Union of Concerned Scientists

POLICY BRIEF

The Healthy Farm

A VISION FOR U.S. AGRICULTURE

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American agriculture is at a crossroads: a point where we can either apply our scientific knowledge to create a vibrant and healthful food and farming system for the future, or double down on an outdated model of agriculture that is rapidly undermining our environment and our health. This model, the "industrial" agriculture system developed by business and science working together in the decades following World War II, had the goal of generating as much product as possible. It succeeded—by using approaches better suited to making jet fighters and refrigerators than working with living systems—but at a high cost.

In pursuit of productivity, industrial agriculture degrades the air, water, and soil; damages fisheries and wildlife habitats; harms rural communities; poisons farmworkers; and undermines the natural resources on which future farmers depend. The good news is that the science of living systems has not stood still, and we have learned that there are alternatives to industrial agriculture that—by recycling resources and working with, rather than against, biological systems—can be just as productive, while sustaining that productivity far into the future.

Agricultural scientists call this sophisticated strategy **agro-ecological agriculture**. Farms that employ it can be thought of more simply as "healthy farms," because they contribute to the health and well-being of people, economies, and the land and natural resources on which we all depend. A growing body of evidence indicates that re-inventing agriculture as a network of healthy farms within functioning ecosystems would offer significant benefits to farmers, rural communities, consumers, and the environment. Indeed, it is vital to the future of farming.

Hallmarks of Healthy Farms

Farming for the future must aim to achieve interrelated goals in these three areas:

Productivity. Healthy farms must ensure an abundant food supply for U.S. consumers and help nourish (through exports) a growing global population that is expected to reach 9 or 10 billion by 2050. They should also produce a wide variety of foods important to healthful diets.

Economics. Healthy farms must contribute to vibrant rural economies, enabling farmers to make a good living and provide their workers with safe working conditions and fair wages and benefits. They should also provide consumers across the income spectrum with access to good, healthy food—this is as much a question of practicality as fairness, since agricultural practices that do not make economic sense for farmers and consumers will not be adopted or retained.

Environment. Healthy farms must use natural resources in a sustainable manner, maintaining or increasing soil fertility and making efficient use of increasingly scarce inputs such as phosphorus and freshwater—recycling them when possible. They should also minimize their use of toxic chemicals, their pollution of water and air resources, and their contribution to global warming, while maintaining or providing habitat for wildlife and beneficial insects.

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Achieving these goals simultaneously requires a delicate balancing act. But working together, scientists, farmers, and agricultural policy makers can do this by thinking of agriculture—and healthy farms—as:

Multifunctional. Policy makers need to invest up front in farms that can serve our environmental, social, and productivity needs, rather than productivity alone. Studies have demonstrated that farmers can adopt well-designed and tested sustainable practices without sacrificing profits (Davis et al. 2012; Boody et al. 2005).

Regenerative. Farms can be designed to incorporate practices that constantly improve the fertility of the soil, foster biodiversity on a "landscape" scale (i.e., beyond the boundaries of the farm), and recycle essential nutrients (Blesh and Drinkwater 2013; Tonitto, David, and Drinkwater 2006; Tscharntke et al. 2005).

Biodiverse. In agriculture as in other systems, diversity is critical for long-term stability. Healthy farms—whether small, medium, or large—must incorporate a wider variety of crops, types of land use, and options for raising livestock and poultry.

Interconnected. Rather than considering farms as isolated entities, scientists now recognize that uncultivated areas on or near farms can provide important benefits for both the surrounding landscape and the farm itself. For example, hedgerows, fields, woodlots, and stream borders provide habitat for insects that pollinate crops and control farm pests, which in turn can boost productivity and reduce the need for pesticides (Meehan et al. 2011, Tscharntke et al. 2005).

This aerial photo over Shelby County, IA, depicts prairie grasses and woodland plantings on and around farmland. Research shows that leaving such uncultivated areas is beneficial to farms and the environment.

Four Steps to Healthier Farms

How can we move from today's industrial agriculture to farms that produce the multiple benefits—for farmers, society, and the environment—essential to meeting the twenty-first century's challenges? While a number of incremental improvements to the current system have been tried or proposed (see box, "Can Industrial Agriculture Be Improved?", p. 4), they are likely to fall short of what is needed.

