Chapter 3

The Changing Character of **the U.S. Agricultural Sector**

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Who will use a new technology is as important a consideration as which technology will be adopted, for the distribution of technology has a considerable impact both on agricultural production and on the structure of the agricultural sector.

The emerging technologies examined for this study will be introduced within a socioeconomic structure that has undergone considerable change in the last 50 years and that promises to continue to change throughout the remainder of this century. This chapter provides a perspective for analyzing technology's distributional impacts on agricultural structure by surveying the characteristics of that structure and noting the past and present factors that define it.

THE PRESENT STRUCTURE OF AGRICULTURE

The heart of agriculture, the farm, is officially defined as a place that produces and sells, or normally would have sold, at least 1,000 dollars' worth of agricultural products per year. So defined, there were about 2.2 million farms in 1982. Farms in that year had an average net income from farming of $9,976 and an average off-farm income of $17,601, for a total of $27,577.

Perhaps the best known characteristic of U.S. agriculture is the trend toward larger but fewer farms. Currently, about 1 billion acres of land are in farms, resulting in an average farm size of about 400 acres. However, this average size has little meaning, since fewer than 25 percent of all farms fall within the range of 180 to 500 acres. Almost 30 percent of all U.S. farms have less than 50 acres, while 7 percent have more than 1,000 acres.

The number of farms reached a peak of about 6.8 million in 1935 and is now approximately 2.2 million. The rate of decline has slowed since the late 1960s, with a loss of about 100,000 farms since 1974.

Employment in farming began a pronounced decline after World War II, when a major technological revolution occurred in agriculture. The replacement of draft animals by the tractor began in the 1930s and was virtually complete by 1960, releasing about 20 percent of the cropland, which had been used to grow feed for draft animals.

The increased mechanization of farming permitted the amount of land cultivated per farm worker to increase fivefold from 1930 to 1980. The amount of capital in nominal terms used per worker increased more than 15 times in this period. Total productivity (production per unit of total inputs) more than doubled because of the adoption of new technologies such as hybrid seeds and improved livestock feeding and disease prevention. The use of both agricultural chemicals and fuel also grew very rapidly in the postwar period. Agricultural production now relies heavily on the nonfarm sector for machinery, fuel, fertilizer, and other chemicals. These, not more land or labor, produced the growth in farm production. The resultant changes have also greatly increased the capital investment necessary to enter farming and have generated new requirements for operating credit during the growing cycle.

One of the best ways to look at changes in the economic structure of U.S. agriculture is

in terms of value of production as measured by gross sales per year. Farms can be usefully classified into the five categories of gross sales shown in table 3-1.

Small farms generally do not provide a significant source of income to their operators. This class of farms is operated by people living in poverty and by people who use the farm as a source of recreation.

Part-time farms may produce significant net income but in general are operated by people who depend on off-farm employment for their primary source of income.

Moderate-size commercial farms cover the lower end of the range in which the farm is large enough to be the primary source of income for an individual or family. Most families with farms in this range also rely on off-farm income. In general, farms in this range require labor and management from at least one operator on more than a part-time basis.

Large and very large commercial farms include a diverse range of farms. The great majority of these are family owned and operated. Most farms in these classes require one or more full-time operators, and many depend on hired labor on a full-time basis. Five percent of these farms are owned by nonfamily corporations, a much higher percentage than in the other three classes. In general, the degree of contracting and vertical integration is much higher in these classes.

Table 3-1.—Sales Classes of Farms

Class	Amount of gross sales per year
small	Less than $20,()()0
Part-time	$20,000 to $99,999
Moderate commercial	$100! 000 to $199,000
Large commercial	$200,000 to *$499,999*
Very large commercial	$500,000 and over

SOURCE: Off Ice of Technology Assessment

Changes in Farm Size and Numbers

Major changes in the structure of U.S. agriculture can be seen in the changes in the number of farms in these classes since the 1969 Census of Agriculture. Inflation in commodity prices has tended to move large numbers of farms from lower sales classes into higher sales classes. Even after the number of farms is redistributed to counteract these nominal changes, the real number of small farms has declined by about 22 percent—a dramatic decline. (Recent reports that the number of small farms has actually increased since 1978 refer to farms that are small in acreage, not small in sales.) The number of part-time farms has also declined by about 18 percent. The number of moderate farms has increased substantially, by about 39 percent, and the number of large and very large commercial farms has increased even more dramatically, by about 43 percent and 53 percent, respectively. Even though the number of moderate farms has increased, the loss of these farms in share of sales and net income to large and very large farms, as shown in the next section, more accurately indicates the changing character of American agriculture.

Changes in Distribution of Saks and Income

Changes in the number of farms do not alone give the whole picture. Changes in the distribution of sales and income are more important and clearly show the direction in which U.S. agriculture is heading. In the sections that follow, sales and income data presented reflect redistributions calculated to adjust for the impact of inflation.

Between 1969 and 1982, sales by small farms declined from 9 to 6 percent. Sales from part-time farms declined from 43 to 22 percent. The market share of moderate farms increased from 13 percent of total sales to 19 percent. In the same period the market share of large and very

large farms increased greatly–from 36 to 57 percent.

