From Vulnerability to Resiliency:
Iowa Agriculture in the Age of Biorenewables

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Iowa agriculture is ecologically vulnerable, because the resource base that is critical for the ecological, economic, and ultimately the social sustainability of agriculture is threatened. Despite more than seven decades of conservation efforts by farmers, extension, and conservation organizations such as Soil and Water Conservation Districts and the USDA's Natural Resources Conservation Service (NRCS), the natural fertility of much Iowa farmland continues to be degraded through uses that are inappropriate given local conditions. The erosion and runoff caused by the intense spring rains of 2008 highlighted the insufficiency of our efforts.

Ecological vulnerability is not limited to the resource base of individual farms. As society's awareness of the environmental impacts of Iowa's dominant model of agriculture increases, that vulnerability extends across Iowa's landscape, traverses both rural and urban areas, and crosses state borders through waterways in the form of sediment and contaminants such as nitrogen and phosphorous that impact ecosystems as far away as the Gulf of Mexico. As Iowa agriculture responds to growth in worldwide demand for food, feed and fuel, it is increasingly urgent that we work together to ensure that we can maintain productivity over the long term while also minimizing environmental impacts, both on individual farms and across the landscape.

The purpose of this white paper is to provide an overview of the most critical sources of agricultural vulnerability and to outline strategies for increasing the resiliency of Iowa agriculture. Demand for the food, feed and fuel that Iowa produces is increasing. At the same time, however, demand among non-farm populations for ecosystem services such as clean water for recreation and drinking is also on the rise. We can strike a balance between agricultural production and ecosystem services. Decades of conservation innovation by farmers and university and government researchers have resulted in wide array of agricultural systems and conservation practices that can dramatically improve the environmental performance of agriculture. This paper delineates pathways toward that goal and provides a basis for community discussions about how we can work together to improve agriculture's environmental, economic, and social resilience and sustainability.

Farm-level Vulnerabilities

The dominant agricultural system in Iowa - specialized production of corn and soybeans - can result in ecological degradation if substantial steps to reduce environmental impacts are not taken. Two areas of major concern at the farm level are nutrient loss and soil erosion.

Nutrient loss -- Summer annual crops such as corn and soybean tap nutrients in the soil for only a few months each year. Organic matter in soils, however, releases nutrients year-round. Because Iowa's heaviest precipitation periods coincide with the seasons during which corn and soybeans use little water – spring and fall, excess water travels through and over the soil, removing nutrients as it flows. Consequently, corn and soybean are "leaky" crops in that nutrients move off

the farm and into streams and rivers. Each drop of water that "leaks" out of the system takes important nutrients and soil particles with it, slowly leaching away the soil's fertility.

Soil erosion -- The mismatch between Iowa's heaviest periods of precipitation and the growing season of corn and soybean also increases the soil's vulnerability to erosion. Bare soils exposed to intense spring rains can erode at high rates, even on relatively level land. It is estimated that Iowa has lost over half of its topsoil over the past century, and while conservation practices have been increasingly applied across the state for decades now, soil erosion continues to be a serious problem in many areas. Like nutrient loss, soil loss can severely degrade the land's productive capacity. Unlike nutrient loss, which can be offset to some extent through use of fertilizers and other soil amendments, soil can only be replaced through natural processes that may take decades to build up even a fraction of an inch. As the spring rains of 2008 showed, intense rainfall on bare or sparsely covered fields can wash away quantities soil that took centuries to build up, and result in damage that could take several lifetimes to undo.

Landscape-level Vulnerabilities

The land, and the biological and social communities that depend on it for sustenance, are connected across geographic space. Landscape-level vulnerabilities occur as impacts at the farm level aggregate to the landscape level, resulting in cumulative effects as they add up over space and time. What is done or not done in one part of the state may impact conditions in other parts of state and country. Two of most serious agriculture-related landscape-level impacts on social and biological communities are water quality impairment and habitat loss and fragmentation.

