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FEATURE

Iowa farmers' responses to transformative scenarios for Corn Belt agriculture

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Transformative approaches to agricultural research, policy, and practice could result in future agricultural landscapes that are very different from the present. The National Research Council (2010) report Toward Sustainable Agricultural Systems in the 21st Century recommends that incremental approaches to improving sustainability, which work within existing agricultural systems, be augmented by transformative approaches, which introduce and assess the possibilities for more dramatic change. Biofuels, environmental effects of agriculture, and farmer adoption of sustainable practices should be among the key considerations in transformative approaches to 21st century agriculture in the Corn Belt.

BIOFUELS

Biofuels have emerged as the leading nonnuclear alternative to fossil fuels (SEG 2007), and transformative approaches can provide information about the merits of different biofuels—corn ethanol compared with other feedstocks, including perennial grasses for cellulosic ethanol (Robertson et al. 2008; Jordan et al. 2007). Current agricultural and energy policy have provoked dramatic increases in corn and soybean production for biofuels (Sorenson and Daukas 2010; Lubowski et al. 2008). With effective future commercial scale technologies, perennial grass feedstock for cellulosic ethanol may outperform corn ethanol in terms of net energy production, terrestrial carbon storage, and other ecosystem services (Simpson et al. 2008; Fargione et al. 2008). Given appropriate enterprise and management choices, perennial biofuels production could emerge as a win-win—a profitable crop that could protect ecosystem services with appropriate management choices. Future policies, technologies, and management choices for biofuels can be incorporated in transformative approaches.

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ENVIRONMENTAL EFFECTS

Agricultural practices affect soil and water quality, biodiversity, and greenhouse gases (GHG). The environmental costs of the increased corn production associated with corn ethanol are known (Robertson et al. 2008). While the ecosystem services provided by agricultural ecosystems are essential, local and downstream water pollution and dramatic losses of terrestrial and aquatic biodiversity have been widely documented in the Corn Belt (NRC 2008; Nassauer and Kling 2007). At the same time, innovative future agricultural enterprises and practices could enhance storage of GHG (Tilman et al. 2006). For example, when comparing soil carbon sequestration per acre in Conservation Reserve Program (CRP) set-aside with carbon offsets realized per acre of corn used for corn ethanol production, GHG reductions from CRP far exceeds that from corn for ethanol (Pineiro et al. 2009).

ADOPTION BY FARMERS

Farmers' management choices ultimately determine agricultural landscape change. The challenge of leading different types of farmland owners to adopt practices that support sustainability could be exacerbated by the following:

- Farmers' unfamiliarity with some enterprises and practices envisioned by transformative approaches to agricultural landscapes (Boody et al. 2005; Nassauer et al. 2002).
- The changing structure of farmland ownership, in which a growing proportion of agricultural land is owned by nonoperators, who may make management decisions differently than farm operators (Duffy 2008; Petrzelka et al. 2009).

As researchers have investigated how farmers make management decisions, farmland ownership has been described in several slightly different ways (Soule et al. 2000), but its effect on adoption of conservation practices has generally been found to be insignificant (Knowler and Bradshaw 2007). However, the continued increase in nonoperator farmland ownership suggests that it deserves further scrutiny. Currently, over 40% of US agricultural land is operated by someone other than the owner (Arbuckle Jr. et al. 2008). In Iowa, more than 60% of farmland is not operated by the owner (Duffy 2008).

Farmland ownership frequently has been thought to influence farmland conservation decisions partly because of a long-standing belief that farmers who rent from nonoperators are less likely to employ conservation practices. However, Soule et al. (2000) reported that numerous investigations have failed to consistently support this hypothesis. At the same time, Petrzelka et al. (2009) report that nonoperators have a lower proportion of their land enrolled in CRP and Wetlands Reserve Program (WRP) nationally (The Census of Agriculture 1999). The same data show that Iowa nonoperators lag operators by 68% in total acres enrolled in CRP/WRP programs.

