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Trends in U.S. Agriculture's Consumption and Production of Energy: Renewable Power, Shale Energy, and Cellulosic Biomass

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What Is the Issue?

Since the early 2000s, energy policy and market conditions have affected the agriculture sector as both a consumer and producer of energy. Farms consume energy directly in the form of gasoline, diesel, electricity, and natural gas, and indirectly in energy-intensive inputs such as fertilizer and pesticides. In addition, some farms produce renewable energy or lease out land for wind turbine, oil, or gas development.

In 2005, the Renewable Fuel Standard (RFS) was enacted, requiring transportation fuel sold in the United States to contain a minimum volume of biofuels, directly impacting agriculture as a producer of biofuel feedstocks. Technological advances in hydraulic fracturing and horizontal drilling have made the extraction of natural gas and oil from shale plays economically feasible, contributing to a decline in U.S. natural gas and oil prices. Farms in drilling regions benefit from lease and royalty payments, but they also experience environmental costs and strained infrastructure. In August 2015, the Environmental Protection Agency finalized the Clean Power Plan (CPP) to reduce carbon emissions from the power sector (although the Supreme Court issued a stay on implementation of the regulation in February 2016). The CPP's emission reductions are expected to be achieved by shifting from coal toward natural gas and renewables, with implications for energy production and consumption in agriculture.

In this report, the authors analyze consumption and production of energy across farms, as well as how changes in the energy sector affect the agricultural sector. The report focuses mainly on impacts on farm businesses, defined as farms where the primary operator spends the majority of time on agricultural production, or, when the operator is largely employed off-farm, where the farm operation has over \$350,000 in annual gross-cash income.

What Did the Study Find?

Although farm businesses account for only 41 percent of all U.S. farms, they account for 93 percent of the value of agricultural production and 90 percent of fuel and electricity consumption.

- Energy consumption by farm businesses varies significantly by principal commodity. In 2014, fuel and electricity constituted 12-16 percent of total cash expenses for rice, cotton, peanut, and poultry producers compared with 7-10 percent for other crop and livestock producers. In addition, the share of indirect energy expenses, in the form of fertilizers and pesticides, ranged from 16-36 percent of total cash expenses for crop producers.

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- Farmers' energy consumption also varies by tillage practice. Tillage reduced through conservation or no tillage is associated with lower fuel but greater fertilizer and pesticide expenditures for corn and wheat producers. In contrast, reduced tillage is associated with greater fuel but lower fertilizer expenditures for cotton producers.

Changes in energy markets and regulations are affecting agriculture in different ways. Farmers have become energy suppliers by growing biomass and installing renewable energy systems and by leasing land to energy companies. Changing energy prices thus affect farmers' input costs, as well as revenue from supplying energy products.

- Over 57,000 farm businesses and other farms (2.7 percent of U.S. farms) were engaged in producing renewable energy such as solar, wind, and geothermal in 2012, more than twice as many as in 2007. In 2012, another 10,000 farm businesses and other farms leased their wind rights to others.
- A small but growing number of farms (nearly 12,000, or 0.5 percent of farms in 2012) is harvesting cellulosic biomass to help meet the Renewable Fuel Standard volume mandates for cellulosic biofuel.
- In 2012, 35 percent of active farm and ranch land was in counties overlaying a shale play (shale counties). In 2014, about 6 percent of U.S. farm businesses averaged \$56,000 in lease and royalty payments from energy production.
- Acreage in USDA's Conservation Reserve Program declined by about 32 percent in shale counties, on average, from 2006 to 2013, compared with a 22-percent decline in non-shale counties.
- The shale revolution has resulted in declining natural gas and oil prices, which benefit farms with the greatest diesel, gasoline, and natural gas shares of total expenses, such as rice, cotton, and wheat farms. However, domestic fertilizer prices have not substantially fallen despite the large decrease in the U.S. natural gas price (natural gas accounts for about 75-85 percent of fertilizer production costs). This is due to the relatively high cost of shipping natural gas, which has resulted in regionalized natural gas markets, as compared with the more globalized fertilizer market.
- The CPP may result in greater electricity rate increases for agricultural and other rural customers than for the average retail customer, due to rural electric cooperatives' greater share of electricity generation from coal. However, direct-use electricity expenses of farm businesses represent only about 1-6 percent of total production expenses, suggesting relatively small impacts of the CPP for most farm businesses.

How Was the Study Conducted?

This study uses the most recent USDA data sources on agricultural energy consumption, production, and energy-related lease and royalty income from the 2012 Census of Agriculture, the 2013 Farm and Ranch Irrigation Survey, the 2013 Agricultural Resource Management Survey, and the 2014 Tenure, Ownership, and Transition of Agricultural Land Survey. The report also updates and expands on a previous ERS report by Beckman et al. (2013) that presented information through 2010-11. Beckman's report focused on how expanding biofuel policies increased the demand for agricultural products such as renewable fuel feedstocks, as well as on how farmers adjusted production in response to high energy prices. The current report limits the discussion on biofuels to the cellulosic feedstock volume mandate of the RFS. The authors update and expand Beckman's overview of energy consumption by distinguishing between the different forms of consumption (electricity, natural gas, and diesel, among others) to investigate the impact of the shale energy revolution and the CPP. Finally, the current report provides updated numbers on renewable energy production on farms and discusses new trends in the energy sector, such as industrial energy generation through oil and gas drilling and farmers' leasing of wind rights.