Healing and Building Soil on Prairie Birthday Farm

By Linda F. Hezel and Robert J. Kremer

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Compared to the time it takes for prairie soils to develop, this is a very short story of reconstructing prairie as an integral part of a 15-acre, food-producing farm called Prairie Birthday Farm in Clay County, Missouri. Reconstruction of native prairie is essential to the farm's goal of producing nutrient-dense, great-tasting food for the family, area residents and chefs. Nutritious and savory food originates from fertile soil. Fertile soil is achieved through organic methods of deliberate soil restoration and protection, which is where prairie plants come in at the farm.

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Prairie reconstruction with native warm-season grasses and forbs began at the farm in 1995 on gently sloped loess soil. The topsoil had become highly eroded from many years of intensive row-crop cultivation by previous owners. The prairie reconstruction was accomplished *without* using herbicides: Instead, non-native grasses, primarily fescue, and weeds were methodically removed by over-grazing with horses, intensive mowing and annual mosaic burning. By over-seeding and inter-planting with desired native species, a prairie plant ecosystem similar to the vegetation that once occupied the farm landscape was reconstructed.

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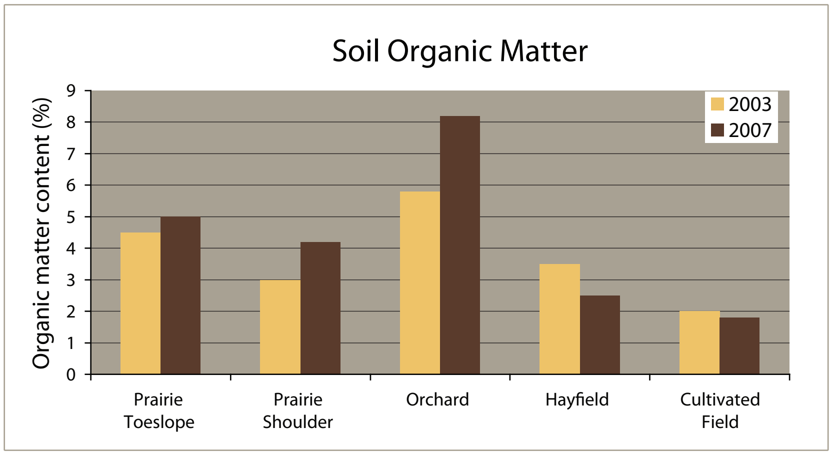
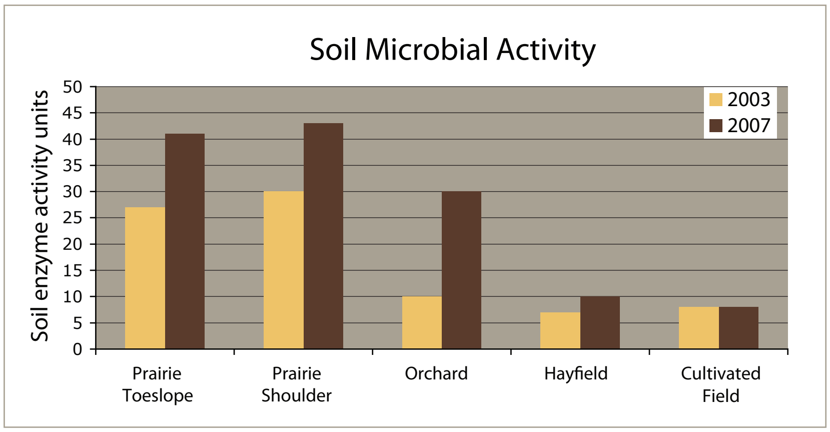
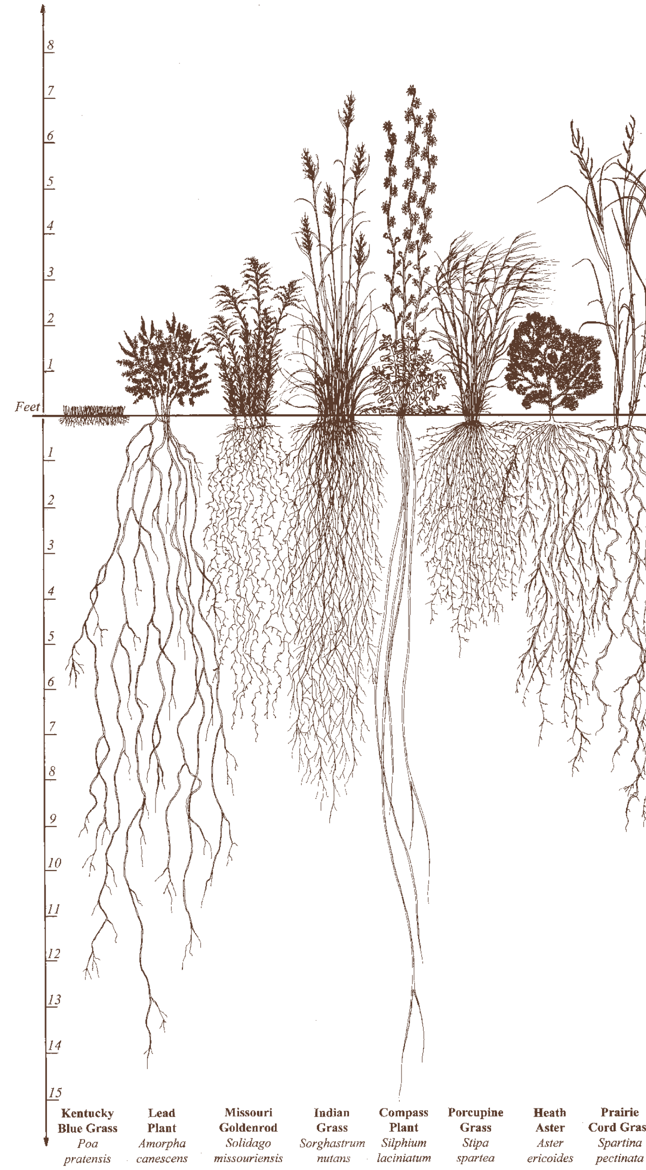
As Daniel Imhoff wrote in Farming with the Wild, *"Developing place-appropriate agricultural systems that work with rather than against Nature requires an understanding of native species and local ecosystem processes prior to European settlement and agriculture" (Imhoff 2003: 18). The soil-building work at Prairie Birthday Farm strives to develop this understanding and put it into practice.*