The most telling changes of all have occurred in the distribution of net farm income. The large and very large farms have not only captured the majority of the market but also controlled or reduced their cost of production. In 1974 these commercial farms had a 47-percent market share and 35 percent of net farm income after adjustment for inflation. In *1982,* just *8* years later, with their market share at 54 percent, these farms had *84* percent of net farm income (table *3-2).* Very large farms have been responsible for the majority of this growth. This class, which accounts for only *1.2* percent of all farms, increased its real share of net farm income fourfold—from *16* to *64* percent. By comparison, small farms in *1982* had a negative net farm income, and part-time farms had declined from 39 percent in 1974 to 5 percent of total net farm income. Moderate farms have seen a substantial decrease in net farm income, from *21* percent in 1974 to 11 percent in 1982.

It is clear that if these trends continue, small and part-time farms are likely to disappear, to the extent that the operators of these farms depend on them for income. The number of small recreational, or "hobby," farms may increase. Large and very large farms will completely dominate agriculture. The number of moderate farms may continue to increase, but they will have a small share of the market and a declining share of net farm income.

Moderate farms comprise most of the farms that depend on agriculture for the majority of their income. Traditionally, the moderate farm has been viewed as the backbone of American agriculture. These farms appear to be failing in their efforts to compete for their historical share of farm income.

Changes in Sources of Income

Employment and the sources of income of U.S. farmers have changed greatly in the 20th century. These changes occurred at a rapid rate in the 1970s. The largest single source of change was the tremendous increase in labor productivity made possible by technological changes, resulting in a sharp drop in the demand for agricultural labor. During the 1930s the disposable farm income per capita was less than *40* percent of disposable nonfarm income. This income differential resulted in the large migration of the farm labor force out of agriculture and rural areas. This out-migration accelerated after the Great Depression of the 1930s because employment and per capita income opportunities increased considerably outside of agriculture. In general, the marginal productivity of labor was higher outside the agricultural sector from the 1930s to the early 1970s. Therefore, migration of labor from farming to the nonfarm sector contributed to national economic growth.

In the 1970s, the average income differential between farm and nonfarm households nar-

Table 3-2.—Distribution of Farms, Percent of Cash Receipts, Percent of Farm Income, and Farm and Off-Farm Income per Farm by Sales Class, 1982

Sales Class	Value of farm products sold	Number of farms	Percent of all farms	Percent of total cash receipts	Percent of net farm income	Average net farm income	Average off-farm income	Average total income
	Less than $5,000	814,535	36.4	1.2	-2.0	($550)	$20,396	$19,846
Small	$5,000-$9,999	281,802	12.6	1.5	-0.9	(700)	22,498	21,798
	$10,000-$19,999	259,007	11.6	2.8	-0.9	(780)	18,648	17,868
Part-time	$20,000-$39,999	248,825	11.1	5.4	0.2	154	14,134	14,288
	$40,000-$99,999	332,751	14.9	16.4	5.2	3,451	12,529	15,980
Moderate	$100,000-$199,999	180,689	8.1	19.1	14.6	17,810	11,428	29,238
Large	$200,000-$499,999	93,891	4.2	21.0	20.4	48,095	12,834	60,929
Very Large	$500,000 and over	27,800	1.2	32.5	63.5	504,832	24,317	529,149
	All farms	2,239,300	100.0	100.0	100.0	$9,976	$17,601	$27,578

SOURCES: Adapted from *Economic Indicators of the Farm Sector: Income and Balance Sheet Statistics, 1983,* USDA Economic Research Service, 1984, Table 59, using farm number and cash receipts distribution data from the 1982 Census of Agriculture, Dept. of Commerce, Bureau of the Census, 1984.

rowed to about 88 percent, owing to rapid increases in farm prices and a substantial increase in the number of farm jobs available from growth in rural industries. These two factors resulted in a slowing of the rate of outmigration.

In 1982 the average income of farm and nonfarm households was quite close, $27,577 and $28,638, respectively. However, two-thirds of the income of farm households came from off-farm sources. The majority of farm operators today have some off-farm employment.

The average income statistics mask economic problems that exist in the middle of the scale of sales classes of farm operations (table 3-2). Farms in the part-time class, with sales in the range of $20,000 to $99,999, are in serious trouble. About 580,000 farms in this class in 1982 had an average total income of about $15,000. Their average net income from farming was only $2,033. These farms are not large enough to generate much net farm income and have lower-than-average off-farm incomes. In contrast, farmers with sales of less than $20,000 have substantial off-farm incomes and low or negative net farm income. The average off-farm income of these individuals enables them to maintain this way of life.

Those owning moderate farms have sufficient off-farm income to maintain a household. However, this group may be under the most stress. To provide an adequate total income, moderate farm owners must earn almost as much off-farm as on-farm income. Farmers with sales in excess of $200,000 have moderate off-farm incomes and moderate-to-very large net farm incomes. As a group, these farmers are well-off.

