

ESTABLISHING A BASELINE FOR MEASURING AGRICULTURAL CHANGES RELATED TO MARCELLUS SHALE DEVELOPMENT

The Marcellus Impacts Project Report #9



Executive Summary

Agricultural production accounts for a substantial portion of Pennsylvania's economy. The primary objective of this research was to establish a baseline for investigating the direct and indirect effects of Marcellus Shale natural gas development on the economic, social, and environmental dimensions of Pennsylvania agriculture. Direct effects may include lease and royalty incomes paid to farmers; changes in farmland use, groundwater, and other resources; and changes in demand for agricultural production. Indirect effects on farmers may include availability of farm labor, effects on water and soil quality, and road accessibility. Agribusinesses may also be affected in the form of higher revenues from increased sales to the gas industry and to some farmers with newly found lease and royalty incomes, shifts to providing services and products that they did not previously provide, and competition with gas companies for workers.

In this research, changes in agriculture that had occurred before high activity in the Marcellus Shale region began are documented using secondary data. High drilling activity did not take off until 2009, although some farmers may have been receiving lease payments prior to 2009 (see Table 1. "Top 10 Pennsylvania Counties in Number of Wells Drilled Annually, 2005-2012"). It is important to note that most reliable and comprehensive agricultural data are gathered every 5 years through the U.S. Department of Agriculture's (USDA) Census of Agriculture. The most recent data available during the research were from 2007, 2 years before gas drilling activity expanded dramatically in Pennsylvania. With the exception of the milk cow analysis, which uses annual survey data from the National Agricultural Statistics Services (NASS), all data contained in this report are from the 2007 Census. To reduce repetitiveness, in-text citations are not included for 2007 Census data. Until the 2012 Census of Agriculture is released, data are not yet available for many indicators. Therefore, the main purpose of this research was to provide a baseline for exploring future impacts. Data are also offered from two focus groups, with farmers and people with professions related to agriculture, who provided insights that will guide analysis when the 2012 Census of Agriculture data become available. Key findings are listed below.

Secondary Data Findings:

- **Changes in Number of Farming Operations (1997-2002, 2002-2007):** Between 2002 and 2007 there was a notable increase in the number of farms in Pennsylvania and the northern tier region; however, farms declined in both Bradford and Lycoming counties. During the same time period, there was an increase in number of farms in the southwest and Washington County lost almost one fifth of its farms.
- **Changes in Average Acreage per Operation (2002-2007):** The average size of farms decreased throughout the state, study counties, and region between 2002 and 2007. Compared to the state, the change in the size of farms in the northern tier significantly decreased, which is likely connected to the volatility in milk prices and general trends in consolidation. Changes in farm

size in the southwest showed a trend toward smaller farms during the period of initial Marcellus Shale development. Greene had the greatest change in average acreage per operation in the southwest region.

- **Changes in Number of Milk Cows (2001-2013):** There was a slight decline in the number of dairy cows statewide. The most striking change in the number of milk cows appeared to be in Bradford County, which decreased from 24,900 in 2009 to 19,600 in 2010. During this time of decline, milk prices were very low and the number of wells drilled in the county increased from 159 to 377. Changes in dairy cow inventory showed a rise in 2010, but then declined slightly afterward. In 2008, while No Shale and Marcellus 2nd Tier Counties experienced slight increases in dairy cows from the prior year, High Drilling and Urban in MS Region Counties experienced decreases of about 15 percent.

Focus Group Findings:

- **Economic Impacts:** Negative impacts included shortages in some farm inputs (e.g., lime) and difficulty of retaining farm labor due to Marcellus development. Positive economic impacts included the ability of farmers to use lease and royalty income to either exit farming or to reinvest in their operations. Intergenerational exchange of property was discussed—higher land values lead to higher tax liabilities for transferring the land to a younger family member, which may price some young farmers out of the market.
- **Attitudes toward Gas Industry:** Mistrust and negative attitudes towards gas drilling firms were expressed. With the exception of one participant who was very much a proponent of the gas industry, even participants who were generally supportive of the Marcellus Shale development assumed that the gas industry was seeking to profit from the venture and that there was little concern for individual residents or for the public good.
- **Environment:** Although the focus of this project was not on environmental impacts, participants expressed concerns, such as lack of monitoring and company accountability, and uncertainty about the environmental impacts without prompting. Northern tier participants also expressed concern about retribution from drilling companies if they complain.
- **Uncertainty:** Participants in both regions expressed uncertainty about the future of drilling in their regions and the impacts of drilling on their regions. Some of the uncertainty was related to a lack of confidence in local, state, and federal governments to look out for economic and environmental impacts.
- **Quality of Life:** Participants in both groups offered conflicting perspectives on the effects of drilling activities on the quality of life.

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This project was sponsored by a grant from the Center for Rural Pennsylvania, a legislative agency of the Pennsylvania General Assembly.

The Center for Rural Pennsylvania is a bipartisan, bicameral legislative agency that serves as a resource for rural policy within the Pennsylvania General Assembly. It was created in 1987 under Act 16, the Rural Revitalization Act, to promote and sustain the vitality of Pennsylvania's rural and small communities.

Information contained in this report does not necessarily reflect the views of individual board members or the Center for Rural Pennsylvania. For more information, contact the Center for Rural Pennsylvania, 625 Forster St., Room 902, Harrisburg, PA 17120, telephone (717) 787-9555, email: info@rural.palegislature.us, www.rural.palegislature.us.

About This Project:

The Marcellus Shale Impacts Project chronicles the effects of shale-based energy development in Pennsylvania by focusing on the experiences of four counties with significant extraction and production activity – Bradford, Lycoming, Greene, and Washington counties. The project examines social and economic changes in these counties within the context of regional and statewide trends. A series of nine reports describes the research results as follows: (1) population, (2) health, (3) education, (4) youth, (5) housing, (6) crime, (7) local government, (8) local economy, and (9) agriculture.

Study Counties

Bradford, Lycoming, Greene, and Washington counties are studied in this project. They have experienced some of the highest levels of Marcellus Shale development in Pennsylvania, yet they have diverse populations, histories, economic bases, and geographic locations. These differences allow comparisons that facilitate understanding of the potential effects of Marcellus Shale development across the commonwealth and by region. The regional comparisons are defined based on adjacency to the four study counties. The northern tier contains 12 counties: Bradford, Lycoming, and the 10 neighboring counties of Clinton, Columbia, Montour, Northumberland, Potter, Sullivan, Susquehanna, Tioga, Union, and Wyoming. The southwest region consists of six counties: Greene, Washington, and the four neighboring counties of Allegheny, Beaver, Fayette, and Westmoreland.

All four study counties are classified as rural by the Center for Rural Pennsylvania with population densities of less than 284 people per square mile.

Table 1 offers an overview of selected characteristics from 2000 for the four study counties as well as counties in the surrounding region and the state. These data provide important context for understanding differences between the counties and regions prior to Marcellus Shale development. As Table 1 shows how the counties and regions differ across indicators. In the northern tier, Lycoming's population was nearly twice that of Bradford's, and Lycoming County had a slightly higher unemployment rate than Bradford County. The percentage employed in mining was very small in 2000 in both northern tier counties, although a larger percentage of people were employed in the industry in Bradford (0.6 percent) than in Lycoming (just 0.1 percent). The two counties had comparable median household incomes.

In the southwest, the differences between Greene and Washington are more pronounced. Greene had the smallest population of the four counties (40,672) and 6.7 percent of employed individuals in the county were working in mining. The unemployment rate (9.2 percent) was more than 3 points above the state's average (5.7 percent), and the median household income (\$41,972) was well below average for the region (\$52,004) and the state (\$55,460). In contrast, the median household income in Washington County was just over \$10,000 higher than in Greene. Only 1.3 percent of the employed work in mining and the unemployment rate was notably lower (5.3 percent).

The two counties of the southwest had more diversified economies than counties of the northern tier. In Bradford and Lycoming, the same three industries (Manufacturing, Health Care and Social Assistance, and Retail Trade) employed around half the population (52.4 percent and 47.4 percent, respectively (Census 2000). In contrast, just over one-third of the working population in Greene County worked in the same three industries (Health Care and Social Assistance, Retail Trade, and Educational Services). Washington's top three industries (Manufacturing, Health Care and Social Assistance, Retail Trade, and Manufacturing) employed 41.7 percent of the working population.

Table 1. Pre-Marcellus characteristics of study counties in 2000

	Population	People per square mile	% employed in Mining	% Unemployed	Median Household Income (adjusted for inflation to 2012 values)
Northern Tier*	47,968	83	0.6%	6.0%	\$47,071
Bradford	62,761	55	0.6%	5.5%	\$48,451
Lycoming	120,044	97	0.1%	6.3%	\$47,038
Southwest*	370,881	505	1.8%	6.6%	\$47,901
Greene	40,672	71	6.7%	9.2%	\$41,972
Washington	202,897	237	1.3%	5.3%	\$52,004
Pennsylvania	12,281,054	274	0.3%	5.7%	\$55,460

The northern tier region contains 12 counties: Bradford, Lycoming, and the 10 neighboring counties of Clinton, Columbia, Montour, Northumberland, Potter, Sullivan, Susquehanna, Tioga, Union, and Wyoming. The southwest region consists of six counties: Greene, Washington, and the four neighboring counties of Allegheny, Beaver, Fayette, and Westmoreland. Source: Social Explorer Tables (SE), Census 2000, U.S. Census Bureau and Social Explorer. * County average includes study counties.

Marcellus Shale Activity

Table 2 shows the number of unconventional wells drilled in the Marcellus Shale each year in the six Pennsylvania counties with the highest total number of wells drilled between 2005 and mid-year 2013 (Pennsylvania Department of Environmental Protection).

