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Agricultural Adaptation to Urbanization in Southeastern Pennsylvania

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Most agricultural output in the northeastern United States comes from counties that have experienced significant development. A mail survey, with 300 responses, was conducted in southeastern Pennsylvania to determine farmer adaptation to urbanization in this region. Despite development, traditional agriculture still predominates. Changes in land use were examined using multinomial logit models. Results show that changes in population density and farm preservation policies have an influence, as increased population density reduced total land operated and having land in an agricultural security area increased it. Both differential assessment and agricultural security areas increased the cultivation of traditional, land extensive crops.

Preserving agriculture, both farmland and farmers, in the face of expanding and intensifying urban pressure has become an issue of increasing public interest. Concerns include loss of potential future food production, provision of a local fresh food supply, maintaining a diverse and healthy local economy, preserving open space for environmental and aesthetic reasons, and allowing farmers the choice to remain in farming as a livelihood. The last issue becomes one of being able to maintain a profitable operation. Urbanization—increased residential population and expansion of non-farm business and industry—increases the pressure on farmers and makes it more costly and difficult to farm in the traditional way. At the same time, urbanization also provides opportunities for alternative, higher value agricultural enterprises to take advantage of a nearby urban market.

The issue is complicated by the fact that population and business/industry growth often takes place in prime agricultural areas. More than half the value of U.S. farm production comes from urbanizing counties. In the Northeast, 57% of the value of agricultural production comes from metropolitan counties, with a further 28% of the value from counties adjacent to metropolitan areas (Census of Agriculture 1992). In Pennsylvania, the top five agricultural counties (in terms of value of annual farm sales) are in the southeast part of the state—the region with the greatest development and competition for agricultural land (Hammer et al. 1996). These counties produce 42% of Pennsylvania's market value of agricultural products, on just 16% of the farmland. Currently, dairy, livestock, and cash-grain farms predominate, but nursery and greenhouse crops are gaining in importance. However, agricultural land is being converted to other uses at a rapid rate. A study of threatened agricultural land classified the "Northern Piedmont" region, including southeastern Pennsylvania, as the second-most threatened agricultural area in the country (Sorensen et al. 1997).

Assessing the future of agriculture in these urbanizing areas leads to several important questions. How does urbanization affect farming and how do farmers adapt? Do they change to more high-value enterprises? Do they switch to or add nontraditional activities to take advantage of the proximity of urban consumers? Do farmers simply wait for the right price and sell land for nonagricultural uses? Are the various farmland preservation/right-to-farm policies effective in helping to maintain a viable agricultural economy in urbanizing areas?

This study addresses these questions for a six-county area in southeastern Pennsylvania, a region where development pressure is significant. The re-

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search is based on a 1998 survey of farm households in the region. The paper focuses on three key aspects of farmer response to urban pressure. First are the changes in production activities. There is an expectation that farmers will shift from traditional, more land-extensive enterprises (grain, hay/pasture) to more high value, land-intensive enterprises (fruits, vegetables), or to more intensive livestock enterprises. Shifts also are expected toward nontraditional activities aimed at urban consumers, such as on-farm processing, pick-your-own products, or "agri-tainment." The second aspect is the land market. Do farmers respond to, or take advantage of, urbanization pressure by selling land for non-farm uses, or do they buy to expand operations to generate higher levels of farm income? The third aspect is the impacts of the several types of programs that have been instituted to help keep land in farms and maintain farming activities.

The first section of the paper reviews research on the effects of urbanization on agriculture and the second section presents descriptive results for the study region. Multinomial logit models are then estimated to examine factors influencing different aspects of agricultural change.

The Effects of Urbanization on Agriculture

It is widely recognized that in addition to the direct effect development has on agriculture, i.e., the loss of land that had been in agricultural production, development also affects the remaining agriculture indirectly (Berry 1978, Berry and Plaut 1978, Plaut 1980, Lopez et al. 1988, Lockeretz 1989, Adelaja et al. 1998). These indirect effects can be placed in four categories (Lopez et al. 1988): regulatory effects, technical efficiency effects, speculative effects and market effects. For the most part, these indirect effects of development increase costs and thereby reduce the profitability of staying in production agriculture.

"Regulatory effects" refer to changes in farming practices often required to accommodate increased regulation due to neighboring development and are generally accompanied by declining political power of farmers in the area. Regulations require farmers to incorporate costs of externalities generated by their operations and are primarily a response to increased environmental concerns such as those caused by livestock waste or odor and chemical run-off. Reduced technical efficiency, the "technical efficiency effect," is caused by spillover effects of development. These include vandalism, loss of land to eminent domain, or the increased effort required to obtain inputs with the loss of an agricultural infrastructure. Changing agricultural practices in response to or in fear of nuisance complaints may also reduce technical efficiency.

