

THE CHANGING STRUCTURE OF AGRICULTURE

*John O. Gerald, Agricultural Economist**
Marketing Economics Division, Economic Research Service
U.S. Department of Agriculture

Structural analysis of agriculture means more than just the organization of agriculture for production with particular reference to sizes and types of farms. It also involves analysis of the resource allocation and pricing processes as these affect, and are affected by, the structure of firms in existence.

It is relatively simple to describe the structure of agriculture and how it is changing, and to state some widely accepted hypotheses concerning why the structure is changing. But when we come to the critical task of evaluating past performance and the means for improving future performance, we find that the hypotheses concerning the implications of the changes in structure are much less widely accepted.

THE STRUCTURE OF AGRICULTURE

Agriculture has an atomistic structure with few if any exceptions. The 3.1 million farms in the United States in 1967 are not likely to constitute a structure in which the typical commercial farmer takes account of the probable reactions of other commercial farmers in making his production decisions. Even in the year 1980 when the number of farms is projected to be 1.7 million, or the year 2000 when the number is projected to be only 585,000, we see no reason to think that a typical farmer will be able to affect the prices he pays or receives.

There is quite a wide distribution of sizes, types, and locations of farms in agriculture. In 1967, 183,000 farms had sales of \$40,000 or more, 318,000 had sales of \$20,000 to \$39,999, and 492,000 between \$10,000 and \$19,999, while 2,153,000 had sales of less than \$10,000. The one-third of the farms that are largest in size account for over 85 percent of sales. Those farms having cash receipts (including government payments) of \$20,000 or more in 1966 are estimated to have received 107 percent of the returns they

*The views expressed herein are those of the author and do not necessarily reflect those of the Economic Research Service or the U.S. Department of Agriculture.

could have received from alternative uses of their resources. Those having returns of less than \$5,000 received only 43 percent of their "parity returns." By far the most farms are in the North Central and Southern states.

Farms are quite heavily capitalized—over 215 billion dollars in 1967. Real estate accounts for about 165 billion dollars of this. Average assets per farm worker in 1967 were \$41,000 as contrasted with \$3,000 in 1940. Although farmers have average incomes below those of nonfarm persons, the farm family has a net worth almost five times as great.

This heavy capitalization nonetheless is not accompanied by widespread incorporation. There are only 6,703 corporate units in the twenty-two states for which reports are now available. These represent 0.7 percent of total farm units and 4 percent of cash receipts in these twenty-two states. Over 80 percent of these units were family or individual corporations. Part-ownership—father-son arrangements, in many instances—is much more prevalent than corporations as an ownership form. One-fourth of all our farms are part-owner units. These include one-half of the land in farms. Tenants account for about a fourth of our farm units, and sharecroppers are so few that they are no longer reported as a separate group.

CHANGES IN STRUCTURE

Early Agricultural Development of the United States

The United States is handsomely blessed with land and water resources. Before Adam Smith wrote *The Wealth of Nations*, England, France, Holland, and Spain were already in the process of developing these land resources. Unutilized or underutilized human resources from Europe and captive human resources of Africa were settled on lands accessible to coasts and navigable rivers. Much of this population knew how to farm and little else. Over 90 percent of our population was on farms during colonial days.

Land situated on navigable waters was soon filled. Toll roads and canals were extended inland in attempts to commercialize new lands. Land with no access to means of transport accommodated a self-sufficient agriculture for a while. The pace of immigration then began to build up American cities.

The advent of railroads provided the technical means for reducing transport costs by as much as 50 to 1. But the railroads served in one respect to delay the industrialization of the United States. They helped to retain a comparative advantage for agriculture in this country. As important perhaps, land was made available to any-

one who settled on it. This was, and still is, a policy of our federal government.

The number of farms increased very rapidly as railroads advanced into new lands—from 1.5 million in 1850 to 6.5 million in 1920. Land in farms grew from 294 to 956 million acres over the same period and the value of land and buildings on farms from 3.3 to 66.4 billion dollars. The distribution of population shifted even more heavily toward rural areas and farming. In 1850 there was one farm for each 16 persons but this changed to one farm for each 12.5 persons by 1880. By 1920, a reversal had set in and our urban population had grown so that the the number of persons per farm was back to where it was in 1850. Nonetheless, we did not reach our peak of 6.8 million farms until 1935.

