Historical Perspective on Adjustment in the Food and Agricultural Sector

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Introduction

Agriculture almost everywhere is characterized by relatively small, family operations that are atomistically competitive profit maximizers having imperfect information and who, for the most part, face a highly inelastic demand for their output. It is profitable for the individual farmer to increase capital expenditures on new technologies and in this way increase farm output. Early adopters of new technology reap hansom benefits. And in the early stages of new technology use, not enough farmers adopt the new technology to cause significant changes in total quantity marketed or in product price. Over time, however, as other farmers find that their neighbors' profit levels rise, they too adopt this new technology in an effort to increase profits. In the longer term, when a majority of all farmers adopt the new technology and the market adjusts to the greater aggregate quantity marketed, market price of farm output falls. Buyers of farm output are unwilling to purchase, at past high prices, the increased quantity of farm output now being placed on the market.

Input prices may also fall if there is general economic growth, but input prices typically fall much less rapidly than do farm product prices. As consumer incomes rise, consumers may change the composition of the food they buy but in total eat very little additional food. However, consumers are willing to pay higher prices for nonfarm goods and services which keeps up the cost of steel, labor, petroleum, chemicals, and other materials used to produce more "luxury" goods. Consequently, the cost of tractors, lumber, fuel, fertilizer, and other cost items on the farm remains strong because of the nature of consumer demand and the organization of industries which produce these materials.

Faced with an increasing farm output, falling farm prices, and stable or increasing farm costs, unit profits on the farm fall. Farmers, then, are required to make substantial adjustments in order to maintain a standard of living for the farm family consistent with that of their nonfarm counterparts. It is not prudent for the individual farmer to retrench, discarding recent technology and capital investments. If she does so, the reduction in her output is too small to show up in the total supply so it will have no effect on market price. She would only end up producing less output at a lower price and thus receive a greatly reduced income.

This is the dilemma facing farmers everywhere. The result has been a decline in farm income for those farm families who have been unable to increase the scale of their operation, diversify into other occupations, or decrease per unit costs more than enough to offset the decline in output price.

In this paper I review briefly the types of adjustments farmers make as well as some of the obstacles to more rapid farmer expansion or contraction. I also present data showing the major adjustments that have been made in the U.S. agricultural sector since 1950 in farm numbers, size of farms, output and enterprise mix, farm inputs, and in those industries purchasing farm produce[1]. I selected 1950 as the starting point because this was a period of rapid technological advance in agriculture and a period when agricultural surpluses in the U.S. became burdensome. It was also the beginning of a period when the federal government struggled to

[1]The material for this review is drawn for the most part from Hallberg (2001). For additional details see the selected citations in the Reference section of this paper.

develop a variety of policies directed toward easing the pains of a troubled sector. This period should thus be instructive for this historical perspective.

Types of Adjustments Farmers Make

Farmers can make a variety of adjustments. They might **decrease output** when prices are low by idling some of their resources -- principally land -- or **increase output** by bringing back into production resources previously idled.

Farmers can **specialize** in one or two enterprises and in this way change their land use or production mix. Seventeen percent of the farms in the U.S. have annual gross sales of over $100,000. These same farms produce about 80 percent of aggregate farm output. Most of these farms are highly specialized grain, dairy, beef, fruit, or vegetable operations. In earlier years most of these farms were much smaller and highly diversified operations.

Farmers can increase the scale of their operation by acquiring **more land** outright or through leasing agreements. This option is, of course, not available to all farmers because of the limits on land area in farming or on land available for leasing. For the most part, farmers can expand the scale of their operation only if others reduce their acreage or give up farming altogether.

Farmers can increase their use of **capital resources** and decrease their use of **labor resources** on a constant land base. Capital resources here include both labor-saving resources such as tractors, trucks, and machinery and land-saving resources such as fertilizer, pesticides, and herbicides.

Finally, farm operators and their spouses might not change their existing farm operation at all, but merely increase the number of hours they work at one or more **off-farm occupations**. For many, this is an effective way of strengthening and diversifying the financial resources of smaller-scale farm operations.

