Do Agricultural Preservation Programs and Preferential Property

Tax Programs Affect Farmland Conversion?

Lori Lynch

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Department of Agricultural and Resource Economics
2200 Symons Hall
University of Maryland
College Park, MD 20742
301-405-1264 (tel.)
301-314-9091 (fax)
llynch@arec.umd.edu

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Population growth and lower density housing resulted in land being converted out of agriculture. In the Mid-Atlantic region as a whole, the rate of farmland loss was almost 50% between 1949 and 1997. In metropolitan areas, the rate of farmland loss was even higher (Lockeretz 1989; Gardner 1994). As a result of public concerns about the loss of farmland and the increase in suburban sprawl, states and counties instituted programs to arrest or slow farmland conversion. Gardner (1977) proposed that four benefits can be derived from the protection of productive agricultural land: 1) local and national food security, 2) employment in the agricultural industry, 3) efficient development of urban and rural land, and 4) the protection of rural and environmental amenities. Economists have dismissed food security and employment arguments due to confidence in the market system to allocate land between these uses (Gardner 1977). Citizens advocate preserving farmland for food security, local economic conditions, and amenity value reasons. These farmland preservation programs set four types of goals: controlling urban growth, ensuring food security, protecting the viability of the local economy, and conserving the environmental services and rural amenities that farmland provides (Hellerstein et al. 2002).

More than 110 governmental entities have implemented transfer of development rights (TDR) and purchase of development rights or purchase of agricultural conservation easements (PDR/PACE) programs to permanently preserve farmland (American Farmland Trust (AFT) 2001, AFT 2002a, AFT 2002b). States have preserved 922,287 acres, local governmental PDR programs 213,654 acres, and local TDR programs 88,575 acres, for a total of 1,224,516 acres in some form of agricultural easements. Spending to

date in both state and local programs to purchase these easements has been $1.984 billion (AFT 2002a), the per capita cost ranging from $0.30 in North Carolina to $87.14 in Delaware. Citizens continue to pass ballot initiatives generating funds for these types of programs: in 2002, $5.7 billion in conservation funding was authorized; in 2001, $1.7 billion; and in 2000, $7.5 billion (Land Trust Alliance, www.lta.org). Given the resources that continue to be expended on these programs rather than on other types of programs, empirical evidence as to their effectiveness in impacting farmland conversion is needed.

Six Mid-Atlantic States (Delaware, Maryland, New Jersey, New York, Pennsylvania and Virginia) experienced a 47% decrease in farmland between 1949 and 1997. Of the 26.1 million acres lost, 20 million acre or 80% were lost before 1974. The loss averaged 800,000 acres per year between 1949 and 1974. The Mid-Atlantic region was one of the first to implement farmland preservation programs. Southampton and Suffolk counties, New York created the first local purchase of development rights programs in the early 1970's. Maryland and Massachusetts each introduced state Purchase of Agricultural Conservation Easement (purchase of development rights programs (PDR/PACE)) programs in 1977. In the Mid-Atlantic study area, all six states had implemented some type of preferential taxation by 1982 and by 1997, 5 of the 6 states had an agricultural preservation program under which farmland owners could enroll their land. Table 1 presents the date of implementation, the data of first easement purchase, the number of acres preserved as of January 2002, and the cost of governmentally purchased easements for the state programs. Additionally, 29 counties (or townships within counties) had begun local PDR or TDR programs. Table 2 presents

the date of implementation, the data of first easement purchase, the number of acres preserved as of January 2002, and the costs of governmentally purchased easements for the local programs. Despite Maryland's successful state program under which 198,276 acres have been preserved (MALPF, 2001), 371,000 acres have been converted to another (usually residential or commercial) use simultaneously. Thus only half as much agricultural land was preserved compared to agricultural land converted. This begs the question – do these agricultural land preservation programs have any effect on the rate of farmland loss? Empirical evidence on their effectiveness is needed.

This paper examines the impact of having a preservation program on the rate of farmland loss for a 50 year period (1949-1997) in six Mid-Atlantic States: Delaware, Maryland, New York, New Jersey, Pennsylvania, and Virginia. Because farmland loss is affected by changing agricultural profitability, demand for land for non-agricultural purposes, and farmers' alternative employment opportunities, we include variables to control for these factors as well. Because a high rate of farmland loss may actually be the reason a county or state begins a preservation program, we need to determine if this endogeniety is causing biased and inconsistent results. If farmland preservation programs are only in counties with a high rate of farmland loss, then we need to establish what might have been the farmland loss rate if the program had not existed to determine if the program is having an impact.