Table 2. Six counties with the most wells drilled and wells drilled each year, 2005-2013*

county name	2005	2006	2007	2008	2009	2010	2011	2012	2013* mid- year	Total, by county
Bradford⁺	1	2	2	24	158	373	396	164	66	1186
Washington⁺	5	19	45	66	101	166	155	195	120	872
Tioga	0	1	0	15	124	273	272	122	13	820
Lycoming⁺	0	0	5	12	23	119	301	202	89	751
Susquehanna	0	1	2	33	88	125	205	191	102	747
Greene⁺	0	2	14	67	101	103	121	105	54	567
Total wells drilled in top six counties:										4943

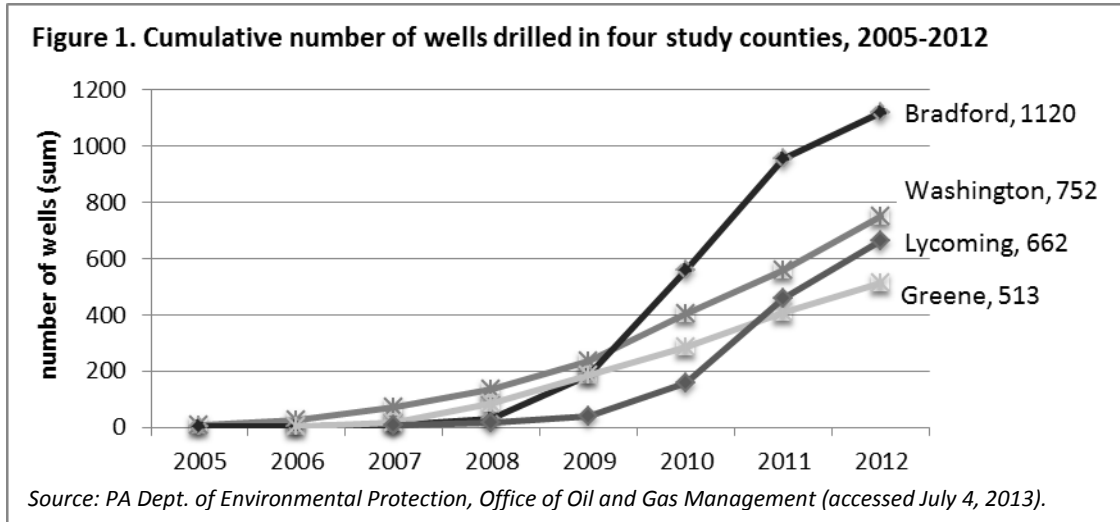
Source: Pennsylvania Department of Environmental Protection, Office of Oil and Gas Management.

*Data through June 30, 2013 (accessed July 4, 2013); ⁺Study counties.

The four study counties have experienced significant Marcellus Shale well drilling and account for half (3,376) of the 6,833 unconventional wells drilled in the commonwealth. The two counties located in the southwest, Washington and Greene, experienced more well development through 2008 than the other

counties. Bradford County experienced significant growth starting in 2009. Despite the late start, Bradford County quickly surpassed all other Pennsylvania counties with nearly 400 new wells drilled in 2011, for a total of 1,186 by June 30, 2013. Lycoming similarly experienced more new drilling activity in 2011 than occurred in the southwest and had the highest number of new wells drilled in 2012.

Figure 1 shows the cumulative number of wells drilled from 2005 to 2012 in each of the study counties. Although some wells may no longer be in production by 2012, and some have not yet been put into production, the lines reveal overall trends in the counties and across regions. The northern tier counties (Bradford and Lycoming) had steeper increases in the past 3 years, whereas those in the southwest (Washington and Greene) had more gradual but steady increases in the number of wells drilled.

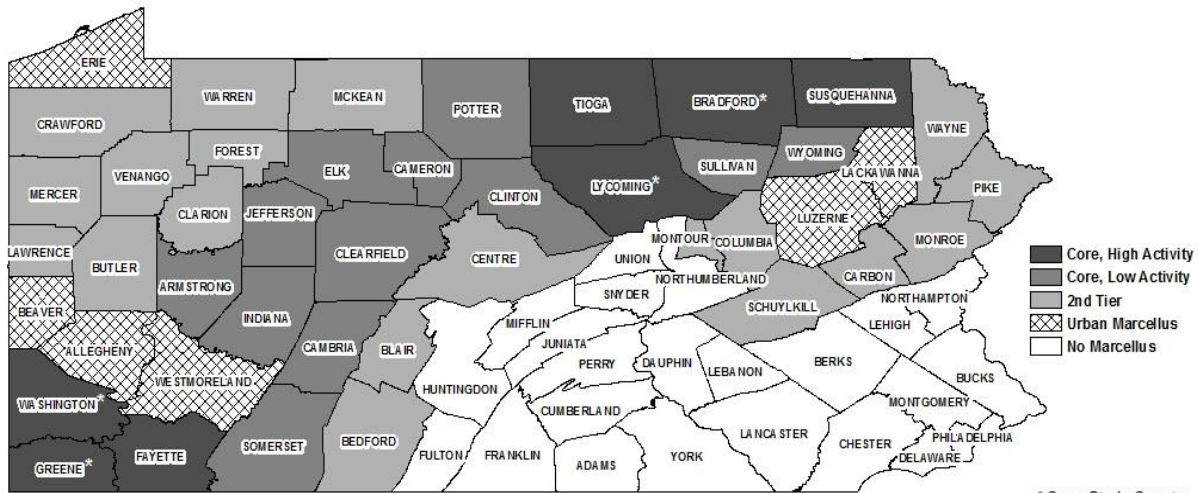


In 2012, the pace of new drilling slowed in Bradford and Lycoming, likely due to the declining price of natural gas. In contrast, drilling in Greene and Washington counties in 2012 was on par with the previous year. This may be because gas in southwestern Pennsylvania tends to be “wet” gas, meaning it contains more marketable compounds (liquid natural gases such as butane and propane) that can generate higher revenues than “dry” natural gas (i.e. methane) alone. Even so, mid-year figures suggest that new drilling activity across all four counties in 2013 may be comparable to 2012. A table listing well counts for all counties in Pennsylvania is in Appendix A.

Classifying Counties by Marcellus Shale Activity

To further understand the effects of Marcellus Shale activity, the analyses compared counties based on their level of Marcellus Shale activity using a five-category county typology. The typology was created by combining several definitions based on estimated shale value and actual development activity, including publicly available maps of the thickness, depth, and thermal maturity of the shale (McLaughlin et al., 2012). This typology also differentiates urban counties because the population and economic dynamics in these counties are fundamentally different from that of rural counties.

Figure 2. Marcellus Shale Typology



* Case Study County
 Typology based on the number of unconventional wells drilled through September 2012

In Pennsylvania, the number of wells is highly concentrated in a small number of counties. There are 7 counties (including the four study counties) that account for 90 percent of the total number of wells drilled through June 30, 2013. These 7 counties are classified as “core” counties with high drilling activity, and are shaded with the darkest gray in Figure 2. The other four typology categories are: “core” counties with low drilling activity, 2nd tier counties (with lower quality shale and limited drilling activity), urban counties with potential or some Marcellus Shale development, and those counties with no Marcellus Shale. For a full description of the typology, see Appendix B.

Data Sources and Methods

Data from the U.S. Department of Agriculture’s (USDA) National Agricultural Statistics Service (NASS) Census of Agriculture, which are collected every 5 years, were used to examine changes in the number of farm operations, the average size of these operations, and the agricultural profile of the four study counties. The research also used data from NASS’s Annual Program for Crop and Livestock Production, which include changes in the number of milk cows.

Given the limitations of county-level data, two focus groups were conducted in April 2013 with farmers, agribusiness representatives, and representatives from agricultural agencies and organizations. One was held in the northern tier and the other in the southwest. There were five participants in the northern tier focus group and nine in the southwest. A range of perspectives was sought by consulting with Penn State Extension and land-use organizations to gather names of potential participants who were invited to participate. Focus group participants were asked a range of questions, including what changes, if any, had occurred in their county related to natural gas development, including farm practices and land use, as well as their outlook for the future. The focus group discussions were recorded and transcribed. The data provided contextual information and in-depth accounts into the experiences of members of the agricultural sector.

What is the US Census of Agriculture?

The first Census of Agriculture was conducted in 1840 by the Census Bureau, Department of Commerce and in 1997 the responsibility was given to the National Agricultural Statistics Service (NASS), USDA. According to USDA, “The [Census of Agriculture](#) is conducted every 5 years and, by definition, is a complete accounting of the crops and livestock produced on all farms and ranches for the Census year and the inventories of livestock on all farms. The Census also collects information concerning operator characteristics, demographics, and income and expenses...The Census information includes data for most commodities produced on U.S. farms and is published by state and county. The data are also summarized by operator/farm characteristics (operator age, etc., and acres in farm, etc.), to the county level” (USDA).

NASS Survey

In addition to conducting the Census of Agriculture each year, NASS conducts annual surveys on specific topics and issues. These surveys are informative, but depending on the topic, are not consistent from year to year and do not cover every county in the nation like the Census of Agriculture. NASS survey data were used for this research to document trends in the number of milk cows.

Statewide Agricultural Profile

To understand how Marcellus Shale development is affecting agriculture, it is important to grasp the features of agriculture in the region and its trends. Therefore, it is appropriate to begin with a brief overview that characterizes the sector at regional, state, and county levels.

Measured by value of sales by commodity group, Pennsylvania nationally ranks fifth in milk and other dairy products from cows; fourth in nursery, greenhouse, floriculture, and sod; fifth in cut Christmas trees and short rotation woody crops; sixth in horses, ponies, mules, burros, and donkeys; and eighth in tobacco. The total value of agricultural products sold in 2007 in Pennsylvania was about \$5.81 billion, ranking the state first in the Northeast and mid-Atlantic regions, and 20th in the nation. There were 63,163 farms in the state in 2007, which represented a 9 percent increase from 2002. The sudden increase may be attributed to an effort by NASS to include farms with the lowest value of sales in the Census. According to NASS:

“The 2007 Census of Agriculture produced a greater number of farms in the lowest value of sales categories. The extensive list building efforts and the augmentation of the area frame sample allowed NASS to capture more of the small farms with less than \$10,000 in value of agricultural sales. Additionally, 2007 was a year of relatively high commodity prices. As the value of farm commodities increased, more very small operations are able to meet the \$1,000 value of sales threshold to qualify as a farm in the census.” (2013)

While the number of farms increased, the average size of a farm decreased from 133 acres in 2002 to 124 acres in 2007. Only 10,655 farms have total sales over \$100,000, and 21,425 have a value of sales under \$1,000. Milk and other dairy products account for the greatest proportion of the state’s value of sales, followed by poultry and eggs. The average age of a principal operator in the state is 55.2, and about 86 percent are male and 14 percent are female.

