Chapter 3.4

Productivity and Output Growth in U.S. Agriculture

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U.S. agricultural output grew at an average annual rate of 1.76 percent over 1948-2002. Input use actually declined in aggregate, so the positive growth in farm sector output was wholly due to productivity growth.

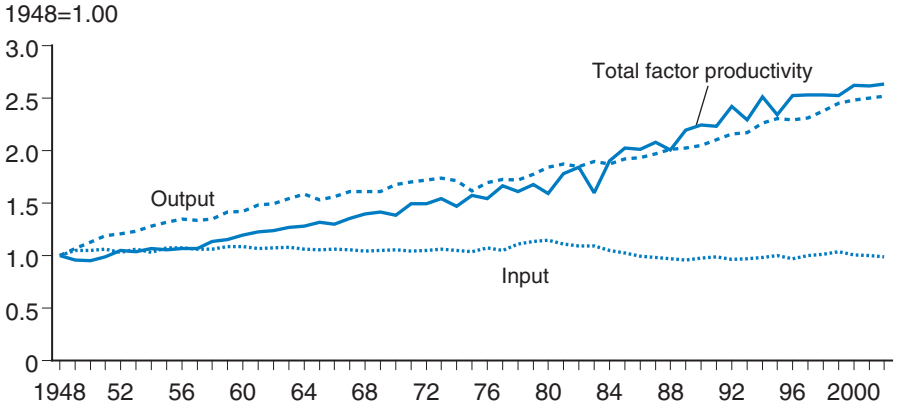
Introduction

U.S. agricultural output has more than doubled in the last 50 years, growing at an average rate of 1.76 percent per year (fig. 3.4.1). This rate is a remarkable achievement considering that labor has been departing the sector and land use has declined slightly, while capital influx has been modest. In spite of the growth in materials like fertilizer, fuel, and machinery, the net contribution of all inputs was slightly negative, leaving productivity growth as the sole source of output growth. While the contribution of other factors like labor, capital, and production inputs has risen or fallen with macroeconomic trends, one intangible input—productivity—has grown inexorably. But what is productivity?

Productivity is not equivalent to output (or production). Productivity reflects improvements in the ability to transform inputs into outputs. In the most literal sense, it is a residual measure of the contribution to output growth after all other factors have been accounted for. It is the nonphysical product of innovation, efficiency, management, research, weather, and luck. And its rate of growth seems to have slowed in recent years, coincident with a dropoff in public funding for agricultural research since the 1980s.

Figure 3.4.1

U.S. agricultural output, input, and total factor productivity, 1948-2002



Source: ERS-USDA, from information in the "Agricultural Productivity in the United States" data product.

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What Is Productivity Growth?

Productivity growth is a reflection of technological change and efficiency improvements, e.g., better management or economies of scale, which result in producing more output from a given level of input. Productivity growth is difficult to measure. Measuring productivity growth requires the careful accounting for all outputs and inputs and especially attempting to measure the improvements and actual flow of services from inputs, i.e., what is actually used. Once all inputs, including their technical improvements, are measured, what is not captured—the residual—is called productivity growth.

Patterns in Output and Productivity Growth

Output growth derives from growth in the use of inputs (capital, land, labor, materials) and total factor productivity growth. Input growth has been the main source of economic growth for the U.S. economy as a whole and for most sectors. Only in agriculture does productivity growth exceed input growth (table 3.4.1), over 1948-2002 and in 10 subperiods.

Labor

The singular importance of the role of productivity growth in agriculture is all the more remarkable given labor's long-term contraction. Over 1948-2002, labor input declined, on average, 2.4 percent each year, a rate unmatched by any nonfarm sector. The historic decline in farm labor—both farmers and farm laborers—occurred as workers sought higher wages and other income opportunities in the nonfarm sector. This rate of decline in labor appears to have slowed since the 1980s (fig. 3.4.2) as average household incomes in the farm and nonfarm sectors have converged (Hoppe) Farm households, like nonfarm households, now pursue multiple careers and diversify their earnings. In fact, the income available to the average farm household can support a standard of living equal to or above that of the average nonfarm household, reducing the desire to leave farming.

Capital

Capital input in agriculture exhibits a different pattern than labor. During 1973-79, U.S. agriculture experienced rapid growth, fueled by a growth in exports resulting from increased global liquidity, rising incomes, and production shortfalls in other parts of the world. U.S. farm exports surged from an average $4.8 billion in 1950-70 to $9.4 billion in 1972 and $17.7 billion in 1973. Exports continued to increase through 1981, when they peaked at $43.3 billion. In addition, domestic forces—including a drop in interest rates and rising inflation—contributed to an increase in borrowing for the purchase of land and equipment. For much of the 1970s, real interest rates were close to zero and at times negative, reducing the cost of capital. Capital input in agriculture increased 2 percent per year between 1973 and 1979, adding an average 0.33 percentage points per year to output growth (table 3.4.1).

