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Agricultural buffers at the rural–urban fringe: an examination of approval by farmers, residents, and academics in the Midwestern United States

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Abstract

In the Midwestern United States, urban areas most often expand by converting farmland into residential sites. This process puts households and working farms in close contact, often resulting in conflicts. Can agricultural buffers, which provide a variety of environmental and aesthetic benefits, help mediate this conflict? This study examined the approval of different buffer types by three stakeholder groups: farmers, residents, and academics. Participants rated three buffer conditions (no buffer, basic buffer, and extensive buffer) for each of six buffer types. Findings reveal support for buffers, with approval of basic buffers over three times that of the no buffer conditions and even greater approval for extensive buffers. Farmers, academics, and residents agreed on their approval for the basic buffers over no buffers, but differed with respect to the extensive buffers. Responses to buffers were nearly equivalent on privately and publicly owned land. The approval for buffers suggests they may provide more than their documented environmental benefits in the agricultural landscape.
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1. Introduction

In recent years, the rural–urban fringe has become the setting of the most intense growth and change in the United States (Friedberger, 2000). One consequence of this new development is that non-farm residents increasingly come to live in close contact with working farms. Such close association often results in conflicts that reduce the likelihood of a satisfying co-existence between farmers and non-farm residents (Daniels, 1999; Hammond, 2002).

To farmers, land is the foundation for the business of agriculture, supporting crops and livestock. Farmers depend on the land for their livelihood. But for urbanites that settle outside of central cities because they enjoy the open space and bucolic environment of the agricultural landscape, many practices associated with modern farms can be a source of tension. These new residents often find themselves annoyed by dust, noise, slow traffic, and odors that accompany farming operations (Kendall, 1993; Hammond, 2002).

One possible, albeit partial, solution to this tension is to introduce agricultural buffers into the fringe landscape. Agricultural buffers are strips or corridors of vegetation designed to ameliorate environmental impacts from agricultural operations. But will residents who sought out an agricultural setting object to changes that might block their view of farmsteads nestled in the open landscape? And what about farmers—will they object to the introduction

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of buffers that might shade their fields, harbor weeds, and attract animals?

Such questions underlie the extent to which stakeholders might approve[1] of agricultural buffers on a working farm. In this paper we examine factors related to the approval of buffers by those who hold a stake in the rural landscape. We begin by exploring the conflict between farming and new housing developments and review evidence suggesting the opportunities to experience this conflict are growing. Next, we examine the costs and benefits of agricultural buffers. Finally, we test the extent to which three stakeholder groups approve of a variety of buffers on a large, publicly held working farm and discuss the implications of the results.

2. Background

The movement of urbanites from metropolitan areas to the rural fringe has led to the coexistence of two groups of residents: those who have lived in rural settings for most of their lives and who depend on farming for all or part of their income (farmers), and those who recently moved to the rural–urban fringe in an effort to enjoy the rural landscape and lower land costs (residents). The close proximity of these two groups, each with their own set of ideals for rural living, has led to conflict in many cases. In order to develop a better understanding of the situation, we review trends in population growth at the rural–urban fringe, sources of conflict for both farm and non-farm residents, and possible land use alternatives to reduce the conflict.

2.1. Urbanites move to rural areas

In the Midwestern US, there has been considerable movement in population away from the center of metropolitan areas to more rural settings, often at the fringe of farmland. A number of factors are driving this trend (see, for example, Alig et al., this issue). For one, the US population is growing: by the year 2050, there are expected to be 403 million Americans, an increase of 122 million, or 43%, over the 2000 Census figure of 281 million (Bureau of the Census, 2002). Continued advances in telecommunications and transportation networks are also making it easier to live and work further from central cities (Edwards and Edwards, 1999). And many Americans prefer living in semi-rural areas, where a rising level of affluence coupled with lower property values and taxes makes this option attractive to an increasing number of households (Daniels, 1999).

Thus in coming years, these and other factors are expected to increase the population of non-farm residents living at the rural–urban fringe. A substantial portion of new housing developments will be built abutting, or at least close to, working farms. As a consequence, conflicts between land uses are likely to grow considerably in the near future.

2.2. Conflict at the rural–urban fringe

Although many urbanites move to rural agricultural settings to seek the privacy and peacefulness of nature, after moving there they are often annoyed with various functions that accompany active farming operations. Frequent complaints focus on pesticide use, noise and dust from large machinery, and odors from livestock (Hammond, 2002).

Farmers, long accustomed to familiar neighbors, have their own set of complaints about these new residents. Farmers express concern about litter, trespassing, pets in their fields, restrictions regarding their activities, and the loss of rural character (Lapping et al., 1989; Hammond, 2002). Instead of receiving compensation for the positive benefits the farmland provides to the nearby public, farmers are often required to defend the very practices that allow farming in the area. In the conflict between residents and farmers, the farmer typically loses (Nelson, 1999).

With the likely increase in conflict at the rural–urban fringe, there is an urgency to find acceptable solutions for farmers and their neighbors. Some have argued that local governments and the courts must provide the solution. Lapping and his colleagues state that the friction between farmers and non-farmers involves a clash of property rights that cannot be resolved in the marketplace. Instead, they assert that legislative

[1] In the survey, participants were asked to rate their response to the following question: "To what extent *do you approve* of the use of (grass buffers, windbreaks, etc.) at the South Farms?" Therefore, the responses indicate the level of approval for each buffer type. The use of the term "approval" refers directly to the responses to this question.

bodies and the courts must act as referees (Lapping et al., 1989, p. 178). But there are hints that a design solution—one that involves the use of agricultural buffers—might provide both farmers and non-farm residents some relief.