The "speculative effect" refers to the shortened time horizon farmland owners often have in the face of development pressure, making them disinclined to invest in the farm, and is often referred to as the impermanence syndrome. Owners of farmland will be unlikely to make significant capital investment in the land if they doubt future buyers of the land will be willing to pay for such investment. For example, owners would be less likely to build a new dairy barn on land they believe is likely to be developed when sold. Finally, the "market effect" can be either positive or negative, and refers to the fact that development brings farmers closer to some markets and changes the prices of inputs and products. Increased access to urban or suburban markets reduces transportation costs, facilitating direct marketing of agricultural products. The increase in land values due to development is also a "market effect," as is the greater opportunity for off-farm employment in urbanizing areas.

In attempting to understand the effect of development on agriculture, and therefore assess the effectiveness of policies meant to protect farming, researchers have found that suburbanization has differential effects on agricultural enterprises (Berry 1978, Lopez et al. 1988, Adelaja et al. 1998) and that these effects are not always negative (Schultz 1951, Ruttan 1955, Sisler 1959, Lockeretz 1988 and 1989, Lopez et al. 1988).

Lockeretz (1988) in an extensive study of the effect of urbanization on agriculture in the northeastern United States, found little correlation between increased development and a reduction in farming.[1] None of the demographic indicators Lockeretz used (population density, the non-farm proportion of the rural population, the rate of population increase and the increase in land prices) was related to changes in either the aggregate measures of the agricultural sector or the intensity of production.

Lockeretz (1989) also noted that development can often be beneficial to farmers. It provides opportunities for direct marketing of fruits and vegetables to receive retail rather than wholesale

[1] Lockeretz (1988) found that part-time farms are most common in counties with higher non-farm populations, where the opportunity for off-farm employment is high. He also found that small, intensive farms are most common in highly-urbanized counties, where land is limited and opportunities for direct marketing are great. Beyond these two findings, Lockeretz found little evidence of a direct impact of urbanization on farming.

prices. Some farmers have exploited the potential for "agritainment" such as farm tours, maize mazes and bed and breakfast establishments. There is also greater opportunity for off-farm employment, which, while it does not increase farm profitability, can make continued farm operation a viable option. Using data from New Jersey, Lopez et al. (1988) evaluated each of the effects of development separately for various types of agricultural enterprises (categorized as livestock, vegetables, fruits and grains) and the use of inputs (land, labor, capital and intermediate inputs). The net consequence of these effects was that production became more labor intensive with urbanization, and in terms of profits, only vegetable production benefited from the combined effects of development.

It is generally agreed that dairy production and livestock farming in general are less compatible with urbanization, but the perceived reasons vary. Adelaja et al. (1998) found that higher land values, by increasing the opportunity cost of land, reduced the size of dairy herds, whereas, Lopez et al. (1988) found that livestock production is especially discouraged by development because it can cause more conflicts with neighbors due to odors (leading to regulatory and technical effects) and requires fixed capital investment, which is discouraged by the speculative effect.

Agriculture in Southeastern Pennsylvania

Six counties from southeastern Pennsylvania were selected for study: Berks, Bucks, Chester, Lancaster, Lehigh and Montgomery. These counties face significant development pressure, but still have a viable agricultural economy. The main urban centers affecting these counties are Philadelphia, Allentown, Reading and Lancaster. These counties are highly developed; the populations in these counties are 57.6% to 90.2% "urban" or "urbanized" (U.S. Census Bureau 1990). Nonetheless, they still produce 38% of the value of Pennsylvania's agricultural output, on only 14% of its farmland (Census of Agriculture 1997). In spite of development, the area of land in farms in these counties actually increased from 991,189 acres to 1,005,425 acres over the 1992–97 period (Census of Agriculture 1997).

In the six urbanizing counties, a total of 800 farms were randomly selected to receive a questionnaire. These farms were selected from address lists provided by the Farm Service Agency, and one out of every ten addresses was selected. A mail survey was sent to each farm in July 1998. To ensure a reasonable response rate, reminders were sent three and five weeks after the initial mailing. A total of 477 surveys (60%) were returned. Of these, 300 questionnaires were complete and 177 were partially complete, or the survey respondent reported the farm had been sold to another farmer or for another purpose.

The survey instrument included questions on the characteristics of the farm, changes in land use and enterprises (farm and farm-related) over a 10-year period (1988–1998), land use policies, utilization of labor on-farm and off-farm, and basic demographic characteristics of the farm household. Survey questions focused on the adaptations being made by farms in this region, including changes in land operated, changes in the mix of farm enterprises, and the start-up of farm-related businesses such as value-added processing and enterprises such as "pick your own" and "bed and breakfast" businesses to appeal to urban consumers. Questions were also asked regarding the extent of urban development pressure, including the prevalence of nuisance complaints against the farm by neighbors and sales of farmland for business and residential development, as opposed to sales for farming. Finally, to provide a context for analysis, data were also collected on the density of population in each township in which responding farms were located and on land use programs that are used locally to protect farming. Population density (people per square mile) data for 1990 and 1998 were gathered from the Pennsylvania State Data Center and the U.S. Census. Questions on land use programs such as differential assessment of agricultural land, agricultural zoning, conservation easements, purchase of development rights (PDR), and right-to-farm legislation (RTF) were included in the survey.

