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Evaluating the Benefits of Peri-Urban Agriculture

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Abstract

By uniting literature from farmland preservation, growth management, food systems, economics, bioengineering, and environmental studies, this article provides an overview and valuation of the services that farms provide for urban areas. This article first analyzes the mission statements of 130 nationally accredited land trusts to ascertain the criteria used in preserving farmland. Land trusts present uniform preference for parcels that provide ecosystem services, wildlife habitat, viewsheds, local heritage, and agricultural productivity. The list of benefits provided by land trusts was compared to a literature review drawing from farmland amenity, agritourism, farmland preservation, and ecosystems studies to reveal the range of market values for the various benefits of farmland. The market value of farmland services varies from −$37,541 to 124,000 per acre depending on the method of analysis and location of the farm. This research has strong implications for land-use planning, economic opportunities, and ecosystems infrastructure in peri-urban areas.

Keywords

peri-urban agriculture; farmland amenity; agritourism; PACE

Introduction

In the past, planners have favored urbanization over rural landscapes. During the turn of the century, planners crafted regulations to push farming further from cities to prevent the spread of zoonotic disease and reduce noise and waste management problems associated with farming. These policies continued as urban areas expanded, removing fertile farmland and taking with it valuable ecosystems services, such as water filtration (Bogue 1956). Planners struggle to manage the coexistence of sprawling residential districts which encroach upon working farms. In particular, planners are concerned about urban proximity to large-scale, concentrated animal agriculture (Schwab 1998; Caldwell 1998). While these farms can produce environmental hazards, they also have unique capabilities for local municipal waste management and energy production. Arguably, planning should seek to

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marry cities with their countrysides, forming mutually beneficial partnerships for job creation and sustainable resource management.

Despite past policies to push farms further from cities and to favor residential development over working landscapes (Jackson 1985), farming still persists on the urban fringe in a meaningful capacity. The perseverance of peri-urban farming underscores a symbiotic relationship that occurs between cities and their hinterlands (Jacobs 1984). Peri-urban farms contain the most fertile soils and produce a wide variety of highly valued goods. US metropolitan statistical areas have more total prime agricultural soils than do rural areas, and account for 55 percent of all farm sales (Jackson-Smith and Sharp 2008). Peri-urban farms have adapted and specialized in high-value food products (Heimlich and Bernard 1993), and they produce 91 percent of all fruits, nuts, and berries; 78 percent of vegetables, 67 percent of dairy, and 54 percent of poultry and though these areas contain only 16 percent of the total US land area, 20 percent of all cropland, and 31 percent of all farms (Heimlich and Anderson 2001; Census of Agriculture, USDA Economic Research Service 2007). Worldwide, peri-urban commercial livestock production is an extremely large sector, representing 34 percent of total meat production and nearly 70 percent of egg output (FAO 1999). As the world population continues to grow, concerns about adequate food supplies will increase, necessitating more attention to preserving these highly valuable farming areas (Brouwer and McCarl 2006).

Recently, planners have come to see a need to support peri-urban farming specifically, as it is under the most intense development pressure and has the potential to contribute to urban services such as shaping urban growth, supplying food, and environmentally processing waste (Daniels and Bowers 1997 and Daniels 1999; Furseth and Lapping 1999; Lapping, Daniels, and Keller 1989). Policies in peri-urban regions determine the shape of the cities they surround. In order to control sprawl, planners must also manage land use in rural areas —where retaining farmland is an important growth management tool (OECD 1979; Daniels 1999; Rusk 1999). Yet, despite farm productivity and profit-ability, farmland has a lower market value than other land uses such as residential or commercial development. In order to retain farmland, the services it provides must be valued, both culturally and economically.

In addition to protecting food supplies and influencing land-use patterns, peri-urban farms provide numerous other benefits which have been partially enumerated in farmland amenity studies (Johnston and Bryant 1987; Bergstrom and Ready 2009). Irwin, Nickerson, and Libby (2003) explain that benefits of actively farmed land can range from the intangible (cultural value of farming as a way of life) to the tangible (food production and ecosystem services such as carbon fixation; Gardner 1977; Fischel 1982; McConnell and Walls 2005; Kline and Wichelns 1998; Duke and Aull-Hyde 2002). Agricultural economists hold that the loss of farmland is a result of market failure to appreciate these benefits (Gardner 1977; Brown, Bergstrom, and Loomis 2007; Bergstrom 2009; Johnston and Duke 2009).

