



An Introduction to the Principles and Practices of Sustainable Farming

by Fabian Menalled¹, Thomas Bass², Dave Buschena³, Dennis Cash⁴, Marty Malone⁵, Bruce Maxwell⁶, Kent McVay⁷, Perry Miller⁸, Rachel Soto⁹ and David Weaver¹⁰

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IN THE LAST 20 YEARS, A GROWING MOVEMENT

has emerged to promote the development and implementation of sustainable farming practices. Despite its growing popularity, the concept of sustainable agriculture is still evolving as it encompasses both changing attitudes towards farming and developing environmental awareness. This Montguide:

- Outlines the foundation of sustainable agriculture systems
- Describes the general principles guiding sustainable farming and ranching
- Provides examples of practices aimed at enhancing the sustainability of the farming enterprise

Because the concept of sustainable agriculture is still evolving, this Montguide should be regarded as an invitation to continue the dialogue rather than a definitive statement on how to increase the sustainability of Montana's agricultural systems.

What is sustainable agriculture?

The term sustainable agriculture has been used and interpreted in many ways. A common thread running through these definitions is that sustainable agriculture comprises site-specific ranching and farming practices designed to meet current and future needs for food, fiber, energy, and ecosystem services including, but not limited to, soil conservation, clean water and biodiversity. Sustainable agriculture emphasizes production and food systems that are profitable, environmentally sound, energy efficient and improve the quality of life for both farmers and the public.

Is no-till agriculture more sustainable than organic farming? Can a producer use genetically modified organisms (GMO) in a sustainable approach? Which time-frame should be used to assess the success of a sustainable farming

Sustainable agriculture:

- Sustains the economic viability of farm operations
- Satisfies human food, fiber and energy needs
- Maintains or enhances the resource base upon which it depends by emphasizing soil conservation, nutrient recycling, biologically based-pest management and biodiversity
- Takes advantage of the knowledge and skills of farmers
- Is durable and resilient to disturbance, pest outbreaks and market variability
- Makes the most efficient use of nonrenewable resources and on-farm resources
- Integrates, where appropriate, natural biological cycles and pest control tools with production practices

system? Is sustainable farming more expensive than conventional farming? The answers to these questions are not black and white. Sustainable agriculture does not rule out one particular technology and it can be applied to large scale operations as well as small and niche market production. In other words, there is no pre-determined body of practices that by itself confers "sustainability."

For example, the adoption of nitrogen-fixing cover crops, designing integrated pest management systems, practicing organic farming, or implementing reduced or no-tillage systems does not guarantee sustainability. Conversely, sustainable agriculture does not mean the re-adoption of outdated production practices. Responsible use of newly developed technologies may play an important role in developing sustainable farms and ranches.

¹ Cropland Weed Specialist, Assistant Professor; ² Livestock Environment Associate Specialist; ³ Agricultural Economist, Professor; ⁴ Forage Specialist, Associate Professor; ⁵ Extension Small Acreage Coordinator; ⁶ Weed Ecologist, Professor; ⁷ Extension Cropping Systems Specialist, Assistant Professor; ⁸ Cropping Systems Specialist, Associate Professor; ⁹ Extension Agent; ¹⁰ Insect Pest Management, Associate Professor

Re-thinking Agriculture to Improve Sustainability

If no single practice by itself secures sustainability, what can be done to reduce the negative impacts of agriculture while maintaining or improving its productivity and sustainability? This is a major challenge with no easy, single solution. However, answers may present themselves if we are willing to re-think our approach to farming (Table 1).

Making the transition to sustainable agriculture is a process that requires a series of steps. In this process, three issues should be recognized. First, we must be aware that agroecosystems are ecologically complex units where soil, water, air, wildlife, insects, pathogens, plants and humans interact. When farmers make management decisions, they influence interactions among crops, livestock, beneficial organisms, pests and the physical environment. While biological and ecological considerations play a role in these decisions, so do a number of economic, social and legal considerations. To achieve sustainability, farmers should be aware of the short-, mid- and long-term consequences of these management decisions. In a sustainable farming framework, external inputs such as synthetic fertilizers and pesticides may supplement ecological processes, but should not supplant them. In this context, producers should be aware of the importance of ecological processes such as nutrient cycling, crop-weed competition, host-parasitoid and predator-prey relationships in determining crop yields and system stability in the design of sustainable farming systems.

