The Land Report

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When people, land and community are as one, all three members prosper; when they relate not as members but as competing interests, all three are exploited. By consulting nature as the source and measure of that membership, The Land Institute seeks to develop an agriculture that will save soil from being lost or poisoned while promoting a community life at once prosperous and enduring. To become a Friend of the Land and support the work of The Land Institute, please turn to page 39.

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Introduction

Brian Donahue

Alexander Pope's famous epistle to Lord Burlington to "consult the genius of the place" is often cited in environmental circles. At The Land Institute, it is being followed in a unique way by looking to the native tallgrass prairie as a model for growing perennial grains in polycultural mixtures–what we call "natural systems agriculture." Pope's advice is more widely invoked by gardeners and landscape designers in the way it was originally issued, as a guide for designing a garden. Most broadly, it could be taken as an injunction to make sure that any cultural landscape, including everything from homesites to farmlands to protected prairies and forests, reflects the natural possibilities and limitations of its region.

But how does one go about consulting the genius of a place? Undertaking scientific investigations of natural ecosystems such as unplowed prairie, as The Land Institute has done, is one important part of the process. But what we see today, even in relatively "undisturbed" parts of the landscape, is only a brief excerpt from an ongoing story. In order to more fully understand the present ecological status quo, we need to be able to place it in a context of longer-term geological forces, soil formation, climate change, and species migration. Beyond that, it turns out that there are now few if any undisturbed places we can study. All of the regions in which I have lived, from Ireland to New England to Kansas, have been deeply and pervasively marked by not just one but several layers of human occupation. When people have been significantly altering a place for thousands of years, it becomes impossible to distinguish a simple natural "standard." Instead, we are faced with finding an ecologically responsible place for ourselves in a complex world of inextricable natural and cultural entanglement. The prairie ecosystem as it exists today is one very useful manifestation of this place's genius, but it is by no means all we need to consult as we go about trying to live here sustainably.

The essays by 1996 interns in this *Land Report* illustrate some kinds of scientific and historical study that allow us to see more deeply into such a multi-layered landscape. They hardly constitute a complete look, but are only the results of a few months of research last spring. Another kind of insight, equally important, comes from living in a place and working with its natural and cultural elements. Interns also get a glimpse of this during their ten months at The Land Institute. All these things go into the way one sees the land, and ultimately, how one treats the land.

Brian Donahue, Sheri Walz and Thomas Ruppert lounge in Lawnchairs.

How we treat the land is the primary artistic impression that we humans can make in the world. The quality of this impression depends on the depth of our understanding, among other things. Other expressions of landscape art also depend on our understanding and sympathy. We close with a collaborative attempt to assemble our insights into this landscape in a novel artistic fashion.

On the front cover photo, local farmer Roger Whelchel talks with interns Robin Mittenthal, Jerry Glover and Jon Richardson about a homestead near The Land Institute. The picture was taken by Aron Gannon. The back cover, by Terry Evans, shows an old oxbow of the Smoky Hill River south of The Land Institute. To the right of the curved line of trees, beneath the marks of modern cultivation, lies a village of the Smoky Hill people, circa 1000 to 1300 AD.

A Brief Natural History of Kansas

Robin Mittenthal

How constant is nature? Humans have recently wrought huge environmental changes such as ozone depletion and forest clearing, but when we leave biological systems alone they can appear stable, returning to a so-called climax state if disturbed by natural forces. This popular assumption is understandable given the short span of human lives, and comforting in the face of rapid cultural and technological change. However, recent research indicates that biological systems are often characterized as much by change and disturbance as by stability. What implications does this have for those of us working to increase the stability of *human* ecological relations?

Ecosystems in Kansas are typical of this mixture of change and stability. Rather than being constant in space and frozen in time, they have shifted continuously in response to geological, climatic, and evolutionary forces. Large changes in flora and fauna have occurred here over the past 250 million years, particularly during the last two million years of the Pleistocene. On a much smaller time scale, relatively recent Native American and European-American arrivals have also altered the face of Kansas. The significant degree to which both groups have changed the landscape bears on how we think about "native" vegetation today and how we should manage it into the future.

Our understanding of ancient life in Kansas is spotty, pieced together from fossils and the rocks in which we find them. From the late Cambrian to the end of the Cretaceous (from 520-65 million years before the present, or "mybp"), most of the fossils found throughout Kansas indicate repeated movements of shallow seas over the area, interrupted by periods of exposure. Fossils of trilobites (small, many-legged arthropods, now extinct), corals, shark's teeth, giant sea-dwelling reptiles, and mollusks in marine sediments such as limestones, shales, and salt beds alternate with terrestrial rocks containing fossils of lowland plant species such as tree ferns, ground pines, and horsetail. Dinosaurs probably lived in Kansas during the Triassic and Jurassic, but the rocks which would contain their bones have been deeply buried or worn away in most places.

For life in Kansas, the most important event of the Tertiary (65-2.5 mybp) was a series of movements in the earth's crust from about 65 to 20 mybp that pushed up the Rocky Mountains. The Rockies created a rain shadow which greatly decreased rainfall on the Great Plains, including Kansas. Lowered rainfall probably helped to push the region from forest toward grassland and switched its herbivores from mostly browsers (eaters of tree leaves) to grazers (grass eaters). The story of the prairie is more complex than this, however, and to understand it we need to look at other evidence.

Grasses appear in the fossil record of the Americas for the first time about 55-45 mybp. When grasses first appeared in South America, both continents were largely forested. The uplift of western mountains in South America, which occurred 20 million years before the rise of the Rockies, brought about hot summers and cold winters. This regional climate change, combined with overall global cooling, drought, and a drop in atmospheric carbon dioxide levels, favored the expansion of grasslands and the grazers which came to be associated with them.

Robin Mittenthal plots cover-class analysis

Grasses first appeared in North America about 18 mybp, some 30 million years after their initial spread in South America. They may have arrived much earlier, but no older fossil evidence has yet been found. One reason for the apparent delay might have been that it was difficult for grass species to pass through the climatic gradient of the tropics. Warm, wet conditions could have kept cold and drought-adapted plants to the south until new biochemical and structural modifications evolved.