The loss of agricultural land to development (Fulton, Pendall, and Harrison 2001; Heimlich and Anderson 2001; Irwin and Bockstael 2006), the disconnect between local farms and their urban markets (Donofrio 2007; Morales 2011), and the recent drive to create sustainable, green infrastructure (Chen et al, 2010; Yiridoe, Gordon, and Brown 2009;

Massé, Talbot, and Gilbert 2011) has engendered a variety of planning programs that aim to reconnect farms with the city. These ancillary programs have a broad focus on food, energy, waste management, recreation, and education. However, the ultimate value and degree to which planners can foster these collaborations is unknown, making program benchmarking difficult (Irwin, Nickerson, and Libby 2003; Bergstrom and Ready 2009). Farmland preservation programs tout the many benefits of retaining agriculture, but information is largely anecdotal, not comprehensive, and lacks quantifiable goals. Public policy makers increasingly seek cost–benefit estimates and program benchmarks related to land-use changes (Revesz and Livermore 2008). An understanding of the positive aspects of incorporating agriculture on the city fringe is necessary to inform future planning endeavors and feasibility studies, compare economic and nonmarket benefits, create measurable goals for programs, predict growth management outcomes, and solicit future public support.

By uniting literature from farmland preservation, growth management, food systems, economics, bioengineering, and environmental studies, this article provides an overview and valuation of the services that farms provide for urban areas. This article categorizes and appraises peri-urban agriculture's benefits through a sample of 130 nationally accredited land trust mission statements and visions. A review of farmland amenity, agritourism, farmland preservation, and ecosystems literature reveals the reach of farmland benefits as well as the range economic values.

Justification for Using Practitioner Land Preservation Data

Farmland preservation programs are a widespread, highly funded, method of permanently preserving farmland. They largely operate in peri-urban regions where farmland experiences intense development pressure. Their program mission statements and visions serve to stimulate both private citizens and local governments to donate billions of dollars a year for land acquisition and endowments, often matching state and federal funding (National Land Trust Census Report, 2005). To date, nongovernment farmland preservation programs have spent nearly $1.5 billion, while states programs have spent over $5 billion on the purchase of easements to permanently protect more than two million acres of farmland (AFT 2010a, 2010b). This figure does not include additional funds, which are often matching, contributed by federal programs, local governments (counties and municipalities), private land trusts, foundations, and/or individuals.

This study uses the mission and vision statements from land trust programs in the United States to ascertain values for retaining peri-urban farmland. These locally based programs reflect the values of their communities but also indicate motivators for state and federal support. The author focuses on the nationally accredited programs as a sample because they are considered best practices among the numerous preservation programs (LTA 2011).[1] Of the 130 accredited land trusts, 93 are involved in farmland preservation. Many of these trusts do not solely hold easements on farmland but also work to preserve open space, wildlife habitat, scenic views, affordable housing, recreational lands, and watersheds. Land trust

[1]The National Land Trust Alliance sets standards for best practices in land conservation through an accreditation seal, which recognizes land conservation organizations that meet national standards for excellence, uphold the public trust and ensure that conservation efforts are permanent. The accreditation program began in 2008 and now represents 130 Land Trusts (LTA 2011).

distribution closely follows that of the most densely settled states and is a good measure of benefits particular to peri-urban agriculture, with over half of the land trusts in the east-coast (thirty-eight in the northeast, twenty-one in the southeast). States with the most accredited trusts include California (fifteen), Colorado (twelve), Pennsylvania (twelve), New York (ten), and North Carolina (nine). Categories for farmland benefits were derived a priori. Each program mentioned an average of five benefits for preserving land. Three land trusts provided no motivations for farmland protection. Table 1 presents benefits from the remaining ninety mission and vision statements in order of importance.

Some of the benefits are at odds with each other (recreational biking and hunting do not mix well) while others overlap (food production is a natural outcome from working farms and a benefit to the local economy). The author used Pearson product– moment correlation coefficient to determine correlation and did not find significant negative correlation between variables.[2] This suggests that there is not a split in land trust motivations with some trusts focusing more on heritage and others focusing more on agricultural productivity as posited by Irwin, Nickerson, and Libby (2003). Overall, land trusts have reached a consensus on their goals.

This ranking of benefits reveals a hierarchy in land trust motivations which differ from regional goals. An analysis of state farmland preservation enabling legislation found that states indicate five important goals of preserving farmland near urban centers: food security, environmental services, protection of rural amenities, planned development patterns, and a healthy local economy (Hellerstein and United States 2002). Mission and vision statements, however, show that while environmental services are ranked highly,[3] the other goals, such as food security, ranked far below goals for protecting wildlife habitat, viewsheds, and heritage sites. Preferentially managing multiple goals presents many challenges for land trusts, especially when local goals differ from regional goals; for example, regions may place a higher value on farms that produce food, while local communities more highly value the wildlife habitat supplied by farms.