Characteristics of Surveyed Farms

In 1998, the responding farmers operated an average 141 acres of land, slightly more than half of which was rented. Their mean age was 52 years, 94% were male, and they had an average 12 years of education. Twelve percent of farms had agricultural sales of at least $250,000 annually. The percentage of farms in the smallest category, those with gross sales of less than $40,000, was approximately 42%. The medium sized farms, those with sales between $40,000 and $249,999, comprised 46% of the responding farms. The majority of farms, 70% were sole proprietorships, while 9% were partnerships and 18% were family corporations. The remaining 4% were classified as "other" including a mixture of ownership categories, non-family corporations and non-commercial farms.

The respondents to the survey are quite similar

Table 1. Measures of Urbanization Pressure on Sample Farms in Southeast Pennsylvania

Township Population Density 1990.	≤200/mi²	201–500/mi²	≥501/mi²	Total
Number of farms	143	121	36	300
Percent of farms	47.67%	40.33%	12.00%	100.00%
Percent Change in Township Population Density 1990–98.	**≤10%/mi²**	**11–25%/mi²**	**≥26%/mi²**	**Total**
Number of farms	183	92	25	300
Percent of farms	61.00%	30.67%	8.33%	100.00%

to the others in the state, as data from the 1997 Census of Agriculture show the average farm in the state had 158 acres, the mean age of farm operators was 53, and 93% of farm operators in 1997 were male. The categories for gross farm sales differ from those used in this study, making direct comparisons difficult. While the categories of farm organization differ somewhat, it seems the sample used in the study has a higher degree of partnerships and corporations, as only 11% of farms in the state fell into that category.

Nearly half of the farms (48%) were located in townships with 1990 population density of 200 people per square mile or less, while another 40% were in townships with 201–500 people per square mile (table 1). The region has experienced rapid population growth, as 8% of the farms were in townships with a population density growth rate of 26% or more from 1990 to 1998 and a further 31% of farms were in townships with 11 to 25% growth rates.

In urbanizing agricultural areas, a frequent problem farmers face is complaints about farming practices. In our sample, almost 40% of respondents reported having received complaints in the previous five years. There was no statistical relationship between township population density change and complaints received, but there was between population density in 1990 and complaints. The tendency was for farmers in the least dense townships in 1990 to have received proportionately more complaints in recent years. This is probably because these townships have more agricultural activity, leading to more complaints from residents.

Adaptation Strategies

One indicator of the impacts of urbanization on agriculture is the adjustment that farmers make in their farming activities. The expectation is that urban pressure will cause farmers to shift from traditional to either more intensive or high value enterprises. In a survey conducted west of Toronto, Johnston and Bryant (1987) identified six strategies adopted by farms in that region: 1) pick-your-own operations, 2) establishment of retail outlets, 3) land-extensive cash cropping, 4) direct livestock sales, 5) supplemental employment and 6) single-lot severance. Among the farmers surveyed in southeast Pennsylvania, however, most still produce the crops traditionally grown in the region, and major changes are not evident. In 1998, 74% of the farms produced cash grains and 71% produced hay or pasture for livestock (table 2). Very few farms produced fruits (4%), vegetables (7%), or nursery plants (2%). Over the 10-year period, there were slight decreases in average acreage per farm in grains, hay and vegetables, and increases in average nursery plant acreage. Paired t-tests be-

Table 2. Changes in Agricultural Production in Southeastern Pennsylvania Survey Farms, 1988 and 1998

	1988			1998		
Crop	N	Mean	Standard deviation	N	Mean	Standard deviation
		—acres—			—acres—	
Grain	186	111.301	231.027	221	109.511	167.433
Hay/Pasture	179	52.022	148.911	212	47.670	114.900
Nursery	5	34.200	39.934	7	40.857	52.737
Vegetables	15	22.533	36.841	20	20.550	34.430
Livestock	N	—number—		N	—number—	
Hogs	38	351.974	587.921	31	343.419	651.748
Horses	63	6.397	4.861	84	7.190	4.661
Cows-milked	97	49.928	42.852	104	52.221	37.399
Beef	74	76.446	111.303	73	73.288	102.193
Laying hens	41	6,409.05	15,173.31	43	3,467.72	11,823.15
Broilers	9	52,808.89	103,570.0	11	127,474.1	205,986.4

tween the 1988 and 1998 means showed that the changes in the acreage of grains, hay and nursery plants were significant at the 10% level or better.

Patterns of livestock ownership also did not change dramatically over the 10-year period. More than one-third of respondents (35%) had dairy cattle in 1998, with slightly lower percentages having beef cattle and horses. There were slight increases in the average number of dairy cows and horses in 1998 as compared to 1988, and a more than doubling of the number of broilers per farm. Slight decreases were noted in the average number of beef cattle and hogs, but a large decrease (46%) in the average number of laying hens took place. However, only the changes in the number of horses and hogs were statistically significant (table 2).