Instead, U.S. agriculture needs to be restructured to align with the agroecological principles discussed above. Such an ambitious effort cannot be accomplished easily or overnight, but based on the current scientific literature, UCS has identified four strategies to make our agriculture substantially more sustainable, multifunctional, and regenerative.

1. Take a landscape approach.

Farms are not isolated from one another or from the natural systems around them, and function best when that is taken into account. Recent research has shown, for example, that uncultivated areas on and near farms—including trees, shrubs, and grasses at the edges of crop fields and along streams—can serve as resources for farmers (Meehan et al. 2011; Tscharntke et al. 2005). By fostering biodiversity and providing habitat for pollinators and other beneficial wildlife, such as birds, bats, and bees, uncultivated areas can boost farm productivity and reduce costs.

Healthy farms contribute to the health and well-being of people, economies, and the land and natural resources on which we all depend.

Researchers recently estimated that the loss of uncultivated habitat near farms in the Midwest has increased the use of insecticide needed to control pests by an amount that would cover some 5,400 square miles of crops (Meehan et al. 2011). In addition, streamside woodlots on and near farms serve to buffer waterways from erosion and polluting runoff.

Farmers can also improve their operations by partnering with neighboring farmers to share and conserve resources. The University of Maine Cooperative Extension has had success pairing dozens of farmers on thousands of acres for innovative collaborations—swapping livestock manure for feed crops, integrating cropping systems, and sharing equipment—that have led to environmental improvement and increased farm profitability (SARE 2005). Such cooperation could generate similar benefits anywhere agricultural diversity exists.

2. Grow and rotate more crops.

Agriculture in the U.S. Midwest is dominated by two crops—corn and soybeans—grown continuously or in simple rotation, a trend that may have worsened in recent years (Plourde, Pijanowski, and Pekin 2013). The most important change we could make to move toward a healthy, sustainable food system would be to grow and rotate a variety of crops including wheat, oats, alfalfa and other legumes, and sorghum in addition to corn and soybeans.

Growing a greater diversity of crops would allow farmers to reap the environmental and energy advantages of longer, more complex crop rotations. Recent research has demonstrated that multi-year, multi-crop rotations produce high yields for each crop in the rotation, control pests and weeds with less reliance on chemical pesticides, and enhance soil fertility with less need for synthetic fertilizers (Davis et al. 2012).

- ***Pests and weeds.*** Because most pests are adapted to thrive on only a limited number of crops, having non-host crops in a rotation drives down their numbers. Reduced use of chemical pesticides, in turn, encourages beneficial organisms such as soil fungi, pollinators, and predatory and weed-seed-eating insects and spiders that further reduce the need for pesticides, which benefits the environment and saves farmers money (Letourneau et al. 2011).

The loss of uncultivated habitat near farms in the Midwest has increased the use of insecticide needed to control pests by an amount that would cover some 5,400 square miles of crops.

Recent long-term research in the heart of the Corn Belt has shown that integrated weed control based on smart crop rotations can reduce the need for fertilizers and herbicides by 90 percent or more, while maintaining high yields and farm profits (Davis et al. 2012).

- ***Soil fertility.*** Rotations that include nitrogen-producing legumes such as peas, beans, and alfalfa provide subsequent crops with substantial amounts of this critical nutrient. And recent research shows that nitrogen from legumes remains in the soil longer than the nitrogen in synthetic fertilizers, leaving less to leach into groundwater or run off fields and pollute streams (Gardner and Drinkwater 2009).

In addition to grain and forage crops, the climate and exceptionally rich soils of the Midwest are well suited to a number of other crops including vegetables and fruit trees. While few now remember it, a century ago at least 10 food crops were grown commercially in Iowa, including potatoes, apples, and cherries (Pirog and Paskiet 2004). Bringing back such crops, especially sought-after heirloom and specialty varieties, represents an opportunity to market foods that could be branded based on their place of origin and sold at premium prices.

New additions to the rural landscape could also include bioenergy crops such as perennial grasses. These so-called cellulosic feedstocks can be grown on marginal land, enhance soil fertility by promoting the growth of various soil organisms, and provide a climate-

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Multi-year, multi-crop rotations—including more small grains such as the oats pictured here—help to control pests and weeds with less reliance on chemical pesticides.

friendly source of energy (their deep roots and long lives enable them to keep more carbon out of the atmosphere than annual bioenergy crops such as corn, whose growth is typically assisted with carbon-intensive fertilizers and pesticides).