Economic Valuation of Farmland Benefits

Quantifying each good or service provided by farmland is important for garnering political support for programs, deciding which land parcels to protect, setting benchmarks for rural–urban services, and evaluating program success. Farmland goods and services can be delineated based on market and nonmarket values (Table 2). Market values are readily available for goods and services provided by farmland that possess directly measureable economic potential, such as agricultural commodity values, income in the farm sector,

[2]Significantly positive correlations existed between a number of motivations: wildlife habitat and water quality (r = .28), wildlife habitat and viewshed (r = .3), wildlife habitat and working farms (r = .23), quality of life and heritage (r = .3), quality of life and economy (r = .26), quality of life and sprawl prevention (r = .24), and ecological systems and sprawl prevention (r = .22). This is expected as many of the motivations for preserving lands build upon each other. A community that desires a sound local economy, desirable development patterns, and local heritage sites will also want to protect quality of life.

[3]The top motivator was protecting ecological systems, specifically watersheds. Water quality was mentioned 38/48 times (42 percent total sampled) in the absence of specific motivations for protecting ecosystem functions and represents most of the answers in that category. Likewise, air quality was mentioned 7/9 times in the absence of motivations for protecting ecosystem functions. Perhaps, this occurred because visions and mission statements that made the broad case for ecosystems functions did not see the need to spell out specific details of water and air quality and visa versa.

hunting and access fees, agritourism activities, and the sale of renewable energy from waste management projects and wind machines. Nonmarket values include those that do not directly benefit the owner of the land, such as farm and ranch tours, indirect public access from recreation or scenery viewing, cultural and heritage values, and nonuse values such as existence of wildlife on the property (Irwin, Nickerson, and Libby 2003; Nickerson and Hellerstein 2003; Nickerson and Barnard 2006). The failure of the market to capture the value of farmland benefits, results in a situation where alternate land uses, such as residential property development, return more value to owners (Gardner 1977). Land trusts emphasize nonmarket farmland benefits, which account for eleven of the fourteen categories (Tables 1 and 2). Additionally, several categories of marketable amenities have potential spillover effects, where nearby nonfarmland properties could also benefit financially (Table 2).

Determining the value of nonmarket goods is important to cost–benefit analyses and program benchmarking. Yet, just as the importance of benefits differs between local and regional communities (Table 1 vs. Hellerstein and United States 2002), so does the valuation of each benefit. Several different bodies of literature have sought to quantify the nonmarket value of farmland, but each examines a different package of benefits and reach of services (Table 2). Farmland amenity literature explores the local impacts of certain farmland benefits through the economic potential that farmland generates for immediate neighbors in residential property values. Agritourism studies, on the other hand, characterize the reach of farmland benefits by noting how far tourists are willing to travel, and how much they spend per trip. Purchase of Agricultural Conservation Easements (PACE) studies show how much is paid to preserve working farmland, presumably to support the entire bundle of benefits listed by land trusts. Finally, ecosystem valuations take a regional view of farmland benefits, and explore cost-replacement or willingness to pay for services that affect the entire planet in aggregate (NRC 2005). Using the benefits listed in Table 1, the author uses the iterative process of a literature review in each field to uncover other benefits from farmland and to generatively explore the value and scope of nonmarket benefits.

Farmland Amenity

Farmland amenity studies relate residential property values to proximity to farmland. Largely, these studies use either an indirect market method, such as the hedonic property value, or a direct, hypothetical survey-based approach, such as the contingent choice method. Hedonic property value studies measure incremental changes in residential property values in relation to proximity to farmland. This method operates on the assumption that the residential property value reflects valuation of nonmarket farmland amenities with a distance-decay function. The contingent choice method uses a survey to ascertain willingness to pay for permanently preserving agricultural lands, and is thus a measure of demand, preferences, and values for maintaining opportunities to enjoy farmland amenities. A meta-analysis (Bergstrom and Ready 2009) has shown discrepancies between the two methods. Hedonic values can vary from −$37,541 to $5,518 per acre, indicating that living near farms is not always valued. Surveys for willingness-to-pay for farmland, however, vary from $0.0001 to $21.90 per acre per household per year, and are always positive though they can be higher the further one lives from farmland. While inconclusive with respect to the

nonmarket value of farmland, these amenity studies have shown that residents more strongly support farmland preservation when farmland is scarce (Irwin, Nickerson, and Libby 2003), agricultural productivity is high, and nearby urban areas are densely built (Kline and Wilchens 1996; Nickerson and Hellerstein 2003), have an older community base with high income, high education, and past experiences with farming (Johnston et al. 2001). Moreover, protecting farmland that allows direct access is preferable (Bowker and Didychuk 1994; Swallow 2002; Johnston and Duke 2007). Direct public access gives people the right to access farm land for various amenity-related uses like agritourism activities (pick-your-own-fruits) or agrivolunteerism (farm education tours). This access can be categorized as nonconsumptive uses (walking and biking) and consumptive uses (hunting), where nonconsumptive uses are more highly valued (Johnston and Duke 2009). Farmland amenities that necessarily depend on direct access, such as recreation, were not mentioned as often by land trusts (Table 1), though one can understand how the public would value "wildlife protection" more when on-farm wildlife viewing access is granted, for example.