Fossil pollen and seeds from scattered sites seem to show that by 14 mybp the vegetation in Texas, Oklahoma, Kansas, and Nebraska was savanna-like, with intermixed trees and grasses on the uplands and denser forest in river valleys. Fossil evidence of trees and the presence of crocodilian and large tortoise fossils indicates a frost-free climate with an annual rainfall in Kansas of 30-35 inches (about what east-central Kansas gets today). Most of the grass species now found on the prairie were not present.

About 7-5 mybp there seems to have been a further drying trend in the region. Annual rainfall in

Kansas probably fell to about 20 inches, and there was a boom in the species diversity of grasses, an increase in the area covered by grasses, and an increase in the numbers and diversity of associated grazers such as horses and antelope. The Great Plains as a whole became more open and forests retreated to river valleys.

During the Pleistocene (2.5 mybp-10,000 ybp), Kansas experienced a dramatic climate change as the earth entered an epoch of periodic glaciations. Over the past 900,000 years, each period of glacial advance has lasted about 100,000 years, with brief warmer "interglacial" spells of 10,000 years or so in between–some scientists feel we are in such an interglacial today. Only the extreme northeast corner of Kansas was ever covered by ice (at least twice, most recently about 25-20,000 ybp), but flora and fauna were profoundly affected by the colder climate far south of the actual glacial advances. Immediately south of the ice, what had been grasslands and savannas were replaced by tundra and spruce forest. Further south, spruce and limber pine were dominant, as indicated by fossil pollen and the remains of mammals and land snails that live in such forests. Relict populations of spruce and pine, small mammals, and snails from the end of the last glacial expansion (18-14,000 ybp) still exist in Colorado and other central Great Plains states on "ecological islands," sites such as canyons and scarps that were protected during more recent events. Huge mammals such as sloths, mammoths, saber-toothed cats, and giant beaver lived in this environment during glacial times. The bison, today considered a symbol of the prairie, is a recent arrival, having moved into North America between 70,000 and 40,000 years ago.

During the shorter periods between glacial advances, warmer and drier conditions allowed grasses which had been pushed far to the south to expand again over a large portion of the Midwest. After the most recent withdrawal of the ice (11,000 ybp), grasslands returned to dominate the region until 5,000 ybp. Pollen from lake sediments and some other evidence suggest that since that time

Geologic Time Scale

Era	*System or period*	*Series or epoch*	*Millions of years ago*
CENOZOIC	Quaternary	Recent	0-0.01
		Pleistocene	0.01-2
	Tertiary	Pliocene	2-13
		Miocene	13-25
		Oligocene	25-36
		Eocene	36-58
		Paleocene	58-36
MESOZOIC	Cretaceous		63-135
	Jurassic		135-181
	Triassic		181-230
PALEOZOIC	Permian		230-280
	Pennsylvanian		280-310
	Mississippian		310-345
	Devonian		345-405
	Silurian		405-425
	Ordovician		425-500
	Cambrian		500-600?
PRECAMBRIAN			600-2,500+

there has been a cooling trend and a shrinkage of the area covered by grasslands, especially in Illinois and Indiana. In eastern Kansas, forests have expanded out of river valleys to cover large areas.

Humans most likely moved into Kansas about 10,000 years ago as the climate warmed. Exactly how much impact the Native Americans had is unclear, but they may have had a strong influence on both wildlife and vegetation. The circumstantial evidence that over-hunting may have been responsible for the extinction of many of the large mammals that disappeared at about that time is strong.

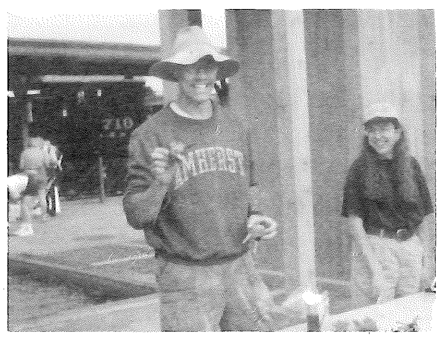
Before Native American arrival, browsing by mammals and fires caused by lightning were important in restricting the growth of trees and shrubs in grasslands. To these existing forces, Native Americans added more fires for driving and attracting game, for promoting the growth of preferred food plants, and for cooking (cooking fires sometimes escaped). This increased frequency of fire on the Great Plains may have kept the prairie larger and more free of trees than it otherwise would have been. Some biologists believe that in the absence of human-started fires, the natural trend toward reforestation of the last 5,000 years would have swallowed up the prairie and the Great Plains would now be largely forested. It's hard to prove whether this is true, but in the brief period since European-Americans started to suppress Native American burning, invasion of the prairie by woody plants has certainly occurred rapidly in many areas, including Saline County and The Land Institute's properties. At the least, there could well have been a return to the more savanna-like conditions of some earlier interglacial periods.

There is other interesting evidence that the nearly treeless prairie is a recent phenomenon. Very few of the plants and animals found on the prairie are found *only* on the prairie and nowhere else; most are also "edge" species in forests and savannas bordering the prairie. This may indicate that what we see as a distinctive "prairie" ecosystem is not in fact a set of species that evolved closely with one another, adapting to local conditions and changing in form and function from their ancestral species; but a set of more or less uneasy neighbors, cobbled together recently from very different environments around the edge of the Great Plains.

This sort of new knowledge about the evolutionarily recent origin and changeability of the prairie may make it sound ephemeral, possibly even disposable. To humans, however, the 10,000 or more years of the prairie's existence should seem venerable, if only because they were enough to produce the soils that make the central United States one of the breadbaskets of the world.