3. Reintegrate livestock and crops. U.S. livestock production was once conducted on the same farms that grew feed crops, but over the past half-century, most livesetock have been removed from that setting and consolidated into enormous CAFOs (confined animal feeding operations) that produce far too much manure to be distributed as fertilizer economically (since crop fields are often too far away). Instead, the manure spills from lagoons, runs off fields, or leaches into groundwater—transforming the nutrients in manure

CAN INDUSTRIAL AGRICULTURE BE IMPROVED?

PROPONENTS OF CURRENT CORN AND SOYBEAN farming methods argue that the best we can do to improve this system is to tinker around the edges with incremental approaches. While the following practices have some merit, they also have serious limitations:

Conservation tillage (for example, "no-till," which reduces erosion by avoiding the practice of tilling the soil to remove weeds) typically depends on the use of chemical herbicides. It does not suppress weeds, and can be less effective than agro-ecological methods at building soil fertility (Teasdale, Coffman, and Mangum 2007).

Precision farming (which attempts to match synthetic fertilizer use to crop needs) requires expensive soil monitoring and GPS equipment. And even after making that investment, farmers may still be tempted to use more fertilizer than necessary to squeeze out additional productivity, especially when crop prices are high.

In addition, neither conservation tillage nor precision farming does enough to reduce nitrogen leaching and runoff, which reduces water quality and harms fish, leading to coastal "dead zones" (Gardner and Drinkwater 2009). As long as U.S. agriculture is dominated by a few crops grown continuously (i.e., in the same field year after year), these incremental solutions can offer only limited benefits. The fundamental restructuring we advocate, on the other hand, can deliver multiple benefits for the environment and the U.S. economy that can be sustained over time.

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In Missouri, agricultural engineer Kenneth Sudduth examines corn from this combine's grain flow sensor. So-called precision farming relies on expensive equipment including soil monitors and satellite-based GPS. Ideally, this information can help growers plan best fertilizer rates for the next crop, but in practice farmers may still be tempted to over-apply fertilizer.

On this farm near Peosta, IA, dairy cattle graze on a field that is between crop rotations. A corn crop is visible on the far right.

from the valuable resources they could be into dangerous pollutants. The current situation is deemed economically efficient only because livestock producers can ignore the societal costs of pollution and the lost value of manure in their calculations (Gurian-Sherman 2008).

Plant and animal agriculture can be reintegrated in several ways. Some livestock, especially beef cattle and dairy cows, could be raised partially or entirely on pastures, which (when well managed and not overstocked) would reduce soil erosion, increase soil fertility, store carbon, and provide habitat for beneficial organisms. Pasture-raised livestock also require fewer antibiotics than those raised in CAFOs, reducing their contribution to the spread of antibiotic-resistant disease. Furthermore, pasture-based and other integrated livestock operations offer midwestern farmers the opportunity to meet rising consumer demand for healthy, humane, grass-fed, and sustainably raised meats and milk (Winrock International 2012).

Crop and livestock reintegration can be accomplished on a regional basis or on individual farms; distributing animal operations throughout the Midwest would produce a range of benefits, from reduced nutrient pollution to enhanced soil fertility. And integrated livestock production would support local markets for forage crops such as alfalfa, helping to facilitate longer crop rotations and conservation practices in the region.

Scientists have shown that cover crops can reduce groundwater pollution from nitrogen by 40 to 70 percent.

4. Use more cover crops.

One of the most beneficial practices that farmers can undertake with relative ease is planting cover crops: rye, clover, drilling radish, or hairy vetch, for example, that are grown not for harvest and sale but to cover the soil at times when it would otherwise be bare. In addition to reducing soil erosion, cover crops capture and hold soil nutrients for future crops, increase soil organic matter, reduce pests and weeds, and provide habitat for beneficial organisms (Union of Concerned Scientists 2012).