Other studies have documented some agricultural impacts from Marcellus Shale activities. In a qualitative study, Malin (2013) found that farmers discuss natural gas developments as inevitable and that they have no real choice but to accept them. She further argues that the economic reasoning in

support of the development is so powerful that farmers feel a lack of agency and lack the capacity to articulate an alternative.

Using NASS data on the number of dairy cows, Adams and Kelsey (2012) found that intensity of gas drilling and decline in dairy cow numbers seem to be associated. However, they caution that the data did not allow them to do more than speculate on the nature or direction of that association. Finkel et al. (2013: 189) conducted a similar study and found that, “Milk production and milk cows decreased in most counties since 1996, with larger decreases occurring from 2007 through 2011 (when unconventional drilling increased substantially) in five counties with the most wells drilled compared to six adjacent counties with fewer than 100 wells drilled.” Like Adams and Kelsey (2012), the authors cautioned that these are findings from a descriptive study that has not established causation.

The Center for Dairy Excellence conducted a survey of dairy farmers in the northern tier (Bradford, Lycoming, Potter, Sullivan, Susquehanna, Tioga and Wayne counties) and southwest (Armstrong, Cambria, Clearfield, Fayette, Indiana, Jefferson, Somerset, Washington, and Westmoreland counties) in the summer of 2011. The results indicate that, in the northern tier, 60.0 percent of dairy farmers intended to leave their herd sizes unchanged, 6.5 percent planned to reduce their herd size, 14.8 percent planned to increase their herd size, and 18.7 percent were uncertain. In the southwest, 65.7 percent intended to leave their herd sizes unchanged, 4.6 percent planned to reduce their herd sizes, 24.1 percent planned to increase their herd sizes, and 5.6 percent remained uncertain (Frey 2011). Unlike the Adams and Kelsey (2012) and the Finkel et al. (2013) studies, the Center for Dairy Excellence data were not analyzed to control for intensity of drilling activity in counties where farmers are located. However, the authors did include a variable measuring whether farmers received natural gas lease or royalty fees. In the northern tier, 62.9 percent of farmers receiving gas revenue would be more likely to modernize their dairy operation, 36.8 percent would be less likely to invest in dairy operation, and 48.1 percent would consider investing in alternative forms of agriculture. In the southwest, 50.6 percent of farmers receiving gas revenue would be more likely to modernize their dairy operation, 31.0 percent would be less likely to invest in dairy operation, and 58.8 percent would consider investing in alternative forms of agriculture (Frey 2011). These findings suggest that dairy farming could move in different directions as a result of the influx of gas drilling revenues.

County Agricultural Profiles

The contribution to the value of the state’s agricultural products sold varies among the four study counties. Bradford ranks 10th, Lycoming ranks 31st, Washington ranks 44th, and Greene ranks 58th out of the 67 counties in Pennsylvania (Adams and Kelsey, 2012). Figure 4 indicates that the four counties have a similar composition of agricultural land use with high proportions of cropland and woodland. Pasture land is more common in the study counties located in the southwest than in the northern tier. In the southwestern counties, pasture accounts for about one fifth of farmland, while in Bradford and Lycoming counties it makes up only 6 and 10 percent of farmland, respectively. Dairy is the most prevalent commodity in three of the study counties: Bradford, Lycoming, and Washington. Bradford has by far the highest annual sales from dairy at \$66.4 million. The other three counties each have less than \$10 million. Greene’s primary commodity, in terms of values of sales by commodity group, is cattle and calves, but still has fewer cattle and calves than the other study counties. Forage is the top crop item in all four counties (Figure 3). Lycoming has the least forage acreage, but it is the leading county for acreage in corn for grain and silage.

Figure 3. Forage, Corn for Grain, and Corn for Silage in Acres

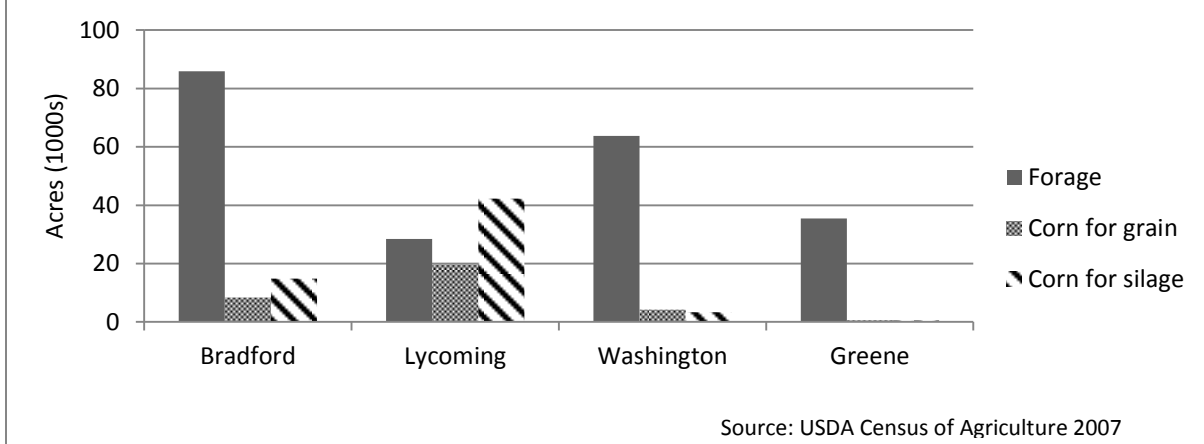
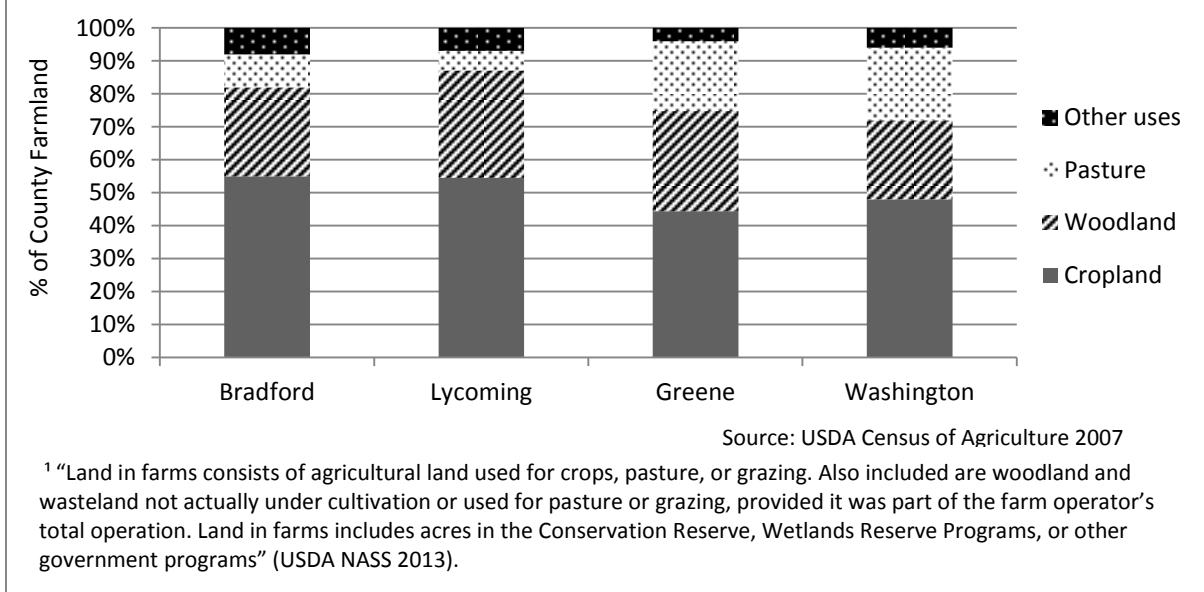
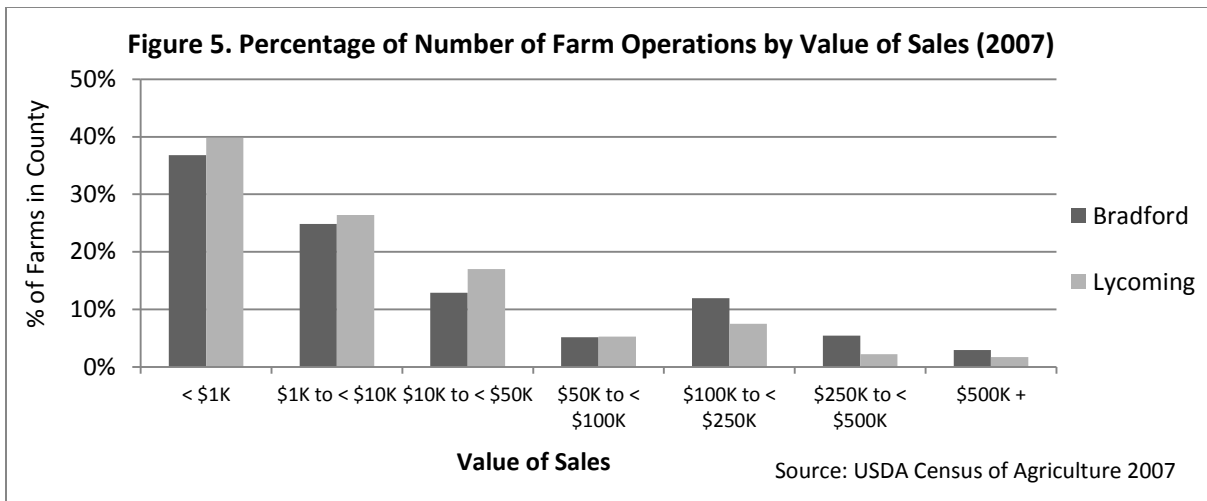


Figure 4. Composition of Land in Farms¹ by Type



Northern Tier

Agriculture is a significant contributor to Bradford’s economy. Bradford county has 1,457 farms, with slightly fewer than half (711 farms) of those farms providing the primary household income source. Although the average market value of products sold per farm is \$83,261, 61.6 percent of farms have less than \$10 thousand in total value of sales. The average size of a farm is 183 acres. Out of the 67 counties in Pennsylvania, Bradford ranks 10th for the total value of agricultural products sold. Its high rank may be attributed to the sale of cattle and dairy products from cows—92 percent of the market value of products sold in Bradford is generated from livestock sales. In addition, Bradford also ranks 1st for land used for forage (hay, haylage, grass silage, and green chop). The average age of farmers in Bradford County is 57.1 years, and the majority are white males (female=173; male=1,284; only 30 of 2,156 operators did not choose the white category).