Another strategy to adapt to urbanization pressures is to engage in non-traditional enterprises, such as on-farm processing, direct marketing, or "agri-tainment." Only a relatively small proportion of the respondents (15%) reported being involved in any of these types of activities, and this involvement did not differ statistically by township population density or change in density. Govindasamy et al. (1999) analyzed data from a survey of farmers in New Jersey who were involved in various types of direct marketing and other income-generating activities, to determine which of these activities are most likely to increase farm incomes. They found that selling produce through garden centers or greenhouses was most likely to increase gross farm income. In addition, hosting farm festivals, direct retailing, selling value-added products and selling in an urban or suburban market all increased the probability of obtaining a higher farm income. Rather surprisingly, pick-your-own operations and the use of temporary sale facilities (such as stands or wagons) reduced the odds of obtaining a higher farm income. Other practices, including farm tours, organic production and sales location in a commercial zone had no statistically significant effect on farm income. The low adoption rate of these practices among respondents probably reflects their recognition that these practices may do little to raise farm income.

A further strategy to adapt to urbanization and maintain a farm livelihood is to seek off-farm income sources. Previous research in Pennsylvania (Hallberg et al. 1987) found that over half of farm families had off-farm employment, and that 72% of those families earned more than half their taxable income from this work. The respondents to this survey conform to this pattern, as almost half (or their spouses) had off-farm work, but off-farm employment generated only about 25% of household income. On average, more than half (53%) of household income came from sales of agricultural products, and another 7% from custom work and other on-farm value-added activities. The remainder was from other sources such as dividends, pensions and government payments, and rent or lease payments.

Another key indicator of the impacts of urbanization on agriculture is change in farmland. To assess this impact, respondents were asked about land purchases and sales, and the subsequent use of the land. Twenty-five percent of the surveyed farmers bought agricultural land between 1988 and 1998. Of those who bought land, 82% indicated it was for expanded agricultural production, either for existing enterprises or new enterprises. However, 36% also said they had purchased land for investment purposes, presumably hoping to take advantage of rising land values. Of those who did not buy agricultural land, only 37% stated it was because they did not need additional land. The remainder indicated that agricultural land was too expensive (61%), that it was not available (29%) or that financing was not available (20%).[2]

The reasons for purchasing, or not purchasing, land provide some indication of future farming intentions and the confidence that farmers have in the future of farming in urbanizing areas. The minority of farmers who purchased land in the 1988–1998 period expects they can continue to farm profitably in the region. At the same time, the 36% who bought land for speculation, as well as those who considered land too expensive or unavailable, indicates that there may be some difficulty in keeping land in agriculture in the future. Access to land may be particularly difficult for young farmers. Furthermore, while the purchases of land by farmers did not differ statistically by township population density or change in density, only 9% of the purchases were in the most densely populated townships, or those with the greatest increase in density. These results reflect the market effect of urbanization impact on agricultural land values.

Sales of land are somewhat more revealing of the impacts of urban pressure on farmers. A considerably higher percent of respondents sold agricultural land in the ten years previous to the survey (41%). Of these sales, only 23% of the parcels are still in agriculture. More than half (52%) said the sold land has been converted to housing, with the remainder being used for business, industry or other purposes. None of the land sold in the townships of greatest population density increase re-

[2] Respondents were able to provide more than one reason for purchasing (or not purchasing) land.

mained in agriculture, and even in the townships with low population density or slight increases in population density, only about one third of the land sold remained in agriculture.

Perceptions of Farmland Preservation Policies

A major focus of public policy in response to urban pressure on farming has been to create programs to mitigate the impacts of urbanization on farmers and help preserve farming activities. These include differential assessment of agricultural land, agricultural security areas, agricultural zoning, conservation easements, purchase of development rights (PDR), and right-to-farm (RTF) legislation. Pennsylvania has all of these tools. In this sample, 75% of the respondents had taken advantage of differential assessment, and 37% were in agricultural security areas. Farms in agricultural security areas do not face restrictions on land use, but they receive three benefits. First, township supervisors in these areas agree not to enact nuisance ordinances that restrict customary farming practices, second, farmers have greater protection against eminent domain claims, and third, the landowner becomes eligible to apply for the purchase of development rights.

To assess the impacts of these programs, farmers were asked if the policies of agricultural zoning, conservation easements, the purchase of development rights and right-to-farm legislation had had a beneficial effect, harmful effect or no effect on their farming operations. While only a minority felt that the policies had any effect, all but zoning were perceived by a higher percentage of farmers to have had beneficial effects. Discussions with focus groups in these counties[3] suggested this may be because zoning is sometimes so restrictive it prohibits other income-generating activities.

Comparisons of the relationship between the opinions about the effects of the land/farm preservation programs and the urbanization measures indicate that township population density change is related to the perceptions of program effectiveness. There is a tendency for a relatively higher percentage of farmers to view the policies as beneficial as the change in population density increases. This effect seems to be most pronounced in the middle range of density increase. Farmers in townships with the smallest increases in population density are most likely to see no effect of the policies. The results are similar for percentage change in density.