Changes in the Structure of Debt in The Farm Sector

At a time when agricultural production has become more concentrated, the structure of debt in the farm sector has also become more concentrated. This process accelerated during the boom years of the 1970s. The size and concentration of farm debt, combined with high production costs and the continuing likelihood of low commodity prices, have led to a great deal of concern about the financial condition of the farm sector. A substantial proportion of the U.S. farm sector is under severe financial stress. Financial *stress* is defined as the perceived inability of the firm or individual to meet cash flow commitments in the form of cash farm expenses, debt repayment requirements, tax payments, or family living needs. This stress can be measured indirectly by use of the debt-to-asset ratio. In general, the distribution of high debt-to-asset ratios is more important than the average debt-to-asset ratio of all farms. The percentage of farms with debt-to-asset ratios greater than 40 percent and greater than 70 percent in January 1984 by gross sales class is shown in table 3-3,

Clearly, debt use is closely related to farm size. To the extent that debt-to-asset ratios show potential financial problems, beginning farmers and operators of larger farms are likely to be in more difficulty than are other farmers,

An important aspect of outstanding debt is the risk of default from the lender's standpoint. If those with the largest proportion of debts to assets are more likely to suffer losses, then there are important risk elements facing agricultural lenders. In January 1984, 24 percent of the total agricultural debt was owed by farmers with over a 70-percent debt-to-asset ratio. Another 32 percent was owed by farmers with debt-to-asset ratios in the range of 40 to

Table 3-3.—Distribution of Farms With High Debt-tomAsset (d/a) Ratios, by Sales Class, January 1984

	Highly leveraged (d/a ratios: 40 to 70"/0)		Very highly leveraged (d/a ratios: over 70°\o)	
Sales class	"/0 of class	No. of farms	0/0 of class	No. Oj farms
Less than $50,000	8.3	123,200	5.0	74,800
$50,000 to $99,999	14.7	44,000	8.7	26,400
$100,000 to $249,999	18.1	52,800	9.2	26,400
$250,000 to $499,999	19.0	17,600	12.6	11,000
$500,000 and over	17.4	5,200	15.3	4,500
All farms	11.1	242,800	6.6	143,100

SOURCE U S. Department of Agriculture, 1983 Farm Producllon Expenditure Survey.

70 percent, Thus, over one-half of outstanding debt was owed by operators with debts greater than 40 percent of their assets, This is a matter of great concern for lenders, since poor farm incomes or decreases in asset values will more quickly erode the equity of highly leveraged operators than of high-equity operators (Brake, 1985),

Another useful way to illustrate increasing financial stress is through the recent increases in debt service burdens, This increase can be measured by the amount of interest expense as a percentage of cash receipts after payment of intermediate production expenses, business taxes, wages, and rents. By this measure, the debt burden of U.S. farms was 17 percent in 1975. By 1981 it had reached 35 percent and has been in the range of 34 to 38 percent ever since. This has resulted in substantial reductions in the amount of receipts remaining to pay for the operator's labor, for the owner's equity in the business, for purchases of capital durable goods, and for payments of interest and principal.

The consequences of increasing financial stress can be seen in increasing rates of payment delinquency and foreclosure. For example, Production Credit Association loan charge-offs were under 0.1 percent in 1978 and 1979. By 1983 these charge-offs had risen to 1.2 percent of outstanding loans—an elevenfold increase in 4 years, Similarly, the number of loans in process of liquidation was negligible in the late 1970s. Data on these loans were not even kept in the Farm Credit System. By 1982, loans in process of liquidation approached 1 percent of outstanding loans, and as of March 1984, Production Credit Association loans in the process of liquidation were over 2.5 percent of all outstanding loans,

DEFINING STRUCTURAL CHANGE IN AGRICULTURE

Traditionally, American agriculture has been dominated by farms in which the operators and their families provided most of the labor, made the management decisions, owned part of the resources, accepted most of the production and price risks, bought and sold in the open market, and depended on the farm as their major source of family income. Such farms have been revered since the days when Thomas Jefferson argued for national policies of public land distribution that favored small, independent landholders. In recent years, the dispersed, independent farm, open market system has become less dominant in American agriculture, Major questions are whether this system can compete for world markets and whether society should take steps to halt present trends that are gradually diminishing this system's prominence. Answering these questions entails viewing the causes of structural change—that is, how farm resources are organized and controlled—through economic and noneconomic perspectives.

The Economic Perspective

An economic perspective encompasses concentration and vertical integration in agriculture.

Concentration

Concentration refers to the proportion of production controlled by the largest firms, It is important to consider because the more highly concentrated the market, the greater the potential impact of a firm or group of firms on price.

Concentration of total production in agriculture compared to that in many of the other economic sectors is generally low. As shown in chapter 2, concentration has occurred to the point where in 1982 about 28,000 very large commercial farms—1,2 percent of all farms—produced one-third of the total value of U.S. farm products and accounted for over 60 percent of U.S. farm net income.

However, concentration in land resources is also occurring.1 Trends in the distribution of harvested cropland according to sales class show that these productive acres are rapidly becoming concentrated in the farms in the large commercial and very large commercial sales classes. Table 3-4 shows the percentage of total cropland harvested by the top two sales classes of farms for the census years *1969* and *1982* and projects them linearly to *1990* and *2000*. If present trends continue, almost half of all cropland will be harvested by farms in these sales classes by 2000.