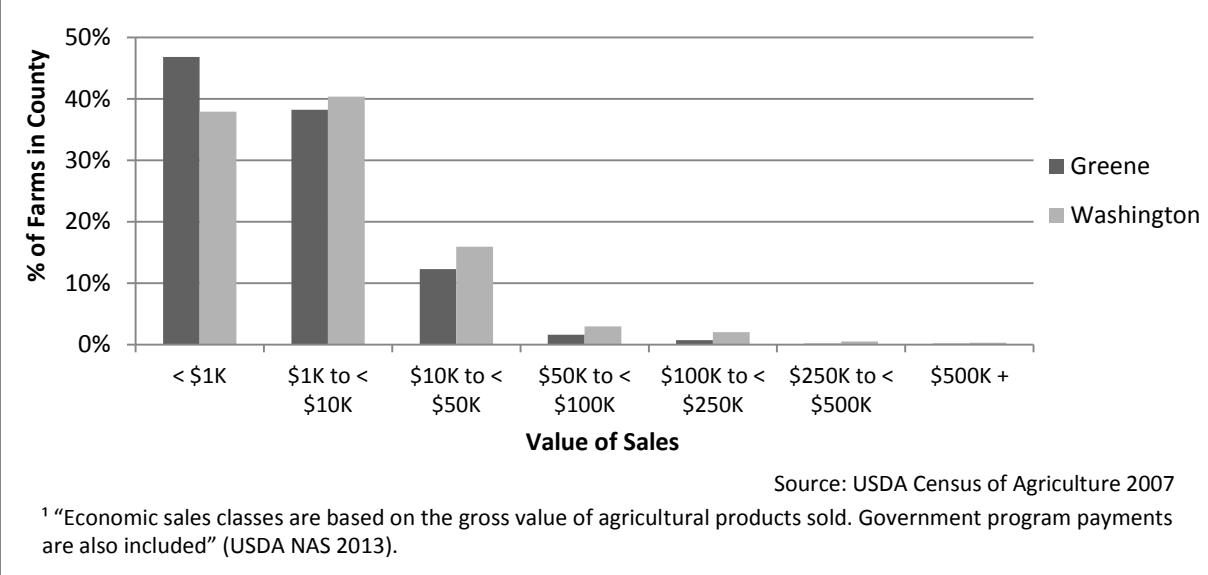


There are fewer farms in Lycoming (1,211) than in Bradford. Lycoming’s farms also tend to be smaller and have a lower average market value of products sold per farm than those in Bradford County. The average size of a Lycoming farm is 132 acres. Of the 1,211 operators, 501 of them indicated farming as a primary occupation, while the remaining farmers rely on other sources for their primary income. The market value of products sold by Lycoming farmers (\$53.4 million) is less than half of Bradford farmers’ market value (\$121.3 million). Lycoming ranks 6th in the state for value of sales of cut Christmas trees and short-rotation woody crops and 9th for values of sales of tobacco. The average age for operators in Lycoming is 56.2, and almost all of them are white males (16 of 1,746 operators did not choose the white category; female=149; male=1,062).

Southwest

Although Greene County has the 4th lowest value of agricultural sales in the state, it ranks 1st in acreage of short-rotation woody crops. It also has the 5th highest number of sheep and lambs. Dairy farming is not common in the county, ranking 59th against all counties in the state for value of sales of milk and other dairy products from cows. Of the 1,245 principal operators in the county, only 386 farm as a primary occupation. Less than 3 percent of Greene County farms have value of sales over \$50,000. The average age of farm operators is 55.9 years and they are typically white males (24 of 1,767 operators did not choose the white category; female=180; male=1,065).

Figure 6. Percentage of Number of Farm Operations by Value of Sales¹ (2007)



Washington County has the greatest number of farms and the smallest average farm size in the state. Of the 2,023 principal operators in the county, 1,261 reported a different primary occupation. The county has the highest number of sheep and lambs in the state and ranks 2nd in value of sales of sheep, goats, and their products. It ranks 4th in the number of horses and ponies, and 5th in number of goats. For value of sales by commodity group, Washington ranks 5th in "other crops" and hay, and 7th in horses, ponies, mules, burros, and donkeys. It has the 4th highest acreage of forage. It is important to note that Washington County's proximity to Pittsburgh affords it more non-farm opportunities than other study counties.

Changes in Agriculture

Farming in the United States has changed substantially over the 100 years. At the beginning of the 20th century, 41 percent of the employed labor force worked in agriculture, but the proportion has now decreased to 2 percent (Dimitri, Effland, and Conklin, 2005). In 1935 a sharp decline of farm numbers occurred simultaneously with an increase in average farm acreage (Hoppe and Korb, 2006). That period coincided with the Great Depression and the collapse of dairy prices. Dimitri et al. (2005) argued that technological development is one of the three most influential long-run forces that drove the consolidation of farms in the United States. They explain that, for many farmers, increased mechanization (e.g., tractors, plant and animal breeding) and the accessibility of chemicals led them to make larger income investments to pay for technologies, especially those that decreased the need for labor. The result was fewer farmers and farmworkers, and larger farms.

While hydraulic fracturing and horizontal drilling do not affect farming in the same way that tractors and chemicals have, these new technologies are having social and economic impacts on agriculture, particularly for farmers who have entered into gas leases. These impacts could influence the number and size of farms in counties where there is Marcellus Shale development. Landowners (often farmers in rural areas) who own the mineral and natural gas rights of their properties are approached by landmen from gas companies or independent contractors to sign leases. Landowners can choose to "...lease the right to explore for gas to a company that has the equipment and expertise to recover or receive the gas for a period of time, and accept payment for the lease and royalties for the value of the gas" (Weidner, 2008). There are many factors that influence the price per acre that a company will pay (e.g., anticipated

quality of gas, expectations and acuity of landowners, demand for gas) to drill for gas and can range from hundreds to thousands of dollars. In addition to lease payments, landowners are also paid royalties for gas that is extracted. Pennsylvania requires that landowners receive royalties of at least 12.5 percent of the value of the natural gas extracted from their property (Weidner, 2008).

Farmers who have entered into or are considering gas leases must make new decisions about their farms, such as how much land should be leased and how the income from the royalty and lease payments should be used. Some examples of how gas leasing could affect agriculture include taking farmland out of production to lease it, as well as investing in existing enterprises, downsizing existing enterprises, or switching to different types of farming (e.g., dairy to beef cattle). These decisions are discussed in more detail in the focus group findings under the section, “Change in Farming Practices and Farm Exits.”

Changes in Number of Farms¹ and Acreage per Operation

Gas leasing may be having impacts on how farmers are using their land and making decisions about their farms. The decision to invest in upgrading a farm enterprise, to stop farming altogether, or to farm less land in response to gas leases could be reflected in changes in the number of farms and average acreage per operation. In this section, county- and state-level data from the U.S. Census of Agriculture were used to establish a baseline for these two indicators. Census data were available through the QuickStats application for farm numbers for the years 1997, 2002, and 2007 and for average acreage per operation for the years 2002 and 2007. Since the survey program that collected annual data to make estimates about farm numbers and acreage was discontinued in 2007, the Census data are more meaningful because the values are actual counts rather than estimates. With the exception of Washington County, which had a sudden initial increase in 2007, the information below is helpful for understanding trends in agriculture before drilling took off in the study counties.² It is important to note that although there were not many wells drilled in the case study counties prior to 2007, it is possible that some farmers were already receiving lease payments from gas companies. Upon the release of results from the 2012 Census of Agriculture in early 2014, pre-drilling data can be compared to recent data.

The average annual rate of change helps to reveal proportional changes that can be less visible when examining counts. The average annual rate of change was calculated by subtracting the value of the later year by that of the earlier year and dividing by the value of the earlier year. For example, in 2002 there were 1,495 farms in Bradford County and in 2007 there were 1,457. The average annual percentage change was calculated as shown below:

$$(1457-1495)/1495 = 0.025 * 100 = -2.5\%$$

Northern Tier Pennsylvania Counties

The pre-drilling data indicate a 3.5 percent decline in the farm count rate across the state and a 1.4 percent increase in the northern tier between 1997 and 2002 (displayed in Table 3 below). Lycoming

¹ According to the NASS, “A farm is ‘any place from which \$1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the year.’ Government payments are included in sales. Ranches, institutional farms, experimental and research farms, and Indian Reservations are included as farms. Places with the entire acreage enrolled in the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), or other government programs are counted as farms. The definition of a farm was first established in 1850 and has changed nine times since. The current definition was first used for the 1974 Census” (USDA NASS 2013).

² For number of wells drilled in the northern tier, Bradford County increased from 24 in 2008 to 159 in 2009 and Lycoming County increased from 23 in 2009 to 120 in 2010. In the southwest, Washington County increased from 19 in 2006 to 45 in 2007 and Greene County increased from 14 in 2007 to 67 in 2008. These were not the peak years but were the years in which there were high initial increases in wells drilled.

County changed very differently from the state and region during this time period. Farm numbers in the county increased dramatically—almost 19 percent over the 5-year period. Bradford County was similar to the region as the farm count decreased by almost 3 percent. Between 2002 and 2007 there was a notable increase in the number of farms, ranging from 8.5 to 10 percent, in both the state as a whole and the northern tier. This sudden increase can be partially attributed to NASS’ effort to enumerate more small farms (as discussed in detail above in the Statewide Agricultural Profile section).

While reported farm numbers increased in the state and region, they declined in both Bradford and Lycoming from 2002 to 2007. Bradford continued to decline at about the same rate as it had from 1997-2002. However, Lycoming experienced a sudden decline in farms at 8.5 percent when it had experienced a significant increase 5 years prior. It is important to note that although there were only two wells in Bradford and five wells in Lycoming during the year 2007, landowners tend to receive both leasing and royalty payments when they enter a lease. Therefore, despite the low well counts, farmers still could have been leasing their land to gas companies during this time, which could have potentially affected their farming operations. However, it is difficult to come to more well-supported conclusions about farm numbers without taking into consideration the 2012 Census data.