Perceptions of the survey respondents about the effects of the specific programs are examined in tables 3–5. Perceived harmful effects of zoning are relatively more prevalent in the townships with the greatest density change (39%), while opinions of a beneficial effect are much more prevalent in the medium-change townships (29%). Farmers in townships with the least density change overwhelmingly state zoning has no effect on their farm operation (59%). Beneficial perceptions of conservation easements are particularly high in the medium and high change townships (16 and 17%, respectively) and quite low in the lowest density change areas (6%). They are seen as relatively more harmful in the highest density change townships (13%). More than 80% of farmers responded that either conservation easements have no effect on their farming or do not apply to their land.

Table 3. Perception of Zoning, by Change in Township Population Density

Perception of Zoning	Change in Population Density		
	≤20/mi²	21–50/mi²	≥51/mi²
Beneficial	7	11	1
	10.00%	28.95%	4.35%
Harmful	13	6	9
	18.57%	15.79%	39.13%
No Effect	41	15	10
	58.57%	39.47%	43.48%
Not Applicable	9	6	3
	12.86%	15.79%	13.04%
Total	70	38	23
	100%	100%	100%

Chi-squared significance: 0.025

Table 4. Perception of Conservation Easements, by Change in Township Population Density

Perception of Conservation Easements	Change in Population Density		
	≤20/mi²	21–50/mi²	≥51/mi²
Beneficial	4	6	4
	5.71%	15.79%	17.39%
Harmful	1	0	3
	1.43%	0.00%	13.04%
No Effect	38	13	10
	54.29%	34.21%	43.48%
Not Applicable	27	19	6
	38.57%	50.00%	26.09%
Total	70	38	61
	100%	100%	100%

Chi-squared significance: 0.000

[3] Before developing the survey, the researchers met with farmers from Berks, Chester, and Lancaster counties to determine what issues they felt were important to farmers in their area. These farmers were invited based on suggestions from the county agricultural extension offices.

Table 5. Perception of Right to Farm, by Change in Township Population Density

	Change in Population Density		
Perception of RTF	≤20/mi²	21–50/mi²	≥51/mi²
Beneficial	8	13	8
	11.43%	34.21%	34.78%
Harmful	0	0	1
	0.00%	0.00%	4.35%
No Effect	38	12	9
	54.29%	31.59%	39.13%
Not Applicable	24	13	5
	34.29%	34.21%	21.74%
Total	70	38	23
	100%	100%	100%

Chi-squared significance: 0.000

Almost no harmful perceptions were held about right-to-farm programs, and among the beneficial opinions, the RTF programs are seen as relatively more beneficial as population density change increases. More than half of the farmers in townships with little change believed RTF programs had no effect on their farming. Similar tendencies are present for the PDR program, although the differences are not statistically significant.

Analytical Models

To estimate how farmers in southeastern Pennsylvania are responding to the effects of urbanization and the several programs designed to help maintain agriculture, a set of multinomial logit models were estimated. The multinomial logit approach provides a set of probabilities for the choices individuals make based on their personal characteristics and those of their farms, and is used with multiple binary choices.

Following Greene (1993), the general multinomial logit model is:

$$\text{(1)} \qquad \text{Prob}(Y_i = j) = \frac{e^{\beta_j x_{in}}}{\sum e^{\beta_j x_{in}}}$$

where Y is the dependent variable representing the choice made, j indexes the choices, x is a vector of individual characteristics, i indexes the individuals, n indexes the independent variables, e is the natural base of logarithms and β is a vector of unknown parameters.

The coefficients in this model do not represent the marginal effects, i.e., how a change in an independent variable affects the probability of a particular choice being made. The marginal effects of the regressors on the probabilities are determined by:

$$\text{(2)} \qquad \frac{\partial P_j}{\partial x_n} = P_j\left[\beta_j - \sum P_j \beta_n\right]$$

Models were estimated for the dependent variables (Y_i) representing (1) change in hay, pasture and grain acreage, and (2) change in acres of land owned and operated (owned plus rented). The estimated models for the change in acres cultivated or land operated incorporate three choices—an increase in acreage/farmland, a decrease in acreage/farmland, or no change. The empirical model for change in farmland operated and cultivation of traditional crops in the six-county area is specified as:

$$\begin{aligned}\text{Prob}_j = {} & \beta_0 + \beta_1\text{Urbanization} \\ & + \beta_2\text{Differential assessment} \\ & + \beta_3\text{Agricultural Security Area} \\ & + \beta_4\text{Complaints} \\ & + \beta_5\text{Off-farm employment} \\ & + \beta_6\text{Policies} \\ & + \beta_7\text{Medium-sized farm} \\ & + \beta_8\text{Large-sized farm} \\ & + \beta_9\text{Nontraditional activities} \\ & + \beta_{10}\text{Respondent's age} \\ & + \beta_{11}\text{Respondent's age}^2 \\ & + \beta_{12}\text{Respondent's education} \\ & + \beta_{13}\text{Respondent's education}^2 \\ & + \beta_{14}\text{Incorporated}\end{aligned}$$

where

Prob_j = 1 if the area of land owned increased between 1988 and 1998, 2 if the area decreased, and 0 if there was no change.