The degree of concentration varies from commodity to commodity. For example, beef cattle operators with sales over *$500,000* per year in *1982* represented only **0.5** percent of all beef cattle operations and accounted for 55 percent of the total value of cattle sales. The *69* largest of these feedlots produced 21 percent of the fed cattle in *1980* (USDA, *1981).* The largest cattle feeders were also some of the largest feed manufacturers and grain companies,

Higher levels of concentration exist for broilers (chickens). In 1977 the *16* largest broiler producers and contractors controlled about 50 percent of the production (Brooke, *1980).* In vegetable crops, such as lettuce and celery, concentration is comparably high (Brooke, *1980).*

On the other hand, concentration is still very low for most crop agriculture. Relative to other American industries, where the market share of the four largest manufacturers frequently exceeds 50 percent, concentration in agriculture—even for cattle feeding, broilers, lettuce, and celery—is low. However, attention is drawn to agriculture because of the rapidity with which certain industries, such as broilers and fed cattle, have gone from a diffused to a concentrated and integrated agriculture (Knutson, et al,, *1983).*

Concern exists that if extended over a period of time, the increasing concentration of agricultural production could lead to higher food prices (Breimyer and Barr, *1972).* This would result from increased merchandising and marketing costs, the potential unionization of agricultural workers, and lack of effective competition (Rhodes and Kyle, 1973).

Vertical Integration

Firms are vertically integrated when they control two or more levels of the production-marketing system for a product, Such control may be exercised by contract or by ownership.

Contract integration exists when a firm establishes a legal commitment that binds a producer to certain production or marketing practices. At a minimum, contract integration requires that the producer sell the product to the buyer. Additional commitments may bind the farmer to specified production practices and sources of inputs, While all forms of contract integration have created concern, the greatest controversy exists with contracts that control both production and marketing decisions of farmers. In addition, from a legal perspective, the producer may not even own the product being grown (Knutson, et al., *1983).*

The extent of contract integration is not well documented. Ronald Knutson estimates that all forms of contract integration represented *32*

I Land resources in the agricultural sector can be viewed in the general category of "land in farms, " as defined by the Bureau of the Census, or in the "harvested cropland " category. The acreage of cropland harvested is a more accurate measure of productive agricultural resources than is the general category of land in farms.

Table 3-4.—Historical and Projected Percentages of Cropland Harvested by Farms With Sales in Excess of $200,000

Sales class	Year			
	1969	1982	1990	2000
$200,000 -$499,000	*12.0*	*25.3*	*27.0*	*32.0*
$500,000 +	*6.0*	11.2	12.0	14.0
Total	18.0	36.5	39.0	46.0

Projection Assumptions:
1 Growth in total harvested acres is linear, resulting in an increase of 2.4 million acres per year.
2 Growth follows the linear trend for the two sales classes and results in an increase of 27 million acres per year for the farms in the $200,000-$499,000 class and of 1 million acres per year for the $500,000+ class.
3 The linear projections are based on the acres harvested by sales classes, adjusted for inflation. In flation in commodity prices tends to move acres from lower to upper sales classes Since inflation in commodity prices is likely to continue, nominal growth in acreage harvested by these sales classes may be greater than projected

SOURCE Office of Technology Assessment

percent of farm sales in 1981 (Knutson, et al., 1983). He makes the following observations on the extent of contracting:

1. Contracting used to be limited to perishable products; now it has expanded to virtually all commodities.
2. Production contracting appears to be associated with commodities where breeding and control of genetic factors play an important role in either productivity determination or quality control.

Ownership integration is a single ownership interest extended to two or more levels of the production-marketing system. It may involve either cooperatives or proprietary agribusiness firms. Knutson estimates that proprietary ownership integration accounts for about 6 percent of farm sales. Some proprietary agribusiness firms such as Cargill (beef), Superior Oil (fruits, vegetables, and nuts), Coca-Cola (oranges and grapefruit), Tysons (broilers and hogs), Tenneco (fruits, vegetables, and nuts), and Ralston Purina (mushrooms) have made substantial investments in agricultural production. In products such as broilers, eggs, cotton, vegetables, and citrus fruits, ownership integration is over *10* percent of total U.S. production (Knutson, et al., 1983).

Cooperative ownership integration is much more prevalent than proprietary ownership integration, accounting overall for 34 percent of farm sales. However, in only 13 percent of cooperative integration is there a legal commitment by farmers to market their commodities or purchase inputs from the cooperative.

The economic implications and concern for structural change of vertical integration are debated. A principal problem in agriculture has been the difficulty of coordinating production with market needs. Vertical integration can make a substantial contribution to satisfying this need. For example, in broilers and turkeys, vertical integration has contributed to the uniform size and quality of poultry sold. It has also contributed to increased efficiency and reduced costs (Schrader and Rogers, 1978).

On the other hand, there are potentially adverse consequences of vertical integration. Contract integration with corporations, and sometimes cooperatives, radically changes the role of the traditional independent farmer. More often than not, the farmer loses control of, if not legal title to, the commodities grown under a production-integrated arrangement. Payment to the grower is largely on a per-unit or piece-wage basis, and not necessarily related to product value.

