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Sustainable Corn and Soybean Production

Agronomy Production Guide

Abstract: Sustainable agriculture renews the environmental, social, and financial resources on which farming depends. This publication discusses the relationship of corn and soybeans to overall farm sustainability and suggests ways to improve the sustainability of corn and soybean production. Two farmers are featured who have found ways to grow corn and soybeans more sustainably. Also discussed are diversification options that are inherently more sustainable than annual row crops.

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Introduction: Is growing corn and soybeans sustainable?

For agriculture to be truly sustainable it must do three things at the same time:

- Enhance the environment
- Support the farm family at an acceptable economic level
- Benefit the local community

Gyles Randall, a soil scientist at the University of Minnesota, states that corn and soybean production in his area does not appear to be sustainable in any of these aspects. The bottom line, Randall says, is that "we will need substantial changes in federal farm policy, cropping systems and usage of crops produced on the farm to sustain a healthy environment and rural community" (1).

Let's take a look at each of the three basic principles of sustainability as they relate to corn and soybean production and look for opportunities for progress.

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NCAT

Environmental Sustainability

To be environmentally sustainable, corn and soybean farms must protect soil and water. The two most common pollutants from corn and soybean production are soil sediments and nitrates. The main source of soil entering waterways is bare ground created by tillage. Poor soil health, excessive fertilizer use, and inappropriate timing of fertilizer application cause nutrient runoff and leaching. Additionally, tile drainage hastens the movement of nutrients from fields to waterways. Sustainable agriculture practices keep soil in the fields and prevent its movement into waterways. I will discuss these issues in more detail below.

Figure 1. Number of farms during the 20th Century

Source: National Agricultural Statistics Service, USDA.

Economic Sustainability

To be economically sustainable, corn and soybean farms must generate a reliable profit margin every season. Given current economics, commodity producers have little control over the price they receive for their products. The farmers become, in essence, "price takers," in that they take what they can get for their crop. With commodity prices flat or in decline, and cost of production going up, it is easy to see why so many farms are going out of business.

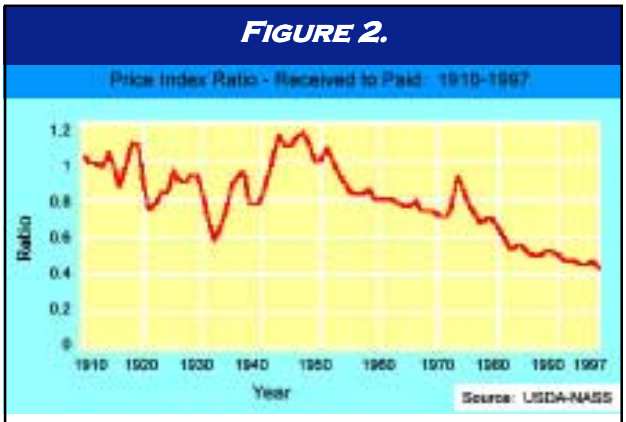
According to a 1998 report of the USDA Commission on Small Farms (2): "As farmers focused on producing undifferentiated raw commodities, food system profit and opportunities were shifted to the companies that process, package and market food." The result: since 1980, farmers' share of consumer spending has dropped 13 percent, while other food-system sectors are enjoying record profits.

As more contract arrangements develop between agribusiness and farmers, the farmer increasingly turns more decisions over to others and plays the role of indentured servant. Unless prices rise dramatically, corn and soybean producers will need to find ways to differentiate their products in order to tap markets that pay a premium.

Social Sustainability

Sustainable rural communities require a vigorous local economy based on successful, income-generating farms. Unfortunately, farmers dependent on corn and soybeans are losing their farms in great numbers and moving elsewhere to find jobs. Overall, the U.S. lost 219,500 farms between 1981 and 1986, as those fields were merged into larger operations (3). Figure 1 shows the decline in farm numbers from 1900 to 1997 (4). The perennial lack of profitability in commodity-crop agriculture is evident in the ratio of prices paid for inputs to prices received for commodities sold. Figure 2 shows declining ratios of sales prices to input prices (4). The net effect is lower profit margins for producers. With fewer people to support the local economy and provide a tax base, businesses, churches, and social organizations close their doors. Also, schools and hospitals consolidate in larger towns and are less able to serve rural people. All of these trends affect the quality of life for those who remain on the land.