2.3. The benefits of agricultural buffers

Buffers are often used in agricultural areas as part of conservation programs that improve environmental quality. Buffers typically contain grassy or treed areas, providing a more natural environment than much of the intensively farmed land surrounding them (Buck, 2001; Lowrance et al., 2002). For both farmers and residents, buffers provide a number of environmental benefits (Henry et al., 1999; Mitsch and Gosselink, 2000). For example, properly placed grass and riparian buffers help prevent movement of sediment into surface waters, and windbreaks help mitigate wind erosion (Pimentel et al., 1995; Chow et al., 1999). Carefully placed grass, riparian, and wetland buffers also improve water quality by capturing residues from pesticides and fertilizers in the rainfall run-off (Cooper and Gillespie, 2001). For instance, herbicide concentrations can be reduced by 29–45% in vegetative buffers (Misra et al., 1996). Phosphorus runoff can be reduced by as much as 95% in a 10-m-wide grass buffer (Vought et al., 1995). Nitrogen, which is a harmful pollutant in many water sources, can be reduced from between 40 and 94% in a buffer or wetland before entering a stream (Groffman et al., 1991; Haycock and Pinay, 1993; Osborne and Kovacic, 1993; Kovacic et al., 2000; Lowrance et al., 2002).

In addition to removing chemicals, riparian buffers also create animal habitat by cooling stream water to temperatures that support a diversity of aquatic life, providing food sources, and offering spawning, den, and nesting areas that are otherwise absent in intensively farmed areas (Naiman et al., 1993). Buffers may also increase the biodiversity of an area and promote the stability of native flora and fauna (Vought et al., 1995; Henry et al., 1999; Lowrance et al., 2002; Paine and Ribic, 2002; Boutin et al., 2003). On a broader scale, buffers can even contribute to a small decrease in the greenhouse effect by sequestering carbon in the soil (Uri, 2000).

For residents of the rural–urban fringe, buffers may provide a number of important social benefits. First, buffers can improve the aesthetic quality of Midwestern landscapes by creating spatial definition, much like an artist paints a picture. Vertical elements in buffers can frame views of an otherwise expansive horizon, while on the ground, colorful and textured plants in buffers can provide interest and variety in the foreground and middle-ground (Nassauer, 1979). Second, buffers can provide opportunities for recreation. With buffers in place, more pleasurable experiences can be had while canoeing streams, traveling along shaded trails, and encountering wildlife. Simply being in or having a view to nature can provide a restorative effect that improves human functioning (Kaplan and Kaplan, 1989; Kuo and Sullivan, 2001).

2.4. Research questions

Although research has examined the attitudes of various groups regarding conservation practices and natural areas (Kline and Wichelns, 1996; Ryan, 1998), little attention has focused on the use of agricultural buffers and their capacity to alleviate some of the conflict at the rural–urban fringe. Several questions arise as agricultural buffers are considered as part of the landscape at the rural–urban fringe. To what extent do stakeholders at the rural–urban fringe approve of agricultural buffers? Are the patterns of approval similar for different types of buffers? Do stakeholder groups differ in their approval for buffers? Does approval for buffers vary on privately versus publicly owned land?

3. Methods

In order to appraise stakeholders' attitudes regarding the use of buffers on public farmland, a photo-questionnaire was developed and distributed to a sample of individuals in Champaign County, Illinois.

3.1. Study area

Champaign County is located on a flat plain in east-central Illinois, where prairie ecosystems produced extremely fertile soil. Most of the land is used for row crops such as corn and soybeans, and many of the features that are considered to give rural areas character (hedgerows, timberland, and natural areas) have either been removed to allow for more row cropping, or never existed. The county's urban core is in Champaign-Urbana, home of the University of Illinois, a large land grant institution. The University is currently expanding its agricultural research area, the South Farms, which lies at the fringe of the metropolitan area. But between 1960 and 1990, urbanization of the area surrounding Champaign-Urbana increased by more than 150%, the largest percent increase of any metropolitan region in the state, and the South Farms complex is now bordered by residential communities on three sides (American Planning Association, 1999). Local residents have expressed concern about the University's farm expansion plans, particularly over the impacts of odors from relocated livestock operations (Wirth, 1999).

3.2. Photo-questionnaire

The photo-questionnaire included descriptions and diagrams that explained the advantages and costs of buffers, simulated color photographs of buffer scenarios and corresponding questions, and space for participants to share their views about buffers on the South Farms.

Table 1
Content provided in the survey prior to requested ratings

Buffer type	Description	Diagrams
Grass waterways	Grass waterways carry storm water to a stream while helping to prevent soil erosion. The roots hold the soil in place when the waterway becomes a fast-moving stream. Wider grass waterways collect more sediment and help to reduce flooding by slowing water down, but take more cropland out of production. Maintenance includes annual mowing.	Basic grass waterway Extensive grass waterway
Riparian grass buffers	Grass buffers are planted on sloped areas to slow rainwater runoff. Soil, fertilizer, and herbicides are collected in the grass buffer, reducing the amount that reaches the stream. Wider buffers capture more sediment but take more cropland out of production. Maintenance costs include annual mowing.	Basic grass buffer at streams Extensive grass buffer at streams
Wetlands	There are three main purposes of wetlands on farms. First, they help to prevent downstream flooding by holding surges of water from fields and drain tiles. Second, they reduce the amount of fertilizer that flows into streams and some drinking water supplies. Third, they support large amounts of wildlife, especially migratory birds. Wetlands take some low-lying cropland out of production and are formed with the addition of dikes. They are not ponds, and can become dry. There is little maintenance.	Basic wetland Extensive wetland
Odor buffers	To reduce odor, trees may be planted next to livestock buildings. The trees help to slow the wind, which allows odor-carrying dust to drop to the ground. A second windbreak, at some distance from the first, will help to further reduce odors. Odor buffers do not eliminate the animal odor. Crop reductions due to shadows might be offset by higher yields downwind. Maintenance includes occasional tree replacement and forest management.	Basic odor buffer Extensive odor buffer
Windbreaks	Windbreaks are lines of trees located at the edge of fields. Windbreaks slow winds, and reduce the amount of soil lost to the air. They provide nesting habitat for birds and change views of farm fields. Windbreaks reduce the crops near their shadows, but they also improve the crop yield at some distance from the trees. Maintenance includes occasional tree replacement and forest management.	Basic windbreak Extensive windbreak
Riparian tree buffers	Stream-side tree buffers consist of one or two zones of trees, followed by a zone of grass next to the cropland. Trees capture underground flows of fertilizer that would otherwise seep into the stream. Trees along the stream also provide wildlife habitat. The stream may function less like a drainage ditch. Some cropland would be taken out of production. Maintenance includes forestry and periodic mowing.	Basic tree buffer at streams Extensive tree buffer at streams

