty data bank. These include a series of studies on the typology of rural poverty (McElveen [1969], Crecink and Steptoe [1970], and Hoover and Green [1970]), broader descriptive studies (Clawson [1967], Martin [1970]), and a study of the retraining potential of the rural poor (Konyha [1971]). In addition to these special studies the 1970 Census of Population developed much new data about rural people and their welfare. These data, together with increasing exploitation of such public records as social security, promise to improve the data base for analyses of the income problems of rural people.

Rural Housing

Rural housing has been a fairly recent addition to the research interests of agricultural economists. In recent years, however, agricultural economists have begun to play an important role in pointing out significant differences between rural housing and urban housing, some of the reasons for these differences, and the impact of various housing programs.

An early contributor was G. H. Beyer of Cornell University, who gleaned information from the 1940 and 1950 Census of Housing on the relationships of quality in farm housing to income, age, race, and tenure of occupants (Beyer and Rose [1957]). A more comprehensive analysis of the 1960 data included rural nonfarm housing in addition to farm housing (Beyer [1965]). Another early effort was the study, under the leadership of Joseph H. Yeager at Auburn University, of rural housing conditions and housing finance in parts of the southeastern Cotton Belt, the Corn Belt, and the dry-land wheat areas. Although there were a few projects before 1960, organized housing research by the USDA appears to date from about 1960, when several cooperative studies of housing credit were initiated under the leadership of Lawrence A. Jones (Jones [1966], Hamlin [1970], Sargent, Davidson, and Jones [1964]).

Work on rural housing underwent a major expansion after the Economic

Development Division was organized in the ERS in 1965 and after rural housing loans became a major part of the Farmers Home Administration program in the late 1960s. One major thread of USDA research involved attempts to develop data on the status of rural housing and on the magnitude of the effort required to improve it to acceptable standards. Several USDA bulletins reflected this purpose. In another area of research the factors associated with poor housing were investigated. Studies were made in the Ozarks (Spurlock [1968]), in South Carolina (A. D. Edwards and Jones [1964], Hurst [1969]). Other work involved gathering and analyzing data on housing costs (a major study was done in cooperation with Ohio State University) and on alternatives (such as mobile homes) to conventional housing (Burnham and Jones [1969]).

Health

Agricultural economists have largely neglected health as a subject for analysis. Since 1945 only four articles about health have appeared in the American Journal of Agricultural Economics.

One study (Stillman [1949]) documented the rural health problem by examining available data on health care facilities in rural areas.

The second article (Ball and Wilson [1968]) was focused on the spatial variation in rates of health training and practice and the quality of health service available across the nation. This was a broad consideration of health manpower and related services available in rural areas. Ball and Wilson showed that rural residents with health insurance have less effective coverage because of the relative scarcity of health services in rural areas. They also demonstrated that economics could contribute substantially to insights regarding health and identified several aspects of health in need of economic analyses.

The third article (Brown [1969]) examined the response of consumers to the health hazard resulting from the use of pesticides on cranberries and its possible effect on demand for the commodity. The study dealt rather more with the effect of a health hazard on elasticity of demand than with health as such.

In the fourth article Perkinson [1969] examined the location of hospital beds in Michigan. The author tested the common presumption that the larger cities were better supplied with health facilities than rural areas. He found this to be untrue, using the number of hospital beds per 1,000 population as the unit of measure. Counties with a town of 5,000 population and located beyond convenient traveling distance from a city of 25,000 or more had more hospital beds per 1,000 population than the larger cities. Several factors believed to influence the supply of hospital beds in Michigan were discussed.

Although only four articles on rural health have appeared in the *American*

Journal of Agricultural Economics, economists have devoted substantial attention to the health status of rural people and the availability of health facilities. A number of special studies and local area studies have developed data, but no national study has generated data specifically on rural people.

Local Governments

Agricultural economists have carried on a small but fairly steady volume of research in the field of local government since World War II. These efforts have involved data collection only to the extent that data were needed to test particular hypotheses. Since 1957, however, substantial volumes of data have been available from the Census of Government and various state and local reports.

Probably the largest single focus has been on property taxes. Since the 1920s the ERS and its predecessor agencies have maintained statistical series on farm real estate taxes and on farm personal property taxes (Mathews and Bird [1970], Shapiro [1963], and Stinson, Courtney, and Bird [1969]). Real estate tax data have been based on decennial census data, updated by annual questionnaires mailed to local tax officials. Minor changes were made in methodology after World War II.