Figure 2.



Source: National Agricultural Statistics Service, USDA.

Breaking Out of the Conventional Paradigm

Economic Opportunities

Economic sustainability increasingly depends on selecting profitable enterprises, sound financial planning, proactive marketing, and good management. The bottom line is that the farmer needs good financial planning tools and the willingness to follow a financial management plan. When the plan reveals that the economic risks of the current farm enterprises are high, it is probably time to look at alternatives. All the good financial planning in the world cannot help you if you are faced with prices out of your control and changing government policies that may impact your income or costs.

The comprehensive financial planning process used in Holistic Management™ begins by planning income, then allocating a planned profit as the first expense item. The remaining income is allocated to cover production costs. This approach requires that costs never rise to the level of anticipated income—thus preserving a profit. This potent financial planning process empowers people to make decisions that are simultaneously good for the environment, the local community, and the bottom line. The holistic financial plan provides a roadmap to help people navigate through their financial year, assured that the profit will be there at year's end. Learn more about this process by requesting the ATTRA publication entitled *Holistic Management*.

If none of this sounds appealing, consider hiring a marketing consultant based on his or her track record of positive results. Ask bankers, neighbors, and the Extension Service for recommendations. Study and use the futures market to ensure adequate future income (5). Look at buying options as an insurance policy. At the very least, project your crop income based on the futures price, and plan expenses so that a profit is expected. Throughout the season, stay on track toward that profit by monitoring spending.

The key to economic survival may lie in exploring other income opportunities. These include contract growing of seed corn, specialty corn, food-grade soybeans, or popcorn. These options are not for everyone; only a certain number of acres of these crops can be grown because of their limited markets. Alternative row crops may be a viable option to lengthen a corn or soybean rotation; learn more about them from the ATTRA publication *Alternative Agronomic Crops*.

Certified organic production is another option. "Organic" not only means new market opportunities but practices that are generally more ecologically sustainable. However, the maintenance of bare ground through tillage and cultivation typical of organic corn and soybean production is not sustainable. For more information on organic production and certification, see the ATTRA publications *Overview of Organic Crop Production*, *Organic Farm Certification and The National Organic Program*, *Organic Field Corn Production*, and *Organic Soybean Production*. For more information on alternatives to tillage, see ATTRA's *Conservation Tillage* and *Pursuing Conservation Tillage for Organic Crop Production*.

The introduction of genetically altered crop varieties has been greeted with both hope and caution by farmers. It is wise to stay current on market trends in genetically modified crops. Market uncertainty surrounds crops like Bt corn and Roundup-Ready™ soybeans. Though genetically modified crops are being grown on a large percentage of U.S. acres, there still remains significant resistance to buying them in key export markets, especially Europe and Japan. Farmers who choose to plant these crops should be aware of this market uncertainty. Read more about GMO crops in the ATTRA publication *Genetic Engineering of Crop Plants*.

Producers should also be aware that some buyers, including major grain traders like Archer Daniels Midland (ADM), have offered farmers price premiums for non-GMO crops, providing a market niche for standard varieties. Whether the non-GMO market continues to offer a premium, and whether it grows or shrinks over time, remains to be seen.

Sustainable Management Alternatives

One way to increase the profitability of corn and soybean production is to reduce input costs and build drought-hardiness through sustainable management practices. The connection might not be obvious at first but will become so with the understanding that one of the greatest threats to agricultural sustainability is soil erosion and reduction in soil quality. Erosion is initiated by raindrop impact on bare soil. Any management practice that protects the soil from raindrop impact will decrease erosion and increase water entry into the soil. Mulches, cover crops, and crop residues serve this purpose well. For more information see the ATTRA publication *Drought Resistant Soil*.

Table 1. Effect of erosion on organic matter, phosphorus, and plant-available water (7).