Obstacles to Adjustments

While the major argument of this paper is that U.S. farmers have made substantial adjustments over the years since 1950, it is important to recognize that there are limits to the short-run adjustments farmers can make. First, farmers are unable to stockpile output as can industrial firms so as to hold out for higher prices. Grain is, of course, storable, but most farmers do not have the capacity to store all of their grain output. Livestock and livestock products, fruit, and vegetables deteriorate too rapidly for lengthy on-farm storage. Further, farmers are generally not able to operate at less than full capacity as are their nonfarm counterparts. A significant portion of the costs in farming are fixed and remain in the same magnitude regardless of the amount of product produced. At one extreme is land which is fixed absolutely and with few alternatives to farm uses. Even the quantity of buildings and machinery is highly fixed for an important number of years once investment has been made in them. As long as they will pay any returns above their salvage value in other uses, they continue to be employed in farming. In general, as long as prices are high enough to cover variable costs of fertilizer, fuel, electricity, seed, and feed and there are no government incentives for taking resources out of production, all resources are fully utilized and output is maintained. Farmers have no other choice. It is difficult to sell land when land prices are depressed as is typically the case when farm prices are depressed. And the opportunity cost of a farmer's labor is extremely low -- especially in rural areas. Even when a farmer does exit from farming, a neighboring farmer usually stands ready to resume operation of this farm and keep it in production.

Secondly, it may take some time for the farm operator to acquire the managerial, technical, and marketing skills to make needed enterprise adjustments or to specialize in one or two enterprises. They have fixed resources that must be disposed of because these resources have no or limited value in an alternative production activity. They must make entirely new contacts to obtain access to both input and output markets for an alternative agricultural enterprise. If several farmers in an area quit producing a commodity such as milk or potatoes, there may be severe impacts on those continuing to produce that commodity because the volume of production remaining may no longer support the local infrastructure or buyers serving that type of production. As this infrastructure leaves or as these buyers disappear, the entire local community along with its social, cultural, educational, and health services may be in jeopardy.

Third, crops and animals have a long gestation period so that changes in the product mix come about rather slowly.

Fourth, one cannot quickly increase farm produced inputs -- breeding stock, milk cows, orchards, feed, hay -- needed for new or expanded enterprises.

Fifth, during periods of low prices, farmers tend to incur huge debts. These debts must be erased before further indebtedness with which to expand the size of operation or to change product mix is possible.

Sixth, during periods of low prices, farmers do what is necessary to maintain incomes – work harder, save on fertilizer and pesticides, use lower quality seed, use home-grown feed instead of purchased feed, etc. This activity often delays if not prevents the types of adjustments that need to be made.

Seventh, there may not be land available with which to expand the operation even if the capital is available to acquire this added land.

Finally, if the farmer's choice is to get out of agriculture altogether or to augment family income with an off-farm job, alternative employment must be found. Retraining might be needed or the family might need to physically move to a new location. Both of these eventualities can take considerable time.

Agricultural Productivity

To set the stage for our discussion of adjustments in U.S. agriculture, it is useful to review in summary fashion the results of farmer adoption of technology in the U.S. over the years since 1950. Perhaps the best measure with which to do this is "total factor productivity" which is the ratio of the index of total farm output to the index of total farm inputs.[2] This measure is plotted in figure 1. As noted here, the changes over the past half century or so have been quite dramatic – increasing steadily from 41 in 1950 to over 103 in 2002.

Some of the more noteworthy productivity increases have been observed in corn and milk production. Average corn yields increased from 38 bushels per acre in 1950 to 130 bushels per acre in 2002. Average milk production per cow increased from 5,273 pounds per cow in 1950 to 18,554 pounds per cow in 2002. Rather large yield increases have also been observed in sorghum, wheat, rice, peanut, and cotton production. Only a few years ago many predicted that "biotechnology" would lead to a revolution in agriculture causing

[2]These indexes are unavailable for 2000-2002. I have estimated them for these years based on real cash receipts from farming and real total expenditures on farm inputs.

huge agricultural adjustment problems. It might well be said, however, that a technological revolution in agriculture is nothing new, nor are the adjustment problems associated with technological change.