It has been argued that in the long run, market power in integrated agriculture will become sufficiently highly concentrated that the consumer will pay higher prices for food. However, no definitive conclusion can be made. The above argument fails to take into account efficiency gains from integration. The extent to which these gains could be realized without the development of a vertically integrated system is open to question,

The Sociological Perspective

Many concerns relating to structural change are of a sociological nature, They revolve around the impact of concentration and integration on the institution of the family farm, on rural communities, and on rural institutions,

Concern has been expressed that continuously increasing the concentration and integration will lead to the demise of the family farm as an institution. The term family farm has been associated with the existence of an independent business and social entity that shares responsibilities of ownership, management, labor, and financing. The family farm system leads to dispersion of economic power and has been associated with the perpetuation of basic American values and of the family as an institution, Increased concentration and integration tend to destroy the family farm institution. Very large farms lose many of the characteristics of the traditional family farm because their business and hired labor aspects clearly predominate. Most of the management functions traditionally associated with the family farm

institution are removed by integration. With integration the farmer takes on more of the characteristics of a businessman.

Another concern is that concentration and ownership integration reduce the number of farms and make the integrator less dependent on the local community. As a consequence, small rural towns and their social institutions decline or vanish. Recent research conducted in California provides some evidence to substantiate such a relationship. Dean MacCannell (1983) has found that rural communities where a few large and integrated farms dominate are associated with few services, lower quality education, and less community spirit.

Concerns are also expressed about the impact of structural change on the nature of the U.S. political system. Thomas Jefferson visualized the merits of a decentralized political system where power was highly diffused and where every individual had the opportunity for input to public decisions. His philosophy placed a high value on independent farmers and landowners as a means of maintaining a democratic system of government.

Already there has been a marked departure from the decentralized power structure ideal visualized by Jefferson. The question is whether agriculture is basically unique and different from other sectors of U.S. society, as has long been maintained—that is, are there unique social, cultural, and traditional values in having land ownership widely dispersed, or should agriculture join the mainstream where the other economic sectors have long been? As U.S. agriculture continues along the trends laid out in this report, it will increasingly take on characteristics of the nonfarm sector. Some will interpret this trend as progress; others will interpret it as a step backward.

CAUSES OF STRUCTURAL CHANGE

A number of factors have been identified by researchers as causes of structural change. However, there has been no delineation of the relative importance of each factor. One of the objectives of this study is such a delineation. Before moving to that analysis in the following chapters, however, it is important to understand why each of these factors is considered important to structural change.

Most observers of structural change cite three main determinants: 1) technology and associated economies of size, specialization, and capital requirements; 2) institutional forces; and 3) economic and political forces (fig. 3-1). This section briefly defines these forces.