In the process of absorbing excess soil nutrients such as nitrogen and phosphorus, then returning those nutrients to the cash crops that follow, cover crops reduce pollution and the need for synthetic fertilizer. Scientists have shown, for example, that cover crops can reduce groundwater pollution from nitrogen by 40 to 70 percent (Tonnito, David, and Drinkwater 2006). And by adding cover crops' organic matter to the soil, farmers can improve the soil's water-holding capacity and make their cash crops simultaneously less vulnerable to drought and less dependent on irrigation. The mulch layer that dead cover crops leave on the soil reduces soil temperatures in the summer and water evaporation, providing farmers with another hedge against drought.

Despite increased interest in cover crops, only about 8 percent of midwestern farms currently grow them (Singer, Nusser, and Alf 2007; see box, "Obstacles on the Road to Healthy Farms," p. 6).

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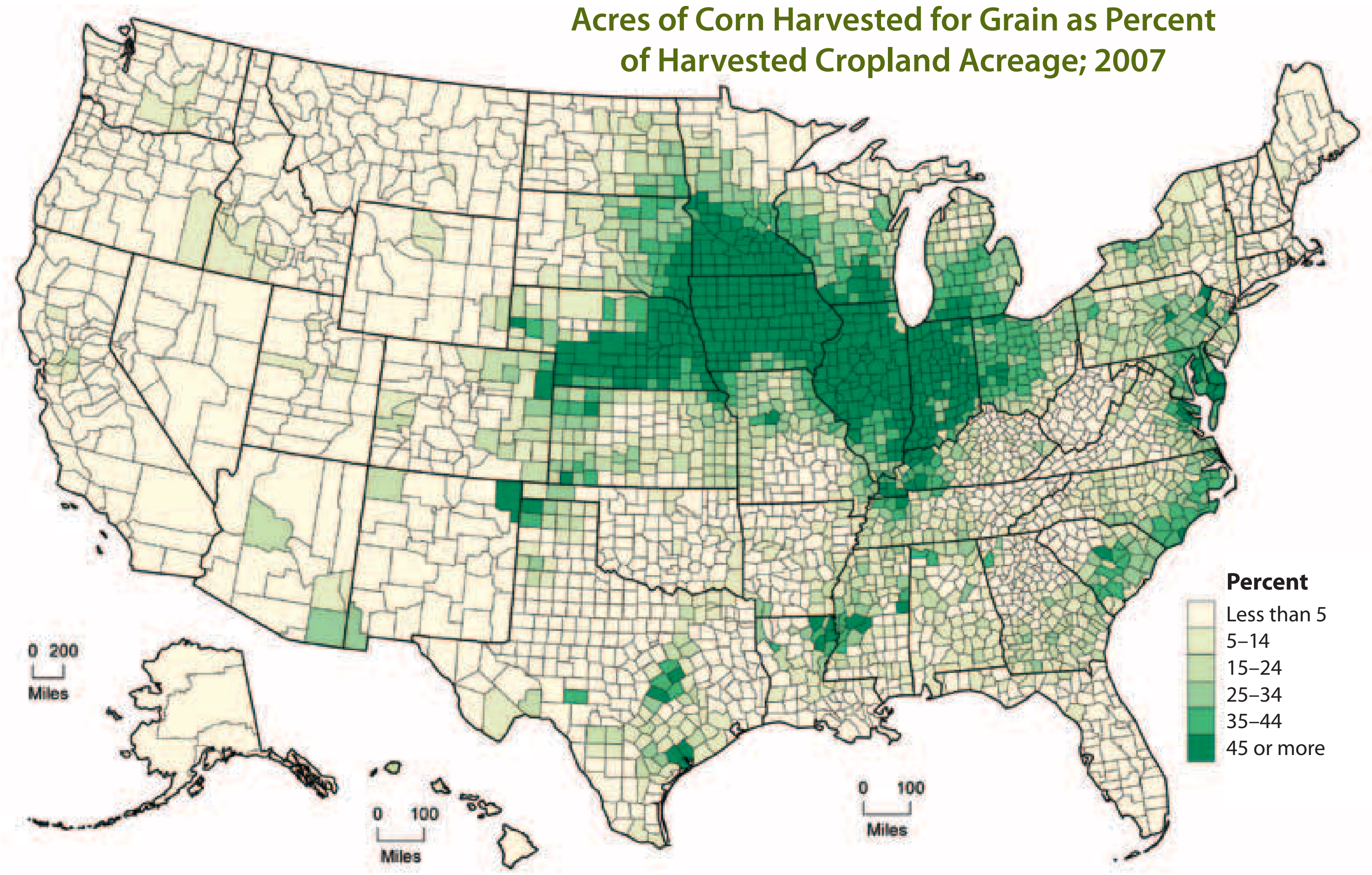
The nine-year Marsden Farm study—conducted by researchers from the USDA, the University of Minnesota, and Iowa State University—replicated the industrial corn-soy midwestern farming system alongside two multi-crop alternatives. A three-year rotation incorporated another grain plus a red clover cover crop (pictured here), and a four-year rotation added alfalfa, a key livestock feed, into the mix. The more complex systems enhanced yields and profits, controlled weeds, and reduced chemical fertilizer, herbicide, and energy use.