Technological Change Leads to Further Agricultural Development

Change did not cease at the end of our railroad building era. By 1964, we had only one farm per 61 persons. Cropland harvested per person dropped from 3.3 acres in 1920 to 1.5 acres in 1964. The value of land and buildings on farms rose from 66.5 to 160 billion dollars. The number of farms dropped from 6.5 to 3.2 million.

Most of you know the generally credited causes of these dramatic changes since 1920. The exploding population of Europe in the eighteenth and nineteenth centuries could not be adequately fed and clothed by land settlement of the United States only. Capital intensification of U.S. agriculture was delayed by the small industrial capacity of the nation. Land resources of Canada, Mexico, South America, Africa, Oceania, and Asia were also opened to development. U.S. agriculture then lost some of its early comparative advantage.

Technological change in farming methods, once put in stride by a reasonably prosperous agriculture during the two World Wars and the Korean War, was rapid. Petroleum replaced hay and feed grains as a source of farm energy, releasing about 90 million acres of land from the production of feed for draft animals to other uses. Commercial fertilizer and pesticides have been substituted for land. In addition, output rose from improved seeds, better and more timely cultivation, planting, and harvesting practices.

The 125 percent increase in farm output from 1910-14 to 1967 required only a 28 percent increase in inputs. Farm-supplied inputs in 1967 were actually less than 50 percent of what they were in 1910-14. Purchased inputs increased 164 percent. These figures

clearly reveal the relatively low capital intensity of farms in the early 1900's.

Substitutions of this magnitude in farm inputs occurred only with major relative changes in the state of technology, productivity, and real prices of inputs. Land prices rose from the near-zero level prevailing in the railroad building era. Labor prices rose sharply. But prices for power, machinery, fertilizer, and liming materials (not to mention high-quality management services) rose less rapidly. Indexes of prices (1935-39 = 100) in 1955-59 were: output, 221; fertilizer, 151; machinery, 191; land, 325; and labor, 455. To the extent that fertilizer and machinery could be substituted in large measure for land and labor, without adversely affecting productivity, farming became more (or more nearly) profitable over this period.

Agriculture in 2000

Some of these purchased inputs, especially power and machinery, encourage expansion of farm scale. However, it now appears that most of these efficiencies are achieved when farms reach the scale of 2 to 4 man years of labor input per year. Also, very high levels of technical competence are necessary on specialized farms to realize the economies of size made possible by some of this power and machinery, and this degree of technical competence among farmers has been scarce. Agriculture has attracted relatively few well-trained young men, and the average age of farmers and full-time farm workers is still climbing. These factors may lead more and more to specialized farming but with custom farming operations rather than on-farm provision of services. So, as the process of making agriculture more efficient in resource use proceeds, we can expect to see increases in land leasing, nonowner management of land, customized farming operations, and further capital intensification.

The question is, how fast will this specialization proceed? Projections by Rex Daly of the Economic Research Service indicate that farms with annual receipts in excess of \$10,000 will only increase from 990,000 in 1965 to 1,060,000 in 1980 but that in 1980 such farms will include almost half of all farms. In 1965, they accounted for only 29 percent of all farms. Large farms with cash receipts of \$40,000 or more are projected to almost double, from 170,000 in 1965 to 335,000 in 1980. Small farms with cash receipts of less than \$5,000 are projected to decrease from 1,860,000 to 855,000.

This, then, is a view of the changing structure of agriculture and why it is changing. As an economic activity, agriculture is finding

that its production function is responsive to technical advance and to changes in the relative prices of inputs. It is finding that its demand function is responsive to changes in consumer incomes and in the relative prices of outputs. It is finding that it needs knowledge of new technical coefficients of production, new conditions in the supply of inputs, new conditions in demand for outputs, and new conditions in the supply of capital funds. These new facts and conditions are arising at an ever increasing rate.

As Sune Carlson pointed out in 1939 in his classic essay, *The Pure Theory of Production*, these are "the forces which influence the entrepreneur in his decisions on what to produce and what methods of production to use." A rational and informed entrepreneur will operate within the forces to maximize their contribution to his own personal goals. As these forces change, so do the plans and actions of the entrepreneur. This responsiveness of individuals to the set of incentives facing them offers a natural means for outsiders to use in changing actions.