Novel practices and enterprises are intrinsically parts of a transformative approach to sustainable agriculture, and farmer awareness of these innovations and their benefits could be essential to successful agricultural landscape change (Gould et al. 1989). This raises the question of how farmers, especially nonoperators who may be less aware of farming practices, would respond to different perennial biofuels alternatives as innovations. A few small studies have investigated farmers' perceptions of perennial grasses in future Corn Belt agricultural landscapes. Hipple and

Duffy (2002) interviewed 52 southern Iowa farmers and found that the perceived challenges of managing switchgrass were a strong disincentive to adoption; in particular, farmers thought that management demands could make it more difficult for them to take additional employment off the farm. Nassauer et al. (2007a) interviewed 26 central Iowa farmers who saw simulations of alternative future agricultural landscapes. They found that farmers see perennial grasses in agricultural landscapes as a management challenge, but they also perceive and value their environmental benefits. Atwell et al. (2009) interviewed 28 central Iowa farmers who described perennial grasses as suitable primarily for marginal farmland.

Petrzelka et al. (2009) suggest that absentee landowners (nonoperators who live outside the county where they own farmland) may be less aware of conservation practices and programs. Their survey found that, while absentee landowners in New York, Michigan, and Wisconsin rated "conservation or concern for the environment" as the strongest influence on their farmland management decisions, only 31% of these landowners had ever enrolled their land in the CRP or WRP, much like the national statistics. Petrzelka et al. describe this as a "gap between high interest and low participation" by absentee landlords, and they speculate that the gap may be caused by a lack of awareness, possibly because absentee landowners have more limited access to information from local sources.

Table 1

Farm program descriptions for each Corn Belt agriculture scenario as read by farmers who rated future landscapes for each scenario.

Scenario farm program	Description in the Web survey
Current	This is the current farm program. No restrictions on tillage, crop rotation, or any other management operation or practice, other than those currently required (such as conservation compliance requirements, manure management plans, etc.). No restrictions on pesticide or fertilizer.
Rotational Grazing	This farm program supports partial conversion of cropland (highly erodible land [HEL] acres or land near streams) to pasture with rotational grazing. If there are waterways within the fields, the waterways must be protected from cattle. Herd size and type can be chosen by the farmer. No restrictions on pesticide and fertilizer.
15 ft Perennial Strips	This farm program provides support for strips of annual crops alternating with perennial plant strips. Perennial strips are 15 ft wide. Crop strips are 120 ft wide. No restrictions on choice of crop rotation in the annual strips. No tillage restrictions for non-HEL acres. Tillage restrictions and best management practices (BMPs) remain on HEL acres. No restrictions on pesticide or fertilizer.
30 ft Perennial Strips	This farm program provides support for strips of annual crops alternating with perennial plant strips. Perennial strips are 30 ft wide. Crop strips are 120 ft wide. No restrictions on the choice of crop rotation in the annual strips. No tillage restrictions for non-HEL acres. Tillage restrictions and BMPs remain on HEL acres. No restrictions on pesticide and fertilizer.
Bioreserves with 19 ft Perennial Strips	This farm program purchases HEL acres or wetlands for biodiversity reserves of about 640 ac in every township. Reserves enhance habitat and water quality. The program also supports converting HEL acres to rotating strips of corn and soybeans (59 ft wide) that alternate with nonrotating perennial prairie mix strips (19 ft wide). No tillage restrictions for non-HEL acres. Reduced tillage requirements continue for HEL acres. No restrictions on pesticide and fertilizer.
Native Perennials for Biofuels	This farm program provides support for converting HEL acres to native perennial cover, such as switchgrass, that is harvested for biofuel. No restrictions on pesticide and fertilizer.

TRANSFORMATIVE SCENARIOS FOR CORN BELT AGRICULTURE

In this study, we took a transformative approach to envisioning six alternative scenarios for Corn Belt agriculture. We described hypothetical farm programs and simulated the resulting future landscape patterns for each alternative scenario (tables 1, 2, and 3). The scenarios are not forecasts or predictions, but they are plausible goals for policy that could produce future agricultural landscapes like those shown in the tables (Nassauer et al. 2007b; Nassauer and Corry 2004).