Econometric Model

Economic theory suggests that the optimal amount of farmland preservation is the amount where the marginal benefit equals the marginal costs assuming that the market and non-market benefits of the land remaining in a farm use can be measured. Given that

the marginal benefits of preserving an additional acres of farmland in areas where fewer acre remain may be higher, the optimal amount of farmland preservation relative to farmland conversion may be endogenous. In addition, people may advocate creating farmland preservation programs in those areas where farmland loss is occurring more rapidly. An identification problem arises because the existence of a farmland preservation program may be a function of the rate of farmland loss. Thus the existence of a farmland preservation program may be positively correlated with the rate of farmland loss. However, local and state governments undertake farmland preservation programs to arrest or stop farmland loss. If we consider the following three simultaneous equations model:

1 $FL_{it} = \beta_0 + \beta_1 PP_{it} + \beta_2 PT_{it} + \beta_3 X_{FL,it} + u_{it}$

2 $PP_{it} = \alpha_0 + \alpha_1 FL_{it} + \alpha_3 X_{PP,it} + w_{it}$

3 $PT_{it} = \phi_0 + \phi_1 FL_{it} + \phi_0 X_{PT,it} + \varepsilon_{it}$

where FL_{it} is the rate of farmland loss in period t for county i, PP_{it} is the existence of an agricultural land preservation program in period t in county i, PT_{it} is the existence of a preferential taxation program for agricultural land in period t in county i. $X_{FL,it}$ is a vector of other variables that affect the rate of farmland loss in period t in county i, $X_{PP,it}$ is a vector of other variables that affect the existence of a preservation program, and $X_{PT,it}$ is a vector of other variables that affect the existence of a preferential taxation program.. The β's, α's, and φ's are vectors of parameters to be estimated. The u_{it}, w_{it}, and ε_{it} are the random disturbance terms for county i in period t. If we assume that u_{it}, w_{it}, and ε_{it} are independently and identically normally distributed, then u_{it} is distributed independently of $X_{PP,it}$ and $X_{PT,it}$ and w_{it}, and ε_{it} are distributed independently of $X_{FL,it}$.

However, the error terms u_{it}, w_{it}, and ε_{it} could be contemporaneously correlated. If the rate of farmland loss (*FL*) increased in equation (2), assuming that α_1 is positive, the likelihood that PP_{it} equals one would increase. Thus in equation (1), the independent variable PP_{it} and the error term u_{it} are positively correlated. Due to this correlation between an independent variable and the error terms, if the three equations in this model were estimated using ordinary least squares (OLS), the coefficient estimates would be biased and inconsistent.

One could proceed by computing the reduced form corresponding to the structural equations (1), (2), and (3). However, given the research question is the impact of the farmland preservation programs, the reduced form parameters are of less interest than the estimated coefficients on the structural variables. Another method is to use instrumental variables (IV) in equation (1) for the preservation program variables. Using two-state least squares (2SLS), we can regress the endogenous regressor (PP_{it}) on the exogenous variables in the equation system. We then use the predicted value from this equation $\hat{PP}_{it}$ to act as an instrument for PP_{it}. We do this for the endogenous regress (PT_{it}) also. We use the Hausman specification test to determine whether endogeneity does exist. We estimate equation (1) with the fitted and the actual variables

$$(4)\ FL_{it} = \beta_0 + \beta_1 PP_{it} + \beta_2 PT_{it} + \beta_3 X_{FL,it} + \beta_4 \hat{PP}_{it} + \beta_5 \hat{PT}_{it} + u_{it}$$

and determine whether $\beta_4 = 0$ and/or $\beta_5 = 0$. If they are significantly different from zero, this suggest endogeniety does exist and the IVs should be used instead of the actual variables.