Erosion level	Organic matter	Phosphorus	Plant-available water
	%	lbs./acre	%
Slight	3.0	62	7.4
Moderate	2.5	61	6.2
Severe	1.9	40	3.6

The major costs to the farm associated with soil erosion come from the replacement of lost nutrients and reduced water-holding ability, accounting for 50 to 75% of productivity loss (6). Eroded soil typically contains about three times more nutrients than the soil left behind and is 1.5 to 5 times richer in organic matter (6). Table 1 shows the effect of slight, moderate, and severe erosion on organic matter, soil phosphorus level, and plant-available water on a silt loam soil in Indiana (7).

When erosion by water and wind occurs at a rate of 7.6 tons / acre / year it costs $40 per year to replace the lost nutrients as fertilizer and around $17 / acre / year to pump irrigation water to compensate for lost soil water-holding capacity (8). The total cost of soil and water lost annually from U.S. cropland amounts to an on-site productivity loss of approximately $27-billion each year (6). These costs do not include the additional losses to society as a whole from reduced air quality, pollution of surface waters, and dredging of streams and drainage ditches.

Erosion is not the sole source of nutrient loss from non-sustainable cropping. There is also significant loss to leaching. Nitrates, in particular, pose pollution problems by leaching into groundwater or moving through tile drains into ditches and surface waters. Dr. Otto Doering of Purdue University estimates that widespread implementation of two best management practices (BMPs)—cessation of fall fertilization and re-establishment of riparian wetlands along waterways—could reduce nitrogen runoff by 20% (9). Runoff from fields farmed organically typically carries less nitrate; in an Illinois study, researchers showed that nitrate levels in organic corn fields were half those found in conventionally farmed fields (10). The exception to this came shortly after a legume green-manure crop had been incorporated in the organic fields in preparation for corn planting; at that time, nitrate levels were the same in organic as in conventional.

However, for farmers to effectively plug nutrient leaks caused by erosion and leaching, more than BMPs are required. Serious changes in pro-

Cover crops, Shinbone Valley, TN (photo printed with permission)

duction systems need to be made. Among the most effective changes identified to date are the introduction of conservation tillage, the use of cover crops, and longer crop rotations featuring perennial forages. These are among the efforts that will build soil health in the long term. For more information on soil health and building soils, request the ATTRA publication *Sustainable Soil Management*. Also request *Protecting Water Quality on Organic Farms*, which is useful for both organic and non-organic producers.

> Long-term rotations with legume sod crops build the soil and provide a natural reserve of nitrogen for subsequent crops while reducing nutrient leaching. Soil is especially resistant to erosion during the sod phases of the rotation.

The production practices discussed below incorporate many of the basic principles of sustainable agriculture, common across many types of farming. These include plant diversity (achieved through crop rotation or intercropping); pest prevention (including weeds, insects, and diseases) through habitat manipulation; nutrient cycling; soil-building; and management flexibility—to name a few. There are any number of practices and systems incorporating these principles from which farmers can choose according to their individual situation. Three are offered below.

Conservation Tillage

No-till has caught on in many states as a way to control erosion and reduce production costs. The primary economic benefits come from lower labor and machinery overhead costs. Additionally, costs of fuel and machinery maintenance are lower. Yields under no-till typically hold steady while the soil quality builds. Over time, water infiltration and soil tilth increase. With no-till, every field operation except planting and harvesting is done with a sprayer. Often the lowest-cost system involves no-till with herbicide-tolerant crops, though herbicide-free systems are being researched.

Ridge-till is a good option in some situations. This system could be considered intermediate in sustainability in that it maintains some degree of ground cover for much of the year but still involves some cultivation. Herbicide use is generally reduced to a one-time band application on the ridge, at or before planting.

Cover Cropping

One of the most useful sustainable-ag practices employed in recent decades is the old but undervalued practice of cover cropping. A cover crop is a planting of (typically) grass and / or forage legumes on a field between production seasons. Such plantings reduce erosion, build soil, and, in the case of legumes, fix nitrogen for subsequent crops. Cover crops are of exceptional value on otherwise bare winter soils, which can erode badly during rains and snow-melt runoff.