These scenarios build on our previous scenario study of two Iowa second-order watersheds—Walnut Creek and Buck Creek (Nassauer et al. 2002). Walnut Creek is a relatively flat watershed (5,600 ha [13,800 ac]) with high corn suitability rating in Story and Boone counties. Its productive glacial till soils are mostly tile drained and were once dominated by wetlands. Buck Creek (8,790 ha [21,700 ac]) in Poweshiek county is characterized by rolling terrain, lower corn suitability, and erosive loess-derived soils. The three scenarios we developed in that study emphasized different leading policy goals. Similar to the current farm program, Scenario 1 emphasized commodity production—corn and soybeans in Iowa. Scenario 2 emphasized water quality protection with incentives for adoption of rotational grazing on continuous perennial cover as one key practice. Scenario 3 emphasized enhanced biodiversity. It established bioreserves on highly erodible land (HEL) or wetland soils and introduced native perennial strips alternating with corn and soybean on erosive land.

In addition to the three scenarios above, in this project we developed three scenarios that varied the amount of perennial cover and the complexity of its pattern. The additional scenario with the simplest cropping pattern was the Native Perennials for Biofuels scenario; two other scenarios included perennial strips 4.6 and 9 m (15 and 30 ft) wide, respectively.

Table 2

Farmer and investor ratings of six future scenarios, as applied to the rolling Buck Creek watershed. Asterisk indicates significant t-test (p ≤ .05).

Current Farm Program

	Attr	Mgmt	Consv	Profit
Farm. (n=493)	5.20	5.52	4.22	5.55
Inv. (n=54)	4.44	5.07	3.87	5.44
P-Value	.000*	.011*	.113	.532

Rotational Grazing

	Attr	Mgmt	Consv	Profit
Farm. (n=492)	5.75	4.63	5.86	4.59
Inv. (n=54)	5.87	5.15	5.94	4.89
P-Value	.511	.029*	.621	.155

15' Perennial Strips

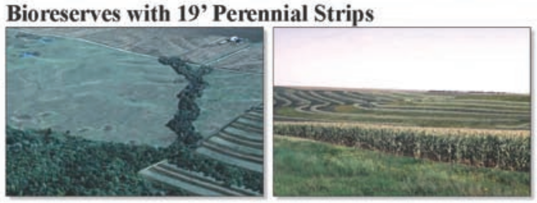
	Attr	Mgmt	Consv	Profit
Farm. (n=492)	5.61	3.84	5.81	4.96
Inv. (n=54)	5.69	4.67	5.83	5.52
P-Value	.683	.000*	.901	.002*

30' Perennial Strips

	Attr	Mgmt	Consv	Profit
Farm. (n=492)	5.62	4.21	5.83	4.91
Inv. (n=54)	5.89	4.85	5.94	5.43
P-Value	.135	.003*	.430	.005*

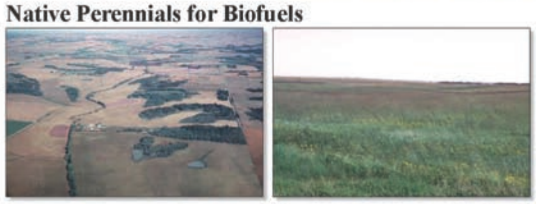
Bioreserves with 19' Perennial Strips

	Attr	Mgmt	Consv	Profit
Farm. (n=492)	5.30	3.49	5.73	4.34
Inv. (n=54)	5.81	4.61	6.11	5.26
P-Value	.017*	.000*	.025*	.000*



Native Perennials for Biofuels

	Attr	Mgmt	Consv	Profit
Farm. (n=493)	5.22	5.20	5.97	4.30
Inv. (n=54)	5.63	5.78	6.17	4.93
P-Value	.067	.009*	.227	.004*



Notes: Attr = unattractive–attractive. Mgmt = difficult to manage–easy to manage. Consv = poor conservation–good conservation. Profit = unprofitable–profitable.