Table 3. Change in Number of Farms in Northern Tier, 1997 - 2007

	1997	% change (1997-2002)	2002	% change (2002-2007)	2007
Northern Tier (county average)	488	-0.8%	484	21.0%	567
Bradford ^a	1,539	-2.9%	1,495	-2.5%	1,457
Lycoming ^a	1,114	18.8%	1,323	-8.5%	1,211
Adjacent counties only (average)	402	-4.0%	372	25.8%	479
Susquehanna ^a	849	31.4%	1,116	-9.7%	1,008
Tioga ^a	986	-1.3%	973	3.9%	1,011
Clinton ^b	350	20.0%	420	27.9%	537
Potter ^b	376	-8.8%	343	10.2%	378
Sullivan ^b	160	6.3%	170	-2.9%	165
Wyoming ^b	387	-7.5%	358	81.3%	649
Columbia ^c	955	-7.4%	884	8.8%	962
Montour ^c	350	-13.1%	304	91.8%	583
Northumberland ^d	784	-8.3%	719	30.2%	936
Union ^d	659	-20.9%	521	10.4%	575
Pennsylvania (county average)	899	-4.0%	867	15.5%	943
Northern Tier (regional total)	8,509	1.4%	8,626	9.8%	9,472
Pennsylvania (statewide total)	60,222	-3.5%	58,105	8.7%	63,163

Source: USDA Census of Agriculture (1997, 2002, 2007).

^a Core, high-drilling activity county.

^b Core, low-drilling activity county.

^c 2nd tier Marcellus Shale.

^d No Marcellus Shale wells.

Between 2002 and 2007, the average size of farms decreased throughout the state, study counties, and region, which may be partially explained by the increased representation of small farms in the 2007 Census. Compared to the state, the change in the size of farms in the northern tier was dramatic—over 5 years the average acreage in the northern tier dropped 13.5 percent compared to 4.3 percent statewide. Lycoming County was not consistent with the regional change in acreage with just a slight drop at 1.5 percent. Bradford, on the other hand, did not drop as much as other counties in the region, but still had a 9.4 percent decline. The change in size of farms between 2002 and 2007 are most notable in Montour and Wyoming counties for which acreage dropped by about one third. The declines in the northern tier are likely connected to the volatility in milk prices and general trends in consolidation.

Table 4. Change in Average Acreage per Operation in Northern Tier, 2002 - 2007

	2002	% change (2002-2007)	2007
Northern Tier (county average)	170	-12.9%	147
Bradford ^a	202	-9.4%	183
Lycoming ^a	134	-1.5%	132
Adjacent counties only (average)	170	-15.5%	145
Susquehanna ^a	170	-7.6%	157
Tioga ^a	206	-11.7%	182
Clinton ^b	127	-17.3%	105
Potter ^b	275	-14.9%	234
Sullivan ^b	183	-7.7%	169
Wyoming ^b	173	-30.6%	120
Columbia ^c	140	-9.3%	127
Montour ^c	131	-34.4%	86
Northumberland ^d	166	-4.8%	158
Union ^d	133	-16.5%	111
Pennsylvania (county average)⁺	141	-5.3%	131
Northern Tier (regional total)	2,040	-13.5%	1,764
Pennsylvania (statewide total)	9,148	-4.3%	8,757

Source: USDA Census of Agriculture (1997, 2002, 2007).

^a Core, high-drilling activity county

^b Core, low-drilling activity county

^c 2nd tier Marcellus Shale

^d No Marcellus Shale wells

⁺ 65 counties used to calculate 2002 average and rate of change (Delaware and Philadelphia excluded)

Southwestern Pennsylvania Counties

Data for the southwest counties show substantial increases and decreases in farm numbers. Between 1997 and 2002, Washington County experienced a dramatic increase of 43.7 percent. During this time statewide farm numbers had decreased slightly while in the southwest region they had decreased by 8.8 percent. The next period, 2002-2007, shows a sudden drop in Washington's farm count of almost one fifth of its farms. In 2007, there was a substantial increase in number of wells drilled in Washington

County from 19 in 2006 to 45 in 2007, a 57.8 percent increase. Although not proportional, changes in Greene County were more consistent with the state and region during this time period than Washington. While the state and region increased by 6.4 and 8.7 percent, Greene increased by 41.3 percent. Part of this increase may be explained by the effort of NASS to include small farms measured by value of sales in the 2007 Census. However, Washington County appeared to be unaffected (See section above for more information on changes to Census data collection efforts above). The decline in farm numbers in Washington County may also be partly a consequence of suburban sprawl from Pittsburgh.

Table 5. Change in Number of Farms in the Southwest, 1997 - 2007

	1997	% change (1997-2002)	2002	% change (2002-2007)	2007
Southwest (county average)	1,046	2.6%	1,138	15.7%	1,210
Greene ^a	864	2.0%	881	41.3%	1,245
Washington ^a	1,744	43.7%	2,506	-19.3%	2,023
Adjacent counties only (average)	917	-7.5%	860	18.0%	998
Fayette ^a	1,006	-2.8%	978	24.7%	1,220
Allegheny ^b	522	-11.1%	464	15.1%	534
Beaver ^b	737	-12.5%	645	27.8%	824
Westmoreland ^b	1,401	-3.4%	1,353	4.6%	1,415
Pennsylvania (county average)	899	-4.0%	867	15.5%	943
Southwest (regional total)	6,274	8.8%	6,827	6.4%	7,261
Pennsylvania (statewide total)	60,222	-3.5%	58,105	8.7%	63,163

Source: USDA Census of Agriculture (1997, 2002, 2007).

^a Core, high-drilling activity county

^b Urban Marcellus

Changes in farm size in the southwest showed a trend toward larger farms during the period of initial Marcellus Shale development. The southwest region declined at a proportion greater than that of the state. Greene had the greatest change in average acreage per operation between 2002 and 2007. Despite the rapid increase (1997-2002) followed by decline (2002-2007) in the number of farms in Washington County, there was no reported change in average farm size.

Table 6. Change in Average Acreage per Operation in the Southwest, 2002 - 2007

	2002	% change (2002-2007)	2007
Southwest (county average)	113	-8.1%	102
Greene ^a	161	-24.8%	121
Washington ^a	104	0.0%	104
Adjacent counties only (average)	103	-6.0%	96
Fayette ^a	128	-10.2%	115
Allegheny ^b	73	-2.7%	71
Beaver ^b	97	-16.5%	81
Westmoreland ^b	112	5.4%	118
Pennsylvania (county average)⁺	141	-5.3%	131
Southwest (regional total)	675	-9.6%	610
Pennsylvania (statewide total)	9,148	-4.3%	8,757

Source: USDA Census of Agriculture (2002, 2007).

^a Core, high-drilling activity county

^b Urban Marcellus

⁺ 65 counties used to calculate 2002 average and rate of change (Delaware and Philadelphia excluded)

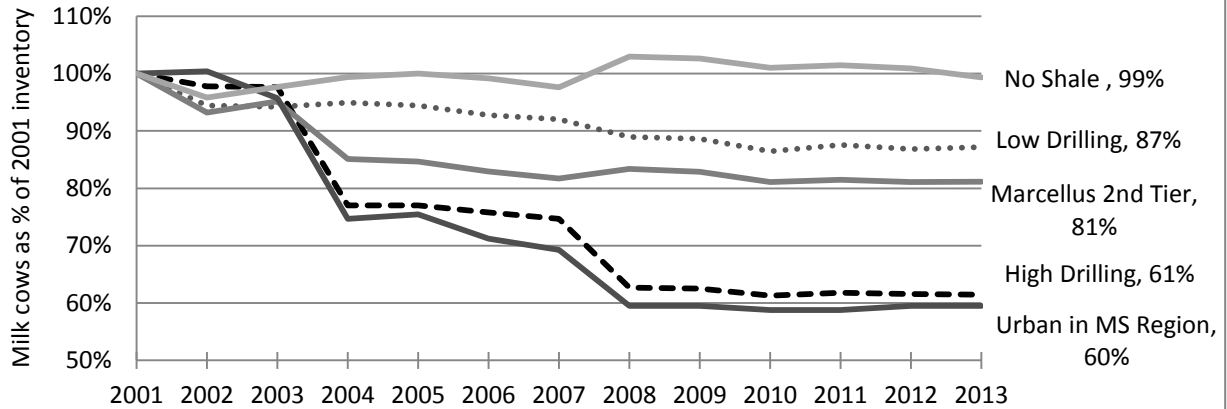
Statewide and Regional Changes in Dairy

Dairy is the top agricultural commodity in Pennsylvania (in terms of value of sales) and in three of the four study counties. Dairy farming is often perceived as a particularly intensive activity, given that cows are milked two or more times each day. In the northern tier focus group discussion, a participant claimed that the signing of a profitable gas lease has led some farmers to exit the dairy industry and enter into “less intensive agriculture.” To explore the potential impacts of Marcellus Shale development on the industry, changes in milk cow inventory were explored across levels of drilling activity, by region, and across the four study counties.

The number of milk cows varied across the state and by drilling activity. From 2001 to 2013, the average annual inventory was just over 60,000 cows in all high-drilling counties and just over 50,000 in low-drilling counties. This compares to a much lower total in urban Marcellus counties (just under 20,000) and much larger inventories in 2nd tier Marcellus counties (105,000) and across counties outside of the Marcellus Shale region (325,000) (NASS). About 20 percent of all milk cows could be found in counties with high- or low-drilling activity across this time period.

Figure 7 shows the milk cow inventory across these five areas as a percentage of the number of milk cows in 2001. The least amount of change was observed in the No Shale counties, whereas low-drilling and Marcellus 2nd Tier counties experienced steady but comparatively small declines in inventory, with 87 percent and 81 percent (respectively) of the number of milk cows as in 2001. In contrast, the number of milk cows in the high-drilling and in the urban Marcellus regions was less than two-thirds the number in 2001. The largest drops were observed in 2003-2004 and then again in 2007-2008, which coincided with the beginning of Marcellus Shale development. Although the number of dairy cows has not been restored since these declines, it has stabilized.