Residential property value differentials in and of themselves have not been a robust measure of nonmarket farmland benefits due to the extreme range in farm types, regional land values, and local preferences (Bergstrom and Ready 2009). Although farmland can generate significant positive externalities for its immediate neighbors, it may also be associated with noise, dust, and odors (Schwab 1998; Kim, Goldsmith, and Thomas 2009). Several farmland amenity studies have quantified the negative economic impacts of animal agriculture facilities (Abeles-Allison and Conner 1990; Palmquist, Roka, and Vukina 1997; Kim and Goldsmith 2009). There have, however, been no published articles on the *positive* economic impact of animal production for local communities. This bias is compounded by the limited scale of farmland amenity studies, which focus only on the immediate community while ignoring benefits that extend to the region. For policy purposes, the negative effect of farmland on nearby property values can only be properly interpreted in a regional context, which takes into account municipal services provided by farmland and economic gains for the community at large, such as tourism-income generated. For this reason, farmland amenity studies should be paired with agritourism and ecosystem services studies to correct for the bias from a smaller scale and scope of benefits measured.

Agritourism as an Amenity Valuation Proxy

Unlike farmland amenity studies, studies on agritourism encompass a broader region. As shown in Table 2, the market value of agritourism is closely related to residential property prices as a potential proxy for valuing nonmarket farmland benefits. Like residents, agritourists will more likely value viewsheds, recreational opportunities, and preserved local heritage. This form of analyzing nonmarket values of farmland has not been compared to, or even discussed, in literature on farmland amenity valuations (Bergstrom and Ready 2009), an omission that shows a divide in the literature and thought on farmland benefit valuation. Though many of the profits from agritourism, such as farm activities and accommodations, should accrue to the farm owner and be captured in property value and farm income, the positive influence of agritourism may also contribute to local community sales income, sales taxes, and employment through stimulation of local businesses such as restaurants and shops (Veeck, Che, and Veeck 2006; Che 2007; Barbieri, Mahoney, and Butler 2008).

In the United States, agritourism is an emergent practice and has not been thoroughly evaluated by scholarly journals (Busby and Rendle 2000; Rilla et al. 2011). A Missouri study noted that nearly 20 percent of all agritourism operators had entered the business in the last two years (Barbieri and Tew, 2010), while a California study noted that almost half (43 percent) of the agritourism operators had been in the sector less than ten years (Rilla et al. 2011). The US Department of Agriculture (USDA) Census of Agriculture only began collecting agritourism statistics in 2002. These statistics, however, do not include income from many major on-farm activities such as festivals, accommodations, or direct sales of products. These measurements also do not take into account the off-farm economic gains of agritourism such as food retail, scenery tours, and visitor housing. Modeling agritourism in the United States yields estimates that tourists spend $174.82 per trip, of which one-fourth is due to the rural landscape, with a total consumer spending of $21.4 billion, about half the net worth of US farm income (Carpio et al., 2008). Case studies that confirm this model have yet to be undertaken.

Agritourism in Europe is more developed. The concept of agritourism emerged in the 1980s, and its practice has increased dramatically since these early studies (Table 3, England's total farms involved in agritourism increased from 12 percent to 23 percent). International studies may indicate an upper boundary for benefits to which developing agritourism countries, such as the United States can aspire. Crumley (2010) notes that the French countryside is the leading destination for national and international tourists, and it generates around $25 billion annually in tourism-related income. Before and after evaluation of an agri-tainment business in Greater Beijing reveal that local employment quadrupled, supplying 13 percent of the total employment to its local rural community (Yang, Cai, and Sliuzas 2010). Because of the visitors generated from agritourism, local businesses could charge two to five times as much for organic produce. This study showed that profits from agritourism came overwhelmingly from nonagricultural activities, emphasizing the spin-off effect that farmland amenities have on the local economy. Comparatively, US involvement in agritourism is low, and farms that do support agritourism often do not capitalize fully on the services they provide (Table 3). Less than half of agritourism operators charged a fee, underscoring the public service, educational, and marketing/outreach nature of these activities (Barbieri and Tew 2010; Rilla et al. 2011).