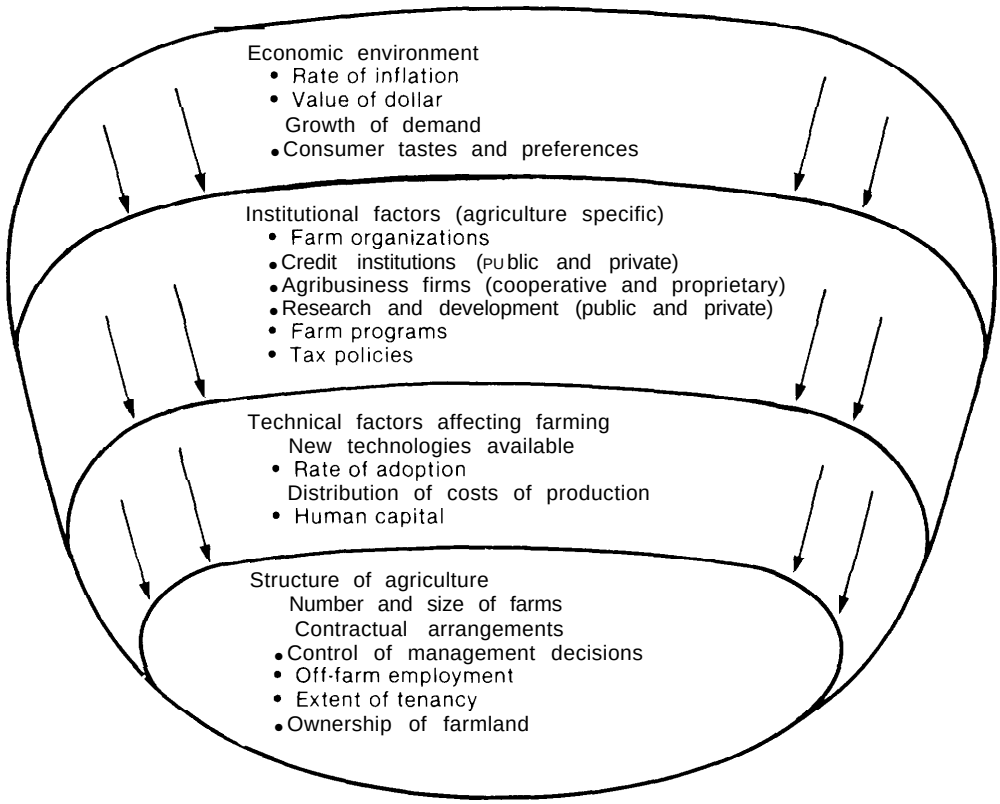
Technological Forces

Certain farmers have a strong incentive to adopt new technology rapidly. The early innovator achieves lower per-unit costs and increased profits, at least for a short time, before other farmers follow his lead. For example, in Washington State a winter wheat farmer with *2,500* acres can reduce average machinery costs by 9 percent per acre by replacing a conventional crawler tractor with a four-wheel-drive tractor. If he also expands the size of his farm to 3,900 acres, he can reduce costs by an additional 18 percent (Rodewald and Folwell, 1977), This nearly 60-percent increase in farm size can be made without additional labor. Once the innovative wheat farmer adopts the technology, other crop farmers generally have two options: purchase a four-wheel-drive tractor and expand the size of their farm or accept a lower net income as market prices for their crops fall. In short, new technology can play an important role in determining acreage and capital requirements. Different farmers have different costs because they use different combinations of inputs, have different management skills, or have different scales of operation.

Economies of Size

The relationship of scale of operation to cost is of particular significance to structure, If costs are relatively the same for all farm sizes,

Figure 3-1 .—Factors Influencing the Structure of Agriculture



SOURCE Off Ice o'Technology Assessment

one would expect all farm sizes to have relatively little incentive to increase in size. In addition, with relatively even costs, consumers would clearly not benefit from increases in farm size. If, on the other hand, costs decline sharply as farm size increases, not only would there be strong incentives for farms to grow in size, but consumers would potentially realize lower prices for food, of at least equal importance to policy makers, if costs decline sharply as farm size increases, efforts to prevent this change from occurring—for example, to preserve the family farm—would not only be difficult but could be counterproductive from a consumer perspective. Smaller farm operators could exist in a cost-declining environment only if they were willing to accept lower returns to contributed labor, capital, and management, and/or had an off-farm job.

Past studies of the relationship between average production costs and farm size support two major conclusions, First, most economies of size are apparently captured by moderate farms. Second, while the lowest average cost of production may be attainable on *a* moderate farm, average cost tends to remain relatively constant over a wide range of farm sizes, Thus, farmers have a strong incentive to expand the sizes of their farms in order to increase total profits.

Earlier studies on economies of size have several limitations. External economies gained from buying and selling in large volumes and from access to credit have usually been ignored. Common ownership of related farm and nonfarm activities has not been considered, There is some evidence that inclusion of such

pecuniary economies would lower the average production costs for large farm units and would shift the conclusion about the size of the most competitive farm (Smith, et al., 1984).

Specialization

Technology has also influenced specialization and regional production patterns. Cotton production has moved westward, for example, into areas of broad, flat fields where larger machinery can be used to optimum advantage. Specialization in crop production is also due in part to technology. Farmers who once relied on crop rotation and diversification to conserve soil fertility, prevent soil erosion, and control pests have replaced these practices by chemical fertilizers, insecticides, and herbicides, with questionable long-run effects. They can thus grow one crop exclusively year after year, specializing in commodities that are the most profitable. Similarly, the development of new disease control techniques has given poultry and livestock farmers unprecedented opportunities to specialize. The vertically integrated broiler industry of today would have been impossible without scientific advances in breeding, feeding, housing, and medicine, which have reduced the real cost of broilers by as much as 50 percent over the past 30 years,

These scientific breakthroughs have generally enabled both small and large farmers to specialize more. However, improvements in farm machinery have perhaps been most important in fostering large-scale, specialized operations. A decision to invest in a specialized piece of equipment means that an operator will emphasize production of the commodity for which the machine is intended, quite likely at the expense of some other commodity, And, insofar as a machine is most economical on a particular size of operation, expansion to that size is encouraged. Thus, specialization and farm growth occur simultaneously.

Capital Requirements

Agriculture is one of the most capital-intensive industries in the American economy. The result is high requirements for credit to finance new capital investments, production, or storage.

Technology has made barriers to entry more formidable, The cost of machinery raises capital requirements for beginning farmers. Technologies that allow individuals to farm increasingly larger acreages have added to the competition for land, resulting in high land prices, the single greatest expense in farming today. The average investment in 1980 in a farming operation with gross sales between $40,000 and $60,000 ranged from $350,000, for fruit and nut farms, to over $800,000, for livestock ranches.

Institutional Forces

Institutional factors have their primary influence on the costs of inputs used in production, the prices of products, and the generation of new technology for agriculture. These institutions may be either in the private or the public sector.

The costs of inputs are primarily a function of competition between private sector agribusiness firms. Input costs do not have to be the same for all farmers, Input suppliers may offer farmers discounts for larger volume purchases of fertilizer or chemicals. Likewise, larger scale farmers may receive higher prices for products marketed through the use of crop contracts or futures markets.