Adjustments In Farm Numbers and Farm Size

Farm Numbers

Perhaps the most striking adjustment in the U.S. agricultural sector since 1950 has been the reduction in number of farms (figure 2). In 2002 there were just over two million farms – 38 percent of the number in 1950 and 32 percent of the peak number in 1935.[3] The vast majority of these farms are relatively small. Sixty percent have annual sales of less than $20,000 and 83 percent have annual sales of less than $100,000. Only 17 percent of the farms have annual sales of $100,000 or more, but these farms generate nearly 80 percent of aggregate farm output. While it is hazardous to compare farm numbers in given sales categories across years, it is interesting to note that in 1960, 91.4 percent of U.S. farms had annual sales of less than $20,000 and these farms produced nearly 50 percent of aggregate farm output.

Another way to examine the decline in farm numbers over the years is to look at the number of farms with selected enterprises in two extreme years of our time period as tabulated by the *Census of Agriculture*. These data for 1959 and 1997 are as follows:

Farms with:	1959	1997	% Decline
	- - - thousands - - -		
10 or more milk cows	1,310	94	92.8
Hogs and pigs	1,273	102	92.0
Layers and pullets	2,172	73	96.6
Corn	1,990	431	78.3
Wheat	740	244	67.0
Cotton	509	31	93.9
Tobacco	415	90	78.3

Farm Size

Another dramatic adjustment U.S. farmers have made over the years is in increasing farm size. Average farm size measured in acres has more than doubled over the 1950-2002 period. Measuring farm size in acres is somewhat misleading because of the differing intensities with which the various agricultural enterprises use the land resource. A clearer perspective on farm size growth can be gained by examining the change in real gross farm income per farm. Here again we see that average size of farms in the U.S. increased nearly three times over the 1950-2002 period (figure 2). There was a marked slowdown in both the rate of decrease of farm numbers and in the rate of increase in average farm size following 1975. This corresponds to a period when net farm income dropped significantly, land values and interest rates were high, and the substitution of machinery for other inputs was declining. All of these factors led to a decline in farmers' propensity to expand the size of their operations.

[3]The sharp decline between 1974 and 1975 is due in large part to the change in definition of a farm initiated by the 1974 *Census of Agriculture*.

One might well argue that the rapid increase in farm sizes is over. There is no doubt a limit on the size of farm one individual can operate and manage with given technology. I am unaware of any recent economies of scale studies suggesting what this limit might be. Nevertheless, the data seems to support a substantial slowdown in farm size since 1980.

Adjustments in Resource Use

Land use and enterprise mix

Land in farms has declined by about 20 percent from its peak of slightly more than 1.2 billion acres in the early 1950s (figure 3). A portion of this decline is clearly due to the redefinition of a farm in 1974. Other factors, however, include land bid away from agriculture by urban, industrial, highway, and airport uses. Considerable land once producing farm crops or supporting livestock enterprises is no longer in production because at current prices of farm commodities this land can no longer turn a profit in agricultural pursuits. This land is not near thriving urban centers, so it is not employed in nonagricultural uses either. It remains idle voluntarily.

The proportion of farm acreage planted to crops and harvested, on the other hand, has remained fairly stable over this period -- varying from 26 percent in the early 1960s to 35 percent at present. Most of this variability can be attributed to land retirement policies in effect from time to time aimed at reducing "surplus" agricultural production.

The proportion of acreage devoted to wheat and the major feed grains has changed very little since 1950. Oat acreage has declined because less of this commodity has been needed for animal feed as machine power has substituted for animal power. Cotton acreage declined slightly through the mid-1980s as the demand for cotton decreased, but has had a slight resurgence in recent years as consumers have shown a preference for cotton fiber over synthetic fibers. Soybean acreage increased significantly in the early years of the period as the demand for protein feed increased and soybeans became a more popular crop. Sugar acreage has increased only slightly. Tobacco acreage has decreased by over one-half. Peanut acreage has remained quite stable since 1950.

There have been changes in the proportion of total cash receipts derived from other enterprises, but they have been relatively minor and consistent with changes in consumer demand. Declines have been observed in dairy, eggs and hogs. Increases have been observed in fruits and vegetables and greenhouse and nursery products – particularly since the 1970s

Labor

Total employment in agriculture has declined by over 70 percent since 1950 (figure 4) consistent with the rapid decrease in farm numbers. The number of hired farm workers has declined by more than 60 percent since 1950. There has been substantial substitution of the relatively cheaper capital and machinery inputs for the relatively more expensive labor input. This has been a major force in the decline of hired farm workers. Further, the agricultural labor market is now much more mobile than it was during the 1950s and 1960s when for various reasons many farm workers were trapped in agriculture.