As part of our previous study, we conducted an integrated assessment of three scenarios applied to Walnut Creek and Buck Creek watersheds (Santelmann et al. 2004, 2007). Compared with a baseline year (1994), the commodities production scenario significantly reduced biodiversity and somewhat reduced water quality, but it increased production of corn and soybeans and economic market return to land. In contrast, alternatives that introduced more perennial cover (either as part of a rotational grazing system or as native perennials for harvest) reduced nitrate loading to streams by more than 50% (Vache et al. 2007). In addition, the bioreserves and perennial strips scenario dramatically increased biodiversity (Santelmann et al. 2007). Results of this integrated assessment provide benchmarks for anticipating the environmental effects of the scenarios reported here.

SURVEY

We conducted an image-based web survey of 549 Iowa farmers. They viewed aerial and ground level views of all six scenarios in two different landscapes, the rolling Buck Creek watershed and the flat Walnut Creek watershed (tables 2 and 3), accompanied by brief descriptions of the farm program for each scenario (table 1). Respondents were instructed to assume that net farm income (including government payments) would not be affected by the scenarios. On a seven-point scale, with "1" low and "7" high, they rated each scenario as shown in landscape views in each watershed according to their perceptions of it as (1) unattractive–attractive (Attr), (2) unprofitable–profitable (Profit), (3) poor conservation–good conservation (Consv), and (4) difficult to manage–easy to manage (Mgmt). The alternatives were shown in several different random orders. After respondents had rated each alternative, they saw all six together and ranked them based on what would be "best for the people of Iowa" in the year 2025.

An invitation to participate in the survey was emailed to 4,458 Iowa farmers who had access to the Internet; their email addresses were purchased from AgWeb.com. The survey was accessible on the Web site of the Center for Agricultural and Rural Development, Iowa State University, from November 2006 through August 2007 and on the Web site of the Agricultural Marketing Resource Center, Iowa State University, from mid-November to mid-December of 2006. During that time, 549 questionnaires were completed.

Our sample is similar to 2007 USDA National Agricultural Statistics Service (NASS) statistics for farmers in the state of Iowa (table 4) in many ways (USDA NASS 2009), but it overrepresents farmers who have greater wealth and greater technological resources, including Internet access. For example, compared with all Iowa farmers, respondents had a considerably larger mean farm size and fewer farms with annual gross sales less than

Table 3

Farmer and investor ratings of six future scenarios as applied to the flat Walnut Creek watershed. Asterisk indicates significant t-test ($p \leq .05$).

Current Farm Program

	Attr	Mgmt	Consv	Profit
Farm. (n=493)	5.42	5.77	4.56	5.86
Inv. (n=55)	5.09	5.67	4.20	5.85
P-Value	.087	.555	.094	.950

Rotational Grazing

	Attr	Mgmt	Consv	Profit
Farm. (n=493)	5.39	4.34	5.38	4.78
Inv. (n=55)	5.31	4.82	5.33	5.11
P-Value	.622	.033*	.778	.079

15' Perennial Strips

	Attr	Mgmt	Consv	Profit
Farm. (n=493)	5.35	4.12	5.46	4.92
Inv. (n=55)	5.67	5.07	5.67	5.44
P-Value	.092	.000*	.245	.006*

30' Perennial Strips

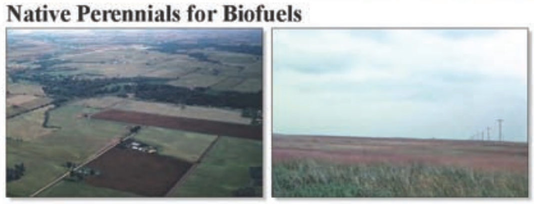
	Attr	Mgmt	Consv	Profit
Farm. (n=493)	5.38	4.24	5.50	4.86
Inv. (n=55)	5.67	4.98	5.64	5.35
P-Value	.113	.001*	.438	.009*