Water quality -- Improving the water quality of Iowa's streams, rivers, and lakes is perhaps the most urgent challenge that we face. As discussed above, water is the medium that transports nutrients and soil particles out of "leaky" agricultural systems, and those nutrients and sediments build up in stream and river systems as they move downstream, eventually finding their way into lakes, larger rivers, and the Gulf of Mexico. Degradation of water quality affects all citizens. For example, recent studies have shown that recreational activities on Iowa's lakes and rivers contribute over $1 billion annually to local economies across the state. At the same time, over 250 water bodies in Iowa are designated as "impaired" due to high levels of bacteria, sediment, and chemical contaminants, much of it from agriculture. When water quality is impaired, fish and other aquatic species cannot thrive, and society's ability to fish, boat, and swim is degraded.

Water quality problems flow beyond Iowa's borders. The hypoxic, or dead zone, in the Gulf of Mexico is an area where nutrients and sediments that drain from throughout the Mississippi River basin contribute to a low-oxygen zone that supports little marine life. The hypoxia zone can extend over an 8,500 square mile area along the Gulf Coast. The hypoxic zone is considered to be one of the nation's most pressing principal environmental problems, and the Upper Midwest contributes a significant share of the nutrients that lead to hypoxia.

Habitat loss and ecosystem fragmentation -- As with nutrient and soil loss, the effects of habitat loss accumulate across geographic space and time. Our adaptation and alteration of Iowa's landscape has created one of the most productive agricultural areas in the world. The transition to a predominantly agricultural landscape has transformed the extraordinarily biodiverse prairies and wooded river and stream valleys into a grid of farms that are dominated

by a handful of crop and livestock species. Today only a fraction of the habitats encountered by early European settlers remain: 28 percent of forest cover, five percent of wetlands, and one-tenth of one percent of prairie. As farm equipment has become larger and drainage techniques more sophisticated, wildlife havens such as fencerows and previously uncultivable wetland has been brought into production, further decreasing available habitat. Aquatic habitats, in particular, can be heavily impacted by farming: streams that run through farms receive the nutrients and soil discussed above, degrading those ecosystems.

Toward a more resilient agriculture: Solutions to ecological problems facing agriculture
With upwards of 90 percent of Iowa's lands in private hands, private landowners and producers are responsible for providing most of the ecosystem services necessary to the long-term sustainability of our state. While some of these services provide substantial direct benefits to the landowners and producers (e.g., agricultural crops, timber, hunting leases), other benefits are shared by society (e.g., air purification, flood control, wildlife habitat) while the cost for producing them is largely borne by individuals. Finding ways to effectively produce these public benefits from private lands while maintaining agricultural livelihoods is the major land management challenge of our time.

Farmers represent a small and decreasing number of Iowans. At the same time, the demand for ecosystem services benefits such as agricultural production, water and air purification, flood control, insect pest suppression, pollination, and outdoor recreation that natural resources and processes provide – continues to grow. As the urban and rural non-farm population increases relative to the farm population, differences in the ways that nature is valued can lead to conflicts between productive (i.e., growing crops) and consumptive (i.e., fishing) uses of the landscape. To the extent that ecological problems stem from farming, agriculture's vulnerability to criticism from non-farmers who desire improved ecosystem services will only increase.

We can no longer approach conservation as something that happens on parcels of individually-owned land. Conservation planning must go beyond practice design and establishment on individual farms with little thought about how they might effect or fit into the greater landscape. Conservation planning must also take the needs of all people, both farm and non-farm, rural and urban, as well as our common natural heritage into account.

Although Iowa's agriculture faces many challenges, the good news is that much is being done to address them, and many agricultural systems and practices exist that can all but eliminate the negative environmental impacts of farming. This section outlines some of the many ways that farmers, non-farming private citizens, government agencies, and non-governmental organizations and can and do work to improve agriculture's ability to provide ecosystem services while meeting demands for food, feed and fuel.