Animal agriculture features prominently in agritourism businesses with 60 percent of the farms visited specializing in animal agriculture (USDA, ARMS, 2004). This figure can, of course, vary regionally in the United States. Some studies show that only a quarter of agritourism farms raise livestock (Barbieri and Tew 2010). In the national survey, the most popular activities on the farm were petting farm animals (67 percent of respondents in the National Survey on Recreation and Environment (NSRE) in the year 2000 reported participation), going horseback riding (15 percent participation), and milking cows (10 percent participation). This finding is directly at odds with farmland amenity studies, which have only reported the negative economic impacts of animal agriculture.

Most farm recreation participants are regional tourists, indicating the power of supporting local economies, and the reach of farmland benefits. For the United States as a whole, the average distance traveled to an agritourism venue was forty miles (Brown and Reeder 2007).

In California, operators estimated that on average 88 percent of their visitors were from the state, with 50 percent coming from the same county (Rilla et al. 2011). Literature from Asia reports similarly that a majority of agritourism visitors come from urban areas, of which 64 percent are from the closest major city (Yang, Cai, and Sliuzas 2010). Unlike farmland amenity studies, which focus only on the economic potential of farmland benefits for the local community rarely over ten miles from the nearest farm, valuation of farmland benefits using agritourism studies explore a broader area and can therefore reach a higher-economic value.

While there is not enough current, comparable data in agritourism to complete a meta-analysis, future studies should include common metrics of analysis related to on- and off-farm dollars spent per tourist per trip. Nevertheless, this compilation of agritourism studies offers benchmarks for fostering agritourism opportunities and valuing farmland. Research in the field is especially informative for planners, as planners control what are considered the major impediments to developing agritourism: zoning, permitting, environmental health regulations, liability, and insurance issues (Rilla et al. 2011).

Purchase of Conservation Easements

Perhaps, the best measure of farmland benefits is the per acre expenditure by PACE programs (AFT 2001). The price of farmland conservation easements is a valuation of developmental rights to the land; the price per acre reflects the value that could have been earned had the land been developed for alternate land uses. Per acre estimates of development right costs are generated from land appraisals that do not take into account nonmarket benefits of farmland, such as ecosystem services. To the extent that a land trust is willing to purchase a conservation easement, that appraisal value can be used as a proxy for the community's willingness to pay for retaining the parcel as farmland. Thus, PACE figures represent a low-end estimate of the amenity value farmland affords because they are bounded by development potential appraisals that do not directly include nonmarket farmland benefits. These proxies are also low because farm owners will often accept tax abatements or other benefits in lieu of payment.

The price per acre that land trusts pay can be seen as the community's willingness to pay for farmland benefits that they would lose should the land be developed. It is unknown to what degree land trusts judiciously chose parcels based on maximizing their vision and mission statement goals (Table 1) as opposed to acting opportunistically. Yet, land trusts presumably seek to protect the entire array of benefits they list in their vision and mission statements. American Farmland Trust data (AFT 2010a) on independent program funds spent from eighty-eight land trusts shows that retaining farmland benefits is valued on average at $3,990 per acre (*SD* $10,000, median = $2,830).[4] The range of PACE per acre was from $88 to $124,000, reflecting the extreme variations in local valuation of farmland retention. This

[4]This figure represents only the dollars spent by each program to acquire easements through independent projects; nearly 50 percent of all programs used only this method of funding. This number excludes dollars spent on joint projects with county and/or state programs, which accounts for 50 percent of the total acres preserved. By excluding joint projects and government funding, these values more accurately reflect the price per acre spent by land trust donors, and hence willingness to pay for retaining farmland in the absence of government price supports.

range is broader than that provided by hedonic farmland amenity studies and much higher than willingness-to-pay amenity studies.

Ecosystem Services

Farmland amenities not likely to be valued by local residents, agritourists, or PACE program benefactors are on-farm ecosystem services, waste management, and energy production capabilities. Agricultural lands comprise about half of the global productive land, which makes farmers the chief managers of ecosystems (Tillman et al. 2002). Following Brown, Bergstrom, and Loomis (2007), ecosystem goods are defined as the generally tangible, material products supported by ecosystem functions, while ecosystem services are improvements in the condition or quality of something of value. To date, there has not been a comprehensive overview of the total type, quantity, and value of ecosystem services that agriculture provides (Stallman 2011). Aside from modeling, replacement cost analyses offer the clearest method to provide dollar values for ecosystem services, yet clear cases where water, soil, and air quality have been markedly improved with land preservation methods alone are rare (NRC 2005). The best example is when New York City chose to invest $1–$1.5 billion in natural restoration of the Catskills Mountains watershed, soliciting purchase of conservation easements for 355,000 acres, rather than construction of a $6–8 billion water treatment plant (Passell 1997; Chichilnisky and Heal 1998; NRC 2005). From this parable, one can assume that the value of a watershed amenity for water quality alone is $2.81–$22.54 per acre. Cost replacement studies for a bundle of ecosystem services have yet to be carried out on the full array of nonmarket farmland benefits (NRC 2005). The most comprehensive study to date (Porter et al. 2009) used a combination of field data from a Scandinavian organic research farm and willingness to pay studies to estimate the total value of the following bundle of farmland ecosystem services: biological control of pests, nitrogen fixation, soil quality, water quality, carbon sequestration, and aesthetic views. Results show that nonmarket ecosystem services made up 48 percent to 81 percent of the value of ecosystem services produced by the farmland, with annual values for nonmarket benefits that ranged from $345 to $2,295 per acre depending on the farm type.