Bioreserves with 19' Perennial Strips

	Attr	Mgmt	Consv	Profit
Farm. (n=493)	4.96	3.64	5.55	4.12
Inv. (n=55)	5.40	4.49	5.78	4.84
P-Value	.055	.001*	.225	.001*

Native Perennials for Biofuels

	Attr	Mgmt	Consv	Profit
Farm. (n=493)	5.32	5.37	5.98	4.53
Inv. (n=55)	5.35	5.65	6.04	5.16
P-Value	.906	.142	.713	.002*



Notes: Attr = unattractive–attractive. Mgmt = difficult to manage–easy to manage. Consv = poor conservation–good conservation. Profit = unprofitable–profitable.

Table 4

Survey respondents compared with all Iowa farmers.

	Respondents	All Iowa farmers†
Demographics		
Male (%)	91.4	90.9
Mean age	52.6	56
Mean acres	513	333
Farming is primary occupation (%)*	82.1	68.3
Farm sales		
$0–$24,999	25.5%	45.8%
$25,000–$249,999	55.2%	33.9%
≥$250,000	19.3%	20.3%
Total numbers	549	92,856

* Percent of respondents who identified farming as their primary occupation.

† All Iowa farmers in 2007 as described by USDA NASS (2009).

$25,000. According to the 2007 Census of Agriculture (The Census of Agriculture 2007), only about 63% of Iowa farmers had access to the Internet, but all respondents to our survey had Internet access. In addition, compared with Iowa overall, a higher proportion of respondents described themselves as full-time or part-time farmers (82.1%), with only 26.6% describing themselves as doing at least some work other than farming.

ANALYSIS

This analysis focuses on differences between Iowa farmland owners who reported that they were occupied in work other than farming or retired and did not and never had actively farmed full-time, part-time, or as a hired farm manager (we term these "investors") and farmers who reported that they currently farm or previously farmed (we term these "farmers"). Investors, as we defined the term, are somewhat different from nonoperators, who are defined by USDA as farmland owners who do not operate any farmland, or absentee landowners, operationalized by Petrzelka et al. (2009) as nonoperators who do not live in the county where they own farmland. Both nonoperators and absentee landowners include many people who were once farmers, but investors include only nonoperators who describe themselves as never having farmed. This definition allowed us to learn more about whether knowledge gained from farming might affect perception of transformative futures for agricultural landscapes.

Many investors (45.5%) describe themselves as living on or near their farmland, so many are not absentee landowners (Petrzelka et al. 2009). In fact, 54.5% describe themselves as making day-to-day decisions on a farm, compared with 93.9% of the farmers. While we found significant differences between the perceptions of farmers and investors, we did not find consistent differences based on other farmer characteristics. Gender, being a retired farmer, owning or not owning farmland, owning highly erodible land, or being responsible for making day-to-day farming decisions did not significantly affect perceptions of future landscapes under alternative scenarios.

As background, investors and farmers who responded to our survey are similar in several ways, including the percent retired (7.3% investors and 12.6% farmers). However, many more farmers (80.8%) live on or near their farmland, and investors have, on average, smaller operations (table 5). While only 59% of farmers report any 2005 income from hay, pasture, or CRP, 74.5% of investors report some income from these enterprises. More investors have some farmland in CRP or WRP (65.5% investors and 53.5% farmers). Crop rotations also differ, with fewer investors having any land in continuous corn, fewer having any land in corn–soybean rotations, and more investors having some land in other rotations.

Table 5

Farmer and investor farm operations.

Measure	Farmers (n = 494)	Investors (n = 55)
Mean total acres in operation	535.25	317.95
Mean % acres in cropland	81.1	66.7
Mean % acres in CRP/WRP	10.7	27.8
Mean % acres of HEL	35.2	36.0
Crop rotations		
% who sow continuous corn	18.4	7.3
% who sow corn/soy rotation	74.7	41.8
% who use other rotation	26.5	45.5
Primary income products*		
Grain/oilseed	63.8	30.9
Other crops, hay, CRP, pasture	15.2	56.4
Hogs/pigs	6.1	0
Milk/dairy	1.8	0
Cattle/calves	10.5	7.3
Poultry/eggs	0.6	0
Other animal products	2.0	5.5

* The percent of respondents who identified these commodities as the largest proportion of their operations' income.