Information in the questionnaire communicated the size, layout, function, and appearance of buffers based on the Natural Resources Conservation Service (NRCS) farm program buffer guidelines. Six types of buffers were described: grass buffers at streams, odor buffers, grass waterways, wetlands, windbreaks, and tree buffers. For each buffer, there was a brief written explanation and a description of several advantages and disadvantages to the farmer and community (Table 1). The full description of the buffer areas is provided by Anderson (2001). On the same page, two diagrams compared a "basic" and an "extensive" buffer, illustrating composition, approximate dimensions, and environmental functions of each (Fig. 1).

Accompanying the text and diagrams for each buffer type were pairs of color photo simulations showing the three buffer conditions: no buffer, basic buffer, and extensive buffer. For each condition, one of the photos in the pair showed the view from ground level and the other showed an aerial view (Fig. 2). The three pairs of images included some of the surrounding landscape with the buffer design identical in type, but changing in size. The buffers were proposed in conjunction with a recreational trail that was illustrated along buffers that

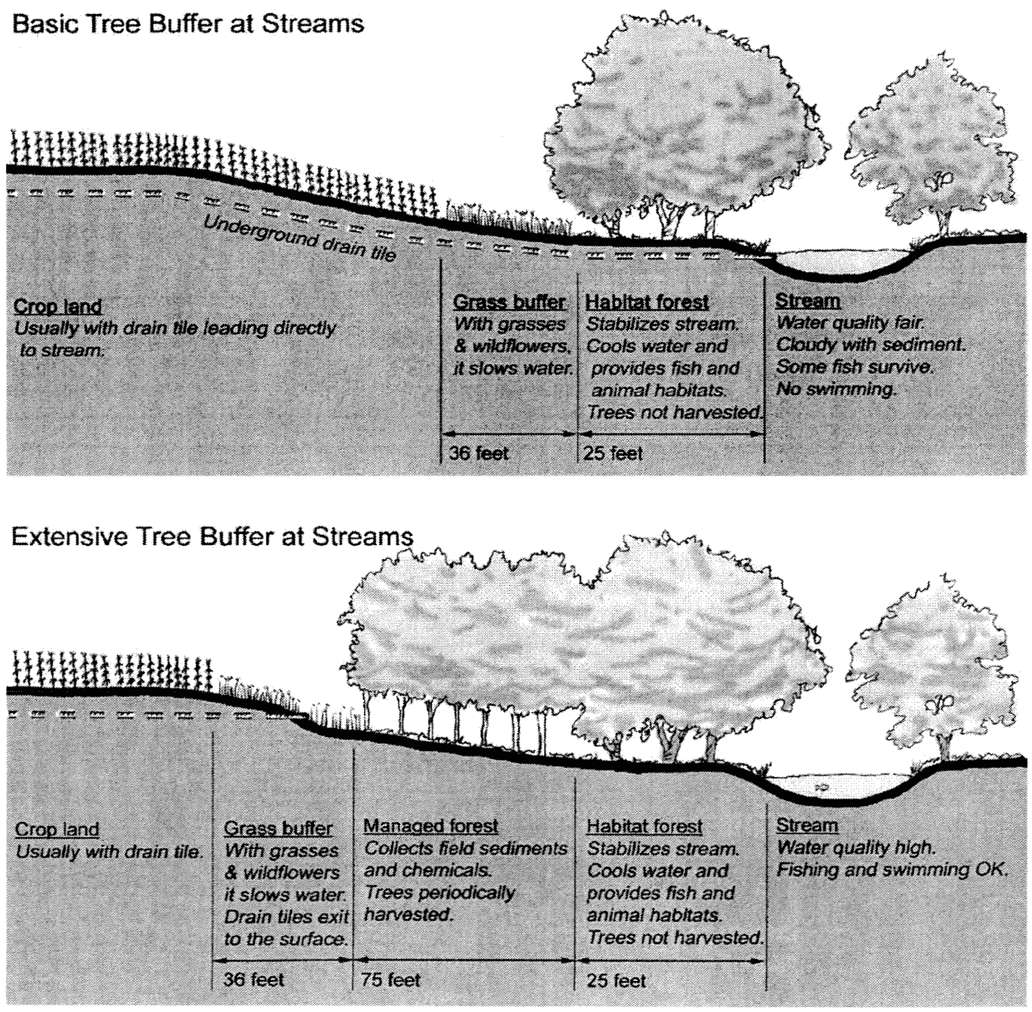

Fig. 1. Typical diagram of basic and extensive buffers provided in the survey, in this case showing a riparian tree buffer.