Another cover-cropping concept is the use of "catch crops." The term refers to a non-leguminous cover crop, overseeded or planted shortly after the main crop harvest. Its principal purpose is to absorb soluble soil nutrients—especially nitrates—to prevent their leaching. Winter annual grasses such as wheat, oats, rye, and ryegrass are often used as catch crops. In summer, forage sorghums and buckwheat are sometimes employed. For more on cover crops request the ATTRA publication *Overview of Cover Crops and Green Manures*.

Combination Systems

Among the most promising systems to date are those that combine conservation tillage with cover crops. Dick and Sharon Thompson, who farm 300 acres near Boone, Iowa, built a herbicide-free weed-management system around ridge-till technology for corn and soybeans. Grain fields are overseeded or drilled in fall with combinations of hairy vetch, oats, and grain rye as a winter cover crop. The vetch provides nitrogen, while the grasses provide weed suppression and erosion protection. The cover crop is not tilled in prior to planting. Instead, the ridge-till planter skims off the top of the ridge enough to create a clean seeding strip. Subsequent passes with the ridge-till cultivator eliminate any cover crop in the inter-row area and help to re-shape the ridges. The Thompsons estimate savings of $45 to $48 per acre using their methods.

Walking the Journey: Sustainable Agriculture that Works. 1992.
A 20-minute video about Dick and Sharon Thompson's ridge-till farming system.
Available for $39 from
Instructional Technology Center
121 Pearson Hall
Iowa State University
Ames, IA 50011
515-294-1540.

Don and Deloris Easdale of Hurdland, Missouri, reduced their annual herbicide costs from $10,000 to less than $1,000 in three years on their 300-plus acres of grain crops (11). They use hairy vetch, winter rye, or Austrian winter peas in combination with their ridge-till system. They flail-chop hairy vetch or winter peas ahead of the ridge-till planter and plant directly into the remaining cover-crop residue. This practice eliminated using a burndown herbicide. The legumes replace much of the nitrogen needed for the corn or milo crop. Some liquid starter and liquid nitrogen is placed below the seed at planting. They more than recover the seed costs of their cover crops in savings on fertilizer and herbicide.

Other Useful ATTRA Publications:

- Sustainable Soil Management
- Principles of Sustainable Weed Management
- Intercropping Principles and Production Practices
- Overview of Organic Crop Production
- Organic Field Corn Production
- Organic Soybean Production
- Alternative Agronomic Crops
- Conservation Tillage
- Pursuing Conservation Tillage for Organic Crop Production
- Protecting Water Quality on Organic Farms
- Moving Beyond Conventional Cash Cropping

Perennial Agriculture

Perennial crops (sod, trees, perennial grain crops) are inherently far more sustainable than annual crops. The main reason is that they do not require tillage to establish each year, hence soil erosion is reduced. Perennial forage crops like alfalfa, white clover, bromegrass, and fescue absorb and recycle nitrates much more effectively than row crops. Research in Minnesota has demonstrated that corn and soybean rotations have leached-nitrate losses 35 times as great as fields in alfalfa or alfalfa-grass mixtures (12).

Agroforestry is a system that integrates perennial trees with annual crops such as corn and beans or with perennial forages. Trees are integrated with crops to increase economic stability through diversification. Some of the more common approaches include alley cropping and silvopasture. Alleycropping entails planting row crops between rows of high-value wood or nut trees during their establishment phase. Silvopasture involves grazing livestock on forage growing under a widely-spaced tree stand. The tree stand is thinned to allow enough sunlight to reach the forages growing below. For more information call ATTRA to request our *Agroforestry Overview* publication.

There are many alternatives to corn and soybean cropping that involve creating a base of perennial forage. Once the cropland has been converted to perennial sod, the problems of erosion and nutrient loss are minimized, making the whole system much more environmentally sustainable. Among the options are grazing systems for beef, poultry, sheep, and hogs. Many other grazing ungulates—such as llamas and alpacas—can also be raised and marketed through a variety of channels. ATTRA has much more information on forage-based systems available on request.

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