Urbanization measure = the percent change in population density (1990–1998) in the township in which the farm is located.

Differential assessment = 1 if the farmer owns land assessed at its agricultural use value rather than its market value, and 0 otherwise.

Agricultural security area = 1 if the farmer owns land in an agricultural security area, and 0 otherwise.

Complaints = 1 if the farmer has received any complaints in the past five years about agricultural practices, and 0 otherwise.

Table 6. Descriptive Statistics for Independent Variables in Multinomial Logit Models

Variable	Mean	Standard deviation	Minimum	Maximum
Urbanization measure	0.1232	0.1238	0.0000	0.8452
Differential assessment	0.7939	0.4061	0.0000	1.0000
Agricultural Security Area	0.3969	0.4911	0.0000	1.0000
Policies	0.3282	0.4714	0.0000	1.0000
Complaints	0.4351	0.4977	0.0000	1.0000
Medium-size farm	0.5344	0.5007	0.0000	1.0000
Large-size farm	0.0916	0.2896	0.0000	1.0000
Nontraditional activity	0.1832	0.3883	0.0000	1.0000
Respondent's age	52.9008	12.7230	27	84
Respondent's age squared	2959.13	1425.67	729	7056
Respondent's education	12.000	3.5626	4	23
Respondent's education squared	156.60	91.099	16	529
Off-farm employment	0.4733	0.5012	0.0000	1.0000
Incorporated	0.1450	0.3535	0.0000	1.0000

N = 131. As surveys with incomplete information were not included, the descriptive statistics are somewhat different than those reported for the entire sample in the text.

Off-farm employment = 1 if the respondent or spouse has off-farm employment, and 0 otherwise.

Policies = 1 if the respondent believes policies including zoning, conservation easements and/or right-to-farm legislation have had a beneficial effect on the farming operation, and 0 otherwise.

Medium-sized farm = 1 if the farm had farm product sales with a gross value between $40,000 and $249,000 in 1987, and 0 otherwise[4]

Large-sized farm = 1 if the farm had farm product sales with a gross value of $250,000 or more in 1987, and 0 otherwise.

Nontraditional activity = 1 if the farm is involved in value-added production or other income-generating activities, and 0 otherwise.

Respondent's age = the age of the survey respondent.

Respondent's education = the years of formal education the respondent has received.

Incorporated = 1 if the farm is a family corporation, and 0 otherwise.

One category was omitted from each of the dummy variables above to serve as the reference category. The base farm therefore has land assessed only at its market value, is not in an agricultural security area, had agricultural sales of less than $40,000 in 1987 and is not a family corporation. The base respondent to the survey also perceives no benefit from agricultural zoning, conservation easements, the purchase of development rights and/or right-to-farm legislation, and neither the respondent nor the spouse has off-farm employment. The descriptive statistics for these variables are reported in table 6.

Multinomial logit models are reported for the change in hay and grain acreage, and change in acres of land operated (owned plus rented) (tables 7 and 9, with marginal effects in tables 8 and 10). The only urbanization measure used is the percent change in township population density, as population density in 1990 was not statistically significant. The change in hay/grain acreage is used a measure of whether or not farmers maintain the traditional farming scheme under urban pressure. The change in land operated is a broader measure of the impacts of urbanization on farming; whether farmers increase acreage to take advantage of market advantages, decrease due to negative effects of urbanization or continue to farm at the same scale. Overall, the results show that urbanization pressure, as measured by percent change in township

[4] The value of sales in 1987 was used to provide a baseline for the size of farm at the start of the study period, as we are evaluating change between 1988 and 1998.

Table 7. Estimated Coefficients for Multinomial Logit Model of Changes in Total Land Operated

Variable	Estimated Coefficients: Increase in land	Estimated Coefficients: Decrease in land
Intercept	2.0619	2.4558
	(0.6902)	(0.6566)
Urbanization measure	1.0595	3.4249*
	(0.6089)	(0.0828)
Differential assessment	0.2745	–0.7032
	(0.6721)	(0.2460)
Agricultural Security Area	1.2257**	0.6558
	(0.0208)	(0.2560)
Policies	–1.0527*	–0.8091
	(0.0661)	(0.1931)
Complaints	1.2760**	0.5980
	(0.0110)	(0.2816)
Medium-size farm	–1.1967*	–0.5425
	(0.0709)	(0.3987)
Large-size farm	–0.7674	–0.7865
	(0.4268)	(0.4896)
Nontraditional activity	–0.3944	0.8149
	(0.5481)	(0.1930)
Respondent's age	–0.0501	–0.1839
	(0.7716)	(0.2866)
Respondent's age squared	–0.0001	0.0018
	(0.9543)	(0.2344)
Respondent's education	0.0583	0.2202
	(0.8692)	(0.5718)
Respondent's education squared	–0.0009	–0.0023
	(0.9486)	(0.6369)
Off-farm employment	–0.5347	–0.2284
	(0.3635)	(0.7270)
Incorporated	–1.3196*	–1.4152
	(0.0838)	(0.1073)

NOTES: N = 131; Significance levels: *Denotes significance at 10%, **denotes significance at 5% and ***denotes significance at 1%. The values in parentheses below the coefficients are the probability $|Z| > z$. Log-L = –114.7425.
65.6% concordant responses predicted by the model.