OBSTACLES ON THE ROAD TO HEALTHY FARMS

DESPITE THE DEMONSTRATED BENEFITS of healthy farm practices and growing interest among new and younger farmers, these practices have yet to be embraced by mainstream U.S. agriculture. This is largely because production-focused commodity markets have created barriers that have sometimes been exacerbated by farm policy decisions of the past.

- **Barriers to a landscape approach.** Today's high crop prices and land values are incentivizing intense cultivation in areas where it makes little ecological sense. Though research demonstrates the benefits of leaving some of the farm landscape uncultivated, scientists and extension agents have not effectively communicated these benefits to farmers. And U.S. Department of Agriculture programs designed to encourage conservation practices that would have broader societal benefits are woefully underfunded.
- **Barriers to longer crop rotations.** The domination of U.S. agriculture by a few crops has been self-perpetuating, with the food and biofuel industries finding new uses for corn and soybeans rather than creating markets for a wider variety of crops. In addition, publicly supported research has been severely skewed toward increasing the performance of these few crops. Conversely, too little research has been focused on improving longer crop rotations (for productivity, resilience, quality, and efficiency), and on demonstrating their feasibility and benefits.
- **Barriers to crop and livestock integration.** A lack of emphasis on improving forage and pasture crops for midwestern rotations has hampered integration there, as has the domination of meat processing and marketing by a few large corporations (Gurian-Sherman 2008; Traxler et al. 2005 Table 11; Frey 1996 Table 9). More local processing options are needed, along with additional research to improve the efficiency of integrated and pasture-based farming.
- **Barriers to cover cropping.** Many farmers are reluctant to grow cover crops because of the up-front investment in seed and labor, and the potential challenge involved in fitting cover crops into the narrow windows between cash crop harvests and the onset of winter (Union of Concerned Scientists 2012). Publicly funded research, incentives, and regionally appropriate demonstration projects could overcome this reluctance.



This map illustrates the dominance of corn on farms in the Midwest. Nationwide, nearly 28 percent of crop acreage is dedicated to corn, and federal farm subsidies, public research dollars, and technical assistance are currently skewed toward supporting it.

Source: USDA, National Agricultural Statistics Service

What Farmers Need to Make the Switch

The vision we have laid out is both ambitious and necessary. A vibrant and truly sustainable agriculture that meets the food security and environmental challenges of the twenty-first century is attainable, but we must begin the transition today or risk losing the resources—including soil fertility, biodiversity, and historical knowledge—upon which our productivity depends.

Because our current agricultural landscape is largely the product of short-sighted farm policies of the past, we need smart new policies and investments to set us on the path to a healthy farm future. These policies must be designed to maximize environmental, public health, and societal benefits while ensuring high productivity and profitability for farmers.

In particular, government policies should:

- **Offer greater financial incentives** for farmers to adopt conservation measures and scientifically sound sustainable, organic, and integrated crop or livestock production practices—at both the farm and landscape level
- **Expand outreach and technical assistance** that will provide farmers with better information about these transformative practices
- **Increase publicly funded research** to improve and expand modern, sustainable farming

Our detailed recommendations can be found in *Toward Healthy Food and Farms: How Science-Based Policies Can Transform Agriculture*, available on the UCS website at *www.ucsusa.org/foodandfarmpolicy.*

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A conservationist with the USDA's Natural Resources Conservation Service (left) meets with an Oklahoma farmer to review the progress of a grass-planting project on his farmland. Increased public funding for such technical assistance would enable more farmers to adopt and perfect healthy farming practices.

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