Incorporating prairie plants, like the big bluestem above, into fruit orchards and other food crops at Prairie Birthday Farm heals and builds soil. Planned burning helps to maintain and improve prairie plantings in the orchard (left).







Since 2003, Robert Kremer has carried out soil testing at the farm, which has revealed an increase in organic matter content and biological activity in the areas of Prairie Birthday Farm where prairie plants have been incorporated into the landscape, as compared with conventionally managed reference sites (hayfield and cultivated field) on property nearby the farm. Food crop beds are woven in between various patches of prairie plantings throughout the farm.

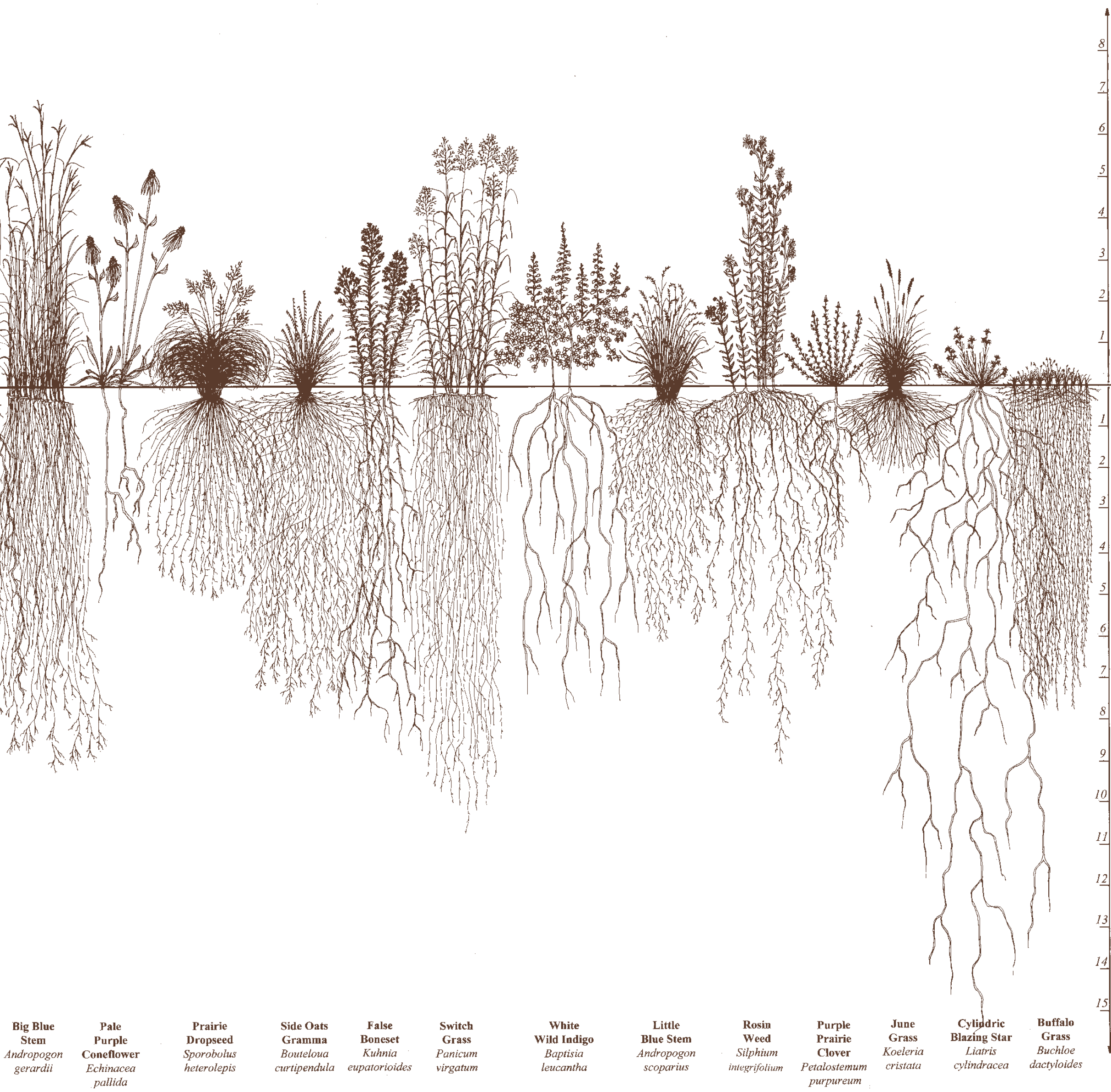
Prairie Plants: Channeling, Mining, Depositing

Roots of many native prairie plants penetrate dense and compacted soils remaining from previous years of conventional farming to form channels for water infiltration, mine the subsoil for nutrients and deposit organic substances that improve soil structure and nurture active microbial communities. Plant ash analysis has revealed that plants have the ability to "mine" trace minerals (violets/zinc, royal catchfly/cobalt, asters/selenium), which may then be released during prairie burns and decomposition, making them available to plants and animals (Mollison 1994).

Indeed, soil health monitoring with annual soil testing carried out by Robert Kremer since 2003 reveals that the conversion to prairie plants has eliminated erosion and considerably improved soil organic matter, soil aggregation and biological activity as reflected in high microbial enzyme activity relative to "reference soils" in nearby over-grazed pastures and intensively monocropped, cultivated fields. The reconstructed prairie is not only restoring soil health toward the level of native prairies but is also providing wildlife habitat. Prairie plants have increased bird, butterfly and beneficial predatory insect numbers and species; provided abundant nectar sources for honeybees; and created a habitat haven for insects important for pollination of the diverse culinary plant species cultivated at the farm. Research validates the importance of such biodiversity to organic farming (Imhoff & Baumgartner 2006).