Farm-level Solutions
There are many conservation practices that can be and have been applied at the farm level with much success in reducing nutrient and soil loss. Terracing on steep slopes reduces soil movement. Grassed waterways placed where fields are most prone to erosion, grass filter strips along the edges of fields, and buffers of grasses, shrubs and trees planted along streams all

capture both nutrients and soil particles; all of these can maintain the fertility and productivity of the soil, greatly reduce environmental impacts, and create quality wildlife habitat.

In terms of water quality, a unifying message is to "slow the flow." Water that is flowing more slowly transports less sediment and nutrients. Strategies for slowing the flow include in-field practices such as ensuring that soils are covered year-round, either with crop residue or cover crops, adoption of additional residue management practices, or increased integration of crop and livestock production utilizing pasture systems. We should also try to slow the flow as it exits our agricultural fields. Buffers and grassed waterways can be very effective in slowing the flow and reducing the sediment transport capacity but to be most effective they need to be sited where they can intercept overland flow. While slowing the flow for surface water runoff can be effective, it may have little impact on reducing nutrient concentrations in water that moves under the soil, commonly though tile drains. There are techniques we can use to treat this tile drainage water, specifically nitrate-removal wetlands.

Other solutions include modification of production systems to more closely match the ecological conditions found in different parts of Iowa. Agricultural systems that capture more water in the spring and fall by incorporating perennial vegetation such as grasses, trees, and shrubs can have both economic value as well as provide significant conservation, carbon storage, and, in the future, biofuel production benefits. On vulnerable portions of the landscape, perennial crops can better protect soil, water, and wildlife, compared to annual crops such as corn and soybean. Those conservation benefits might be paid for through compensation to farmers for storing carbon in the soil or sales of perennial grasses, trees, and other materials as feedstocks for liquid fuel and industrial chemical production. These types of systems would be expected to provide environmental benefits in terms of water quality improvement and erosion abatement.

Another option is to better integrate crop and livestock production through the use of small grains and forages in cropping systems currently composed of only corn and soybean. Integrated crop-livestock systems can have lower feed, fertilizer, and energy costs, more efficient nutrient cycling, and less erosion. Many Iowa farms have areas that are not ideal for row crop production; such areas may be suited for livestock production or non-traditional crops such as timber or nut trees.

Landscape-level Solutions

Because environmental problems associated with agriculture are not confined to property lines or political boundaries, solutions to those problems must follow a landscape-level approach to be effective. Not all portions of agricultural landscapes are equally suited to protecting or enhancing the delivery of ecosystem services. For example, if water purification and flood control is the objective, streamside buffers or nitrate removal wetlands should be installed in the areas where they can do the best job of intercepting and slowing surface runoff. Existing conservation programs are voluntary, however, meaning that they will only treat the most appropriate areas if the owner of that land happens to contact a local natural resource professional AND is willing to establish the right practices. The owners of the most critical portions of the landscape for enhancing ecosystem services, however, may never walk in the door. The importance of targeting priority areas for conservation practices is heightened by the limited amounts of public and private funding available for conservation efforts.

Targeted conservation -- Strategic deployment of conservation practices and systems in portions of the landscape where they have the most impact can result in major improvements in the environmental performance of agriculture without significant impacts on agricultural production. Much of the most sensitive land is of marginal quality for producing commodity crops. Thus, targeted conservation approaches would compete very little with agriculture on our prime farmlands would be more effective both ecologically and economically.

Pathways toward resilience: Community responses to challenges

While targeted approaches to conservation may provide the most ecological impact for the lowest cost, there are significant social barriers that must be overcome in order to institute such approaches. The system that provides government support for conservation through technical assistance and funding has since the 1930s been based on voluntarism rather than regulation. Farmers have to solicit support in order for agencies to provide conservation assistance. As a result, for the most part only landowners who are aware of problems AND willing to do something about them are reached. Moving toward a system of targeted conservation would take a major shift in the institutional orientations of state and federal conservation agencies.