Table 8. Marginal Effects for Multinomial Logit Model Analyzing Changes in Total Land Operated

Variable	Marginal Effects[a]: Increase in land	Marginal Effects[a]: Decrease in land	Marginal Effects[a]: No change in land
Intercept	0.2827	0.2724	–0.5551
Urbanization measure	0.0104	0.4930	–0.5034
Differential assessment	0.1019	–0.1319	0.0300
Agricultural Security Area	0.2182	0.0307	–0.2488
Policies	–0.1721	–0.0665	0.2385
Complaints	0.2314	0.0181	–0.2505
Medium-size farm	–0.2191	–0.0140	0.2331
Large-size farm	–0.1132	–0.0806	0.1937
Nontraditional activity	–0.1341	0.1576	–0.0235
Respondent's age	0.0008	–0.0269	0.0260
Respondent's age squared	–0.0001	0.0003	–0.0002
Respondent's education	–0.0014	0.3231	–0.0309
Respondent's education squared	0.0003	–0.0011	0.0009
Off-farm employment	–0.0988	–0.0039	0.1027
Incorporated	–0.1907	–0.1488	0.3394

[a]Marginal effects are calculated at the sample means.

population density, and the programs to preserve land and/or farming have had an impact on agricultural practices.

The change in acres of farmland operated (owned plus rented) is considered a measure of the overall impact on agriculture of the variables in the model. Of the 131 farms with complete responses for this model, 60 (46%) had no change in the amount of farmland operated, 43 (33%) increased their acreage from 1988 to 1998 and 28 (21%) decreased it. Having land in an agricultural security area and receiving complaints about agricultural practices are positively related to increases in total land operated, while medium-sized farms, incorporated farms and those who perceive benefits from land policies were less likely to have increased land operated (table 7). The marginal effects calculations (table 8) show that having land in an agricultural security area increased the likelihood of having increased land operated by 0.218, indicating this policy may be having its intended effect of enabling continued agricultural production. Surprisingly, the receipt of complaints about agricultural practices increased the likelihood of increased land operation by 0.231. This result probably reflects the correlation between low-population density townships and complaints, showing that farms in low-population density townships where agriculture is widespread were more likely to expand production. Having a medium-sized farm, an incorporated farm and perceiving benefits from agricultural preservation policies reduced the likelihood of expanded land operation by 0.219, 0.191 and 0.172, respectively. This indicates medium-sizes farms had sufficient land to be viable, while incorporated farms may be less likely to change because of difficulty in forming agreement among the several owners. The rather counter-intuitive finding that those who find benefit in agricultural preservation policies were less likely to increase their land holding is probably because these respondents are more likely to live in townships with high population change and face the greatest pressure from urbanization.

Of farms that decreased total land operated, only the percent change in population density was statistically significant. Each 1% increase in population density increased the likelihood of reduced land operated by 0.493, showing the direct and dramatic effect of urbanization on agriculture.

Table 9. Estimated Coefficients for Multinomial Logit Model of Changes in Acres of Traditional Crops

	Estimated Coefficients	
Variable	Increase in land	Decrease in land
Intercept	0.6331	−0.2411
	(0.8991)	(0.9683)
Urbanization measure	−2.2382	0.4914
	(0.2801)	(0.8034)
Differential assessment	1.3029**	0.0768
	(0.0469)	(0.9090)
Agricultural Security Area	1.7903***	0.2702
	(0.0010)	(0.6741)
Policies	−1.1777**	0.2361
	(0.0414)	(0.7148)
Complaints	−0.2767	−0.8148
	(0.5712)	(0.1604)
Medium-size farm	−0.0032	1.7141**
	(0.9958)	(0.0178)
Large-size farm	−0.2901	0.9668
	(0.7503)	(0.3991)
Nontraditional activity	−0.7386	0.3251
	(0.2328)	(0.6142)
Respondent's age	0.0081	−0.1174
	(0.9593)	(0.4971)
Respondent's age squared	−0.0004	0.0010
	(0.7954)	(0.5105)
Respondent's education	−0.0860	0.2007
	(0.8060)	(0.6807)
Respondent's education squared	0.0023	−0.0038
	(0.8659)	(0.8376)
Off-farm employment	−0.3561	−0.4025
	(0.5317)	(0.5656)
Incorporated	−0.3805	−0.6964
	(0.5737)	(0.4105)

NOTES: N = 131; Significance levels: *Denotes significance at 10%, **denotes significance at 5% and ***denotes significance at 1%. The values in parentheses below the coefficients are the probability $|Z| > z$. Log-L = −113.7145.
55.0% concordant responses predicted by the model.