Prairie Mollisol Formation

Prairie reconstruction continues at the farm on silt loam soils that developed in loess deposits layered over glacial till parent materials; these soils were originally dominated by tallgrass prairie vegetation (Nelson 2005: 255–277). The majority of these soils are classified as Mollisols, derived



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The extensive root systems of prairie plants encourage proliferation of soil microorganisms and improve soil structure including porosity, water infiltration and aggregation.

from the word *mollis*, Latin for "soft," which describes its organic, friable structure. Mollisols are typically formed where the natural vegetation is grassland. Grasses deposit their annual accumulation of leaves and stems onto the soil surface and, combined with substances from the dense network of roots below ground, these contributions are processed and added to the accumulated soil organic matter. Mollisols can take from 1,000 to more than 10,000 years to develop naturally, depending on the nature of the underlying parent material, the climate and the vegetation.

"Breaking the prairie" was an apt expression for the work required to plow through the tight bundle of roots of dense stands of prairie grasses in the 1800s. Unfortunately, as Lee Reich wrote in *Weedless Gardening*, "stirring up the soil of the American prairies quickly burned up centuries of accumulated organic matter; within 60 years, more than a third of the humus had been lost. That loss of organic matter (one benefit of which is to stabilize soil against wind and water erosion) was dramatically demonstrated when it was coupled with a few years of drought to create the Dust Bowls of the 1930s." (Reich 2001: 14).

A visual survey of intact tallgrass prairie landscape clearly reveals the diversity of perennial grasses and forbs that comprises this natural ecosystem. Less obvious is the complex and dynamic below-ground ecosystems in which nearly two-

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Profile of a typical Mollisol soil type developed under prairie vegetation.

thirds of the prairie plant biomass thrives in the form of roots that intimately explore the soil environment. The importance of soil characteristics to grassland ecosystems is evident by the fact that biologists use them as key characters in classifying prairie types (Nelson 2005). Perhaps even more critical are the complex interactions of soils, the microbial communities thriving within them and the native plant roots, which results in a balanced, functional ecosystem essential for maintaining environmental quality.

Soil Quality vs. Soil Health

The overall functioning of the soil ecosystem can be expressed as "soil quality," which is a term that soil scientists developed for assessments of soils managed in agroecosystems, where optimum, economic crop productivity is emphasized. "Soil health" is a more holistic expression of the functional capacity of soil as a vital living system whereby plant and animal growth and environmental quality are sustained, and plant, animal and human health are promoted. The soil health concept may best describe the ecological balance embodied in prairie ecosystems because the internal regulation of nutrient cycling through decomposition and other soil microbial activities supports optimum plant growth yet minimizes nutrient losses through erosion and gaseous release. Furthermore, constant organic matter replenishment and interactions with microorganisms and plant roots promote stable soil aggregation, unrestrained porosity and rapid water infiltration that alleviates run-off and soil erosion. Interactions of soil biological, chemical and physical processes yield the "healthy state" of environmental quality exemplified in natural ecosystems. This soil health is the fundamental requirement for healthy food.

"A fertile soil," wrote Louise Howard in 1954, "that is, a soil teeming with healthy life in the shape of abundant microflora and microfauna, will bear healthy plants, and these, when consumed by animals and man, will confer health on animals and man. But an infertile soil, that is, one lacking sufficient microbial, fungous, and other life, will pass on some form of deficiency to animal and man" (Howard 1954: 162). Most conventional agroecosystems have disrupted healthy ecological functions with the soil and vegetation disturbances of crop management practices. While it is not known exactly how much land can no longer be farmed because of soil degradation, if the best estimates are correct, between 0.5 percent and 1 percent of the currently cultivated land of the world is being lost each year (Davidson 2000: 30).

The prairie ecosystem is often used as a benchmark or reference ecosystem that reflects an "ideal" soil quality or soil health. Soil organic


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Native prairie plants at the farm create wildlife habitat, increase beneficial predatory invertebrate numbers and provide abundant nectar sources for honeybees, which in turn are essential to food crop pollination.

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Because native edibles like elderberry can tolerate insect and weather stresses, they help increase the overall productivity and ecological, as well as economic, stability of the farm.

matter, accumulated and maintained at high levels under prairie vegetation, is responsible for numerous dynamic interactions among soil properties and is thereby considered the key indicator of soil health. Healthy soils function within the prairie ecosystem through organic matter that facilitates a highly diverse community of soil microorganisms actively contributing to numerous soil functions including plant-nutrient cycling, improved plant growth, improved soil structure, carbon sequestration, beneficial symbioses with plant roots and suppression of plant diseases, insect pests and invasive weeds.