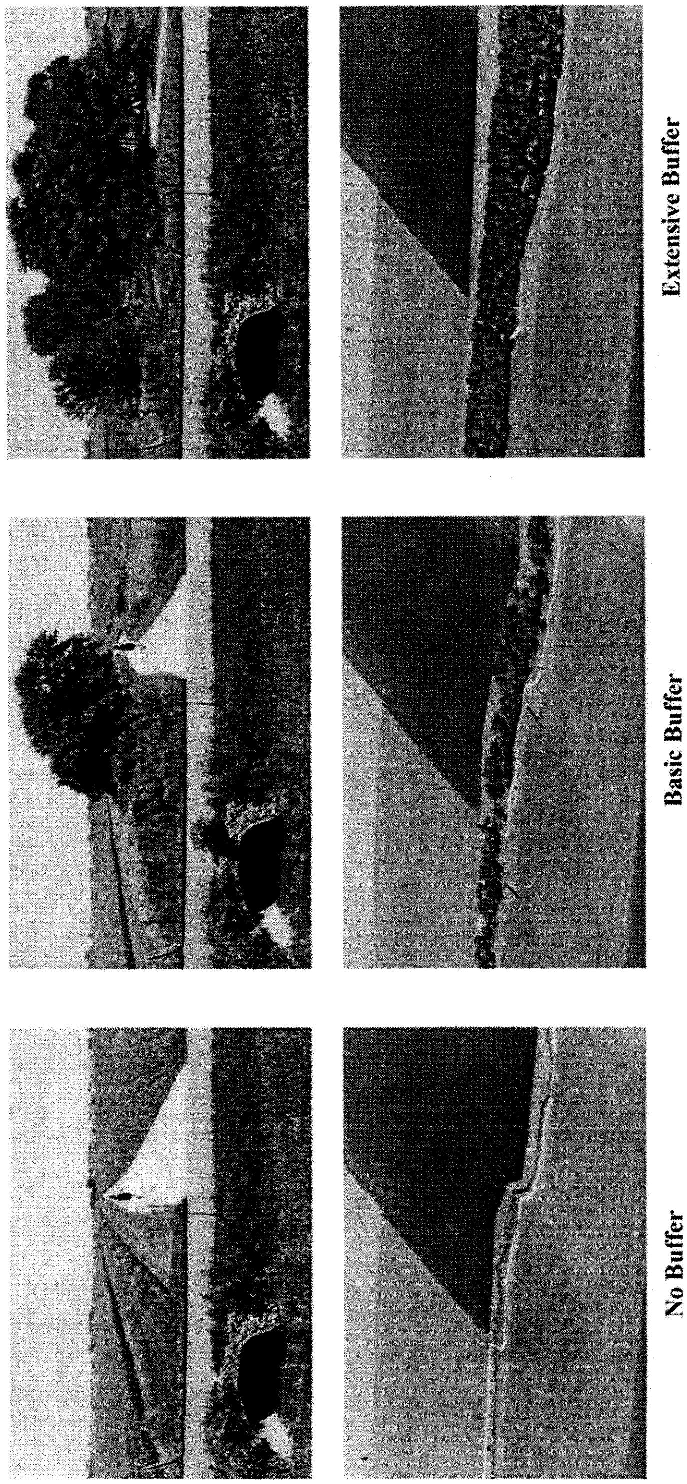

Fig. 2. A typical photo simulation from the survey, in this case showing a riparian tree buffer.

would typically be found at the edge of a farm (e.g. windbreak), but not along grass waterways that more typically are found within a farm field. Ground-level photographs were taken with a digital camera shot from a 10-foot folding ladder,[2] while aerial photos were shot from a small airplane using a 35 mm camera with a telephoto lens. All photographic editing was accomplished using Adobe® PhotoShop®.

Participants were asked two questions regarding each type of buffer. First, "To what extent do you approve of this buffer at the South Farms?" They responded for each of the three buffer conditions (no buffer, basic buffer, and extensive buffer) using a 5-point scale ranging from 0 = "not at all" to 4 = "very much".[3] Second, "If government shared the cost, which would be the best option for *private farmers* in Illinois?" Participants answered by choosing between no buffer, basic buffer, and extensive buffer.

3.3. Participants

The participants in the study included local Champaign farmers (farmers), professors and researchers in the College of Agriculture, Consumer, and Environmental Sciences (academics), and individuals who live in close proximity to the South Farms, along the rural–urban fringe (residents). Each of these groups has a stake in the use of agricultural buffers. The farmers in this rural–urban fringe area must deal with the conflicts arising from the close proximity of farms to residential areas. The academics conduct their field trials on the South Farms, and as a result they must deal with complaints from nearby residents regarding their farming activities. The residents live in the rural–urban fringe area where farms (both public and private) and housing coexist.

[2] The "ground-level" photographs were taken from a small ladder in order to provide participants slightly elevated views of the ground plane. Although this was only important for the buffers without trees—where much of the detail regarding the buffer was close to the ground—for consistency, all the "ground-level" simulations were made from base photos taken from the ladder.

[3] Participants of the study responded to the questions about approval of various buffer types by making a check in one in five boxes. The box on the far left was labeled "not at all" and the box on the far right was labeled "very much." The middle three boxes were not labeled.

A sample of farmers was obtained through the Champaign County Farm Bureau annual meeting. The survey was described during the meeting, and farmers were provided with survey packets including the survey, cover letter, and return envelope. Of 287 copies distributed at the 2001 Champaign County Farm Bureau annual meeting, 94 were returned, providing a response rate of 33%. It was not possible to initiate follow-up contact with farmers to increase the response rates.