Acreage in hay, pasture or grain production (considered a proxy for traditional, or land-extensive, agricultural practices) showed some similar trends. Fifty-five farms (42%) had no change in acreage of these traditional crops from 1988 to 1998, while 52 farms (40%) increased their acreage and 24 farms (18%) decreased it. Having land assessed at its agricultural use value and having land in an agricultural security area were both associated with increased production of these traditional products (table 9). Having land assessed for its agricultural use value and operating land in an agricultural security area increased the likelihood of increased acreage of hay, pasture or grain by 0.304 and 0.407, respectively, (table 10), showing these policies are having their intended effect of protecting agriculture. However, the perception

Table 10. Marginal Effects for Multinomial Logit Model Analyzing Changes in Acres of Traditional Crops

	Marginal Effects[a]		
Variable	Increase in acres	Decrease in acres	No change in acres
Intercept	0.1664	−0.0763	−0.0901
Urbanization measure	−0.5643	0.2187	0.3456
Differential assessment	0.3044	−0.0758	−0.2286
Agricultural Security Area	0.4073	−0.0808	−0.3265
Policies	−0.2954	0.1119	0.1837
Complaints	−0.0116	−0.0973	0.1088
Medium-size farm	−0.1148	0.2436	−0.1288
Large-size farm	−0.1332	0.1566	−0.0233
Nontraditional activity	−0.1971	0.0953	0.1018
Respondent's age	0.0097	−0.0172	0.0075
Respondent's age squared	−0.0002	0.0002	−0.0001
Respondent's education	−0.0338	0.0342	−0.0004
Respondent's education squared	0.0008	−0.0007	−0.0001
Off-farm employment	−0.0578	−0.0335	0.0913
Incorporated	−0.0440	−0.0736	0.1176

[a]Marginal effects are calculated at the sample means.

of benefits from agricultural preservation policies decreased the likelihood of expanded production of traditional crops by 0.295, again indicating that those who perceive a benefit from these policies are those under the greatest pressure. Having a medium-sized farm, with 1987 gross sales between $40,000 and $249,999, increased the likelihood that production of these crops was reduced by 0.244, as they converted their land to other uses.

Conclusion

The overall objective of this paper was to examine the effects on agriculture of urbanization pressure, and the effects of a variety of programs designed to alleviate this pressure on farmers. The study area was six counties in southeastern Pennsylvania, an area of strong and increasing urbanization, but also an area of productive agriculture, and an agriculture that is still characterized by traditional agricultural enterprises.

Urbanization (defined as an increase in population density) puts pressure on farms and farmers to change or adapt. These changes can take the forms of selling land, reducing farm operations, moving to more land-intensive or high-value enterprises, engaging in nontraditional activities that cater to urban populations, and earning income from off-farm work. Considerable public policy efforts are focused on alleviating these pressures to enable farmers to continue farming as they have.

The results of a survey of farmers in the six-county region of southeastern Pennsylvania show that both urbanization and the public programs are having impacts on agriculture. At the same time, major changes or adaptations do not appear to be taking place. Traditional agricultural enterprises, such as livestock and grains still predominate, and widespread changes were not noted. While the market effect brings farmers and consumers closer together, few farmers are responding to this by changing products or marketing techniques. This finding reflects that of Govindasamy et al. (1999) in that many types of value-added production and direct marketing may not increase farm income.

Multinomial logit models were used to examine the impacts of urbanization, the perception of farm and farmland preservation programs, and a set of farm and farmer characteristics on changes in the amount of land in traditional enterprises and land operated as a farm. In contrast to Lockeretz (1988), increasing population density was found to have a strongly negative impact on the amount of land operated. This is an impact that would be expected. This result does not answer, however, the question of why this change is occurring. It is likely that profitability is too low and the land is too valuable in other uses. There was some indication from the survey that land availability and cost limit the ability of farmers to expand. Also, most land that was sold went into nonagricultural uses.

Farm size in 1987 was also associated with a negative impact on change in acreage in hay, pasture and grain and total land operated. Medium-sized farmers were less likely to expand total production and more likely to reduce production of traditional crops. This may be because medium-sized farms may not feel the need to expand, because they are sufficiently profitable, while smaller farms may need more land to provide sufficient income.

The results provide evidence that the farm and land preservation programs are having the desired effects. Having land in an agricultural security area was strongly associated with an increase in both the total amount of land operated and the cultivation of traditional crops, indicating this policy may be mitigating the regulatory and technical efficiency effects of urbanization. Assessment of farmland at its agricultural use value was also associated with an increase in the acreage of traditional crops as it reduces the market effect of increased land values. However, farmers who perceived benefit from farm preservation policies such as agricultural zoning and right to farm legislation were less likely to increase total land operated or land in traditional crops. As farmers in rapidly urbanizing areas were more likely to find these programs beneficial, this result may indicate that these farmers feel the most pressure from urbanization. Although farmers who need these programs most recognize their benefit, farm policies may only be effective where urbanization pressure is not overwhelming.

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