Because state agencies do not use targeted approaches, it is often up to communities to do so. Cooperation among community members at the watershed level is an effective pathway to the simultaneous maintenance of agricultural productivity and reduction of environmental impacts. The most effective projects and programs are those that bring all interested parties - farmers, agricultural associations, community groups, conservation agencies, and civic organizations - together to reach for common goals such as improved water quality. Threats to the environment are not confined to agricultural lands; run-off, wastewater, habitat loss, and other problems also stem from activities in towns and cities. Bringing both agricultural and non-agricultural interests to the table allows all parties to take responsibility for their activities and work together toward solutions. Across Iowa and the nation, people have come together at the watershed level to bring innovative solutions to environmental problems. Watershed and similar groups represent an effective means for setting priorities - *targeting* - and working together to address them.

We have made substantial progress over the last decades in conserving the agricultural resource base and reducing the environmental impacts of farming. Iowa State University Extension and partner organizations such as the Iowa Department of Agriculture and Land Stewardship, the Iowa Department of Natural Resources, and the USDA's Natural Resources Conservation Service have contributed greatly to those improvements and have numerous programs in place to support further advances. Community organization at the watershed level, in particular, is enthusiastically encouraged and supported by all of the organizations listed above and more. In this new era marked by increased demand for agricultural products, we must ensure that progress continues rather than being reversed. We have the tools to improve even more; what remains to be seen is whether we have the social and political will to work together toward long-term sustainability of Iowa agriculture.

Bullet Points

- During the initial community conversations on bioeconomy, numerous participants expressed that we must not allow the improvements we have achieved in agriculture's environmental performance to be reversed.

- Despite more than seven decades of conservation efforts, the natural fertility of much Iowa farmland continues to be degraded through uses that are inappropriate given local conditions.

- The spring rains of 2008 exposed serious deficiencies in our efforts to maintain our agricultural resource base; the soil and its nutrients.

- As the urban and rural non-farm population increases relative to the farm population, differences in the ways that nature is valued can lead to conflicts between productive (i.e., growing crops) and consumptive (i.e., fishing) uses of the landscape.

- To increase water quality, a unifying message is to "slow the flow" with buffers and wetlands.

- *Targeted conservation* – strategic deployment of conservation practices and systems in portions of the landscape where they have the most impact – can result in major improvements in the environmental performance of agriculture without significant impacts on agricultural production.

- Watershed-wide community cooperation is needed to set priorities and overcome resistance to targeted conservation.

Discussion Questions

Useful Information Sources

Soils, Soil Erosion, and Water Quality
http://www.econ.iastate.edu/research/webpapers/paper_11462.pdf
http://www.ag.iastate.edu/stories/archives/2008spring/images/WaterQualSumm.pdf
http://www.ia.nrcs.usda.gov/news/brochures/publications.html

Ecology, Wildlife, Nature
http://www.ianpage.20m.com/IANBookletSeries.html
http://www.iowadnr.gov/wildlife/privatelands/files/gaining_ground_wildlife.pdf

Watershed Improvement
http://www.soc.iastate.edu/extension/presentations/publications/bulletin/PM1869.pdf
http://www.extension.iastate.edu/Publications/PM2013.pdf
ftp://ftp-fc.sc.egov.usda.gov/IA/news/CommunityLeadersGuide.pdf
http://www.iowadnr.gov/water/watershed/index.html

Targeted Conservation
Schulte, Lisa, Heidi Asbjornsen, Ryan Atwell, Chad Hart, Matt Helmers, Tom Isenhart, Randy Kolka, Matt Liebman, Jeri Neal, Matt O'Neal, Silvia Secchi, Richard Schultz, Jan Thompson, Mark Tomer, and John Tyndall. (FORTHCOMING). *A Targeted Approach for Improving Environmental Quality: Multiple Benefits and Expanded Opportunities*. Ames, IA: Iowa State University Extension.
http://bombadil.lic.wisc.edu/WBI/reports/nrbFinalReport.pdf