Second, because of the ecological complexity of agricultural systems, sustainable farming requires the adoption of a systems-level and interdisciplinary perspective. As with any system, farms consist of a set of parts acting in coordination to achieve desired actions or results for the whole. In addition, a farm exists in a landscape where

adjacent land use and community objectives should be considered. Consequently, one should clearly define the goals of the production system and search for the actions that will achieve those goals.

Finally, sustainable farming aims at maximizing many ecosystem services including yields, clean water and air, the presence of wildlife and other organisms valued by society, carbon sequestration, and recreation. Clearly, these goals can compete with each other at times. Thus, achieving sustainability must, in reality, be considered an optimization process that engages all participants including farmers, laborers, policy makers, retailers, consumers and researchers. For example, better water quality in an agricultural ecosystem can reduce the cost and need for drinking water treatment of those living in the region as well as more distant communities. Likewise, water is one of the most valued resources for livestock, so saving and protecting water quality can enhance livestock production.

Enhance the Sustainability of the Farming Enterprise

The road to sustainability is long and complex. Each farm represents a unique combination of biological, climatic, soil and management conditions such that no single “silver bullet” exists to secure sustainability. However, there are principles that will help farmers move in the direction of more sustainable agroecosystems. Among them:

- Use water and nutrients efficiently
- Keep soil covered throughout the year
- Reduce or eliminate tillage in a manner consistent with effective weed control
- Diversify your farming enterprise to spread agronomic and economic risk

TABLE 1. Factors affecting the rejection or adoption of new approaches to farming. (Adapted from Robertson and Swinton, 2005. *Reconciling agricultural productivity and environmental integrity: a grand challenge for agriculture. Frontiers in Ecology and the Environment* 3:38-46.)

Forces that discourage the adoption of sustainable agricultural practices.
• Agricultural subsidies that favor excessive production of a single commodity
• Economic incentives that reward growers for externalizing environmental costs to the rest of the society. For example, policies that do not penalize water contamination due to pesticide run-off or soil erosion
• Political pressure to minimize environmental restrictions
• Consumers insufficiently or wrongly trained about agricultural issues
• Large populations seeking inexpensive food
Forces acting to re-couple agriculture with ecological integrity
• Knowledge about the resources and process provided by agriculture such as clean water, soil conservation and recreation. Collectively, these benefits are known as ecosystem services
• Understanding of the impact of agricultural management practices on ecosystem services
• Policies or incentives that pay or reward producers for providing ecosystem services
• Policies that help alleviate pressure on marginal lands
• Public education to inform consumers and those involved in policy making about the environmental costs and benefits of alternative management scenarios

- Rotate crops to enhance yields and facilitate pest management
- Use cover crops and green manure and/or animal manure to build soil quality and fertility
- Protect water quality
- Develop ecologically-based pest management programs
- Integrate crop and livestock production
- Increase energy efficiency in production and food distribution
- Maintain profitability

Designing an economically viable, sustainable and productive modern agricultural system is based on enhancing the health of the land and rural communities and concentrating on long-term solutions rather than short-term treatment of symptoms.

In summary, any group of two or more people may never agree on a static definition for sustainable agriculture. But by taking a wider view, most of us can agree on a set of principles for sustainability. While there are still many things we need to learn, there are many success stories. Producers across Montana, along with students and researchers at Montana State University, have developed sustainable farming practices. The following examples illustrate how the use of these principles can help realize systems that are striving for sustainability.

To Till or Not To Till?