Notes: CRP = Conservation Reserve Program. WRP = Wetlands Reserve Program. HEL = highly erodible land.

Statistically, investors' perceptions of the scenario landscapes were significantly different from those of farmers (tables 2 and 3). Investors perceived 9 of the 12 future landscapes to be significantly easier to manage than farmers did. In contrast, farmers perceived the Current scenario on rolling land as significantly easier to manage than investors did. Related to profitability, investors perceived all 8 of the future landscapes that incorporated perennials to be significantly more profitable than farmers did. Investors and farmers had more similar views of the attractiveness and conservation value of the future landscapes. However, investors saw the Current scenario as less attractive and poorer conservation than farmers did, and they saw the four scenarios with perennials as more attractive and better conservation than farmers did.

While their ratings suggest that farmers perceive landscapes that result from the Current scenario more favorably than investors do, farmers' ranking of the Current scenario (table 6) compared with other scenarios was dramatically different for rolling land compared with flat land. Ranking each scenario within each watershed (from first to sixth) according to what would be "best for the people of Iowa" in the year 2025, farmers thought the Current scenario was best for the flat watershed, but ranked it last for the rolling watershed. They ranked the Rotational Grazing scenario best for the rolling watershed, with the 9 m (30 ft) Perennial Strips scenario second best. In contrast, investors perceived the Current scenario as relatively undesirable for both the rolling and flat watersheds and saw the Bioreserve with Perennial Strips scenario as best for both landforms.

Considering the challenge of leading different types of farmland owners to adopt practices that support sustainability, it is important to note that forced ranking of all the scenarios reveals widely divergent views within both the farmer and investor groups (table 6). Both groups were almost as likely to rank most scenarios last as first. Exceptions to that rule are most informative. For example, investors ranked the Bioreserve with Perennial Strips scenario first in far greater proportions than they ranked it last, and they ranked the Current scenario last in far greater proportions than they ranked it first, for both watersheds. Farmers' rankings also suggested some consensus in their perceptions of the Bioreserve with Perennial Strips scenario. However, unlike investors, they ranked it last far more frequently than they ranked it first. Farmers' rankings also show some consensus on the Rotational Grazing scenario and the 9 m (30 ft) Perennial Strips scenario, ranking each scenario first far more frequently than they ranked it last.

Farmers and investors had very different perceptions of the Current scenario and the Bioreserve with Perennial Strips scenario. They also had different views of the Rotational Grazing scenario, with a much higher percentage of farmers seeing it as best, especially in the rolling landscape. Interestingly, both groups were more likely to see the 9 m (30 ft) Perennial Strips scenario as best compared with the 4.6 m (15 ft) scenario. Notably, farmers had rated the 30 ft Perennial Strips scenario as easier to manage than the 15 ft Perennial Strips in the rolling landscape (table 2). At the same time, both groups rated the Native Perennials for Biofuels scenario and the Current scenario as easiest to manage, but their overall ranking (table 6) placed the Native Perennials for Biofuels scenario last far more frequently than the 30 ft Perennial Strips scenario.

Table 6

Farmers' and investors' ranking of each scenario within each watershed.

Scenarios	Percent of investors who ranked first	Percent of investors who ranked last	Median rank among investors	Percent of farmers who ranked first	Percent of farmers who ranked last	Median rank among farmers
Walnut Creek watershed (flat)						
Current	7.3	32.7	5	21.7	24.7	3
Rotational Grazing	16.4	12.7	3	21.1	11.5	3
15 ft Perennial Strips	5.5	7.3	3	11.1	6.9	3
30 ft Perennial Strips	20	3.6	3	16.2	4.0	3
Bioreserves with 19 ft Perennial Strips	30.8	23.7	3	12.5	33.4	4
Native Perennials for Biofuels	20	20	3	17.4	19.4	4
Buck Creek watershed (rolling)						
Current	1.8	36.4	5	14.6	31.0	4
Rotational Grazing	16.4	10.9	3	27.1	6.7	3
15 ft Perennial Strips	12.7	10.9	3	12.8	10.7	4
30 ft Perennial Strips	21.8	14.5	4	19.2	6.9	3
Bioreserves with 19 ft Perennial Strips	32.7	10.9	3	12.6	24.3	4
Native Perennials for Biofuels	14.5	16.4	4	13.6	20.2	4