**Figure 7. Milk Cow Inventory by Marcellus Typology Categories
(as % of 2001 inventory)**

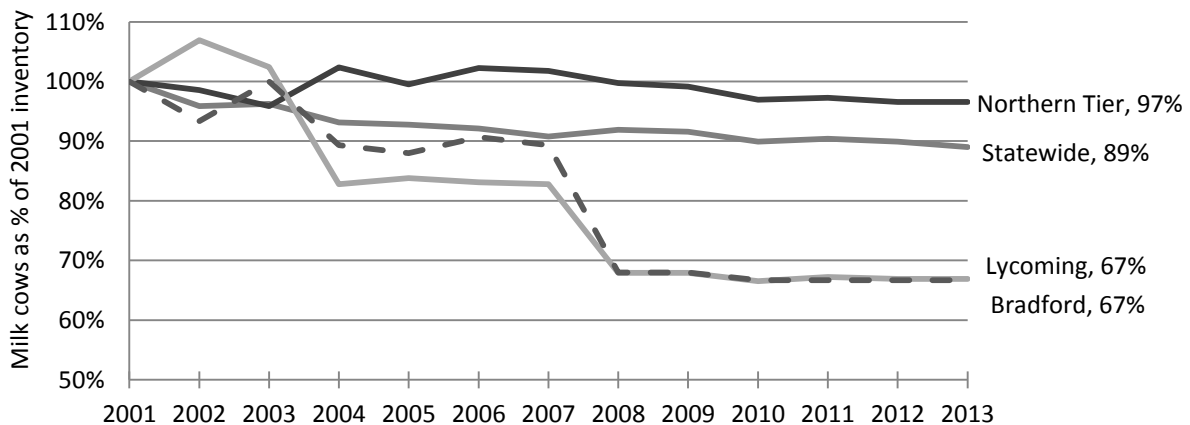


Source: USDA NASS Annual Program for Livestock Production. Data is collected from area and list frame samples to produce estimates. For more information, see: <http://www.nass.usda.gov/QuickStats/Screens/faqs.htm#conducted>

Northern Tier Pennsylvania Counties

As drilling activity in the Marcellus Shale region rapidly increased in some counties, statewide there was a slight decline in the number of dairy cows (Adams and Kelsey, 2012). Between 2007 and 2010, the number of milk cows in Pennsylvania declined by about 1.7 percent. However, different counties experienced different levels of change, which Adams and Kelsey contend may be associated with the size of a county's dairy sector and level of Marcellus Shale drilling activity. Figure 8 shows the milk cow inventory by county as a percentage of 2001, from 2001 to 2013.

**Figure 8. Milk Cow Inventory in the Northern Tier
(as % of 2001 inventory)**

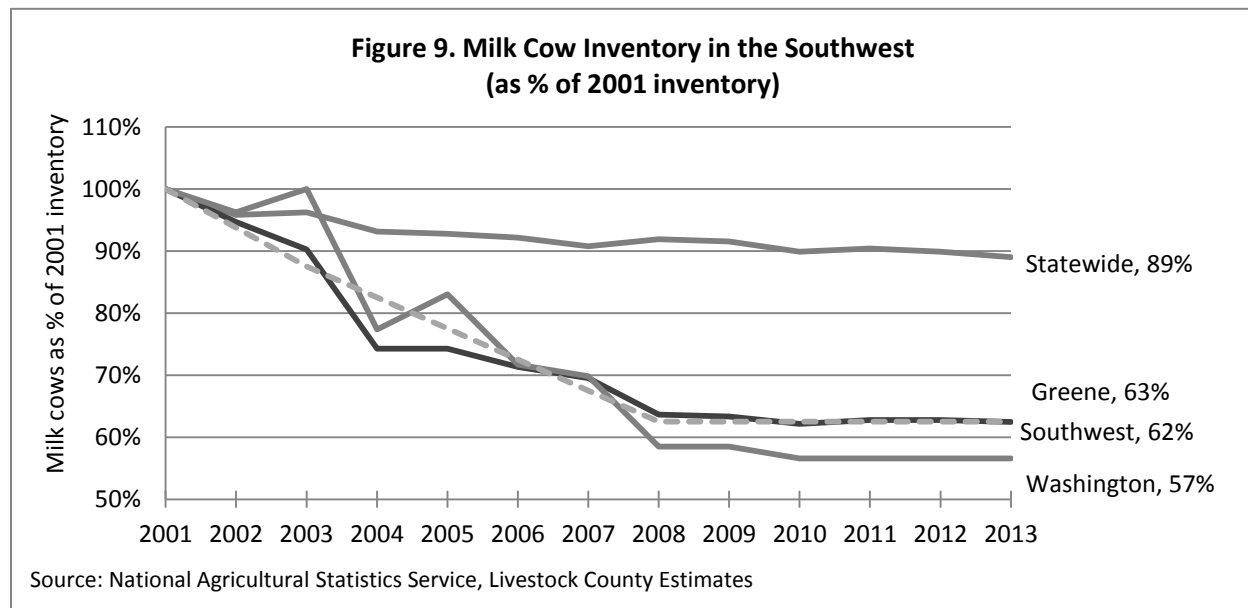


Source: National Agricultural Statistics Service, Livestock County Estimates

Whereas the number of milk cows remained relatively stable across the northern tier region, the milk cow inventory statewide declined to 89 percent of the 2001 level. Changes in Lycoming (dotted line) and Bradford were more striking, as they both experienced greater fluctuation 2001 to 2008. These changes include notable declines in milk cow inventory from 2007 to 2008, the years that Marcellus Shale development began to pick up. During this time of decline, milk prices were very low and the number of wells drilled increased, especially in the following years. Causation, however, is difficult to establish given the many factors that may affect milk cow inventory and the earlier patterns of decline (i.e. 2003 to 2004).

Southwestern Pennsylvania Counties

Figure 9 presents the milk cow inventory as a percentage of the 2001 inventory in the state, across southwest counties, and in Washington and Greene. The changes in dairy farming over the 2000s reflect dramatic fluctuations across the southwest despite relative stability in the milk cow population statewide. More than one-third of the milk cow population was lost in Greene, Washington, and in the southwest region overall from 2001 to 2013, although most of the change occurred leading up to 2008.



Adams and Kelsey (2012) concluded that the intensity of gas drilling and the decline in dairy cow numbers seem to be associated but caution that the data did not allow for more than speculation on that association. The focus group findings offered some insights into the dynamic ways that farmers are affected by drilling activities.

Focus Group Findings

Common themes that emerged during the focus group include substantial economic gains for some farmers in the form of lease and royalty revenues, and for agricultural businesses through increased sales of traditional and new goods and services. However, participants also mentioned substantial inconveniences, paradoxical impacts on agricultural land use and production, and uncertainty about environmental quality and the future prospects for farming in the region. Focus group participants in both the southwest and the northern tier used the phrase “it’s a double-edged sword” multiple times. Other comments included, “I think you’re going to find as many negatives as positives” and “hang on for the ride.” Others responded that “it’s too soon to tell” or “ask us in 10 years” when asked about whether gas drilling will be good or bad for their regions.

Economic Impacts

When asked how Marcellus Shale development has affected agriculture in the area, respondents commonly mentioned economic impacts. In the northern tier, participants noted economic benefits, but the discussion did become contentious at times. One woman involved in dairy farming for several decades stated that gas development has been a boost to the economy in the Bradford-Sullivan area. She explained that economic benefits have helped some farmers avoid bankruptcy. An organic dairy farmer presented a different perspective. While he agreed that landowners were experiencing an economic boom, he explained that “...the drilling and the gas development is a nail in the coffin for agriculture in the northern tier.” He said many farmers are dependent on off-farm income sources, such as royalties from gas leasing, rather than having self-sustaining farm operations. He claimed that dairy and other livestock farming were no longer viable. He argued that, “...agriculture’s dead apart from money from another source” and “...livestock agriculture apart from maybe the confinement operations is probably going to disappear.” He acknowledged that these trends are common, and not restricted to gas-drilling counties; however, he stated that the economic benefits from gas drilling are enabling many farmers to downsize or leave farming, rather than continuing to struggle to survive.

Positive impacts on the economic situation of farmers were also mentioned during the southwest focus group. For some farmers, they would have been unable to continue farming without Marcellus development. One participant stated that, “They [some farmers in the county] couldn’t survive if they didn’t have a supplementary income” and another agreed that, “It helped them stay in business.” A participant explained that funds generated from gas leasing were used by some farmers to reinvest in their operations. This is something that has benefited farmers for whom purchasing new equipment has long been outside of their budget. One agribusiness owner explained the effect of the ability of farmers to reinvest on his agribusiness: “Oh, it’s been a boon to us, so I can’t say anything bad. Best thing that ever happened to us....People’s got money and they can spend it. They’re either gonna buy something that they can touch or they got to pay the government. It’s that simple. I’d want to touch it if it was mine....There’s a lot of rusty machinery here and as soon as you get that kind of a windfall, you would like to have something that’s comfortable and shiny.”³

There was general agreement that many farmers and agribusinesses were profiting from Marcellus Shale development. However, some raised concerns about changes occurring as a result of those economic benefits.

Change in Farming Practices and Farm Exits

Despite reports of economic benefits enabling some to stay in farming, respondents also claimed that the economic benefits have led some farmers to change farming practices or to exit farming. Participants shared stories of farmers converting from dairy to beef cattle, raising horses in connection with the horse racing industry, improving the breeds of their livestock and switching from crops like corn and soybeans to hay and small grains. As one participant explained, “There might be some farms switching over to growing hay and grain, mostly just for mulch as well. The pipelines, and the seeding and mulching that they do on all these disturbed areas. There’s a market for that now that wasn’t there before, a big market. I couldn’t put a handle on how many have switched over to that kind of production.”

³ When stating that, “People’s got money and they can spend it,” this man may also be alluding to the claim that gas drilling has resulted in economic benefits to not only agriculture, but other sectors including hotels, trucking companies, and others. Please see Report #8 on economic impacts for more information.

Some cautioned that it is not fair to attribute all changes to gas drilling. They pointed out that the drought in the Midwest affected prices for cattle and hay, and that dairy farmers have been facing increasingly difficult economic conditions for decades. Several participants in both the southwest and the northern tier described how farmers have long been in perpetual crisis. However, many farmers now have the money from lease and royalty checks to respond to new market opportunities, invest in or expand existing operations, or exit farming altogether.

Another concern expressed was the paradox of intergenerational exchange of property and the future of farming. On the one hand, land values are increasing and some farmers have more money to invest in their operations. On the other hand, higher land values lead to higher tax liabilities for transferring the land to a younger family member, and it may price some young farmers out of the market.