The other stakeholders (academics and residents) were surveyed using methods patterned on Dillman (2000). A sample of academics was obtained by distributing 387 surveys to the University of Illinois members of the College of Agriculture, Consumer, and Environmental Sciences. Surveys were received from 194 academics via campus mail, for a response rate of 50%. A sample of residents was obtained by randomly extracting a deliverable list of 359 addresses from subdivisions near the South Farms. Surveys were received from 182 residents, providing a response rate of 51%.

4. Results

Results are presented in four sections. First we examine support for agricultural buffers. Second, we examine how support for buffers varies by stakeholder group. Next, we investigate reactions to the various buffer conditions on private farmland. The final section explores the comments from participants of the survey.

4.1. Buffer approval

To what extent do stakeholders approve of agricultural buffers? To answer this question, we compared the mean approval ratings across the six types of buffers for the no buffer, basic buffer, and extensive buffer conditions. A repeated measures analysis of variance (ANOVA) found striking differences; $F(2, 412) = 415.5$, $P < 0.0001$. On a 5-point scale (0 = not at all to 4 = very much), the no buffer condition earned the lowest approval rating (mean = 0.8). Approval of the basic buffer (mean = 2.6) was over three times that of the no buffer condition, while approval of extensive buffers was higher still (mean = 2.9). These means are each significantly different from each other ($F(2, 412) = 415$, $P < 0.001$). This result was reinforced by responses to the statement "Overall, I think it is important that the University should have buffers at the South Farms" (mean = 3.4 on a 0–4 scale, S.D. = 1.1).

Did the pattern of approval for the most extensive buffer condition hold for each of the six buffer types? To answer this question, we conducted repeated measures ANOVA's comparing the mean approval ratings for the three buffer conditions (no buffer, basic, and extensive) for each of the six buffer types. On the whole, as can be seen in Fig. 3, the pattern did hold. For each of the six buffer types, the no buffer condition earned the lowest approval rating and the basic and extensive conditions earned considerably higher ratings. Note that for the three buffer types without trees (grass waterway, riparian grass buffer, and wetland), ratings of the basic and extensive conditions were not significantly different from each other. Conversely, for the three buffer types with trees (odor buffer, windbreak, and riparian tree buffer), the extensive condition was rated slightly, but significantly, higher than the basic condition.

4.2. Approval by stakeholder group

Do the stakeholders (farmers, academics, and residents) differ in their approval for the three buffer conditions (no buffer, basic, and extensive)? The means and standard deviations from a repeated measures ANOVA (3 × 3) comparing approval ratings for each of the three buffer conditions by each of the three stakeholder groups are presented in Table 2. The ANOVA revealed a significant interaction between the buffer conditions and the stakeholder groups; $F(2, 4) = 12.7$, $P < 0.0001$. Notice in Fig. 4 that for the no buffer condition, approval by farmers was greater than by residents, but the opposite occurred for the extensive buffer. The response pattern for academics was similar to that of the residents. Farmers approval of extensive buffers less than the basic buffer, while the opposite was true for residents and academics. These ratings were reinforced by written comments on the questionnaire. One farmer wrote: "While I strongly support buffer zones, I feel we should not go overboard with them." A resident

Table 2
Buffer approval means and standard deviations by stakeholder group comparing three buffer conditions on a scale of 0 = "not at all" to 4 = "very much"

Stakeholder group	Approval of buffer condition					
	No buffer		Basic buffer		Extensive buffer	
	Mean[a]	S.D.	Mean	S.D.	Mean	S.D.
Farmers	1.2 c	1.2	2.7 a	1.0	2.3 b	1.4
Academics	0.8 b	1.0	2.6 a	0.9	2.9 a	1.2
Residents	0.5 a	0.8	2.6 a	0.8	3.1 a	0.9

[a] Means in the same column followed by the same letter are not significantly different at $P < 0.05$ (d.f. range from 2, 423 to 2, 441).

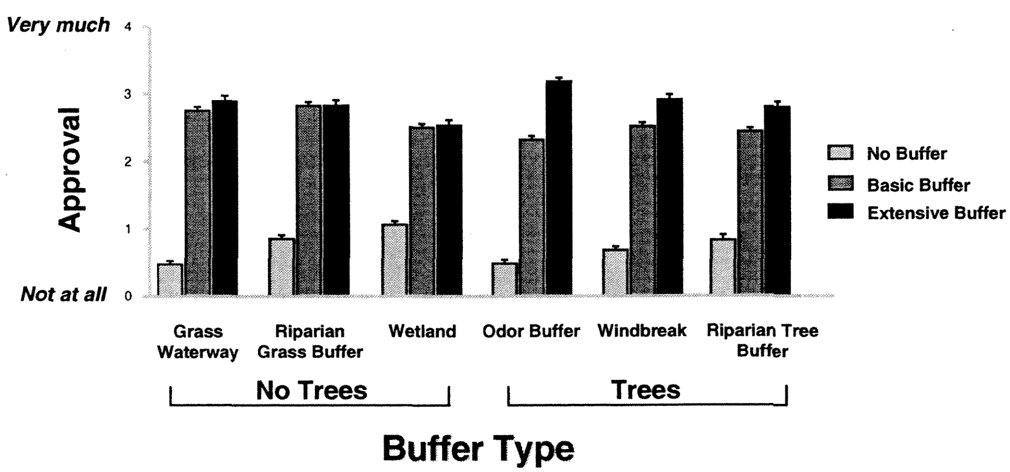

Fig. 3. Mean approval comparing six buffer types under three buffer conditions.