More generally, new information about the mutability of natural systems can be used irresponsibly to suggest that no habitats, prairie or otherwise, deserve to be protected from human influence. Instead, I think this information should be used to inform us about precautions we must take to avoid damaging sensitive ecosystems as they exist today, and to guide us in planning for a future in which natural systems will need leeway to change in response to climate and other forces as they have in the past. We need to use our heightened awareness to protect both individual prairie species and the connections between them.

Our studies of natural history can show us what past changes have pushed species to extinction, and the rates at which the plant and animal life of the Great Plains changes when subjected to different types of environmental stress. As humans continue to subdivide, graze, plow and otherwise modify the prairie, and global climate change promises to shift temperature, rainfall and wind patterns dramatically, such information is of more than academic importance to our future. Though we need not exalt it as a standard of absolute stability, the prairie has been here long enough to serve as one workable model for a "native" ecosystem and for The Land Institute's Natural Systems Agriculture. Ephemeral though it may be by some measures, it should not be despised.



Robin helps with children's activities

A Land History

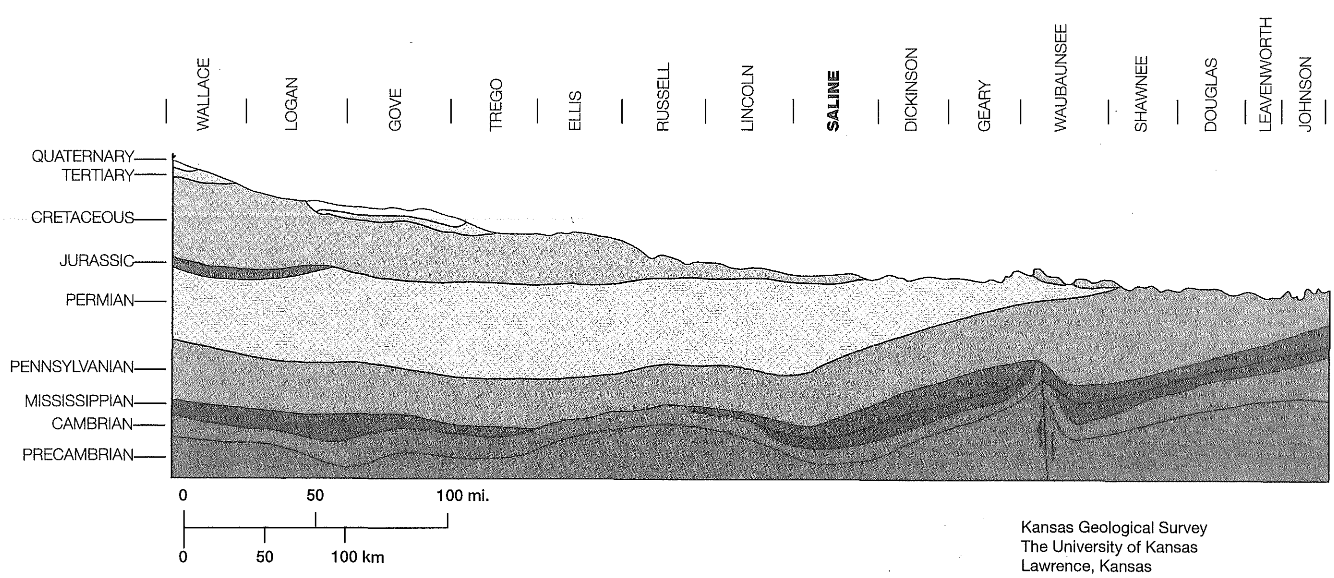
Jerry Glover

A funny thing happened to me on the way to the landfill. I was driving through the hilly upland area west of the Smoky Hill River valley, when suddenly over a hill crest in an adjacent wheat field staggered a giant-wheeled spray rig, running twenty-five to thirty miles per hour. Like its annual predecessors, the combine, plow, harrow, and seed drill, this machine was attempting to homogenize a varied landscape each piece of which possessed a unique history and relief. The light colored patches of soil on the slopes indicated this complex system had been stripped of its dark topsoil, exposing the less fertile subsoil. Not only would greater energy be expended than eventually harvested but the soil was being lost in the bargain. It wasn't really funny but rather odd that so little consideration was given to the history of the land.

The implications of the land's history for sustainable use *is* considered at The Land Institute. Currently, The Land Institute manages some 277 acres of Saline County land. The largest block is directly north of the office, a 160 acre quarter section (known as "The 160") of grazed pasture, native prairie, and cultivated land. A mile and a half to the west, The Sunshine Farm is located on 72 acres of level bottomland that is part of the Smoky Hill River's flood plain. As shown on the accompanying map (p. 9), this property contains a mix of bottomland and upland that is fairly representative of the proportions found county wide. These acres provide a layered mosaic for study by Land Institute staff and interns. The purpose of this article is to review the geological history of the landscape and the natural history of the soils blanketing it, and to discuss how these histories have affected past agricultural use and current use by The Land Institute.

The oldest of the exposed geologic features on The 160 are the limestone and shale layers deposited over 240 million years ago during the Permian period.[1] Formed by what Rachel Carson called the "silent snowfall" of marine organisms and minerals, these layers were deposited over millions of years in shallow inland seas. The layers underlying the landscape can be seen most clearly from the Water Well

Kansas Geologic Cross-Section



Road bridge just west of The Land Institute. The Smoky Hill River has cut down through the layers of Ninnescah Shale to the harder shale found in the Wellington Formation. In most other places these layers lie deeply buried. Surface occurrences of the Permian System are found on slopes where natural erosion has removed more recent deposits.