Interestingly, there was a noticeable upturn in hired farm workers during the boom period of the early 1970s. Hence farmers are now able to make short-term labor adjustments when conditions warrant in contrast to

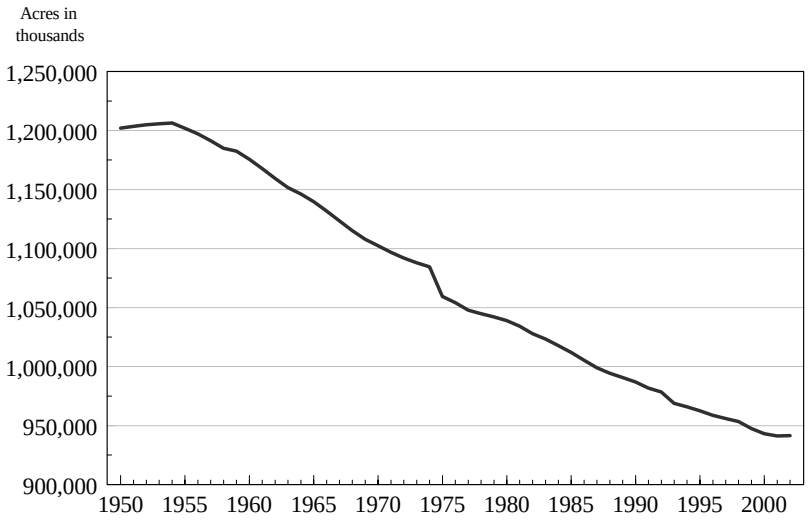

Figure 3. Land use in U.S. agriculture, 1950-2002.

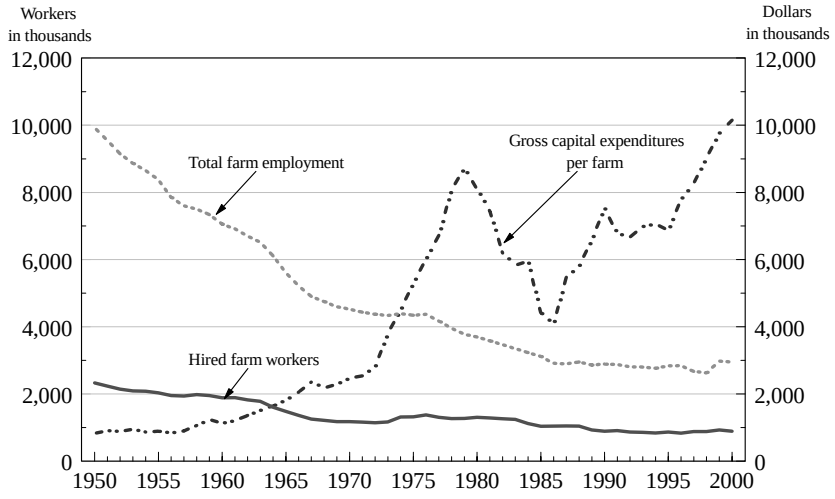

Figure 4. Farm employment and gross capital expenditures on agricultural land, machinery and equipment per farm in the U.S., 1950-2000.