Data

The Mid-Atlantic states of Delaware, Maryland, New Jersey, New York, Pennsylvania, and Virginia are included in the dataset. Data were compiled from the *Census of Agriculture* and the *Census of Population and* Housing at the county level for the years 1949 through 1997. The analysis uses data on 263 counties[1] and 10 time periods of 4-5 years each.[2] These time periods correspond to the years the *Census of Agriculture* were taken. This resulted in a total of 2609 observations as some counties exited farming completely during the 50-year period. The data set was constructed as a panel by crop reporting district and by time period. A county's data was included in the crop reporting district to which it belonged. The USDA National Agricultural Statistics Service defines these crop reporting districts to reflect similar geography, soil types and cropping patterns (Figure 1).

The data from the *Census of Population and Housing*, which are collected every 10 years, was adjusted to coincide with the years of the *Census of Agriculture*, which are collected every 4 to 5 years. We assumed that the variables changed at a constant rate between the population and housing census data years. This constant change was used to interpolate the data to the year the agricultural census was collected. Thus if the number of housing units changed 10% from 1990 to 2000, we assumed that the housing units grew 1% each year.

Farmland loss is affected by changes in agricultural net returns per acre, change in nonagricultural net returns per acre, farmers' alternative employment opportunities, and the existence of and activities of preservation policies. Table 3 provides the names and descriptive statistics for the variables included in the analysis.

The dependent variable is the rate of farmland loss for time period *t*. It is calculated as the $\frac{A_{t+1} - A_t}{A_t}$, where A_t is the number of acres in the initial period. The rate of farmland loss averaged 7.37% over the study period.[3]

Demographic variables calculated as a percentage change use the initial year of the time period as the ending year of the percent change calculation. Thus the percent change in housing units for time period *t* was calculated as $\frac{HU_t - HU_{t-1}}{HU_{t-1}}$, where HU_t is the total housing units at time *t*. The rate of change from the previous period should be endogenous to the rate of farmland loss in the current period. This permits the percentage change variables to be used as independent variables.

The agricultural net returns are proxied by county-level agricultural sales per acre and expenses per acre in *t*. Farmers are more likely to remain in agriculture if sales are higher than expenses. Sales per acre averaged $551.39 in 1997 dollars and expenses per acre averaged $331.99. Sales per acre nearly doubled between 1949 and 1997. Decreases in or negative agricultural net returns may explain the farmland loss that occurred in areas where the population decreased.

County-level harvested cropland acres in *t* indicate the size/scope of the agricultural sector.[4] These acres are indicators of the level of agricultural activity. There may be a nonlinear relationship between harvested cropland acreage and farmland loss (Lynch and Carpenter 2003). Therefore, harvested cropland is also included as a squared term in the equation. Harvested cropland acres averaged 54,274 acres per county. The highest number of harvested cropland acres in any one county was 334,294 acres.

We include several variables to proxy the non-agricultural net returns for land: whether the county is in a metropolitan area, the population level scaled by the size of the county, the percent change in the number of housing units, the percent change in median family income and the percent change in the median housing value. As people move into the county, the net returns to residential and commercial uses will increase. Thus population growth is hypothesized to increase the rate of farmland loss. Given that the number of individuals per housing unit has decreased, we include a direct indicator of the growth in the housing stock. As the number of housing units increases, the rate of farmland loss is expected to increase. As family income increases, people may demand larger homes. Larger homes usually sit on larger parcels. Thus we expect that an increase in the median family income could increase the demand for farmland and accelerate the farmland loss rate.

An increasing proportion of farmers supplement their farm income with off-farm employment. Their off-farm income opportunities will be greater if they are better educated and the unemployment rate in the county is low. However, an increase in off-farm opportunities will increase the relative benefit of selling the land and shifting full-time to alternative employment. Off-farm employment opportunities are proxied by both the percent of the county population that has at least a high school education and the percent of unemployment. These opportunities could have either a positive or negative effect on the rate of farmland loss. The unemployment rate averaged 5.49%, with a range of 0.07% to 14.5%. The rate of median family income growth may also signal a strong local economy and possibility more off-farm employment opportunities.

For the farmland preservation variables, four different types were considered:

state preferential property tax programs, state purchase of agricultural conservation easement programs, local purchase of agricultural conservation easement programs, and local transfer of development rights programs. Information was collected on the existence of these programs by county (AFT 1997, 2001, 2002a, 2002b). A binary variable, PT_{it} indicates whether the state had established a preferential property tax program by t. Another binary variable, $PP_{it,}$ indicates if the county had one or more local- or state-level preservation programs in place by t. Counties were credited with having a program if any locality (township) within the county had a program that had preserved at least 1 acre. By 1982, all the states had established preferential property tax programs. By 1997, 44% of the counties had a local or state preservation program in place.