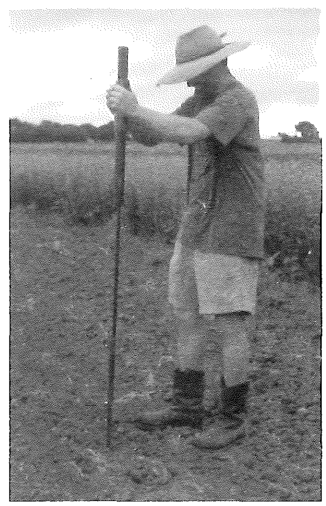
Many of the upper layers of Permian deposits were washed away in the distant past. Also missing are the entire deposits of the Jurassic and Triassic periods. This has left a more than 100 million year gap between the remaining Permian deposits and those of the Cretaceous period. The Dakota Formation is characterized by sandstones and shales deposited 60 to 140 million years ago at the edge of receding seas during the Cretaceous. Surface exposures of the Dakota Formation, indicated by scattered chunks of reddish sandstone, occur on The 160's summits and ridgetops. Much of this formation has also been erosionally removed.

Jerry Glover probing soil on the Sunshine Farm.

Much more recently, the landscape was covered by shallow blankets of wind-blown silt, called loess. The oldest of these loessial deposits, blown in more than one hundred thousand years ago during the Illinoisan Stage of the Pleistocene epoch, are found at the bases of hills or low on the slopes. Younger loessial deposits, blown in during the Wisconsinan Stage of the Pleistocene epoch which ended about ten thousand years ago, are found higher on the hill sides and often cover hilltops. In some cases these deposits have been erosionally thinned, exposing the Dakota Formation at the summits.

Youngest of all the geologic materials found on The 160 are the deposits of water borne material, or alluvium. These deposits have been formed over thousands of years by streams and rivers in low-lying areas dropping material eroded from higher in the region's landscape. Alluvial accumulation of eroded material still occurs during floods. Looking downstream from the Water Well Road bridge, these thick, fertile layers can be clearly seen on both banks. Alluvial deposits extend from the base of the upland on The 160 west across the river to The Sunshine Farm on Ohio Street, and beyond to the hills on the western edge of the Smoky Hill River basin.

Until little more than one hundred years ago virtually all of these geologic deposits of limestone, shale, sandstone, loess, and alluvium were blanketed and infused with the prairie ecosystem. Prairie soils are grouped into a large soil order called Mollisols. Found in regions around the globe geographically similar to the Great Plains, Mollisols have deep, dark-colored, fertile topsoils. Under native grasses and forbs, as much as 1,100 pounds per acre of organic matter may be added annually.[2] This steady accumulation of organic matter, and the biological activity associated with it, has transformed the various mineral deposits, or parent materials, into fertile topsoils.



Although these topsoils share common characteristics, there are also important distinctions among them due to landscape positions, age, and differences in mineral composition of the parent material. Hans Jenny, an influential soil ecologist, viewed these three factors (plus a region's climate and living organisms) as the primary forces driving the transformation of raw parent materials into soil.[3] Prior to European agriculture, the common factors of climate and grassland vegetation worked to homogenize The 160's soils while differences of time, topographic position, and parent materials worked to distinguish one soil from another.

These differences in soil often mean (or should mean) different uses for the land. The Natural Resources Conservation Service (formerly called the Soil Conservation Service) has developed a classification system to define the various constraints placed upon land use by differences among soils. Called land capability classification, this system places soils within classes I through VIII. Class I soils present (theoretically) few limitations for agricultural use. Ascending classes have increasingly narrow limits for agricultural use, with Class VIII soils being altogether unsuitable. Small letters specify the limiting factor: "e" designates high erosion potential, "w" designates flooding potential, "s" shallow or stony soil. A short walk across The 160 can reveal, first hand, the differences and similarities of the soils and the constraints they have placed on sustainable agricultural use.

Our walking tour begins on the Wauhob Prairie, which adjoins The 160 on the southwest corner. The Wauhob Prairie has never been cultivated and thus offers a convenient native prairie system for study and appreciation at The Land Institute. The reason for its preservation through the region's past century of widespread cultivation is its location on a steep limestone and shale slope, deposited during the Permian period. Here topography has had a clear impact on the formation of topsoil. Natural erosion constantly works against the buildup of organic matter, keeping the topsoil at a shallow six to eight inch thickness. This soil, formed in calcareous layers of limestone and shale, is mapped in the Kipson-Clime series. With steep, six to twenty percent slopes, these thin soils are Class VIe indicating severe erosion potential.

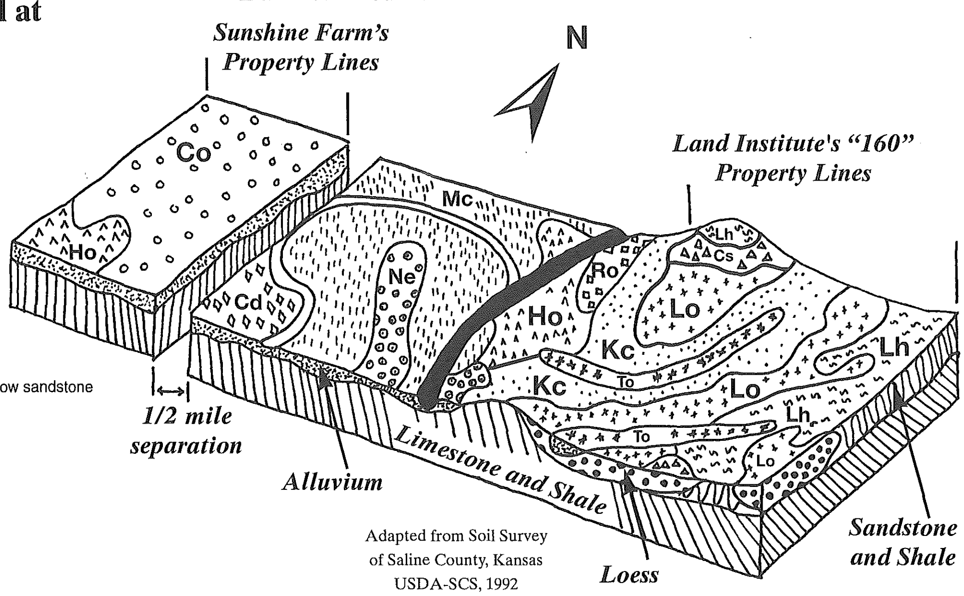
At the bottom of the north side of the Wauhob Prairie, the Kipson-Clime soil changes abruptly to the level and darker colored soil of the Tobin series. Extending finger-like eastward into the uplands, this alluvial soil is the only site of current cultivation on The 160–containing a few research plots along with forage crops for the cattle. Designated as Class IIw, Tobin soils are sometimes subject to flooding and have formed in material deposited during periods of high water. The Tobin series is the only alluvial soil group on The 160, but much broader alluvial soils extend west across the river bottoms and include the Cozad and Hord series soils of the Sunshine Farm. These are Class I soils and offer the greatest potential for environmentally sound tillage agriculture.