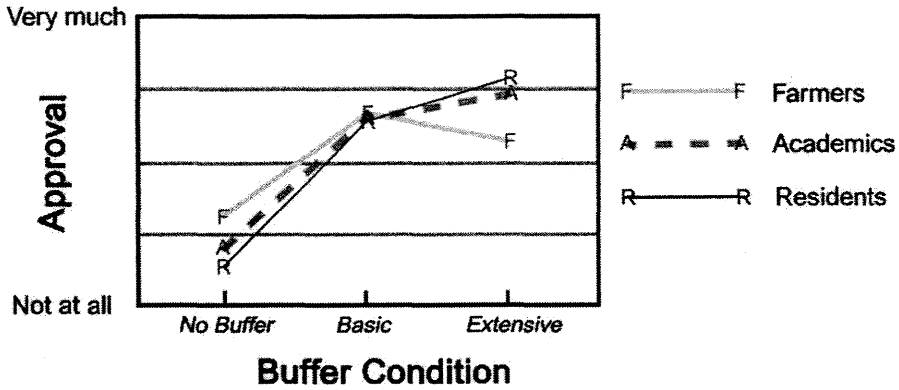

Fig. 4. Mean approval ratings of buffer conditions by three stakeholder groups.

added that environmental benefits of buffers make the extensive buffer the "... best option for everyone."

To what extent does the pattern of results described in Fig. 4 hold for stakeholders' responses to each of the six buffer types? The individual means and patterns of interactions can be observed in Table 3 and Fig. 5, respectively. Notice how the general pattern seen in Fig. 4 is repeated for each of the six buffer types: for the no buffer condition, farmers generally have the highest approval, while residents report the lowest approval. For extensive buffers, the opposite pattern occurs.

Table 3
Buffer approval means and standard deviations by buffer type comparing three buffer conditions with three stakeholder groups on a scale of 0 = "not at all" to 4 = "very much"

Buffer type	Buffer condition	Mean approval ratings			*F*-statistic	*P*-value
		Farmers	Academics	Residents		
Grass waterway	None	0.6 a	0.6 a	0.4 a	1.6	N.S.
	Basic	2.9 a	2.7 a	2.7 a	1.1	N.S.
	Extensive	2.6 a	3.0 a	3.0 a	2.4	0.09
Riparian grass buffer	None	1.2 a	0.9 ab	0.7 b	3.7	<0.05
	Basic	3.0 a	2.8 a	2.8 a	1.4	N.S.
	Extensive	2.3 a	2.9 b	3.0 b	4.7	<0.05
Wetland	None	1.5 a	1.1 ab	0.8 b	5.2	<0.01
	Basic	2.4 a	2.5 a	2.6 a	0.9	N.S.
	Extensive	1.9 a	2.5 b	2.8 b	8.0	<0.0005
Odor buffer	None	0.8 a	0.7 a	0.2 b	10.0	<0.0001
	Basic	2.5 a	2.4 b	2.2 b	4.1	<0.05
	Extensive	2.6 a	3.0 b	3.6 c	15.0	<0.0001
Windbreak	None	1.1 a	0.8 b	0.4 c	8.9	<0.0005
	Basic	2.6 a	2.6 a	2.4 a	1.5	N.S.
	Extensive	2.2 a	2.9 b	3.3 c	12.2	<0.0001
Riparian tree buffer	None	1.5 a	0.9 b	0.5 c	15.9	<0.0001
	Basic	2.3 a	2.4 a	2.5 a	0.6	N.S.
	Extensive	1.9 a	2.9 b	3.1 b	15.3	<0.0001

Means in the same row followed by the same letter are not significantly different at $P < 0.05$.

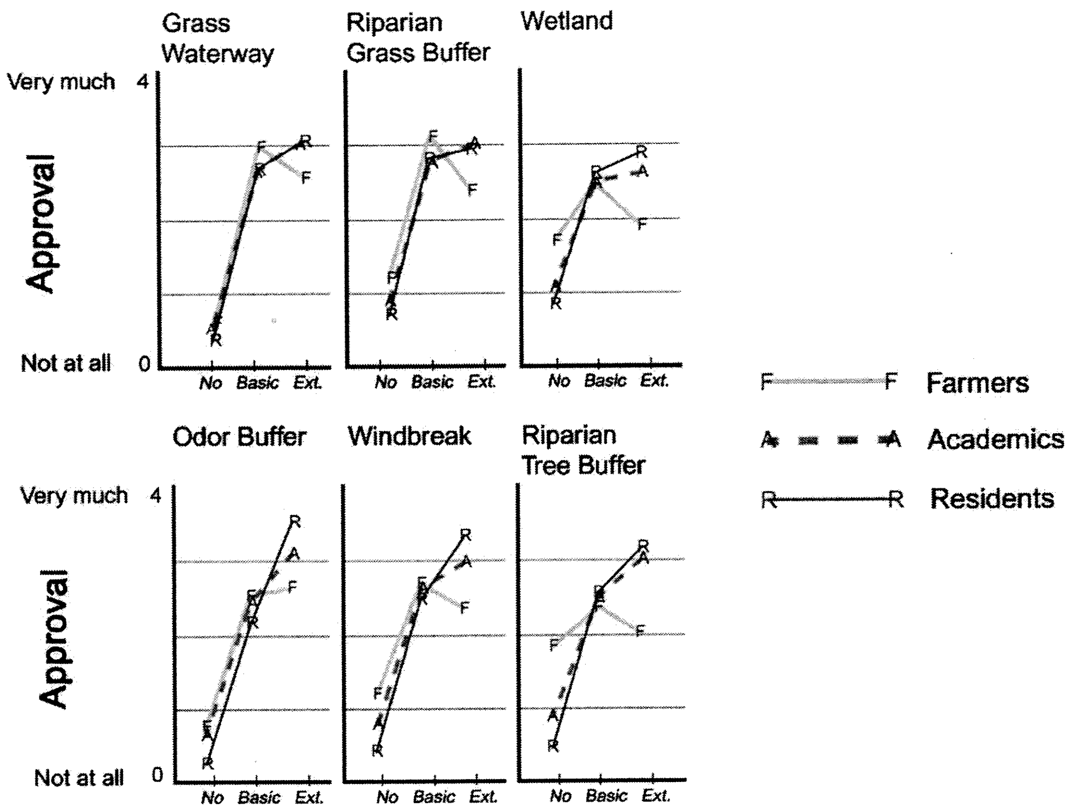

Fig. 5. Mean approval ratings for no buffer (No), basic buffer (Basic), and extensive buffer (Ext.) for each of six buffer types by three stakeholder groups: farmers (F), academics (A), and residents (R).