Table 3.4.1

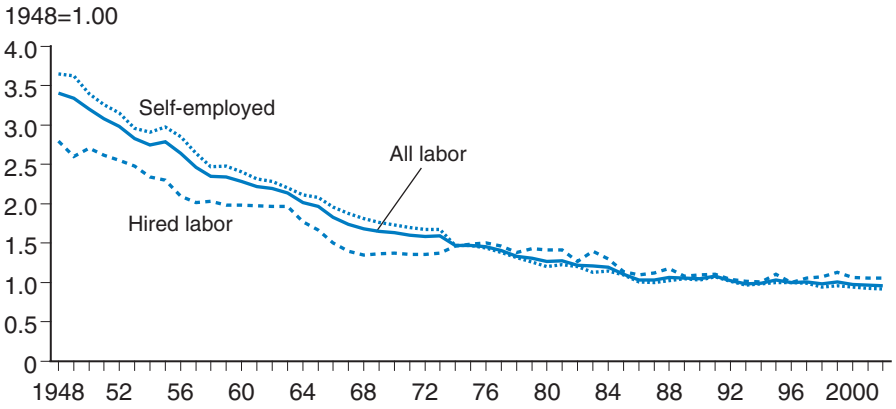
Source of growth for U.S. farm sector

Item	1948-2002	1948-1953	1953-1957	1951-1960	1960-1966	1966-1969	1969-1973	1973-1979	1979-1989	1989-1999	1999-2002
					Percent growth per year						
Output growth	1.76	1.76	0.89	4.44	1.06	2.26	2.51	2.53	1.00.	2.21	-0.40
Sources of output growth											
Labor	-0.62	-1.16	-1.05	-0.75	-1.10	-1.05	-0.28	-0.72	-0.41	-0.09	-0.44
Capital	0.01	0.69	0.15	0.07	0.11	0.35	0.17	0.33	-0.55	-0.23	-0.03
Land	-0.06	0.02	-0.11	-0.10	-0.05	-0.15	-0.22	0.00	-0.08	0.00	-0.06
Materials	0.64	1.54	1.10	1.50	0.69	0.30	0.64	1.50	-0.64	1.13	-1.26
Total factor productivity	1.79	0.65	0.81	3.73	1.40	2.81	2.221	1.40	2.69	1.41	1.38

Source: ERS-USDA from information in the data product, "Agricultural Productivity in the United States" on the ERS website.

Figure 3.4.2

The secular decline in agricultural labor has slowed down, 1948-2002



Source: ERS-USDA, from information in the "Agricultural Productivity in the United States" data product on the ERS website.

However, the economic environment changed in the early 1980s. A change to restrictive monetary policy by the Federal Reserve pushed interest rates up sharply. The dollar appreciated on foreign exchange markets, and world export prices fell. The average real interest cost on variable-rate debt rose to nearly 16 percent in 1981-83. Real interest rates remained high thereafter, as the stringency of Federal Reserve policy was heightened due to large fiscal deficits. This mix of fiscal stimulus and monetary restraint slowed the growth in export-dependent sectors of the economy, including agriculture. The value of U.S. farm exports fell from $43.3 billion in 1981 to $26.2 billion in 1986, as both volume and prices dropped. Growth in agricultural output slowed to about 1 percent per year during 1979-89, versus 2.5 percent over 1973-79 (table 3.4.1). Capital's contribution to output growth was negative during this period, averaging –0.55 percentage points per year.

Land and Material Inputs

Land's contribution to growth in agricultural output was negative for all recent time periods but 1948-53, 1973-79, and 1989-99. Over 1948-2002, the contribution of land to output growth was –0.06 percentage points per year. It seems ironic that the contribution of land to output growth would generally be negative in a land-based industry like agriculture. The explana-

How Is Productivity Measured?

The U.S. Department of Agriculture (USDA) has been monitoring agriculture's productivity performance for decades. In fact, USDA was the first Federal agency in 1960 to introduce multifactor productivity measurement into the Federal statistical program. Today, ERS routinely publishes total factor productivity (TFP) measures from production accounts that distinguish multiple outputs and inputs and adjusts for quality change in each input category. Its TFP model is based on the translog transformation frontier. It relates the growth of multiple outputs to the growth rates of capital, land, labor, and intermediate inputs, weighted by their shares in total costs. The changing demographic character of the agricultural workforce is used to build a quality-adjusted index of labor input. Similarly, much asset-specific detail underlies the measure of capital input. The contribution of feed and seed, chemicals, and energy are captured in the index of intermediate inputs. An important innovation is the use of hedonic price indexes in constructing measures of fertilizer and pesticide consumption. The result is a series of TFP indexes spanning 1948 to 2002.

ERS defines the farm sector as it is defined in the U.S. national income and product accounts. Production of goods and services that are secondary to agriculture is assigned to the primary producing industry. This enables certain secondary activities closely linked to agriculture for which information on production and input use cannot be separately observed to be included in the total factor productive activity of agriculture. Examples include the provision of machine services, contract feeding of livestock, recreational activities, and other activities involving the use of the land and the means of agricultural production.

tion lies in the vast availability of farmland in the United States. The positive growth in materials reflects the substitution of those inputs for land. Material inputs' contribution averaged 0.64 percent per year over 1948-2002. Still, this did not offset the negative contributions of labor and land, making the contribution of all inputs negative.

Parallels can be drawn between the 1973-79 and 1989-99 periods. Both were periods of rapid output growth, fueled largely by growth in demand for agricultural exports. And input growth accounted for a disproportionate share of output growth during both periods. Growth in intermediate inputs contributed more than 1 percentage point per year to output growth during 1989-99. The net contribution of input growth to output growth was 0.8 percentage point per year during 1989-99, versus 1.02 percentage points during 1973-79.

Productivity Growth

Since productivity grew 1.79 percent per year over the period of 1948-2002, farm sector productivity in 2002 was 263 percent above its 1948 level. As a consequence, and in the absence of input growth between 1948 and 2002,

productivity growth single-handedly caused farm output to grow 259 percent above its 1948 level.

Looking at productivity trends over the long term is appropriate. Productivity is largely the result of long-term investments in scientific research, so while agricultural productivity has risen and fallen year to year—typically driven by year-to-year fluctuation in output due to weather—it has generally trended upward. However, since 1996, productivity growth has slowed. Is this a change in trend? A key source of productivity growth—public investments in research—has been flat in real terms since the 1980s. (See Chapter 3.2, Agricultural Research and Development".) Only time will tell how this may affect future productivity growth.

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