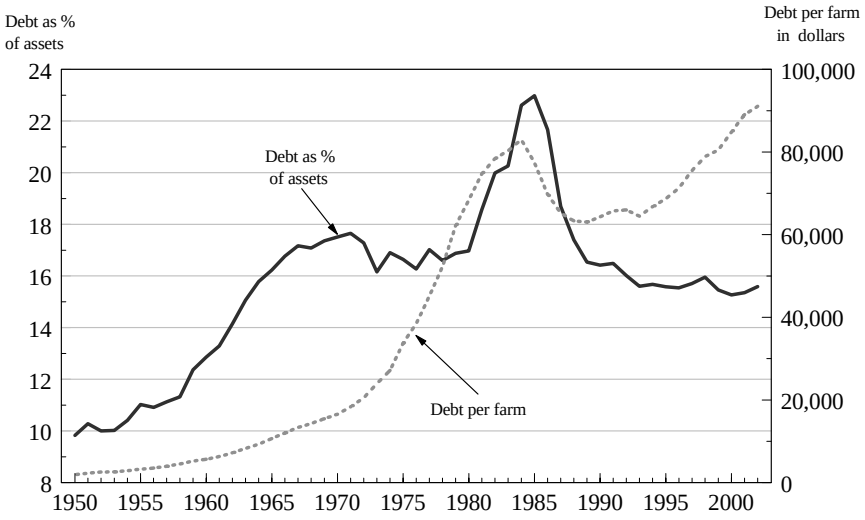

Figure 5. Farm debt as a percent of farm assets and farm debt per farm in the U.S., 1950-2002.

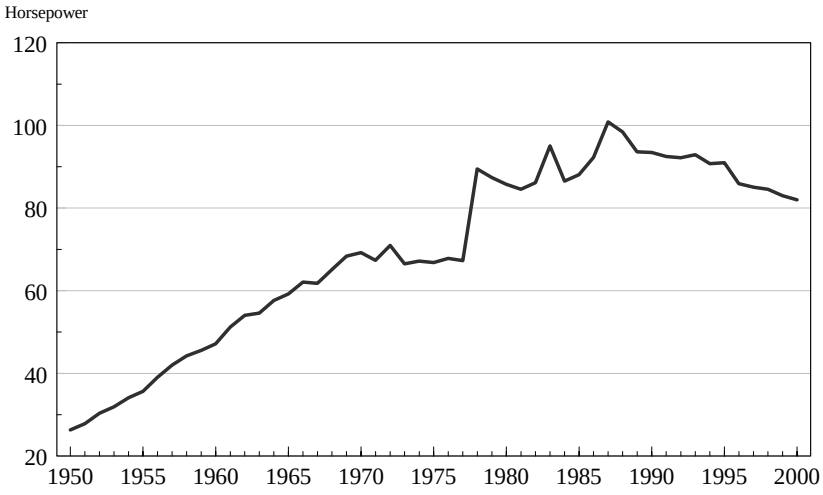

Figure 6. Tractor horsepower used per 100 acres planted in the U.S., 1950-2000.

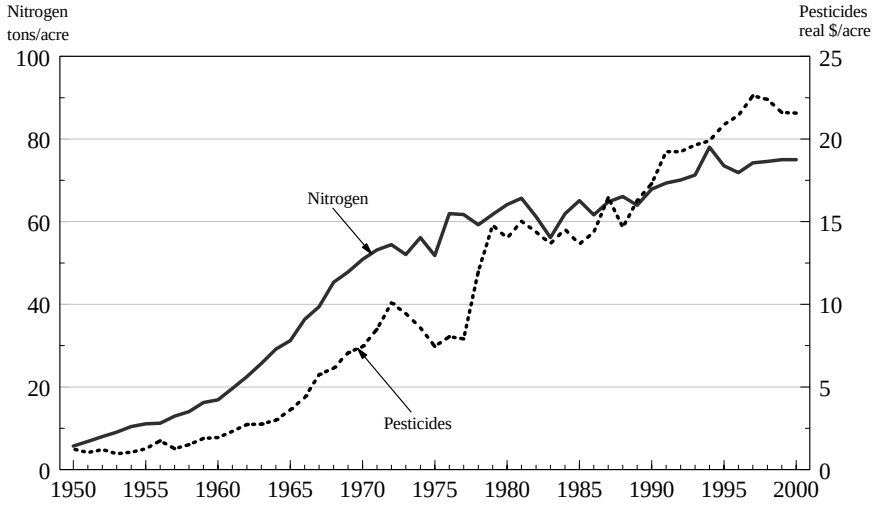

Figure 7. Nitrogen and pesticide use per acre planted in the U.S., 1950-2000.