Research and Extension Service

New technologies are generated in both the public and private sector. Basic agricultural research is primarily a public sector function performed by the U.S. Department of Agriculture (USDA) and the land grant universities. Applied research functions are shared between the public and private sector, with the private sector dominating development activities. Extension activities assist in evaluating and transferring technological innovations into practice. An integral part of agricultural research and extension policies is the generation of higher levels of training and expertise embodied in human capital, The result is more skilled farmers, agribusinessmen, scientists, and agricultural policy makers.

Research and extension have had differential impacts on farms, farm workers, rural com-

munities, and even entire regions, depending on their characteristics and the type of technology developed, Some technological innovations, particularly mechanical innovations, have favored and hence fostered larger farms. Other technological innovations that could be applied on farms of any size are often first adopted by larger farms (paarlberg, 1981; Perrin and Winkelman, 1976). By being the first to adopt new technologies, larger farms receive greater benefits than those not adopting the technologies (typically, smaller farms).

A major effort of the extension service is to disseminate timely information through public meetings. The topics covered in publications and public meetings are heavily influenced by current research results, Any bias toward larger farms that is embodied in research results would most likely be carried over into meetings and publications.

Even though extension personnel make information available to all farmers, those farmers that make the most use of the research results and extension information can generally be characterized as more innovative, more aggressive, and better managers, usually of larger farms (Paarlberg, 1981). Such farmers are also generally more vocal, providing feedback to research and extension personnel on the usefulness of the information received. Even though no overt effort is made to exclude particular groups, such as operators of small farms, the net result is that many research and extension programs become more oriented toward those select groups that generally avail themselves of the information (Paarlberg, 1981),

This lack of structural neutrality was recognized in 1979 by Secretary of Agriculture Bergland when he questioned the use of Federal funds for research projects having the objective of producing large-scale, labor-saving technology and set up a special task force to investigate the impact of research and extension on structure. At the same time, Congress earmarked research and extension funds for increased work with small farms and for projects involving direct marketing from farmers and consumers, However, no special programs were developed for moderate farms,

The Bergland initiative on research was reemphasized with the change in administration in 1981. It has, however, been rekindled by the announcement of joint initiatives in biotechnology research between private sector companies and universities. Questions have arisen as to whether the primary beneficiaries of the initiatives will be the private sector firms or the initial farmer adopters of the resulting new technology,

Public policy

Many public policies affect the structure of agriculture by influencing resource use, capital requirements, technology development and adoption, freedom of decisionmaking, exchange arrangements, risks, and costs and profits. Some policies are oriented specifically to the farm sector, such as price and income policy (commodity programs). Others affect agriculture directly but are more broadly oriented, such as tax policy. Still others are general—national macroeconomic policy, for example—and affect agriculture indirectly.

Public policies offer viable ways to maintain or alter the structure of the agricultural sector. In this section, areas of public policy involvement that affect the structure of agriculture are briefly examined.

Commodity Programs. -Beginning with the Agricultural Adjustment Act of 1933, a series of commodity programs have evolved to deal with price and income problems in farming. These programs have covered such commodities as wheat, feed grains, cotton, wool, sugar, rice, peanuts, tobacco, and dairy products. To stabilize and increase farm prices and incomes, a variety of program tools have been used: price supports, direct payments, acreage allotments, set-asides, conservation reserves, surplus disposal, and stock accumulation.

There is widespread agreement that these programs, in the short run, held farm incomes above what they would otherwise have been; there is much less agreement about their long-

term effects on income. Price stability from these programs has, however, enabled farmers to adopt new and improved technologies.

Commodity programs along with technological advances influence structural change in agriculture through the following mechanisms. Since farmers are price takers, no one farmer can significantly influence the aggregate supply of a commodity and hence the price that he receives. However, the individual farmer can do something about his operating costs. By adopting a new technology an innovative farmer increases productivity and lowers his firm's cost structure. Since price is not affected at the early stage of technology adoption, he reaps a profit. As his cost structure falls, the farmer increases his output at the given price, It is possible that innovative farmers used some of their profits to buy up assests of less efficient neighbors, thus starting the change in the structure of farming. As more farmers realize the benefit of new technology and follow this innovator, the adoption of the new technology becomes widespread. As they do this, aggregate supply increases, and the price of the product declines. After a period of adjustment a new equilibrium is reached at a lower price, a situation in which the innovator no longer receives a profit and in which the laggard adoptors of new technology suffer an economic loss. This dynamic interaction has been referred to as the "agricultural treadmill" (Cochrane, 1958).

Under a commodity program in which the price of the commodity is supported, the same treadmill concept applies. However, under such a commodity program the price does not fall when the aggregate supply increases, because the product price is supported by Government action. Instead, each early adopter continues to reap a profit and seeks to expand output by acquiring the land of his less innovative neighbors. Thus, farm technological advances coupled with Government-supported product prices result in structural change in which productive assests in farming are concentrated in the hands of aggressive, innovative farmers. However, since the total amount of arable land is limited, competition for this land between the innovative farmers causes the price of land to rise, The cost of production will thus rise until a new equilibrium is reached in which the expanded, innovative farmers are back in a no-profit situation while the laggard adoptors end up with a loss. In this case the equilibrium is reached by an increase in land values rather than a fall in product prices.

