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Agricultural Productivity Growth in the United States: Measurement, Trends, and Drivers

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What Is the Issue?

Since 1948, total U.S. agricultural output more than doubled. Over the same period, the U.S. population also more than doubled. The ability of the farm sector to feed far more people today while using less farmland than six decades ago is attributed to increases in agricultural productivity. However, slowing growth in U.S. crop yields during 1990-2000 has raised concerns about a possible productivity slowdown in the U.S. farm sector. Slower growth in productivity could affect food prices, food security, and the environment as farmers intensify use of land and chemicals to produce more output.

This study examines changes and trends in U.S. agricultural inputs (e.g., land and labor), output (e.g., crops and livestock), and productivity over the last six decades and the drivers behind productivity changes. In particular, it attempts to answer questions about a possible productivity slowdown and the ability of the U.S. farm sector to sustain productivity over the long term.

What Did the Study Find?

Between 1948 and 2011, U.S. agricultural output grew at 1.49 percent per year. With little growth in total input use (0.07 percent per year) during the period, the extraordinary performance of the U.S. farm sector was driven mainly by productivity growth, at an annual rate of 1.42 percent (as measured by total factor productivity (TFP)—output per unit of total inputs).

Changes in input use. Though total annual use of agricultural inputs changed little since 1948, the mix of inputs used shifted significantly, with increased use of intermediate inputs (e.g., fertilizer and pesticides) and decreased use of labor and land. Over time, the prices of farm machinery, energy, chemicals, and purchased service inputs (e.g., custom machine work) all fell relative to the price of farm labor. The declines were large—between 1948 and 2011, the relative price of agricultural chemicals fell by three-quarters while the relative prices of farm machinery, purchased services, and energy fell by about two-thirds. The drop in relative input prices encouraged farmers to substitute chemicals, purchased services, energy, and machinery use for labor.

Changes in output. The output mix for U.S. farms changed as well over the period, with crop production growing faster than livestock production. The share of farm production revenue

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attributed to crops increased from 52 to 56 percent between 1948 and 2011, while the share for livestock dropped from 47 to 39 percent and the share for other farm-related output increased from 1 to 5 percent. Relative prices among agricultural outputs also changed. Overall, the farm prices of fruits/nuts and vegetables/melons during the period rose relative to the prices of other crops. Prices of poultry and eggs grew much slower than prices of other livestock products. Shifts in consumers' diet preferences and uneven technical changes in production among agricultural commodities could be contributing factors behind those relative price changes.

Partial factor productivity versus total factor productivity. Partial factor productivity, such as crop yield (or land productivity) and labor productivity, measures average outputs per unit of a single factor. Over the study period, U.S. crop yields and labor productivity grew substantially. For example, soybean yields doubled, corn yields grew more than fourfold, and labor productivity increased by nearly 16 times from 1948 to 2011. However, an increase in a partial factor measure of productivity may not necessarily be caused by technical change but could be attributed to the increased use of other inputs. Total factor productivity measures the contribution from all inputs in production and can be a more informative measure in understanding changes in overall agricultural productivity. From 1948 to 2011, TFP grew by about 150 percent.

Is agricultural productivity slowing? Some studies suggest U.S. agricultural productivity has slowed by comparing decadal productivity growth rates. Yet, TFP estimates can fluctuate considerably from year to year, largely in response to weather events and other transitory factors. Using arbitrary dates (such as by decade) to break down the sample and make comparisons could give misleading information regarding a productivity slowdown. This study uses historical TFP time series data (1948-2011) to evaluate this issue. Analysis reveals an upward shift in TFP after 1985 and finds no statistical evidence of a productivity slowdown over the last six decades.

Changes in drivers of agricultural productivity. Investments in public and private agricultural research are the major factors driving technological change that leads to TFP growth. Public research and development (R&D) investments grew rapidly in real (inflation-adjusted) terms from 1948 to the early 1980s but grew much more slowly and variably since. In 2009, real public R&D investments began to decline, and by 2012, they were nearly 6 percent lower than in 1982. Private R&D investment, however, has been growing faster than public R&D investment. From 1982 to 2010, private agricultural input research grew by over one-third in real (inflation-adjusted) terms. While extension services can enhance the dissemination of new technology, extension full-time-equivalent staffs (FTE) declined by more than 20 percent between 1980 and 2010 nationally, with program diversity and different rates of decline across regions.

Future productivity growth scenarios. Based on model estimates with alternative public R&D investment assumptions, future TFP growth is not expected to be affected much by the decline in public R&D investment in the short term (within 10 years). However, in the long term, TFP growth may slow at a greater rate. For example, from 2010 to 2050, if annual public research expenditures remain unchanged in nominal (unadjusted for inflation) terms, the annual rate of TFP growth is expected to fall from the historical average of 1.42 percent to 0.86 percent in 2050. Furthermore, it will become increasingly difficult for TFP to catch up even if public R&D investments increase again because there is typically a long lag between a research investment and the resulting TFP growth.

How Was the Study Conducted?

This study draws mainly from ERS's agricultural productivity accounts, which provide data on TFP and estimates of input use and output in the U.S. farm sector during 1948-2011. The study also uses data from several other sources, including USDA's National Agricultural Statistics Service and National Institute of Food and Agriculture, the U.S. Bureau of Economic Analysis, and the U.S. Bureau of Labor Statistics. Productivity slowdown tests were conducted using time series data and techniques that enable one to detect structural breaks.