Soil core sample

As the walk continues north out of the bottomland and starts up the steep slope beyond, the level Tobin soil is again replaced by Kipson-Clime soil. Cultivated by previous farmers in spite of erosion, this area has been reseeded to native grasses by The Land Institute. Higher on the slope, soils formed in loessial deposits appear. Soil in the Longford series, formed in the older loess deposits, occurs on the mid-slope with deep topsoil ten inches or more thick. Further up the hill the Longford soil gives way to a Crete series soil extending nearly to the summit. These Class IIIe soils occur on two to seven percent slopes making them potentially cultivable, although their use is greatly limited by the danger of erosion. Much of the wheat in Saline County is grown on such erodible upland soils despite this hazard. Many of The 160's loessial soils were cultivated in the past, but all have been returned to native grasses by The Land Institute.

Soils and Parent Material at The Land Institute

Map symbol	Map Unit	Land capability	Site
Cd	Cass fine sandy loam	IIw	Sandy lowland
Co	Cozed silt loam	I	Loamy terrace
Cs	Crete silt loam	IIIe	Clay upland
Ho	Hord silt loam	I	Loamy Terrace
Kc	Kipson-Clime complex	VIe	Limy upland
Lh	Lancaster-Hedville complex	VIe	Loamy upland/shallow sandstone
Lo	Longford silt loam	IIIe	Loamy upland
Mc	McCook silt loam	I	Loamy terrace
Ne	New Cambria silty clay	IIs	Clay terrace
Ro	Roxbury silt loam	I	Loamy terrace
To	Tobin silt loam	II w	Loamy lowland



Adapted from Soil Survey of Saline County, Kansas USDA-SCS, 1992

Miranda Weiss and Jerry Glover doing cover-class analysis on The 160.

Near the summit of the hill in the northwest corner of The 160, a distinct ridge marks the uppermost extent of the Crete soil. Above the ridge, scattered pieces of sandstone on the surface indicate soil formed in the sandstone and shale of the Dakota Formation. Designated Class VIe, too rocky and steep for agricultural use, this Lancaster series soil has remained protected by the perennial cover of grasses. For at least fifty to sixty years, annual cultivation of the slopes below exposed the loessial soils to the winds and beating rains, resulting in a visible drop at the boundary of the Lancaster and Crete soils. Soil cores taken on either side of the boundary have shown as much as a six inch loss of topsoil on the upper edge of the Crete series soil. At this rate, the dense, much less fertile subsoil would have been exposed in as little as forty or fifty years.

The summit of the hill offers an excellent view of the surrounding region. Fifteen miles to the southwest, Coronado Heights, a large outcropping of the Dakota Formation, stands clearly above the landscape. The bottomland river terraces with their level, alluvially derived soils extend nearly from the western horizon back to the base of the hill where we stand. The Sunshine Farm, a mile and a half to the west, lies on this flood plain. From the hill it is apparent why Saline County agriculture with its large extent of level bottomland soils has been so productive over the years.

Looking southeast, the rest of The 160 appears similar to the landscape covered so far. Trees and tall grasses mark the narrow waterways where uncultivated Tobin series soils have developed. The rolling slopes to the east are covered by a pattern of soils similar to those traversed in the walk up this hill. The limestone and shale derived Kipson-Clime soils occur on the steep lower slopes, the loessial soils of the Longford and Crete series mantle the side slopes, and finally the Lancaster series soil, formed in the Dakota Formation material, caps the high ground at eastern edge of the property. The northeast corner of The 160 is covered by native prairie, being too rocky and broken to cultivate.

From the native sites and reseeded grasslands to the cultivated bottoms, this landscape provides The Land Institute with continuing lessons in land management and its consequences. Land previously eroded through cultivation is now covered with perennial grasses. A long term rotational grazing study involving Texas longhorn cattle attempts to reverse the damaging effects of past overgrazing still visible on parts of the landscape. Since the upland areas are unsuitable for conventional annual cropping systems, current cultivation is restricted to the less erosion prone bottomlands. The native prairie sites provide opportunities for the study and appreciation of prairie ecosystems less disturbed by human presence.

The fundamental principle of The Land Institute is to look to the history of the land, through study of its geology and living systems, to further develop its land management methods. Instead of expending great amounts of energy to homogenize a landscape, as in the case of the giant spray rig, the goal is rather to harvest energy sustainably by recognizing and respecting the land's variation.

Notes

1 Two books cover much of the information reported in this article. *Kansas Geology: An Introduction to Landscapes, Rocks, Minerals, and Fossils,* 1985, University Press of Kansas, Lawrence, KS; and *Soil Survey of Saline County, Kansas,* USDA Soil Conservation Service, 1992.

2 Buol, S.W., F.D. Hole, and R.J. McCracken. 1980. *Soil Genesis and Classification.* Iowa State University, Ames, IA. One of the co-authors of this book, Francis Hole, is a long-time Friend of the Land and spoke at the 1986 Prairie Festival.

3 Jenny, Hans. 1994. *Factors of Soil Formation: A System of Quantitative Pedology.* Dover, New York, NY. Jenny, a good Friend of the Land, greatly influenced The Land Institue and many of its supports. Readers may recall that in the last issue of *The Land Report* several articles appeared paying tribute to Jenny's great contributions to soil ecology during his life.