To create the IV for PP_{it} and PT_{it}, we sought variables that would explain the existence of the programs and were uncorrelated with the error for the rate of farmland loss. We used variables indicating the rate of farm loss, NL_{it}, what percent of the county land was in farmland, $\%L_{it,}$ the percent of agricultural and resource employment, PAG_{it}, the actual median family income, MI_{it}, the median housing value, MH_{it} the number of housing units in the county scaled by county acres, HUA_{it} and the total population in the county, TP_{it}. These variables could influence the citizenry's desire to preserve farmland in their county. The regression analyses to create the predictions of PP_{it} and $PT_{it,}$ are presented in Table 4. Using a Hausman test ($HU_{(8)}$=9.25), we find using a random effects model for the panel data is the appropriate statistical model for the existence of a preservation program; for the property tax program ($HU_{(8)}$=82.03), a fixed effects model is used. The included variables explained 29.33% of the variation in the existence of a

preservation program and 48.85% in the existence of the preferential taxation program. The higher the percent of agricultural and resource employment in a county, the less likely it was to have either a PDR, TDR or Preferential Taxation program. A county is more likely to have a preferential taxation program if the number of farms is growing at an increasing rate, has a higher median family income, and a lower median housing value.

Using a Hausman test, we find that there is endogeneity with respect to the existence of a preservation program and a preferential property tax program and thus the IVs are used in the regression model. The model is estimated using a random effects model, thus the unexplained variation in the rate of farmland loss or the residual for the estimated model is comprised of three parts, ε_{it}, μ_i and w_t. The means of the three disturbances are assumed to be zero, and each has a variance equal to σ_ε^2, σ_μ^2, and σ_w^2, respectively. The covariances between the error terms are also assumed to be 0. The model incorporates both the within and the between random components.

The random effects model to be estimated is defined by the following equation:

$$(5)\ FL_{it} = \beta_0 + \beta_1 PP_{it} + \beta_2 PT_{it} + \beta_3 X_{FL,it} + \beta_4 \hat{PP}_{it} + \beta_5 \hat{PT}_{it} + +\varepsilon_{it} + \mu_i + w_t$$

(Greene, 1995), where FL_{it} is the vector of the county-level rate of farmland loss for counties in crop reporting district i in the five-year time period t, $\boldsymbol{\beta_0}$ is the vector of constants, the other $\boldsymbol{\beta's}$ are the vector of estimated coefficients, and $X_{FL,\,it}$ is the matrix of county-level characteristics that explain farmland loss for crop reporting district i in the five-year time period t such as sales per acre, percent change in housing units, and the unemployment rate. $\hat{PP}_{it}$ *and* $\hat{PT}_{it}$ are the IVs representing the existence of a preservation program. $\boldsymbol{\varepsilon_{it}}$, $\boldsymbol{\mu_i}$ and $\boldsymbol{w_t}$ are the error terms. They are the effects of

unobserved variables that vary over both crop reporting district *i* and five-year time period *t* and within each crop reporting district and within each time period.

Results

We find that having a preservation program and a preferential property tax program does decrease the rate of farmland loss. Lynch and Carpenter (2003) found that preferential property tax program did decrease the rate of farmland loss; but that other types of preservation programs had no impact on the farmland loss rate. However, once we take into account that counties with high rates of farmland loss are more likely to have these types of programs, we find that they do slow the rate of farmland loss. This result suggests that the resources devoted to farmland preservation may be having the desired outcome.

We also found that having a higher number of harvested cropland decreased the rate of farmland loss at a decreasing rate. Higher sales per acre and lower costs per acres were significant in explaining a decrease in the rate of farmland loss. Counties with high per acre populations (population was scaled by the size of the county) were likely to have a higher rate of farmland loss as were counties with a high rate of growth of housing units. As the growth rate of median income increased, a county was less likely to lose farmland. As education achievement increased, a county was more likely to have a high rate of farmland loss. Counties who are in metropolitan statistical areas are likely to have a higher rate of farmland loss.