Participants highlighted other challenges associated with the gas-drilling boom. Farmers are finding that there are shortages of some farm inputs, such as lime, due to gas industry competition. Farmers and agribusinesses are also finding it difficult to compete with the gas industry for laborers. One focus group participant in the southwest stated that the labor shortage has had a dramatic impact on logging and forestry:

“The second thing is certain industries in the area have almost gone by the board—like the logging industry. There were people who could sell timber off their farms, and a lot of the little local sawmills had not been able to afford the help to do their job. It was usually minimum wage people, unsophisticated workers. Now then, they're out of business. I don't know what other ag, maybe, related businesses have kind of been swept off the boards, but the employment picture has changed certain advantages for certain parts of agriculture.”

Three negative effects commonly mentioned were damage to infrastructure, reduction in available farm land, and generating uncertainty about the future. Like participants in other focus groups, farm and agribusiness participants emphasized the problems associated with road damage from heavy trucks and equipment used by gas companies. One participant noted that even when the gas industry fixes a damaged road, that can create new challenges: “The roads are so wide now that, one, they'll never have the money to take care of them because now, they've made a one-mile road into a two-mile road because it's, like, twice as wide as what it was before. The township will never be able to maintain the gravel just to go on it....They're cutting through things and tearing up people's yards. It's just a mess.”

Another participant made a similar point by noting that when there are upgrades to infrastructure, those upgrades can bring new challenges with them.

“I lived on a dirt and gravel road that the gas company came and blacktopped. While everyone thought that was great, but the problem is, the township knew how to take care of a dirt and gravel road. They didn't know how to take care of a blacktop road. I can't tell you how many times that first winter the farm had to pull the school bus out of the ditch because the road wasn't taken care of.”

Participants also used the concept of infrastructure to refer to investment in social and economic factors that would enable them to take advantage of new opportunities. For example, one participant described how there were no investments or policies in place to enable farmers to transition to different kinds of agricultural production and marketing. They discussed the need for agricultural market and distribution facilities that might support farmers seeking alternative products and practices.

There was a general recognition that gas drilling affected land availability and use. Gas drilling tends to reduce usable crop and pasture land because a well pad typically requires about five acres. Construction of roads to get to the well pads and pipelines can take up additional land. One participant stated, “I

know our neighboring farm that had one of the first pads put in and it has a long access road back to it, they estimated that they lost 30 acres of crop ground by the time it was all said and done.” By contrast, one farmer in the northern tier commented that, once the construction had been completed, there was more usable farm land because the drilling operation had cleared some unproductive brushland. As he put it, “It looks like a few pluses and a few minuses.” Still, participants in the focus group in the northern tier described some decline in usable land. In cases where those declines were temporary, farmers still face challenges. One participant described his neighbor’s situation: “There’s two gas well pads on his property. There’s pipelines going in now everywhere so he’s scratching his head, where’s he going to get corn this year because the pipelines are still open, they hit rock and they’re jack hammering just to get the pipeline in so that temporary situation is looking longer term.”

Another participant stated that rental farmland is becoming scarce:

“One of the things with the escalated value of land, anybody who at one time had thought about selling a farm has no incentive to sell it at this point or to pass it on to somebody else. They would rather sit on it for the mineral values. Between that and some of the government set-aside programs, it’s made rental rates just unattainable, and there’s a lot of people that are sitting on land that have it in the government program and are looking for mineral development money off of it, so they have no incentive to rent it to anybody else, to lease it, so some land I’ve seen in our area just get idled for that reason I think.”

Such insights from the focus groups reflect complexity in trying to describe the impacts of gas drilling activities on farmland use and availability. The issue of mineral rights and decisions to sell are not made in isolation from government set-aside programs or from other broad economic trends. Gas drilling is just one of many factors affecting agriculture.

Attitudes towards Gas Industry

With the exception of one agricultural focus group participant, others expressed mistrust and negative attitudes towards gas drilling firms. However, participants nearly universally recognized differences among firms and among subcontractors.

One participant explained how the complexity of the operations makes it difficult even to know who to talk to when there is a problem.

“I think there's another issue...and that applies to the actual farm ground. There is no accountability for somebody to stay with a pipeline, and what you'll have is a parent company having a half a dozen different subcontractors. One comes in, pushes the dirt aside. Another comes in, pipe. Another one pushes it back. Another one tries to put something over top...What happens in our case is, they ask for permission to put stone in. Yes, you can put the stone in as long as you remove the stone when you're done. It's a different subcontractor that comes along at that time and they say, we're not responsible. Then you have stream issues where they cross the streams. You'll have what needs to be done at the time of construction. Then they don't remove it at the time, so now, we have a dam there. When you're looking at the regular area where the pipeline went, some of it's acceptable. Some of it isn't. There's no accountability and there's no traceability.”

Some participants emphasized that difficulties arise even if one has a good attorney to help get solid leases and contracts signed. One exchange between participants highlighted how complicated the legal issues can be when it comes to assigning responsibility for a problem. One participant who signed a gas lease stated, “We had the attorneys do it and it had a million addendums and when you get right down to it, this subcontractor says, I'm not responsible.” Another participant responded, “Yeah. We had as

good a counsel as anybody could possibly want, and you still get taken advantage of. I guess if you consider yourself a steward of the land, you want to be left with as little of a bad footprint as possible after they've moved on. I don't care how good you are. I don't know." A third participant offered support: "Trying to read those leases and those right-of-way agreements. Even if you get the comments back from the attorneys...it's really tough going through that crap." The exchange seemed to capture a sense of resignation. When a problem arises, farmers may not know which contractor to confront. And even if the farmer did know, as one farmer pointed out, he or she would still be facing the lawyers supported by a "billion-dollar industry."

Although the focus of this project was not explicitly about environmental impacts, participants expressed concerns and uncertainty about the environmental impacts without prompting. A series of comments during the southwest agriculture focus group reflects farmer uncertainty over whether the gas development is good or bad. One participant stated, "They have a nasty imprint and there's a lot of money floating around, so which is better?" A second participant responded, "The question is, will we have any water to farm? *[Laughter]*" The first respondent then said, "Exactly. That's what I was just—and we don't fully understand the environmental impact." The second participant then quipped that having water "makes it a lot easier to survive. *[Laughter]*"

Another exchange demonstrates environmental concerns related to uncertainty, the lack of accountability, and lack of monitoring. One participant initiated the exchange:

"I think what you have—I think what you have in any place, whether it's a neurosurgeon or somebody else, good respectable, knowledgeable people you don't have to worry about. If you have the people who are subcontracting in this industry who are conscientious, they know what they're doing, I don't think environmentally, we have a whole lot to worry about. I think what you have are those guys who don't know what they're doing or could care less about what they're doing that will affect the environment, and that, we'll be stuck with because you have no idea who's doing what on your farm."

Another participant responded to that comment by stating that "There really isn't any groundwater monitoring going on." Other participants then expressed their concerns that the gas industry was extracting a lot of water from the area streams and that they were unaware of any monitoring in terms of environmental impacts.

Similar water concerns were raised in the northern tier. However, northern tier participants added an additional concern to the water quality issue, namely, the concern about retribution from drilling companies if they complain:

"I think in the long-haul probably the water impacts, not just surface but ground water, to the area is probably going to have the biggest change. The reality is no matter how careful they are, no matter what they are doing, there are going to be groundwater problems and there are already lots of them, and there's a lot that the state isn't even talking about, they're covering up and that really disturbs me that they're not honestly addressing those issues. And there's a lot of people who are impacted by drilling and they don't want to say anything about their water quality because they don't want to jeopardize the income from the wells. I know people who have methane in their water, but they don't want to make an issue of it."

Although this was a small sample of residents in the four study counties, the expressions of inevitability and powerlessness seemed to resonate. With the exception of one participant who was very much a proponent of the gas industry, even participants who were generally supportive of the Marcellus Shale development assumed that the gas industry was seeking to profit from the venture and that there was

little concern for individual residents or for the public good. These findings are consistent with those of Malin's (2013).

Organic Agriculture

While not directly mentioned in the focus groups, probably because of the small representation of organic farmers, Marcellus Shale development has raised some potential challenges to individuals involved in organic agriculture. Pennsylvania Certified Organic (PCO), an organic certification non-profit that certifies many of the organic farmers in the state, released a document titled, *Guidance for Natural Gas Exploration and Drilling on Certified Organic Farms*, in 2012. The guide stated that, "All land disturbed by industry may have to be removed from certification for at least 3 years, if at risk of contamination, and will need to be evaluated for contaminants prior to evaluation" (Pennsylvania Certified Organic, 2012). If an organic farm is at risk of contamination, an organic inspector will visit the operation to assess the extent of the risk. PCO takes into account the nature of the activity, when it will occur, what areas of the property will be impacted, the steps taken to monitor the activity, water test results, methods of preventing contamination (e.g., buffers, fencings built using approved materials), and which input materials will be used, including the materials used during reclamation, such as seeds and fertilizers.

An organic dairy farmer in the northern tier expressed concerns about contamination of natural resources by gas companies during a focus group:

"One of the things that I think has a huge impact on agriculture that is a sleeping giant and that is what if there is a contamination issue and say a dairy herd is all of a sudden quarantined because of bad water. The impact of this hit us really big a couple years ago when I think it was when that story came out that a farmer's cattle got into that frack water pond and when that hit the news, I was shipping milk at the time to an organic milk company and the consumer hotline was just ringing off the hook the next day, and immediately, whether it's true or not, if the consumers perceived that their food quality is jeopardized by what's going on here, all of a sudden, I could lose my milk market overnight and all of the sudden the company started to take a very proactive role of testing all water supplies and regularly they're testing milk to make sure that they can flag a potential problem before anything goes in the carton because they realize the consumer market could just collapse overnight in the event of something like that happening."

Not only can contamination lead to a negative reaction from consumers, but if contamination occurs on an organic farm the operator will have their organic certification revoked. Even if an organic farmer does not have a gas lease, he or she could be at risk of contamination if neighbors lease their land to a gas company. Effects on organic agriculture need to be monitored in future studies.

Uncertainty

Conclusions related to uncertainty made in the "Natural Gas Extraction—Impacts on Rural America" released by the National Agricultural and Rural Development Policy Center were consistent with the attitudes expressed by focus group participants. The Farm Foundation Forum concluded that there is "much uncertainty about natural gas extraction" and that while "short term impacts are generally known, long term impacts are less certain" (Ferrell and Sanders, 2013). Focus group participants in the southwest and the northern tier recognized a drop off in drilling activity over the past year. Some of that decline in activity was masked by pipeline activity, according to participants. However, the decline in activities, the layoffs, and effects on supporting businesses were noticeable to most focus group participants. One participant asserted that drilling companies are expecting to ramp up again in the next

year. However, there is still uncertainty. Ironically, one participant thought the slowdown has been a positive:

“In a way, as the price declined and the industry declined, it’s really more manageable for our smaller counties with the number of people and the number of machines here. It was just too big, too much at once. The traffic in Towanda was just a standstill, but I think with the overkill, it hurt with so many pipelines and so many ponds, I think that hurt the ag a little as far as the land and the water quality.”