The People of the Smoky Hill

Brian Donahue

Humans reached the North American Plains on the heels of the retreating glaciers 11,000 years ago, if not before. Most anthropologists believe that Native Americans had journeyed to this continent over the land bridge from Asia some 20,000 (or perhaps many more) years ago at the height of glaciation, and gradually filtered south and then east. Many Native Americans themselves believe that their ancestors arose in this part of the world and have lived here "since the rocks were wet"–which actually sounds like a different way of saying the same thing to me. I am a great believer in deep cultural memories of ice.

As the climate warmed and dried, the park-like spruce forest that had prevailed over much of Kansas during the glacial period gave way to more open grassland with an abundance of meltwater lakes and ponds, and timber along the streams. This grassland supported a host of grazers including mammoths, camels, horses, peccaries, sloths and two species of bison. The earliest humans here lived primarily by hunting this abundant big game with spears, although they probably also hunted smaller game and foraged many plants whose remains are not as well preserved. Not much is known about the ways of these people from the small number of sites that have been uncovered.

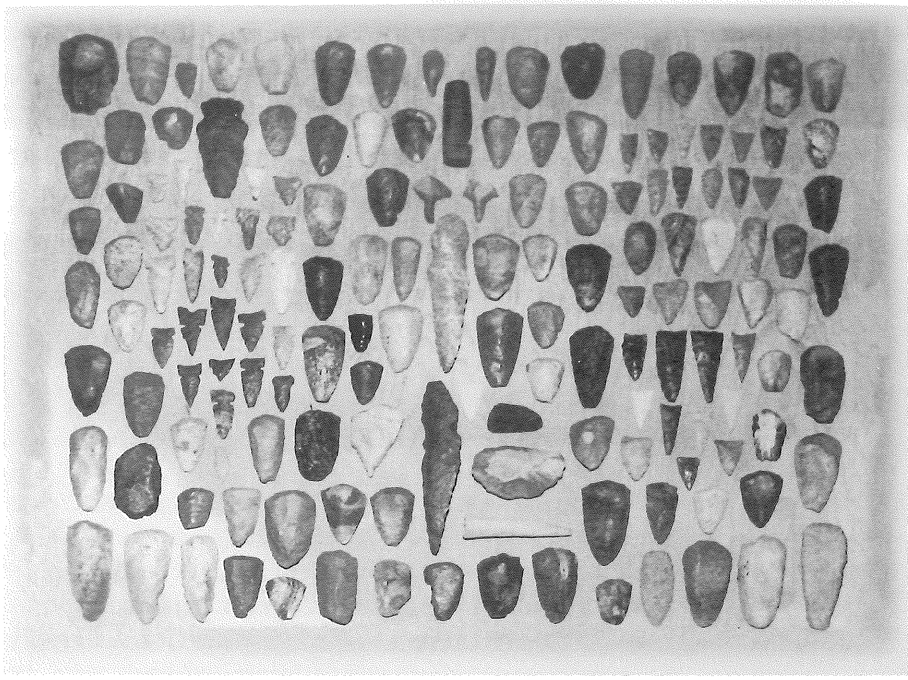
The Land Institute's closest neighbors

What is known is that by about 10,000 years ago most of the large grazers were gone, extinct. Whether they were eradicated directly by over-hunting is debated among anthropologists, but humans obviously had a hand in the matter. A single species of large grazer, the "dwarf" bison known to history as the buffalo, survived to dominate the North American Plains. For most of the next ten thousand years, bison provided the focal point around which Native life in this part of the world seems to have revolved—although again, buffalo were only the central element in a broad-based foraging way of life. It has been argued that among the large grazers bison survived because they had a higher reproductive rate and were better adapted to human hunting—indeed, like humans they were relative newcomers to America, crossing from Asia some 40,000 years ago. Historian Dan Flores writes "in an ecological sense, bison were a weed species that had proliferated as the result of a major disturbance." After the Pleistocene extinctions, prairie grasses, bison and humans formed an ecological system that was to some extent culturally maintained.

But bison do not seem to have been uniformly available through all this time. A dearth of archaeological sites and of bison bones from the warmest part of the current interglacial, some 7,000 to 4,000 years ago, indicates that bison and hence hunters were scarce on the Plains. The first firm evidence of Native campsites in Saline County dates from the late part of this "Archaic" period. About 2,000 years ago, it appears that the people frequenting this part of the world came from the "Woodland" culture further east, perhaps out on long hunting trips. One of their many campsites was found on Land Institute property between the classroom building and the Kreihbel House. These people made ceramic pots, and used the bow and arrow to hunt. In their heartland in the Mississippi Valley and as far west as about Kansas City they grew crops, but there is no evidence of cultivation in Saline County during this period.

About 1,000 years ago, the picture changed dramatically with the appearance of horticulture on the Plains. This expansion of agriculture westward is known to archaeologists as the "Plains Village Tradition." The people who gardened in the Saline County area represent what is called the Smoky Hill culture, which lasted for a few centuries until about 1300 AD. During this period, people lived in very small villages and individual homesteads scattered along the river terraces and in the smaller creek bottoms, near their fields.

Donald Blakeslee of Wichita State University gave a vivid portrait of the early Plains Village Tradition in a talk at the 1993 Prairie Festival. To cope with the dryness and extreme variability of climate on the Plains, these people relied on a broad, diverse diet. They were not specialists, but generalists who spread their bets. Their small fields (perhaps an acre or two per family) were placed in wooded bottoms, which could be cleared sufficiently for hoe culture with a minimum of effort, by girdling the larger trees and burning the underbrush. This



Flint tools of Central Kansas (courtesy of Harley Elliott).

location of the fields also provided shelter from the winds, conserving moisture. After a few years of cultivation had depleted the available nutrients, a new field would be opened in the typical pattern of "swidden" farming. These gardeners planted a polyculture of corn, bean, squash, and sunflowers together in the same field, along with several now-disused native crops including "little barley," marsh elder and a domesticated variety of *Chenopodium.* They also gathered a great many roots, nuts and berries, ate shellfish, and hunted an extraordinary range of animals–everything from bison to shrews. The bones of 51 animal species were found in the excavation of a single lodge. About the only thing they *didn't* eat were grizzly bears, bats, and the odd weasel.