Agricultural economists at some of the agricultural experiment stations also were active. Examples include George Aull at Clemson University, who pioneered in assessment ratio studies in South Carolina, Gabbard and Cherry [1948], Heneberry and Barlowe [1962], Loftsgard, Johnson and Ostenson [1963], Pine [1956], Simmons [1949], and C. C. Taylor et al. [1960].

In the 1940s and early 1950s the emphasis was primarily on taxes paid by farmers. Bulletins were published by the USDA and other organizations estimating sales, state and federal income, and other types of tax payments by farmers (R. Bird [1955], Stocker [1953, 1955, 1956, 1963], Stocker and Ellickson [1959]). Agricultural economists also were active in studying differential assessment laws for farmland (Hady and Stinson [1967], Hady [1970], House [1961, 1967]).

During the late 1950s and early 1960s gradual changes in emphasis occurred under the leadership of Stocker in the ERS and others. The research emphasis shifted to include work on the local government services that the farmer's taxes helped pay for and the organization of the local governments that levied the taxes and supplied the services (Hein [1960], Lutz [1961], Stinson [1967], and Stocker [1957]). Most of this work was not primarily directed at data collection, but it often produced useful data. A joint study by the USDA and Indiana University (Stoner [1967]) produced new information on the extent of cooperation among local governments in the United States. Attention was also given to the costs of providing various governmen-

tal services in units of varying sizes—a partial return to an area of active agricultural economics research in the 1930s (Shapiro [1963], Voelker [1969], and Wessel [1963]).

The growth of interest in rural economic development has resulted in a considerable expansion of work on state and local governments, but the major part of this work has not been directed specifically at the exploitation of new data sources.

The Future

Before examining some present problems with agricultural data and speculating about the future, the reader who has waded this far through a tedious manuscript deserves some comments that may place our data systems in a perspective that may not have been obvious from the previous pages. Agricultural economists in the United States during the quarter century following World War II were more fortunate than most of their colleagues elsewhere in the wealth of data at their command. Never before in the history of economics did practitioners have the means to test empirically the basic precepts of their science. Data were available (albeit not always in the exact form or detail desired) to test relationships between supply, demand, price, use of resources, incomes, and dozens of other areas of interest to economists, policy makers, and the agricultural industry). Agricultural economists owe a deep debt to such pioneers as Stine, Waugh, Bean, Ezekiel, Wells, and dozens of others in the USDA and in the land-grant colleges.

When the major body of data was being developed in the 1920s and 1930s, some of the most important questions being asked of the data and of agricultural economists had to do with the performance of farms and the welfare of farm people. The data assembled from the Census of Agriculture and many other sources were designed to help answer these questions. In recent years agricultural economists are finding the traditional systems of data to be obsolete. One reason for this is that the agricultural industry itself has changed. Farms are fewer, larger, and more specialized. Farming is more highly integrated with supply businesses and processing and marketing businesses, which are an increasingly important part of the total agricultural industry. Finally, fewer rural people farm, and fewer farmers live on farms. These trends and others are well known to agricultural economists.

Policy issues of recent years have come to revolve around the performance of the entire agricultural industry and its major sectors, not just farming, and the economic situation of rural people, not just those who farm or live on farms. Thus our traditional data systems have failed to supply the raw materi-

al needed to address many of the modern issues of concern to agricultural economists.

Agricultural economists have become concerned about the availability, adequacy, and relevancy of data. Under various titles the need for more and better data has been the subject of at least one session at the annual meetings of the AAEA in the past several years. Some typical session titles were "Adapting Data to New Conditions" (1958), "Statistical Bottlenecks to Econometric Analysis" (1964), and "Improvements Needed in Statistics for Making Policy and Program Decisions" (1966). (See Wells [1958], Schaller [1964], and AAEA [1972].)

Despite this apparent concern over the years, it is interesting that the centerpiece of the statistical session of the 1972 annual meeting was a paper entitled "Our Obsolete Data Systems: New Directions and Opportunities" (AAEA [1972]) the report of the AAEA Committee on Economic Statistics. It provides a view of some major deficiencies in our statistical data systems.

> "These agenda items overlap considerably but can be reduced to a general concern about obsolescence in older data systems, and most frequently, to a need for new and better data.
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> "1. Developing a new theoretical basis for obsolete data systems is an urgent necessity. The most clearly obsolete concepts are our demographic ideas. . . .
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> "2. Better measures of social well-being are needed whether in health, education, personal safety, housing, income and employment, or leisure and recreation. . . .
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> "3. Program evaluation is an increasingly strategic need to which our data systems are now poorly prepared to respond. To the traditional program management emphasis on efficiency has been added a growing concern for the equity and general social performance—not only of public programs but also of some of our society's private institutions such as the medical delivery system.
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> "4. The income and asset distributions of rural society need to be explored. . . .
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> "8. Regional and local area development data systems should be developed. . . .
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> "9. We need better statistics on nonfood and fiber sector economic activity in rural areas. . . .
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> "It is quite clear that the greatest flaws in our data systems arise from our failure to conceptualize social problems in a systematic manner and to match this with equal concern for the design of statistical systems to measure social system phenomena. . . .