4.3. Buffers on public and private land

The approval ratings assessed thus far concern buffers on public farmland—the University's South Farms. To what extent do stakeholders have similar attitudes about buffers on private land? To answer this question, we evaluated responses to the survey item asking participants to select the best buffer condition (no buffer, basic buffer, or extensive buffer) for private farmers. The percentages of individuals selecting each buffer condition for all buffer types are shown in Fig. 6. Results indicate that most individuals felt a basic or extensive buffer would be a better option for private farmers than no buffer. In fact, depending on buffer type, only 3–15% of the participants indicated the no buffer condition would be best. Comparing the responses from different stakeholder groups, the pattern of results was nearly identical to the approval ratings for buffers on public land (as seen in Fig. 4). For private land, farmers indicated the basic buffer would be the best option while academics and residents indicated the extensive buffer was the best option.

4.4. Selected comments from participants

Survey participants were encouraged to include comments regarding the survey itself and any additional thoughts about the use of buffers. Most of the comments from residents were positive, reinforcing their approval for buffers and supporting the use of buffers on the university's South Farms. Some comments from farmers, however, revealed concerns about economics, unwanted pests, and maintenance issues associated with buffers. One farmer commented, "... there needs to be an economic benefit for constructing buffers, as profit margins are too small to tie up

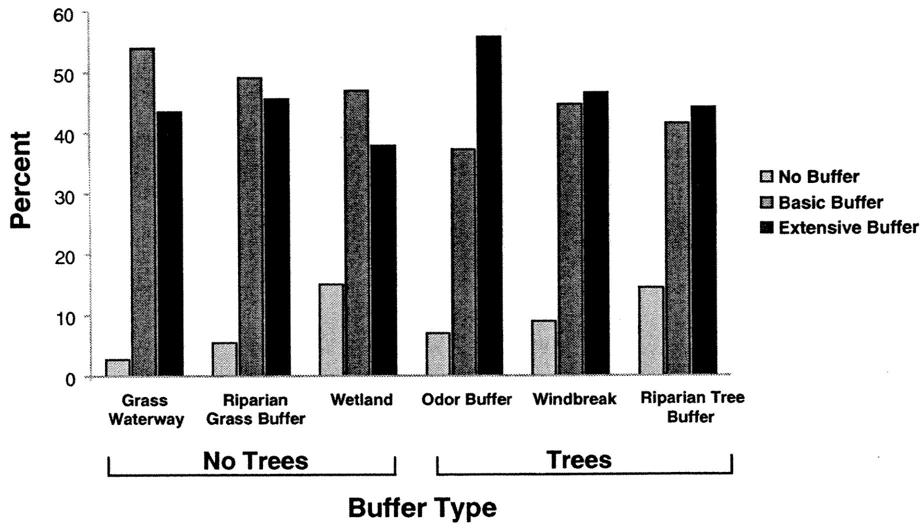

Fig. 6. Percentage of participants selecting the no buffer, basic buffer, or extensive buffer condition as the best option for private farmers for each of six buffer types.

productive land." Several other farmers commented on problems with beavers in riparian tree buffers. One farmer summed up the situation, "I am in favor of wildlife and conservation practices, but we who farm are having a tough time making ends meet. I could not afford to plant and manage trees around my farms . . . I like the look and the wildlife habitats, but it is too idealistic." Many of the comments from academics referred to the fact that the University should practice good environmental stewardship. As one academic noted: "The University should be a leader in using and demonstrating conservation practices in agricultural landscapes."

5. Discussion

This study examined the extent to which three stakeholder groups approved of various agricultural buffers at the rural–urban fringe. The findings reveal considerable support for the use of buffers. Approval for the basic buffers was over three times that of the no buffer conditions, and the extensive buffers were rated higher still. This pattern of approval held over a range of buffer types, with particularly high ratings for extensive buffers with trees. Farmers, academics, and residents agreed on their approval for basic buffers over no buffers, though farmers showed less approval than other stakeholders for the extensive buffer.

These findings provide new information about approval for agricultural buffers at rural–urban fringe, suggest design alternatives for land use at the fringe, and raise new questions regarding the role of buffers and natural areas in urban sprawl and land planning.

5.1. Contributions

The findings contribute to our understanding of the role of agricultural buffers at the rural–urban fringe. First, the work provides evidence of the widespread approval for agricultural buffers in the landscape. The aesthetic and functional qualities of buffers are likely to contribute to this approval. The findings here are consistent with a good deal of previous research on aesthetic preferences for natural or open spaces (Kaplan and Kaplan, 1989; Kent and Elliot, 1995; Geoghegan, 2002) and rural landscapes (Nassauer, 1989; Arendt, 1992; Kline and Wichelns, 1996; Brush et al., 2000; Ryan, 2002). The results suggest Midwestern US rural landscapes including buffers would not only be acceptable, but actually strongly approved over those without buffers.