The Plains Village people made especially good use of rodents, particularly pack rats (whose above-ground nests are easy to find), rice rats (which flourished on the weed seeds found in abandoned fields), and even deer mice. All of these creatures store a great many seeds and nuts, and Blakeslee believes the people simply harvested the rodents along with their granaries, yielding a kind of instant stew. This omnivorous diet, along with their multi-cropped gardens, allowed people to find something to eat through all the unpredictable swings of the Plains climate. Later Plains Village people (such as the Wichita and Pawnee) did not have quite so broad a diet, and seem to have moved toward a greater reliance on bison hunting in seasonal rhythm with planting and harvesting their gardens.

After about 1300, horticultural people disappeared entirely from the Smoky Hill River, and cultural patterns throughout the Plains seem to have undergone another shift over the next century or two. Why this occurred is not clear–it has long been attributed to drought, but may have simply been cultural evolution. In fact, the Smoky Hill horticultural tradition may have flourished during several centuries of *dry* weather that made bison scarce, necessitating a broader food-base; while a cycle of wetter years beginning in the 14th century may have caused a resurgence in bison hunting that lasted until the transformation of life on the Plains in the 19th century. Climate scientists have learned that the effects of changes in weather patterns are so localized that it is dangerous to generalize over regions as large as the Great Plains, except at the level of the broadest long-term swings such as glacial cycles. It will be a few years yet before the emerging picture of the Native people of this region, and their changing relationship with the prairie landscape gains a satisfying coherence.

We do not know if there was a village or homestead of the Smoky Hill people in the immediate vicinity of The Land Institute. But they were not far away, and their diversified, flexible approach to this landscape should never be far from our thoughts. One is struck simultaneously by the dynamism with which various Native peoples responded to this changing land, and by their success in finding ways to live here for such a long time. Both their adaptability in the long run, and the relative stability of their adaptations in the short run, should give our brashly confident, bull-market culture something to ponder.

Sources:

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Dan Flores, "Bison Ecology and Bison Diplomacy: The Southern Plains from 1800 to 1850," *Journal of American History,* 1991.

Waldo R. Wedel, "Holocene Cultural Adaptations in the Republican River Basin," in Brian W. Blouet and Frederick C Luebke, eds, *The Great Plains: Environment and Culture,* 1979.

Harold and Marge Reed, and Harley Elliott, presentations at The Land Institute, 1995/6.

The Native Landscape

Tammy Hinman

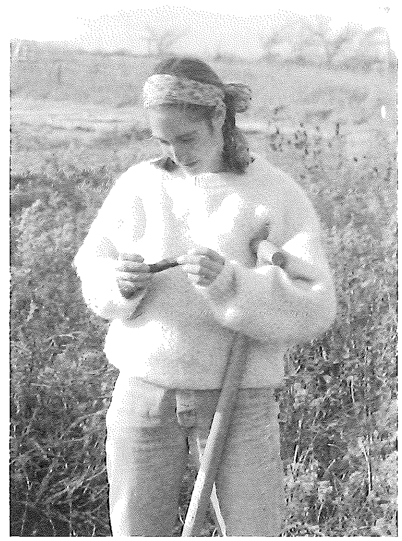
The horticultural people of the Smoky Hill River Valley disappeared from the area of what is now Saline County about the year 1300. The reasons for their departure are unknown, although many speculate that it followed a prolonged drought. What was once a landscape dotted with horticultural homesteads and villages was replaced by a hunting ground frequented by several surrounding tribes. We are unsure how great an impact these peoples had on the prairie ecosystem through hunting and burning—this paper will review some of the leading theories. From the 1700's, encroaching Europeans increasingly influenced the Native people's relationship with the land, and finally replaced it entirely.

By the 16th century, farming and hunting tribes formed villages to the north, south, and east of Saline County. The Wichita were one of the earliest historic tribes in central Kansas and were found around the Arkansas River valley to the south. The Pawnee (who were probably descended from some of the people of the Smoky Hill) farmed along the Republican River valley in northern Kansas. The Kansas and the Osage situated their villages in southern Missouri and Arkansas, respectively. All of these tribes knew of the great buffalo herds in the Smoky Hill and Arkansas River valleys. They either hunted in the Saline County area or passed through on their way west. Until the late 1700's, this overlap in hunting areas apparently did not cause much conflict.

These historic tribes practiced dual subsistence economies. In their home villages they grew a triad of domesticated species: corn, beans and squash. They typically farmed the fertile flood plains and relied on periodic flooding, slash-burning and nitrogen-fixing legumes to return nutrients to their fields. From this agricultural base along the river valleys they launched seasonal hunting trips onto the Plains.

Most of these tribes went on two hunts that lasted several months, one in early summer after planting, and the other in late fall after harvest. Corn and beans provided food en route to the hunt. They also gathered edible and medicinal plants along the way. Caches of the Wichita reveal carbonized wild plums, which are still prevalent in remaining prairies and along waterways in Saline County. The Pawnee robbed wood rat nests for ground nuts. On their summer hunts, they also relied on prairie turnips, pomme blanch, and wild plums. Trips were often arranged to take advantage of these resources. It is possible that over the centuries, Native people encouraged the spread of certain "wild" plants they found most useful.

The Plains Indians may have had a more sweeping influence on the prairie through the use of fire. The prairie ecosystem evolved with fire, which discourages invasion by shrubs and trees. We know historic Indian tribes set fires on the prairie. What is not so well understood is the extent of this deliberate burning, or the reasons for it. Was lightning the primary cause of prairie fires, or did people more often set them? Were humans a significant or even necessary part of the evolution of the treeless prairie? These issues have been debated for the past century, and are not yet settled.