> "Agricultural economists have a major intellectual obligation to contribute to the development of an adequate data system for social needs. This is a must if the rural areas of the nation are to become viable communities of reasonable growth and if rural people are ever to attain levels of human welfare comparable to the rest of society. The unique characteristics of rural society are not likely to be recognized in the construction of a national system of social statistics unless rural social scientists take an early and active role in the intellectual investments leading to development of those data systems—a process already well under way."

The reader should not conclude from the above quotations that all is both wrong and hopeless. Such is not the case. Our agricultural data systems have served very well in the past; in fact, agricultural economists have been envied by other social scientists for the wealth of data they have at their disposal. But social and economic changes have occurred and will continue to occur, making our traditional systems in truth "obsolete."

As we have noted, the changes include broadening of the questions which we address to ourselves. When our present data systems were developed, most of the questions dealt with the efficiency of farms, the productivity of farms in the aggregate, and the welfare of farmers. Our data served fairly well for these purposes. Now, however, we are increasingly concerned with the performance of the industry. We are concerned with the capacity of this industry to provide the nation's supply of food and fiber at reasonable cost and with the exportable supplies that help pay for our imports. We are concerned with the relationships among segments within the industry and between it and other industries and the national economy. We are concerned with how the industry uses our nation's resouces and how income is divided among participants in the industry. At present out data do not address these questions very well.

Data systems must change over time with the changing structure of economic research. On the demand side, there has been a shift in relative emphasis from microeconomic or "firm" research to macroeconomic or "social" research. We are realizing, as Shaffer [1968] expressed it, that we have been overly concerned about the efficiency of an already fairly efficient pea-packing plant when there are more pressing social problems. Emerging social problems such as providing adequate public services, environmental quality, and energy supplies require more aggregative economic analysis of the whole or major sectors of our society.

The changing structure for economic research in agriculture is related to developments in the scientific method, to the increasing costs of research, and to technological developments in automatic data processing. The early em-

phasis was on farm management and the collection of data in keeping with the inductive scientific philosophy associated with Francis Bacon and later in American agriculture with George Warren and the empiricism of the Cornell school.

Over time, our general research philosophy has sought equal treatment to all substages of research in a cyclical inductive-deductive scientific method. As described by Cohen and Nagel [1934], modern scientific method involves five generally recognized substages of research—recognizing and defining the problem, formulating a hypothesis, designing empirical procedures, assembling and analyzing the data, and interpreting the findings. Completion of one research cycle often leads to new problems and the need for new data. Data requirements are interrelated with other substages of research and are specified more in terms of a preconceived body of theory and applied to a particular research problem in the form of a cause and effect hypothesis. As progressive research cycles have been completed, a model of technical and economic relationships in agriculture has evolved and data needs have become more systematic, additive, and recurring.

Public support for research and development in agriculture is diminishing in relative terms while salary and other costs are increasing (Hathaway [1969]). As the cost structure for research resources and the demand for aggregate social research increase, economizing principles must be applied. Research resources, including data generating activities, will be combined along an expansion path of least cost combination.

Another major development is the advance in automatic data processing and accompanying growth in simulation and systems analysis. This has encouraged the evolution of a more complete scientific method involving research cycling which with each round becomes more complex, more realistic, and increasingly sophisticated with respect to interrelationships between all substages of research. It also points up the need for more research requiring not only net social benefit or macroeconomic analysis but also connecting links to disaggregated levels such as firms, individuals, and households. Large-scale systems analysis enables an additive and integrative approach to these research needs and the simulation of many relevant alternatives with respect to technical and economic uncertainties and policy choices. Advances in automatic data processing technology, involving both hardware and software, constitute a major unrealized positive shift in the supply curve for economic research. Originally computers were used merely to replace routine and costly manual data processing and storage. But as more sophisticated economic systems are translated into machine language and are combined with data systems, the researcher's imagination provides the only real limiting factor to the size and complexity of data and analytical systems.

Some attributes of data systems that proved essential in the past are very likely to continue so in the future. Data are an essential ingredient in decision making, whether the decision is based on barn-door arithmetic or the most sophisticated and computerized analytical system. The value imputed to data per se derives from their use by management in private enterprise, by government policy makers, and by the general public as consumers and voters. The purpose of a data system is to make the desired data accessible to the decision makers.