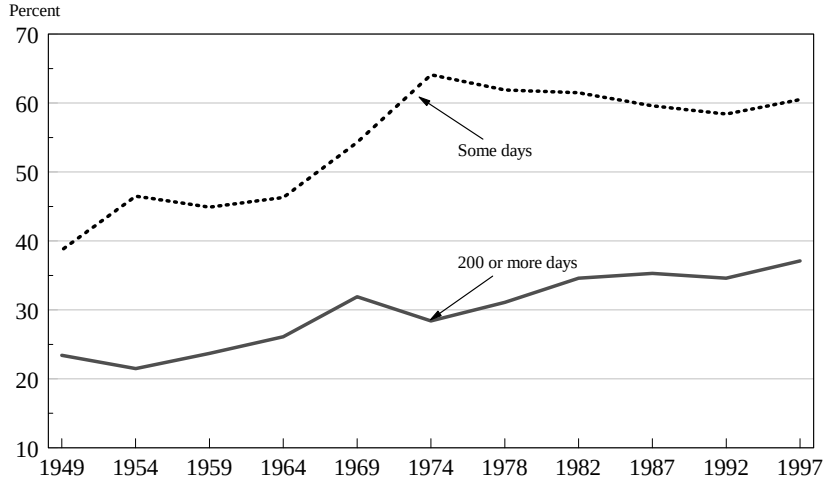

Figure 8. Percent of farm operators working off farm in the U.S., 1949-97.

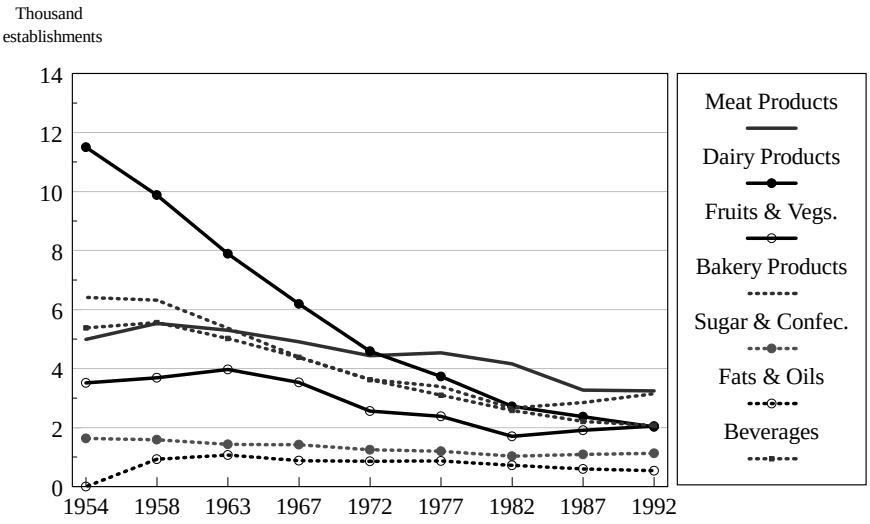

Figure 9. Number of establishments in U.S. food-processing, 1954-92.

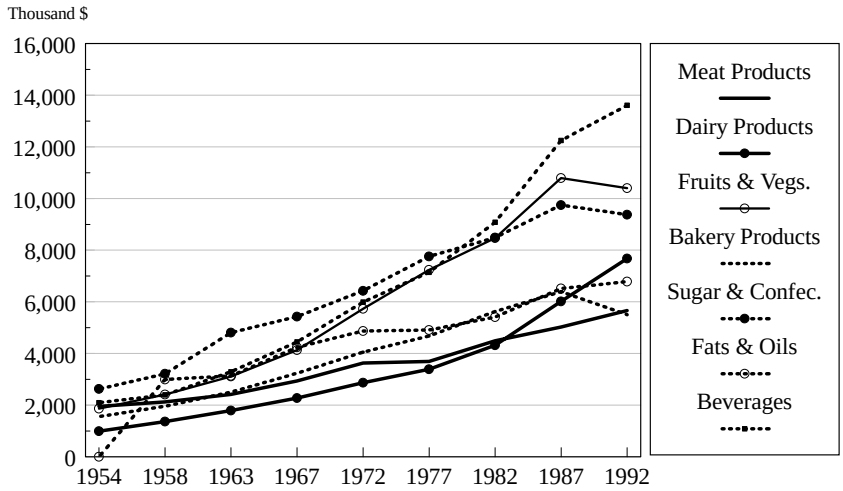

Figure 10. Real value added per establishment in U.S. food-processing, 1954-92.