Estimating values for on-farm waste processing and renewable energy production is a relatively emergent field. Though protecting ecosystem services was listed as the main motivator for preserving farmland, waste management, and renewable energy production were barely mentioned. Omission of waste-to-energy services from agritourism or farmland amenity literature is understandable, as few would pay to picnic or live near a waste treatment plant. Furthermore, land trusts may neglect to mention these farm benefits (Table 1) because of conflict with local communities that might oppose siting of nearby waste or wind facilities. These ecosystem services are often at odds with other, highly valued, attributes of farmland, such as viewsheds and recreation. Likewise, many residents may resent agritourists encroaching on their communities, as evidenced by the lack of focus in land trust mission and vision statements.

Waste management and on-farm energy production are closely related farmland services associated with animal agriculture. The benefits derived from these farms may outweigh the negative valuations presented in many amenity studies (Yiridoe, Gordon, and Brown 2009).

Farm animals can be fed a variety of by-products, such as spent brewery grains (Mussatto, Dragone, and Roberto 2006), or residential food waste (Chung 2001; Hoelting and Walker 1994). Diversion of food waste from landfills, decreased feed costs for farmers, and reduced greenhouse gas emission from decomposing feed matter are a few of the benefits from such collaborations.[5] Anaerobic digestion (AD) of animal manure and municipal organic matter further reduces greenhouse gas emissions and can create a valuable, renewable clean energy fuel in the form of methane (Pognani et al. 2009).

Large-scale on-farm waste-to-energy production is a relatively recent phenomenon with numerous benefits for farms and urban centers. AD biotechnologies produce biogas from swine, bovine, and poultry facilities (Massé et al., 2011). One cow can produce 16 kW of electricity a day through methane digestion, and economies of scale are more likely to benefit from such systems as installation costs can be quite high (Masse et al., 2011). Furthermore, AD energy output can be significantly augmented by codigestion with municipal organic wastes (Hartmann and Ahring 2005; Macias-Corral et al. 2008) and industrial organic wastes (El-Mashad and Zhang 2010). In the United Kingdom, most biofuel plants are on-farm and located near a major city (NNFCC 2011). It is estimated that if these ventures were developed to their full potential, they could supply up to 50 percent of UK residential gas needs.[6] These biogas plants generate multiplier effects for the local community in the form of indirect employment through garbage collection, fertilizer sale, and energy production. Codigestion creates another environmental and cost-saving benefit of periurban farms which has yet to be analyzed in farmland benefit studies. A review and meta-analysis of the best practices and extent of on-farm waste-to-energy generation is greatly needed.

Conclusion

Most of the farmland benefits sited by land trust programs did not have a market value, prompting further studies to economically assess these benefits so that program benchmarks can be made. Meta-analysis of farmland amenity studies have indicated that the nonmarket value of farmland is between −$37,541 and $5,518 per acre, while agritourism estimates the value of farmland in terms of amount spent per visit ($120–$400) and percentage of total farm income (4 percent to 20 percent). PACE programs indicate that communities will pay on average anywhere from $88 to $124,000 per acre to preserve farmland. Finally, the broadest survey of nonmarket farmland ecosystem services estimates annual savings of $345 to $2,295 per acre. A comparison of these studies suggests that the benefits of farmland extend far beyond the local community and should be viewed in a regional context.

[5]While AD is a relatively new technology, use of peri-urban farms to process residential and commercial food waste as animal feed is not. In the United States, 0.12 of all marketed swine (USDA 2009) are fed 550,000 tons of residential food waste each year. The process of feeding residential organics to swine may play a bigger role in developing nations. Until recently, Ciaro, Egpyt used over 300,000 to process 8,000 tons of organic waste daily, representing 60 percent of all food waste and supplying 70,000 jobs (Slackman 2009; Fahmi and Sutton 2010).When these swine were culled, the city erupted in cholera epidemics due to the collapse of the informal waste collection and management service provided by the pigs. It is unknown what percentage of food waste is managed by farms but significant potential exists for the developing and developed world alike to strengthen these peri-urban farm economic partnerships.