SOME IMPLICATIONS OF PAST AND PROSPECTIVE CHANGES IN STRUCTURE

Outside forces have altered conditions facing farmers. Some, but not all, of these alterations have been made by the government. Free land and low transport costs, in part a result of land grants to railroads, are examples from days when government was expected not to meddle in private initiative. More recently, control of marketing and direct price supports for dairy products, wheat, and cotton, with no similar action for feed grains and meats, may have contributed to a shift of consumption toward fruits and vegetables, meat, and synthetic fibers. Increased consumer incomes are usually credited for these. With recently increasing prices of animal products, relatively, as a result in part of feed grain and other programs which have diverted land to soybeans, consumption may be tending to shift again to crops, but this time in the way of plant protein analogs as substitutes for meat and milk products.

Distribution of Assets and Income

The effects of explicit agricultural policies of the past have usually been reflected in changes in land values and in prices of food and fiber to consumers. We have used practically all devices imaginable in providing, and then maintaining, value to a natural resource with which the United States fortunately is well blessed and which, due to many factors some of which cannot be specified, was rapidly developed through a conscious policy of the federal government.

Some economists claim that such devices have been regressive in terms of equality of income distribution. If so (and it may be true only in regard to farm income distribution), why did we do all these things? There seems to be a consensus that we did them in futile attempts to alleviate poverty of certain groups of people or, in other words, to achieve more nearly equal distribution of income.

Most of these policies have had the longer-run effect of drawing resources into and then retaining them in agriculture. The long-run elasticity of supply for agriculture has been high.

But this result in turn created another result. It assured American consumers of adequate food supplies at reasonable prices. There can be little doubt that this result has been, and is, progressive rather than regressive in terms of achieving a more equal distribution of income. The progressive features of explicit agricultural policies of recent decades, applying as they do to 100 percent of our population, may more than offset in net effects on income distribution the regressive features internal to farm income distribution affecting 5 to 6 percent of the population.

Productive Capacity

Do we still need government programs to insure the income redistribution effects of low food prices? See if the following figures and ideas add any meaning. In 1967, of the 308 million acres of crops that were harvested, 71 million acres were used to produce exports. On top of these 71 million acres (which have fallen as low as 31 million acres in the period since 1950) we had about 30 to 35 million acres of land diverted by government and our rate of progress in yields over recent years has added the equivalent of 5 million acres per year to our productive capacity, not to mention the potentials we have for increasing our land resource base through water resource development.

It appears that U.S. consumers have no worries about food supplies, or the at-farm real costs of those supplies, for quite a few years if agriculture is technically progressive. However, we know that for industries to be progressive in their adoption of technical advances, they must earn the revenues with which to install the new technologies, or appear to be able to earn for repaying creditors. In the face of an excess capacity and an inelastic consumer demand, an industry must control its total output to maintain profits. An atomistically structured industry is usually considered to require the assistance of the government to achieve such control.

Corporate Control

Some people believe that agriculture itself will be able to regulate its output decisions, eliminating the need for government control of output. Bargaining power is widely discussed as a possible alternative to continuation of government controls.

Corporate management is expected by these writers to increase and to be more politically astute than many of our farm managers of the past. Thus, they should be able to bargain among themselves concerning the production rights and rewards of feeding and clothing our population.

Without passing judgment on the relative levels of political astuteness of different types of managers, let us examine the trends which may help to determine the ownership form of the future. First, farm family incomes are below those of nonfarm families. Excess capacity in agriculture argues that the incomes of farm families will remain relatively low for some time, particularly so if the output controls, now exercised by government, are reduced. Several researchers also foresee an increase in the relative costs of social and commercial services for rural America. A 94 percent increase in agriculture's needs for capital between 1964 and 1980 has been projected. This increase apparently will have to be borne by 30 to 50 percent fewer operators. There is thus some basis for believing that present farm operators will be unable to divert enough of their cash flows into new technology and land purchases to finance this growth. While land value increases since the 1930's probably have financed much of our present scale of use of land and technology, land value increases of the next two decades or so may not be adequate. Outside venture capital may become necessary to install new technology.

A more basic reason why present farm operators may not be able to provide the capital to install new technology is that a significant proportion of today's operators are at or near retirement age. They will disinvest. But present land values and known economies of scale in land operation are already of such magnitude that new entrants may find themselves heavily encumbered with debt for less than economic sized units, unless these new entrants undertake management as nonresident owners. The corporation is the best understood and most widely used form of nonowner management of capital, and also has the advantage of making intergeneration transfer of both ownership rights and management roles easier. Corporation farming may well be expected to grow in importance, but we are as yet unable to specify how rapidly or how far it may expand.