Conclusions

Several research studies have suggested that farmland preservation programs have had no or little impact on the rate of farmland loss. If farmland preservation programs

only exist in counties that have higher rates of farmland loss, we may have the explanation for this result. If a high rate of farmland loss is the reason that a county implements a program, one must take into account the identification program that this simultaneity generates. In the analysis of six Mid-Atlantic states, we do find that there is endogeniety and a 2SLS method is needed to address this issue. Using the predicted existence of a preservation program and a preferential property tax program, we find that that they do significantly decrease the rate of farmland loss. Given that counties may have different reasons for their farmland loss, for example, some counties in the analysis lost farmland because they lost population rather than because the land was being converted to housing, this does not suggest that instituting a farmland preservation program may arrest farmland loss in all areas.

Interestingly, very few variables included to explain the existence of farmland preservation were significant. We expected that metro counties were more likely to have a program but this wasn't true. Nor were counties with higher median family incomes more likely to have a preservation program although one might think that the income elasticity of environment objectives would be positive. Conversely, counties with higher median family incomes were more likely to have a preferential taxation program. We also found that counties with a high degree of their population employed in agricultural sectors were less likely to have a program.

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Table 1. State-level Agricultural Land Preservation Programs by 2002

State	Year of inception	Year of first easement purchase	Acres protected (1/2002)	Program funds spent	Funds spent per capita
Delaware	1991	1996	65,117	$69,378,401	$87.14
Maryland	1977	1980	198,276	$335,001,530	$48.01
New Jersey	1983	1985	86,986	$375,180,691	$29.34
Pennsylvania	1988	1989	209,338	$560,621,620	$34.12
Virginia	No program				

Source: American Farmland Trust. 2002.

Table 2. Local PDR and TDR Programs begun by 1997 by State and County, 2000 acreage reported

Maryland	Year of inception of first local program	Year of first easement purchase by PDR program	Acres protected (1/2002)	Program funds spent in PDR Programs
Anne Arundel	1991	1992	8,679	$25,200,000
Baltimore	1979	1981	18,537	$51,300,000
Calvert	1992	1992	8,000	
Carroll	1979	1980	37,190	$54,210,903
Charles	1992		1,183	
Frederick	1991	1993	17,296	
Harford	1993	1994	26,800	$48,900,000
Howard	1978	1984	18,176	$187,560,000
Montgomery	1980	1989-pdr	50,931	$28,079,376
Queen Anne's	1987		2,000	
Talbot	1989		500	
Washington	1991	1992	7,332	
New Jersey				
Morris	1992	1996	3,835	$46,701,384
Burlington	1996		563	
New Jersey Pinelands	1981		5,722	
New York				
East Hampton	1982	1982	281	$5,500,000
Eden	1977		31	
Perinton	1993		56	
Pittsford	1995	1996	962	$8,199,917
Southampton	1980	1980		
Southold	1984	1986	1,318	$11,512,250
Suffolk	1974	1976	8,120	$60,142,788
Pennsylvania				
Bucks	1989	1990	9,550	$50,104,299
Chester*	1989	1990	7,386	$18,500,000
Lancaster	1980	1984	40,190	$80,000,000
York	1990		240	
Plumstead Township	1996	1997	1,195	$4,362,949
Solebury Township	1996	1998	1,285	$11,500,000
Virginia				
Blackburg	1996		23	

Source: AFT 2002, 2001

Table 3. Means and Standard Deviations by County
(N=2609)

	Mean	Std.Dev.
% change in Number of Farms	0.11766	0.13744
% of Land in Farms	0.39053	0.19676
% of Ag. and Res. Employment	0.09944	0.10606
Median Family Income ($)	29,928.70	11,105.00
Median Housing Value ($)	61,296.80	33,716.10
Housing Units per acre	0.19662	0.59254
Total Population	136,006.00	238,648.00
Harvested Cropland (1,000)	54.2742	47.0928
Harvested Cropland Squared	5162.57	9703.55
Sales per acre ($)	551.39	2392.91
Costs per acre ($)	331.99	2225.94
Population per acre	0.57271	1.79583
Metro Area	0.33768	0.47301
% change in housing units	0.07987	0.06728
% change in median income	0.1158	0.08224
% change in housing value	0.10806	0.09227
% Completed High school	0.47781	0.17619
% Unemployment	0.05492	0.02194
Property Tax Preference Program	0.56573	0.49576
Preservation Program	0.08509	0.27907
Predicted Property Tax Preference	0.58158	0.17685
Predicted Preservation Program	0.11909	0.07449