Advancing Ecologically Based Farming Systems

Information gained from limited studies of soil functioning under natural grassland and prairie ecosystems has recently been applied to strategies developed for optimizing nutrient management and plant diversity for restoration of environmental quality in agroecosystems. This "ecologically based farming system" approach deliberately relies on the biology and ecology of the ecosystem to reduce chemical inputs compared with conventional production systems. Integration of natural ecosystems (grasslands, forests, wetlands) into the agricultural landscape, originally envisioned in the writings of Aldo Leopold (Jackson & Jackson 2002), is encouraged to further protect the environment by serving as nutrient sinks and capturing soluble nutrients and potential contaminants before they reach aquatic ecosystems.

Farming processes at Prairie Birthday Farm are an advancement of the ecologically based farming system: prairie and other native plants benefit organic production not only through the integration of established prairie within the farm landscape, but also by intercropping these plants with horticultural crops. Climate change and the degradation of land and water resources demand crops and species that are adapted to difficult environments such as those with poor soil or degraded vegetation, or that are subject to drought. Native edible plants like persimmon, plum and elderberry occupy micro-environments around the farm. Because they can tolerate insect and weather stresses and occupy specialized niches, these native edibles increase the overall productivity and ecological, as well as economic, stability of the farm. Their diversity of taste, color, texture and modes of preparation represent a rich component of the disappearing cultural food-based heritage of Missouri. They are an important way of supporting cultural as well as plant diversity in a world of increasing globalization. Food culture—which encompasses taste preferences, cooking, presentation and ritual uses—makes our lives more interesting and enjoyable.

At the farm, improvement in soil health is further demonstrated within an innovative intercropping scheme of established native grasses and forbs in the alleys of the fruit tree orchard. The native plants eliminate the need for weed management and soil disturbance and, in addition to

*"During every week from April to September there are, on the average, ten wild plants coming into first bloom. In June as many as a dozen species may burst their buds on a single day. No man can heed all of these anniversaries; no man can ignore all of them. He who steps unseeing on May dandelions may be hauled up short by August ragweed pollen; he who ignores the ruddy haze of April elms may skid his car on the fallen corollas of June catalpas. Tell me of what **plant birthday** a man takes notice, and I shall tell you a good deal about his vocation, his hobbies, his hay fever, and the general level of his ecological education"*

—Aldo Leopold,
A Sand County Almanac, *1949*

the benefits derived from the prairie ecosystem, the root systems and their associated rhizosphere microorganisms intermingle with orchard roots to provide nutrients mineralized from organic sources, improve water uptake and likely enhance beneficial microorganisms that suppress potentially devastating root diseases.

The organic management system practiced at the farm illustrates how native plants can be used to not only restore soil health within a natural system but also within an organic farming enterprise for production of quality food (without disruptive impacts to the environment). The free ecological services of the prairie excel in repairing previously degraded soil at the farm, and in turn, the farm benefits the surrounding community with nutritious and tasty food, wildlife habitat and improved water quality.

Robert Kremer is a microbiologist with the U.S.D.A., Agricultural Research Service, Cropping Systems & Water Quality Research Unit in Columbia and also an adjunct professor of soil microbiology at the University of Missouri. His research interests include the discovery of biological and ecological characteristics of soil health affected by management in different agricultural systems and in natural ecosystems. He conducts soil testing at Prairie Birthday Farm.

Missouri Prairie Foundation member Linda Hezel, R.N., Ph.D. (curriculum and instruction), grows vegetables, fruits, herbs, edible flowers and native plants, and conducts research on Prairie Birthday Farm in Kearney (www.prairiebirthdayfarm.com). She sells produce, eggs and honey from the farm to local chefs and area residents. She also hosts volunteer apprentices through the Kansas State Growing Growers Program. Linda has done all of the planting and restoration work at the farm, with the help of her husband, Richard Moore, her sons, Christopher and David, and her siblings Sally, Harriet, Alice and John, who pitch in when they visit from St. Louis.


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Additional Resources

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Wild Farm Alliance, http://www.wildfarmalliance.org