A second and more specific contribution of this work is to identify the extent to which the width of buffers impacts approval ratings. We found that the standard or basic grass and wetland buffers were approved of as much as a more extensive grass and wetland buffer. This pattern, however, did not hold for buffers that contained trees. Greater approval for more extensive areas with trees may result from the increased diversity and visual interest in treed buffers (Fry and Sarlöv-Herlin, 1997; McCollin et al., 2000; Darke, 2002). The higher approval ratings might also be attributed to the improved functional benefits of more extensive areas with trees. It is possible, for example, that participants realized that an extensive buffer with trees would reduce soil erosion and protect the water supply better than a basic buffer.

The findings also demonstrate interesting stakeholder differences and, more importantly, similarities, in approval for buffers. That residents and academics approved of settings with buffers was not surprising since they have the opportunity to share the ecological and aesthetic benefits without contributing to the costs of establishing or maintaining the buffers. The farmers' reactions were less predictable. Their approval for a basic buffer over none at all suggests that they are looking beyond the cost of conservation practices, to see some value in these buffer areas. Several researchers have demonstrated that visual factors can be important for farmers' adoption of conservation practices (Erickson and De Young, 1992–93; Ryan et al., 2003), and it is likely that such factors were a part of farmers' reactions to the buffers in this study. It is also likely that farmers' reactions were influenced by the functional qualities of buffers. Thus, it is our best guess that, in responding to the buffers, individuals were considering a variety of visual and functional characteristics. Although each of the stakeholders may be influenced by some of the functional outcomes of buffers (improved water quality and reduced odors and chemical drift), the aesthetic qualities of buffers may be more important to the residents than to the farmers. This is question for future research.

Finally, the work contributes to our understanding of stakeholder attitudes toward conservation practices, specifically on publicly owned land. Previous studies have investigated preference for, acceptance of, and economic valuation of buffers and other conservation practices on private farmland. To our knowledge, no previous studies have dealt with stakeholder approval for buffers on publicly held farmland. There is no clear pattern regarding how citizens' expectations for private industry apply to public institutions. On one hand, the expectation is the same for both public and private entities. Such is the case with the US Postal Service: the public expects services equivalent in efficiency and effectiveness to private carriers such as FedEx or UPS (Truitt, 1995). On the other hand, television viewers hold public television to a higher standard than commercial television (Epstein and Neubauer, 1999). The findings reported here suggest that where agricultural buffers are concerned, stakeholders have similar standards for publicly and privately owned farmland. Stakeholder approval for buffers appears to be related more to the type and extent of the buffer area than to the ownership of the property on which they occur.

5.2. Implications

The findings suggest that an increase in use of buffers on farms would be a favorable alternative for both farmers and residents at the rural–urban fringe. Buffers can reduce a number of environmental problems including pesticide movement, noise pollution, livestock odors, and soil erosion. Buffers can also improve the visual appearance of the landscape without reducing the rural character of the area. Public farmland in the rural–urban fringe would provide a good place to implement real-life prototypes of the kinds of buffers simulated for this research so that further tests could be made of their benefits and costs. The use of buffers in public areas could serve as a demonstration of conservation practices at work, providing an educational opportunity for farmers and other citizens.

The results presented here have implications beyond the use of buffers on public property. Buffers could be incorporated into the design of residential developments at the rural–urban fringe. As opposed to relying on the farmer to dedicate land for buffers, a portion of the land in a newly developed area could be allotted for buffer zones abutting farmland, as with conservation design housing (Arendt, 1992; see also Austin, this issue). Ultimately, the findings suggest an increased use of buffers within the rural–urban fringe might require countywide or regional planning to organize the input from different stakeholder groups.

Collaboration with residents regarding land use might lead to creative solutions that would improve the visual quality and ecological health of the area.

5.3. Generalizations and future research

This study was conducted in an area that consists of flat farmland running continuously across the horizon. The environmental benefits and aesthetic value of buffers could be significantly greater in this area that is devoid of natural variation. Future studies should examine the appropriateness of buffers beyond the Midwestern US. Do trees matter as much in other areas? To what extent does buffer width influence approval ratings in different parts of the world?

Considerable efforts were made in this study to obtain representative samples and maximize the return rates for each stakeholder group. It should be noted, however, that participants in the farmer group were selected from members of the Champaign County Farm Bureau, an organization that might not appeal to more liberal-minded farmers. The lower net return rate for farmers (33% versus 50 and 51% for academics and residents, respectively) indicates the results may not adequately represent farmers in the area. Additional research on farmers' approval of buffer areas and motivations for adoption of conservation practices should include more extensive efforts to represent all farmers in the area.

Future research might also focus more directly on the conflict between farmers and residents, attempting to understand if the stakeholders feel buffers would provide a sufficient solution to the problem. Questions probing the conflict itself, the use of buffers at the rural–urban fringe, and the willingness of the stakeholders to financially support such a solution would be appropriate.

Finally, there is concern regarding the extent to which the positive changes in the rural landscape, through the use of buffers, would actually promote more urban sprawl into existing farmland. Buffers that improve the visual quality and add to character of the rural–urban fringe might draw an increasing number of urban residents to the edge. Efforts to reduce conflicts at the fringe should not compromise initiatives intended to limit growth and development.

As we look to the future, more sustainable approaches must be considered for areas where the agricultural landscape is threatened by urban sprawl and development. In his assessment of growth at the rural–urban fringe, Daniels (1999, p. 99) suggests the negative impact of urban sprawl could be minimized by designs that protect of water quality, maintain open space, and create true edges between the rural and developed environments. Agricultural buffers offer design solutions that could address these issues. The findings from this study suggest that a variety of stakeholders at the rural–urban fringe would approve of a great many more buffers at the rural–urban fringe.

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