Table 4. Estimated Coefficients for Instrumental Variables

	Preservation Programs			
	Coeff.	Std.Err.	t-ratio	P-value
% Change in Number of Farms	-0.06160	0.04183	-1.47259	0.14086
% of Land in Farms	0.03245	0.03610	0.89896	0.36867
% of Ag. and Res. Employment	-0.20693	0.06870	-3.01183	0.00260
Metro County	0.00002	0.01619	1.46460	0.14303
Median Family Income ($1,000)	-0.00238	0.00148	-1.60681	0.10810
Median Housing Value ($1,000)	0.00004	0.00042	0.09985	0.92046
Housing Units per acre	-0.00167	0.01245	-0.13426	0.89320
Total Population (1,000)	0.00001	0.00038	0.22474	0.82218
Constant	0.12683	0.04442	2.85548	0.00430
R-Squared	29.33			
LM, 2 df	13089.21			0.00000
Hausman, 8 df	9.25			0.21474

	Preferential Taxation Programs			
	Coeff.	Std.Err.	t-ratio	P-value
% Change in Number of Farms	0.15873	0.07393	2.14703	0.03179
% of Land in Farms	0.06001	0.05822	1.03085	0.30261
% of Ag. and Res. Employment	-0.27857	0.10694	-2.60498	0.00919
Metro County	-0.01654	0.02577	-0.64193	0.52092
Median Family Income ($1,000)	0.00772	0.00289	2.67566	0.00746
Median Housing Value ($1,000)	-0.00289	0.00072	-3.99476	0.00006
Housing Units per acre	-0.01464	0.01947	-0.75212	0.45198
Total Population (1,000)	0.00004	0.00006	0.65384	0.51322
Constant	0.49841	0.06552	7.60701	0.00000
R-Squared	48.850			
LM, 2 df	31883.620			0.00000
Hausman, 8 df	82.080			0.00000

Table 5. Estimated Coefficients for Rate of Farmland Loss Model

	Estimated Coefficient.	Std.Err.	t-ratio	P-valu
Harvested Cropland	-0.0008782	0.000119	-7.36983	0.00
Harvested Cropland Squared	0.0000021	0.000001	4.02932	0.00
Sales per acre	-0.00001	0.00000	-7.82651	0.00
Costs per acre	0.00001	0.00000	3.32450	0.00
Population per acre	0.01652	0.00151	10.94680	0.00
Metro Area	0.01496	0.00525	2.84858	0.00
% Change in housing units	0.16935	0.03621	4.67651	0.00
% Change in median income	-0.17026	0.05124	-3.32250	0.00
% Change in housing value	-0.00242	0.02956	-0.08194	0.93
% Completed high school	0.29942	0.03478	8.60799	0.00
% Unemployment	-0.14004	0.12055	-1.16169	0.24
Predicted Preservation Program	-0.37364	0.03833	-9.74906	0.00
Predicted Property Tax Preference	-0.50014	0.03010	-16.61420	0.00
Constant	0.31899	0.04017	7.94006	0.00

Figure 1. Crop-reporting districts

[1] Independent cities of Virginia are also included in the analysis. In several cases, due to either aggregation in data or actual boundary changes during the study period, counties and/or independent cities have been combined for this analysis.

[2] Counties with fewer than 5 farms in 1949 were excluded from the entire analysis. Six counties were excluded due to limited agricultural activity in 1949: Bronx, Queens, Richmond, Kings, and New York counties of New York state, and Arlington County of Virginia.
[3] Farmland is defined by the U.S. Agricultural Census to consist of land used for crops, pasture, or grazing. Woodland and wasteland acres are included if they were part of the farm operator's total operation. Conservation Reserve and Wetlands Reserve Program acreage is also included in this count.

[4] Harvested cropland includes land from which crops were harvested or hay was cut, and land in orchards, citrus groves, Christmas trees, vineyards, nurseries, and greenhouses.