A factor which may tend to retard the progress of corporate

farming is the prospect of relatively low returns. Another one is the relatively limited space over which management can be effectively exercised. Electronic surveillance and other such developments may expand the economic spatial unit of management in farming, but still the capital required for an economic management unit seems likely to remain considerably below that of many urban economic activities. There may be sufficient families with the net worths required to finance economic management units in farming.

Let us return now for a moment to the question of political astuteness of different types of managers. Price is the distributor of rewards in either proprietary or corporate forms of ownership. Agriculture has excess capacity at present. Longer-run substitution elasticities of demand apparently are high. Foreign competition for domestic outlets is imminent for some products. Analog and synthetic feasibilities of sizable proportions are now in prospect.

If only land is taken into account, geographic shifts in crop production have been pervasive and unceasing. According to one estimate, more than 50 million acres of cropland were involved in supply adjustments within and among regions between 1949 and 1954. Animal products production has perhaps been even more geographically mobile. It has been estimated that actions which prevent such shifts may add as much as 10 to 25 percent to production costs. Society may be unhappy to give massive bargaining power to managers of any type in agriculture if this power is then used to add these costs to its food and fiber bill rather than using it to achieve technological progress.

The public's vital interest in adequate food supplies at reasonable prices certainly seems to us to imply continuing critical surveillance by the public of the resource allocation and pricing processes in agriculture whether they are conducted in the public or private arenas.

Vertical, or Conglomerate, Corporate Control

Another structural trend argument cited by some against continuation of government control of output decisions in agriculture is that vertical integration is growing and that this trend eliminates the necessity of profits from any one stage within the integrated firm for advances in technology to be applied to that stage.

From our vantage point in marketing economics, we do not see any reason for concluding that vertical integration is growing. Farm families have relinquished many processing and marketing activities to nonfarm firms over the past fifty years. This, of course, could be

expected to occur as the bulk of our population became more concentrated in location, thereby reducing the ability of farm families to huckster their products directly to consumers or to small retail stores serving consumers in nearby villages, towns, and small cities.

The extent of this economic separation of farm families from their ultimate customers is measured in a gross manner by the series we maintain on the farmer's share of the consumer's food dollar. This share has declined almost steadily from 51 percent in 1947 to 38 percent in 1967. The figures we presented earlier on the absolute decline in use of farm family provided inputs and the very rapid growth in use of nonfarm produced inputs tells the same story about what goes on behind the farm gate, the point from which we marketing economists have traditionally taken over in viewing the functioning of our food and fiber system.

If vertical integration has occurred in our food and fiber system, then this trend is counter to that noted for the general economy not only of the United States but of most Western nations. Many economists, from Adam Smith to contemporary writers, have concluded that the progress of industrialization has so far been marked by further specialization and by further separation of ownership rights and management roles.

"Creative Destruction" Revisited

There is no question but that some stages of production, processing, and marketing have been combined into new ownership and management forms in the past. Joseph Schumpeter described such processes of "creative destruction" twenty-five years ago in his *Capitalism, Socialism, and Democracy*.

There are some facts which support the view that conglomerate vertical ownership (and nonprice vertical coordination) of agriculture may prove to be an arrangement which competition will not long tolerate for the bulk of our food and fiber needs. First is the fact that the progress of industrialization has so far been marked by further specialization and by further separation of ownership rights and management roles. While there may be some economies of a vertical nature in specialization of management roles, we suspect there are more economies in specialization of a horizontal nature. Total capital constraints and diseconomies of scale may prevent extensive exercise of both of these options simultaneously. This is particularly true of present farmers. Yet, unencumbered land values at present provide a considerable restraint against undisciplined entry of outside entrepreneurs into agriculture who have only the econ-

omies in vertical management to achieve. The role of price in coordinating vertical flows may not be declining, as some suggest. It may only be changing, as others suggest.

Second, feeding activities are the principal on-farm activities for which the management role has been taken over by nonfarm firms thus far (except for some new forms, in effect, of land leaving through contracting), insofar as we have access to relevant knowledge. These are not land-based activities, and adequate land collateral with which to obtain simple trade credit is not required. The entire equity of the grower is often less than the investment in the single lot of broilers which takes only 8 to 11 weeks to reach market weights. Sequences of input-output flows can be ordered through the scheduling of birds placed with different growers to achieve continuous flows. This is not the case for corn, cotton, wheat, and most other crops where the growing process is seasonal and requires large acreages. Sequential processes are much more discrete and are subject to considerable risks in an uncontrolled market. We have no good measures of the number of firms affiliated in a vertical pattern. Is the broiler industry more or less integrated now than was the poultry meat industry of thirty years ago? No one knows.