Tax Policy .—Tax laws and provisions are widely recognized as being a determinant of agricultural structure. There is not agreement, however, about the relative importance of tax policy because of tax policy's interactions with other structural determinants. Some tax laws and provisions can be directly related to structure (i.e., estate and corporate tax law), while others (i.e., investment tax credits, depreciation provisions, capital gains, and cash accounting) are indirectly related and often interact with credit and commodity policies,

In animal agriculture, tax factors such as cash accounting, current deductibility of costs of raising livestock, and capital gains treatment for sales of breeding livestock, together with investment tax credits and accelerated depreciation, influence livestock investments and can affect structure. Tax policy issues in animal agriculture include tax shelter and nonfarm investments, tax provisions as a factor in economies of size, and the legal structure of agriculture, The cattle sector provides one example.

For mechanical technology, current tax laws favor the substitution of capital for labor and may speed the adoption of mechanical systems. Two tax factors are at work: payroll taxes, which increase the cost of labor, and provisions for investment tax credit and accelerated depreciation, which decrease the cost of machinery (Carman, 1983).

The income tax advantages of cattle feeding were packaged as limited partnership syndicates in the late 1960s and early 1970s and sold to nonfarm investors. The growth of nonfarm investment in cattle feeding was closely associated with the movement of cattle feeding out of the Midwest and with the growth of large-scale feedlots in the High Plains area.

Other factors also played a role, but limited empirical evidence suggests that tax-induced investment in cattle feeding through limited partnerships was related to structural change (Carman, 1983),

It is conventional wisdom that tax provisions are an important consideration in the adoption of capital-intensive innovations, since investment tax credit and accelerated depreciation do have a significant impact on after-tax costs. Such innovations include the large four-wheel-drive tractors, circle irrigation systems, minimum tillage systems, and large-scale and improved harvesters.

An important implication can be drawn about structural change from the above discussion. Small farms and very large farms have more off-farm interests against which to offset farm losses than do moderate farms. This could be a significant factor in accounting for the decline of the moderate farm.

Agricultural Credit Policy .—Public policy directly influences the supply of capital to farmers through the Farmers Home Administration (FmHA) of the USDA and the Farm Credit System, which includes the Federal Land Bank, Production Credit Association, and Bank for Cooperatives. The original capital for the Farm Credit System was supplied by the Federal Government, but the system is now wholly owned by its borrowers. However, the Farm Credit System is still accorded agency status, whereby interest costs on its bonds and discount notes are lowered. The FmHA is a Government agency that has a mandate from Congress to make low-interest loans to family farmers who cannot obtain credit elsewhere. The FmHA and the Farm Credit System together account for approximately 40 percent of the total farm debt outstanding (8 and 33 percent, respectively) (Barry, 1983),

The general intent of farm credit policies has been to ensure appropriate capital availability for agriculture. Policies established by these agencies and their attendant programs are thought to have influenced the structure of the farm sector, although the extent of their impact has not been studied thoroughly,

Economic and Political Forces

Agriculture operates in a broader overall economic and political environment. This environment determines the rate of interest, the rate of inflation, and the value of the dollar—all of which influence the costs and prices of farm products, The increased importance of these effects has made macroeconomic policies that influence the overall economic environment within which agriculture operates more important to farmers.

THE DYNAMICS OF STRUCTURAL CHANGE

A study of this type cannot possibly analyze all of the technical, economic, and institutional factors that influence the structure of agriculture. This study therefore concentrates on those factors that appear to be the most critical in affecting structure and that also relate to current farm policy decisions. These factors include:

- The technical factors influencing the costs of production as related to farm size.
- The major farm program elements.
- The institutions that lead to the development and assimilation of new technology.

The factors interact in a dynamic fashion to influence the structure of farming. New technology continuously infused into agriculture is adopted by the most progressive farmers. While the initial adopters assume increased risk in applying a new technology, they generally also gain substantially higher returns. Farm programs that reduce price risk help assure higher returns.

As more farmers realize the advantages of new technology, the adoption process becomes more general. As this happens, supplies increase, with the tendency to force down mar-

ket prices. If Government policies prevent market prices from falling, surpluses build up, as they have in the dairy industry or did before the payment-in-kind (PIK) program. If market prices fall, Government payments rise.

Wider adoption of technologies also changes the nature of costs as farm size increases. If larger farms are the first adopters, their costs are substantially lower. The laggers in adoption realize much higher costs. By not adopting, they become, in effect, left behind—eventually being either forced off the farm altogether or forced to take an off-farm job. Moreover, the higher returns gained by early adopters of technology encourage them to seek expansion of output by acquiring more land. Given the fixed land base, however, innovative farmers can only grow in size by acquiring the land of their neighbors. Thus, growth and prosperity of large, progressive farmers can only take place by the failure of those who are slow to adopt technology.

These consequences often lead to suggestions of turning off the technological wheels of progress. Such a strategy, however, would have a devastating effect on the competitiveness of American farmers in world markets. Instead of just some people being left behind, the whole American farm system would be left behind.