The Native Perennials for Biofuels scenario was ranked last by 16% to 20% of both groups, but it was also ranked first by 14% to 20% of both groups.

CONCLUSION

Our study has several implications for transformative approaches to achieving sustainable agricultural systems. Overall, our results suggest that adoption of innovative farming practices may be profoundly affected by the growing proportion of non-operators owning farmland, particularly if nonoperators have never actively farmed. Compared with active farmers, investors may be more open to adopting practices that improve ecosystem services on and off the farm, notably the Bioreserves with Perennial Strips scenario in our study. Farmers see the Bioreserves with Perennial Strips scenario as significantly more difficult to manage than investors do. In addition, they may be reluctant to vary familiar practices shown in the Current and the Rotational Grazing scenarios, which many active farmers see as best for the people of Iowa. These results suggest that as investors own more Iowa farmland, there may be increased interest in adopting unfamiliar innovations that improve ecosystem services, if policy ensures that the innovations do not reduce farm income, and if active farmers take on new management challenges. Results also suggest that complementing transformative approaches with an incremental approach to sustainability, focused on "mainstream production systems" (NRC 2010), may be particularly important for ensuring that active farmers adopt sustainable practices.

Considering the four scenarios that include perennial grasses, potential feedstock for cellulosic ethanol, our results suggest that the balance between perceived profitability and management costs is important to both investors and farmers. They had similar reactions to the Native Perennials for Biofuels scenario, which explicitly stated, "This farm program provides support for converting HEL acres to native perennial cover, such as switchgrass, that is harvested for biofuels." Though farmers saw it as more difficult to manage than investors did, about one sixth of both groups saw the Native Perennials for Biofuels scenario as best, suggesting that these respondents might represent potential early adopters of perennial production for cellulosic ethanol. However, more respondents in both groups ranked the Native Perennials for Biofuels scenario last. This suggests that establishing a critical mass of adopters in a concentrated area for ethanol production could be challenging. The 9 m (30 ft) Perennial Strips scenario ranked higher than the Native Perennials for Biofuels scenario with both groups, perhaps because it combined familiar enterprises (corn–bean rotations) with the widest perennial strip, which may be seen as acceptably manageable. Compared with the Native Perennials for Biofuels scenario, the 30 ft Perennial Strips scenario was seen as more profitable, even though more difficult to manage. Importantly, farmers saw 7 out of the 8 perennial strip landscape alternatives as significantly more difficult to manage than investors did. Neither group was positively disposed toward the 4.6 m (15 ft) Perennial Strips scenario, and only investors were enthused about the Bioreserves with Perennial Strips scenario that incorporated 6 m (19 ft) perennial strips.

Interpreting our results, it is important to note that we measured perceptions and not direct behavior, and that we did not study the important questions of how farm decision makers get new information or how they make management decisions with new information (Petrzelka et al. 2009). It is also useful to note that focusing on nonoperators who have never been farmers, as we did in defining our "investors" subgroup, may shed new light on the stubborn question of how to promote adoption among farm decision makers who are reluctant to adopt novel practices (Knowler and Bradshaw 2007). Investors may be challenging to engage by traditional outreach (Petrzelka 2010), but they also may be more open to transformative practices that have ecosystem benefits, even practices that appear to be difficult to manage. Policies and communication strategies that build constructive partnerships between investors and active farmers, while also targeting their distinct experiences and needs, could contribute to sustainable agricultural systems in the 21st century.

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