Third, preservation of foods is becoming less costly in terms of energy requirements, and future reductions may well bring costs of preserved foods, as a safeguard against variation in "uncoordinated" production, below the costs of coordinating production. Also, food analogs now being produced may increase their share of the food market. Analogs are made from basic fungible agricultural ingredients; quality is determined in the factory, not by what leaves the farm. Costs of quality control in analog production may be considerably below costs of quality control by means of "coordinated production and marketing." Also, rapid increases in the relative price of labor for the selective harvesting of top quality fruits and vegetables are encouraging more dependence upon mechanical harvesting which may result in less than top quality for much of the harvest. Such products go into canned and frozen products. Consumer acceptance of such complex processed products may be influenced by variables other than the innate quality of the harvested product. In this respect, "quality" can be fabricated instead of having to be grown. And perhaps most important, the technical competence and management ability of farmers are improving. We see no reason to think that farm managers of the future will ignore consistent price incentives for delivery of desired qualities at the right times and places. Thus, one of the claimed reasons for "more coordination" has the potential of being subverted by other trends.

From these facts, we cannot be sure that agriculture will become just a stage of production in an industrialized, vertically integrated food and fiber system. Agriculture may continue as a separate industry in large measure, buying inputs from unaffiliated firms, selling outputs to unaffiliated firms. Technological progress may have to be financed from profits generated in agriculture, or not be installed. The years between 1969 and 2000 may be critical ones in this respect, but facts presently available to us permit no final conclusion.

Policies—To What End?

Our conclusion, then, is that the structure of agriculture in 1980 or 2000 or any other future period cannot be forecast with precision. If we knew with certainty what structure our citizens would like to see emerge, then policy variables can be manipulated to yield such a structure. In the absence of such knowledge, we must be tolerant of diverse views, but we cannot be tolerant of proposed actions which put our future food supply in jeopardy. Society's actions over our whole history establish clearly its concern with adequate food supplies at reasonable prices.

COMMERCIAL AGRICULTURE'S DUAL SITUATION

There has been a spate of self-recrimination among professionals serving the public's interest in agriculture over the present dual situation in agriculture. We find it hard to understand this phenomenon.

It seems clear to us that we agricultural economists are not yet able to specify ideal policies for achievement of all the goals our society might have set for itself. These goals may conflict. We can shift from one broad set of policy variables affecting the prices of products and factors to another broad set affecting income transfers. But different goals require differing mixes. Goals of efficiency may respond to price variables; income redistributions are a side product. If we shift to direct income transfers, income distributions may respond, but what are the side effects on efficiency?

Perhaps complete equality of income distribution, or even abolition of poverty in our economy, is an impossible goal. Some policy makers appear poised nonetheless to attempt the achievement of the latter goal. It behooves agricultural economists and other social scientists serving agriculture to be sure that impoverished people in rural areas are not exempted for lack of information from equal consideration when those policies are being devised. We should get our research under way now, not after the policies have been put into effect. The efforts of the President's National Advisory Commission

on Rural Poverty were heroic; we should not permit those efforts to be wasted by not building on them. People do count, though for positive economic analysis they may have to be treated as simple factors of production. People are the only factors of production that respond to the set of incentives facing them.

Other publicly employed professionals serving agriculture, including agricultural engineers, chemists, and biologists employed by the USDA and the land-grant colleges, have made significant contributions to agriculture. But, the really large impacts that have led to our present dualistic structure appear to be those of early land settlement policies; later, but still in the days before the USDA and the land-grant colleges really had anything to say about policy, industrialization which led to very rapid capital formation; and finally, our labor policies of the early 1900's which may have created significant barriers to off-farm employment opportunities for farm people.

We do not want to leave the impression that we think structural change has sharpened the distinction between two classes of American farmers. There were always two or more classes rather sharply defined at the extremes. Nonetheless, a large number of farms in existence now, perhaps as many as 2.5 million, are not likely to be in existence thirty or so years from now. This number of farm firms yet to exit from agriculture is not as large as the 3.6 million that have exited over the past thirty years. Both farm people and rural nonfarm people serving farm families have a relatively much larger urban base into which to be merged than did the estimated 33 million who left farms between 1920 and 1962. Hopefully, our research and educational activities, and our policies, can be directed in such a manner that the smaller number yet to leave can do so at less sacrifice and suffering than was true for many in the past.