Some of the uncertainty is linked to challenges with local governance. One concern that was raised more in the southwest than in the northern tier was the idea that local governments are either incompetent, corrupt, or unwilling or unable to stand up to the large gas companies and, therefore, not adequately managing the situation. One participant stated, “One of the things—I don’t know how familiar you are with municipalities in other areas, but here, they’re small communities and they—really, the only thing that your elected officials do are roads.”

Another said:

“Sometimes, the communities can’t even fill—get people to volunteer to be an elected official, so you have borough councils that aren’t filled. You have a reluctance for people to run, say, for a township supervisor, and so you get what you elect. A lot of times, you’re lucky to have somebody who’s interested and knowledgeable and they’ll sustain that interest...for a short while.”

The focus group participants also provided general support for the idea that state and federal government agencies and politicians are not looking out for local residents and that they are not providing opportunities for them to participate in the widespread benefits from the gas drilling boom.

One comment from the southwest focus group captured the uncertainty that seemed to be prominent in that group: “Unfortunately, here in Washington [and] Greene counties, we’re the guinea pigs. We’re the energy capital of the state, but we’re also the guinea pigs.” Many participants seem to feel that they are in the midst of a large experiment to determine what the long-term impacts of the gas drilling boom will be.

Quality of Life

A number of participants in both groups offered conflicting perspectives on the quality of life as a result of the drilling activity. Some described cases where young people who had grown up in the Marcellus area are seeing opportunities to return. Others told stories of young people who now want to leave the area or who, if they had left, would never want to return now. One comment from a long-time resident of the northern tier was striking:

“You look at the aerial photos of this county alone, and the drastic changes in the last 4 or 5 years is drastic. It’s significant! ...This is a personal opinion, because I stand to gain from the gas industry myself. We own a piece of ground right across the New York border. We all know what that issue is, so it’s not like I’m anti-gas because I don’t have anything to gain from it, but I’ve always considered myself, born and raised in the western section of the county, and it’s kind of why I’m working...here I always wanted to be in Lycoming County. You couldn’t convince me to consider being anywhere else, but I’ve told people for the last few years, if I went home tonight and my wife said let’s move, and as long as it’s a place that I would accept, I’d start looking tomorrow. That’s doesn’t mean that it’s all a bad thing, I’m not saying that, but the quality of life in Lycoming County has changed. I’m not saying it’s destroyed, I’m saying it’s changed – it’s not what it used to be. There’s good and bad with that in all aspects, I think. It’s different, that

doesn't mean it's all bad, it doesn't mean it's all good either. For those people that had a certain perspective of life here in Lycoming County, it's changed, and it'll never be the same again and that's a fact of life. That's not anything that any politician or any one person or a group of people is going to change tomorrow. It's just the way this country is and that's if you don't like it, get out."

This comment reflects the complexity involved in the way residents interpret what the Marcellus Shale developments mean for quality of life in the area. He acknowledges economic benefits, and he is not willing to judge that it is good or bad. But he is willing to state that it is different and that he no longer feels committed to staying where he grew up.

Conclusions

The focus group participants consistently identified both positive and negative impacts from Marcellus Shale development. Most participants appreciated the economic benefits, but many also expressed concerns about the trustworthiness and accountability of the gas industry, about the public costs in terms of infrastructure and environmental damage, the effects on the quality of life, and the long-term impacts on farming. Whether the overall impact of Marcellus Shale gas drilling on Pennsylvania agriculture will be beneficial or detrimental is unclear because the development is still in its infancy, and available data currently are limited. Focus group participants expressed similar sentiments when they were asked to give their assessment: "it's too soon to tell" and "check back in 10 years." The publication of the 2012 USDA Agricultural Census data should enable the documenting of more detailed changes in the study counties and surrounding counties. Data from surveys and other secondary data will be needed to determine the dynamic influences and relationships between drilling activities and changes in farming operations, quality of life, and decisions related to land use and availability.

Acknowledgements

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The project team gratefully acknowledges support from the following: the Department of Agricultural Economics, Sociology and Education in the College of Agricultural Sciences at Penn State; the Pennsylvania Office of Rural Health; the Department of Education Policy Studies in the College of Education at Penn State; The Pennsylvania State University Children, Youth, & Families Consortium; and the Penn State Institutes for Energy and the Environment. We also thank Penn State's Survey Research Center for their assistance with the focus groups. Several individuals contributed to the project through background research, data collection and analysis, including Matthew Filteau, Mark Leach, Kylie Davis, Kirsten Hardy, and Kaitlyn Chajkowski. We appreciate their hard work.

We gratefully acknowledge the members of our advisory committees who provided us with important insights at key points in the project and gave us access to data sets. We also thank the 125 community members and county commissioners who shared their experiences through focus groups and interviews. We greatly appreciate their time, assistance, and insights.

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Appendix A: Unconventional Wells Drilled by County and Year, 2005-2013

county name	2005	2006	2007	2008	2009	2010	2011	2012	2013*	Total, county
Bradford⁺	1	2	2	24	158	373	396	164	66	1186
Washington⁺	5	19	45	66	101	166	155	195	120	872
Tioga	0	1	0	15	124	273	272	122	13	820
Lycoming⁺	0	0	5	12	23	119	301	202	89	751
Susquehanna	0	1	2	33	88	125	205	191	102	747
Greene⁺	0	2	14	67	101	103	121	105	54	567
Westmoreland	1	0	4	33	39	49	59	42	22	249
Fayette	0	2	6	20	57	44	54	43	12	238
Butler	0	3	12	11	10	35	35	69	44	219
Armstrong	0	3	2	7	19	36	35	44	26	172
Clearfield	0	0	1	6	24	39	58	19	2	149
Wyoming	0	0	0	0	2	24	71	15	25	137
Clinton	0	0	0	4	9	35	39	10	1	98
Sullivan	0	0	0	0	0	22	19	27	5	73
Potter	0	0	8	6	8	36	11	1	0	70
Elk	1	1	6	8	6	16	22	1	3	64
McKean	0	2	1	5	7	22	19	5	3	64
Centre	0	0	1	4	7	41	8	2	0	63
Indiana	0	0	0	5	6	7	21	2	0	41
Jefferson	0	0	0	3	3	7	15	9	0	37
Allegheny	0	0	0	1	3	0	5	13	8	30
Lawrence	0	0	0	0	0	0	2	16	8	26
Beaver	0	0	0	0	1	1	5	17	2	26
Somerset	0	0	1	0	7	4	7	5	1	25
Clarion	0	0	3	1	3	3	10	4	0	24
Forest	0	0	0	0	5	1	0	12	4	22
Cameron	0	0	0	3	2	3	7	0	0	15
Mercer	0	0	0	0	0	0	0	5	3	8
Cambria	0	0	0	0	2	1	3	1	0	7
Blair	0	0	0	0	0	4	2	0	0	6
Venango	0	0	0	0	0	0	2	3	0	5
Warren	0	0	2	0	0	0	1	1	1	5
Wayne	0	0	0	1	0	4	0	0	0	5
Columbia	0	0	0	0	0	1	2	0	0	3
Crawford	0	0	0	0	0	0	0	3	0	3
Lackawanna	0	0	0	0	1	0	1	0	0	2
Luzerne	0	0	0	0	0	2	0	0	0	2
Bedford	0	0	0	0	0	1	0	0	0	1
Huntingdon	0	0	0	0	0	1	0	0	0	1
Total, by year	8	36	115	335	816	1598	1963	1348	614	6833

Source: Pennsylvania Department of Environmental Protection, Office of Oil and Gas Management.

*Data through June 30, 2013 (accessed July 4, 2013). ⁺Study counties.

Appendix B. Marcellus Activity County Typology Definitions for Pennsylvania^a

Category	Geological Definition	Activity level	Counties
Core Counties with High Drilling Activity^b (N=7)	More than 50 percent of the land area is in the core Marcellus formation	Annual average 64 or more Marcellus wells 2005 to 2010	Bradford, Fayette, Greene, Lycoming, Susquehanna, Tioga, Washington
Core Counties with Low Drilling Activity (N=12)	More than 50 percent of the land area is in the core Marcellus formation	Annual average less than 64 Marcellus wells 2005 to 2010	Armstrong, Cambria, Cameron ^c , Clearfield, Clinton, Elk, Indiana, Jefferson, Potter ^c , Somerset, Sullivan ^c , Wyoming
Counties in the Marcellus 2nd Tier (N=19)	1 percent-50 percent land area is in the core <u>and</u> 25 percent or more land area is in the less viable areas (2 nd tier or gray areas in Figure 2)	Not applicable	Bedford, Blair, Butler, Carbon, Centre, Clarion, Columbia, Crawford, Forest ^c , Lawrence, McKean, Mercer, Monroe, Montour ^c , Pike, Schuylkill, Venango, Warren, Wayne
Urban Counties in the Marcellus Shale-- Core or 2nd Tier (N=6)	Marcellus Core or 2 nd Tier <u>and</u> identified as urban by the Center for Rural Pennsylvania	Not applicable	Allegheny, Beaver, Erie, Lackawanna, Luzerne, Westmoreland
Counties with No Marcellus Shale (N=23)	25 percent or less viable Marcellus land area or no Marcellus land area	Not applicable	Adams, Berks, Bucks, Chester, Cumberland, Dauphin, Delaware, Franklin, Fulton ^c , Huntingdon, Juniata, Lancaster, Lebanon, Lehigh, Mifflin, Montgomery, Northampton, Northumberland, Perry, Philadelphia, Snyder, Union, York

^aSee McLaughlin, et al. 2012.

^bNote this category includes all four study counties.

^cThese counties are excluded from those analyses that use American Community Survey (ACS) three-year estimates, as their populations are too small to be estimated.

*For more on maps, see the Penn State University Marcellus Center for Outreach and Research (<http://marcellus.psu.edu>) and Dell, Lockshin, and Guber (2008).

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September 2014