[6]Likewise, Sweden employs on-farm AD infrastructure for ten centralized biogas plants (SEPA 2005). Since 1997, one plant near Linköping has processed 100,000 tonnes of slaughterhouse and organic waste and produces 4.7 million m^3 of upgraded biogas. This project has occurred with an investment of 14 million Euro, European Monetary Unit (EUR) (IEA 2007). The current Swedish biogas production amounts to 0.3 percent of the total use of energy (SEPA 2005).

Farmland amenity studies have focused on a smaller scale of analysis and demonstrate the valuation of farmland by the local community. While this method of valuing farmland benefits shows that farmland can have a negative effect on its immediate community, the other fields of study take a regional approach and consistently demonstrate positive economic outcomes. Agritourism studies suggest that farmland is appreciated by people nearly eighty miles from the farm parcel and mostly from the nearest major city. Thus, farmland can generate livelihoods and income for a variety of regional players. Ecosystems studies also suggest that farmland benefits be viewed in a more regional scope, as improved air and water quality has ramifications for the entire planet, though most immediate effects for nearby communities (Costanza and D'Arge 1997). Combined, this information suggests that scale is important when evaluating farmland benefits, as there may be dramatic differences in local and regional valuations.

As opposed to focusing on accrued value of retaining farmland, planners have focused on the cost savings when compared to residential development. Numerous analyses of local tax to municipal services costs are conducted every year by planners. A meta-analysis of 125 Cost of Community Services studies conducted in 2007 for residential development versus that of farmland (Kotchen and Schulte 2009), found that the cost per dollar of revenue raised was greater for residential areas than farmland/openspace in every case. On average, residential lands require $1.16 for every tax dollar contributed, while agricultural lands require $0.27 for every dollar contributed. While scholars continue to debate if the density of development alters municipal service costs (Burchell et al. 2002; Cox and Utt 2004), the meta-analysis shows that residential growth expands the tax base while at the same time demanding more in public service expenditure than is generated. This study tactic, while decidedly antigrowth, calls for a municipal blend of farmland with residential units such that the cost services demanded are balanced by the taxes collected.

The above literature review, however, points to more fine-grained land preservation policies with greater economic gains overall when synergies between farmland and nearby cities can be created for amenity generation. Namely, local and regional nonmarket values for residents, agritourism industries, and ecosystems services should be evaluated when considering conservation easement status. Adding these methods to the existing cost–benefit analysis enables planners to make the case for greater annual returns on a variety of farmland amenities. The unified view of the value of nonmarket benefits should help planners raise funds for conservation easements, deliberate where development should occur, and prioritize local land uses. In addition to this cost–benefit analysis, community growth management strategies where a critical mass of contiguous farmland will be needed, is an additional overlay. Land trusts will need to reconsider their mission where these goals do not align. Is conserving a parcel that greatly benefits the local community's desire for agritourism/recreation of equal value to a larger or better-placed parcel that could steer future development in a cost-effective manner?

This comprehensive list of farmland amenities includes many emergent benefits of farmland, such as agritourism and waste-to-energy facilities. Future studies may wish to draw from all the above methods from farmland amenity, agritourism, ecosystem, and PACE studies for a more comprehensive valuation of farmland benefits. Scholarly literature

has a long way to go in supplying valuations for many of the emergent farmland amenities listed above. Because mental and physical health benefits (Tables 1 and 2) of farmland have yet to be discussed in the literature, proxies for their values cannot be estimated. Likewise, many of the estimates for ecosystem services are low because the complete bundle of benefits has yet to be evaluated. A more holistic view of farmland benefits is especially important for animal agriculture farms, which have been evaluated largely in a negative light by farmland amenity studies, though these same farms present significant positive economic influences in agritourism and ecosystem studies. Special planning expertise is required to manage and incorporate these many benefits into the urban fringe to the advantage of local and regional communities alike.

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Biography

Catherine Brinkley is a veterinary student as well as a PhD student in City and Regional Planning at the University of Pennsylvania. She is a contract research for the United Nations Food and Agriculture Organization in the design and management of animal agriculture facilities in relation to urban consumers.