No-till farming has been a very important factor in reducing soil erosion rates in the Northern Great Plains. It has also been widely adopted because of the enormous time and fuel savings, as well as environmental benefits including efficient water use, increased soil organic matter, improved soil structure, and enhanced soil biodiversity. On the other hand, concerns regarding no-till farming include increased reliance on herbicides, the associated risk of selecting herbicide-resistant weed biotypes, potential weed shifts towards difficult to control species such as cheatgrass (*Bromus tectorum*), foxtail barley (*Hordeum jubatum*) and prickly lettuce (*Lactuca serriola*), changing disease and insect pressures, and managing cooler and wetter soils in spring.

In recent years, there has been a growing interest in developing reduced-input systems that incorporate no-till practices. One approach is to plant a cover crop that will produce high biomass, then graze, mow or mechanically crimp that cover crop and no-till plant into the residue. Developing these no-till systems is technically challenging and preliminary results from research conducted at Montana State University are encouraging but thus far inconclusive.

Examples of Successful Approaches to Achieve Sustainability

- A large multi-family farm in central Montana runs diversified livestock and crop operations on several thousand acres. The ranching operation includes hogs, cattle and poultry. The poultry is processed and direct-marketed. Garden, greenhouse and ornamental horticultural production also take place with some garden crops direct-marketed. No-till farming is used on cropland whenever possible, including a rotation of wheat and barley.

While the hog operation is conventional from a modern swine housing standpoint, the manure is separated into solid and liquid components for the most beneficial use. The solids are composted and stored on a stacking pad before being used for flower production in spring and fall gardens, as well as greenhouse production. The liquid fraction is stored and treated in a 6 million gallon lined anaerobic lagoon before being used for irrigation to supply wheat, barley and hay fields with water and nutrients. Due to the wide variety of agricultural commodities produced, the separation of manure is vital to keeping costs of fertilizer low, as well as providing irrigation. This example demonstrates how a large operation with modern means of production can incorporate many sustainable practices to the benefit of the farm, ranch and community.

- David Weaver, an entomologist at Montana State University, and his students found in a comparative survey that adoption of no-till practices during fallow increased mortality of the wheat stem sawfly by native parasitic wasps in adjacent crops. In the majority of the locations studied, heavy tillage of fallow fields had no impact on numbers of the wheat stem sawfly in the adjacent crops, but these sites had fewer parasitic wasps. In contrast, lightly-tilled or no-till fallow fields had greater numbers of parasitized wheat stem sawfly larvae in the adjacent crop. The study was conducted almost exclusively in fields growing solid-stem winter wheat which is partially resistant to lodging caused by mature wheat stem sawfly larvae. Earlier research has shown that parasitism levels are not impacted by the solid-stem trait and it appears that no-till management of fallow ground enhances survival of the delicate parasitic wasps, allowing them to attack the wheat stem sawfly larvae in the nearby crop.

- Bruce Maxwell, a weed ecologist at Montana State University, and his students found that the impact of wild oats on small grain production was quite variable from site-to-site and year-to-year. There were some years and sites where it was not economically justified to control wild oats even considering their future potential to rise to high population levels. In other cases, it was crucial to reduce the density of the wild oats. In both cases, the sequence of moisture conditions played a major role in determining the value of wild oat management. These results suggest that site-specific information on the response of crops to inputs

is very important in optimizing wild oat management as well as managing other inputs like nitrogen. This research showed that site-specific technologies can increase the ability of farmers and farm consultants to predict input response, increasing economic efficiency and minimizing environmental side-effects.

- Perry Miller, Rick Engel, Clain Jones and others have found that annual legumes such as pea can reduce reliance on fertilizer nitrogen and can be managed to conserve water for subsequent crops. Winter pea, terminated at first bloom, has been especially effective at balancing soil N contribution and soil water use. Research continues to identify the energetically optimal legume species, growth period and the role of tillage. More information on the impact of legumes can be found in *Fertilizer Facts No. 45 and 51* available online at <http://landresources.montana.edu/FertilizerFacts/>

More information on sustainable agriculture can be found at:

Print Resources

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Online resources

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