Table 1

Ranking of Motivations for Preserving Farmland. Percentage of Mission and Vision Statements that Mention the Motivators are Listed in Parentheses

1	(63 percent) Ecosystem Functions
	a. (26 percent) specifically mention protecting ecological systems, including: biological resources, natural resources, ecological health, health of the environment.
	b. (53 percent) Watersheds, including: water quality, safe drinking water, or healthy waters.
	c. (10 percent) Air quality
	d. (2 percent) Soil quality
2	(59 percent) Wildlife, including: endangered species, native plants and animals
	a. (10 percent) specifically mention biological diversity
3	(52 percent) Viewsheds, including: view, aesthetic quality, scenic values, vistas, sense of place, natural beauty, unique topographical features, attractive settings
4	(48 percent) Heritage, including: local history, archeological sites, historical/cultural resources
5	(48 percent) Retain working farms, including: continued agricultural productivity, financial security for future farming generations, retain family lands
6	(37 percent) Way of life, including: quality of life, rural communities
7	(30 percent) Recreation, including: walking, hiking or biking
	a. (8 percent) specifically mentioned hunting/fishing
8	(23 percent) Shape land-use, including: pacing development, prevent sprawl or inappropriate development, community separators, buffers for communities, or upholding traditional land-use patterns
	a. (4 percent) specifically mention lower local taxes, including: minimize burden on county services
9	(20 percent) Local Economy, including: attract businesses
	a. (9 percent) specifically mention tourism
10	(10 percent) Food, including: fresh healthy food, local food movement, local flavors
11	(9 percent) Health, including: community health, public health
12	(9 percent) Ethics/Values, including: spiritual value, connection to the land, refuges for people, spiritual rejuvenation, land that inspires and restores us, landscapes that inspire and empower individuals and communities, spiritual and artistic vitality, fulfill the human need for farmland
13	(9 percent) Community Cohesion, including: build communities, connect people to each other and the land, family cohesion, volunteerism, neighborliness, engaged citizens, connect families through recreation
14	(6 percent) Educational Opportunities

Note: Miscellaneous objectives included: sustainable communities (2/90), increase property values (2/90), create urban areas with vibrant rural hinterlands (2/90), support retiring farmers, “reasons personal to an individual owner,” greenhouse gas reductions (in transport of people and food, and more compact communities), reduced energy consumption.

Table 2

Farmland Amenities Parsed Based on Ability to Quantify Products as Market or Nonmarket

Nonmarket		Market
	Indirect measure of value	**Agricultural commodities** (food sales)
Ecosystem: air, water, and soil quality	Replacement costs	
Viewsheds	Tourism/residential property values	**Retain working farms** (agricultural jobs*, farm incomes, farm property values)
Heritage	Tourism/residential property values, visitor center fees	
Quality of life	Residential property values	**Local economy*** (local business revenues)
Recreation	Tourism/residential property values	
Preferred land-use patterns	Tourism/residential property values, local Government spending per capita	**Tourism***: hunting, recreation, bed, and breakfasts, photography, educational opportunities
Community cohesion	Residential property values	
Educational opportunities	Tourism	**Clean energy*** produced from biofuel or wind generation (kilowatt produced and sold)
Ethics/values	Tourism/residential property values	
Wildlife/biodiversity	Tourism/residential property values	**Waste removal and processing*** (ton processed, handling fees)
Health	Health expenditures per capita	

Note: Nonmarket values are those that cannot be directly capitalized in farm parcel prices. There are multiple spillover effects, such as agritourism businesses that do not operate on farm properties and their economic potential therefore is not realized by farmland owners.

These categories (*) can be considered both market and nonmarket as they are not always captured in the value of the parcel. Categories mentioned in program mission and vision statements are in bold.

Table 3

Agritourism Valuations of Farmland

Site	Farms Involved	Annual Revenue Increase for the Community	Additional Farm Income	Source (Method)
France	20 percent (of the 735,000 total farms)	$25 B	NA	Crumley 2010 (national survey)
US	1 percent (of the 2,204,792 total farms)	NA	$566 million	USDA sAgricultural Census 2007 (national census)
Region in England	73 percent, for a community with 112 farms total	$150,000	13 percent to 19 percent*	Frater, 1982 (before-after case study)
England	12 percent* (30,000 total farms, 1974 numbers)	NA	300–400 M*	Frater, 1982 (national survey)
England	23 percent*	NA	140 M*	Denman 1994; Ministry of Agriculture, Fisheries and Food, 2005 (national survey)
China	1	42 percent increase, ($270,000–11.25 M)	NA	Yang, Cai, and Sliuzas 2010 (before-after case study)
Israel	197 farms	2 percent increase in price of tourism goods total	NA	Fleischer and Tchetchik, 2005 (Hedonic valuation)
Tennessee	210 surveyed		$400 per visit at farm	Bruch and Holland 2004 (survey)
Pennsylvania	15 percent (our of 1465 farms surveyed)	$120 per person visit in local community	4 percent net worth to agritourism	Ryan, DeBord, and McClellan 2006(survey)

Note: Economic impacts from the 1983 study are adjusted to US$2011.

(*) indicates accommodations only.