Tammy Hinman examines a native herb

Some paleobotanists, anthropologists and historians believe that the Plains Indians burned to maintain open land to increase forage for the buffalo herds. Other scholars discount this incentive for burning mid-grass and tall-grass prairies, because the great buffalo herds were primarily found west of the 98th meridian, in the short-grass prairies. The 98th meridian borders western Saline County, so it is questionable how many buffalo were found here. However, much remains unknown about the migrations and grazing habits of these animals, and about how they responded to long-term drought cycles and hunting pressure.

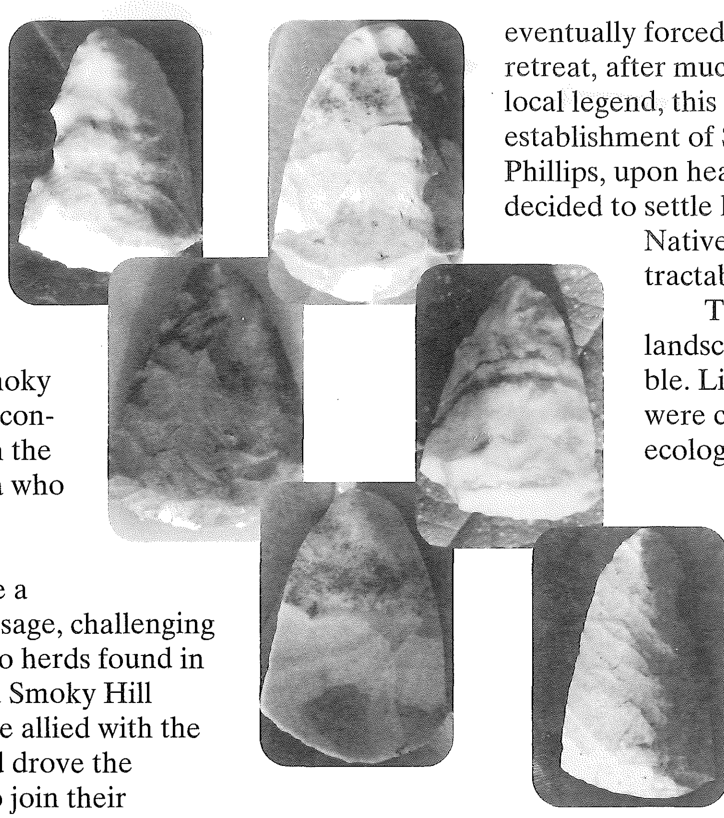
Whether or not human burning to encourage bison had an important impact on the prairie ecosystem, the introduction of the horse certainly did. The Plains Indians acquired horses during the 1700's. Owning horses became a mark of prosperity and status. The horse made the Native people more efficient buffalo hunters, but posed new ecological problems. As horse herds grew in size, it became difficult to feed them in the winter. The Pawnee relied on cottonwood bark as a substitute for hay, causing them to move repeatedly. The early winter hunt became as much a search for horse feed as for meat, as both bison and horses were drawn to the more nutritious grasses found in short-grass prairie during the dormant season.

Late winter was an especially lean time. Historian Richard White, in *Roots of Dependency,* claims that the Pawnee's prairie fires were set primarily to induce early feed for horses, rather than for buffalo. The Pawnee regularly burned in the fall which increased early grass growth in the spring, precisely when the Pawnee most needed horse feed. They set fires in the vicinity of their lodges and along their hunting routes in the Platte, Republican, Blue and Smoky Hill River valleys. They did not burn the entire area annually, but about every third year. George Catlin, an early explorer, wrote of the Plains Indians, "...many times the fires were deliberately set for the purpose of getting a fresh crop of grass for the grazing of their horses and also to make easier traveling in the summer."

Along with the horse came ready access to guns and trade. This caused the Plains Indians to place even greater importance on the buffalo hunt, which depleted the herds and led to territorial disputes. The emphasis on the hunt eventually caused the Osage people to abandon their horticultural ways

Interns get acquainted with native tallgrass prairie

completely. With their new dependence on the buffalo, the Osage ventured further west into the Smoky Hill River valley where conflicts began to arise with the Pawnee and the Wichita who were already hunting this ground.



The Pawnee became a constant threat to the Osage, challenging them to the great buffalo herds found in the upper Arkansas and Smoky Hill River valleys. The Osage allied with the Kansas in the 1760's and drove the Pawnee further north to join their Nebraska relatives, and forced the Wichita further south. The Pawnee continued to use the hunting ground along the Smoky Hill River and fought with the Osage through the 18th and early 19th centuries.

By the 1800's, the Europeans began to have a more direct impact on the Native inhabitants of Kansas. An 1825 treaty placed the Osage and the Kansas on reservations in the eastern part of this state that were only a fraction of their original grounds. This treaty also relocated many Native peoples from the Eastern states to reservations nearby, which they were assured would be their last move. The presence of 10,000 friendly Kickapoos, Delawares, Sacks and Foxes, Shawnees, Pottawatomies, Kansas, Ottowas, Wyandotes and Osage posed a more immediate obstacle to insatiable white settlers than the famed warriors of the Western Plains. The publication of the 1853 Kansas/Nebraska Territory map solved this "problem" by labeling reservation boundaries ambiguously. The lack of precise boundaries opened the area up to squatters and eventually led to yet another relocation of these tribes to Oklahoma Indian Territory.

During this time of rapid white settlement, a battle apparently took place at Indian Rock in what is now Salina. Details of the battle are sketchy, but it became one of the city's "founding myths." While on a hunting trip, Native Americans from the reservations (the "civilized Indians") were attacked by the Western Plains tribes (the "wild Indians"). A Cheyenne later told an early settler that the battle ended on Indian Rock, where the "civilized tribes" eventually forced the Western tribes to retreat, after much bloodshed. According to local legend, this battle paved the way for the establishment of Salina. Founder William Phillips, upon hearing of the battle's outcome, decided to settle here knowing that the Natives who won the battle were tractable and not a threat.

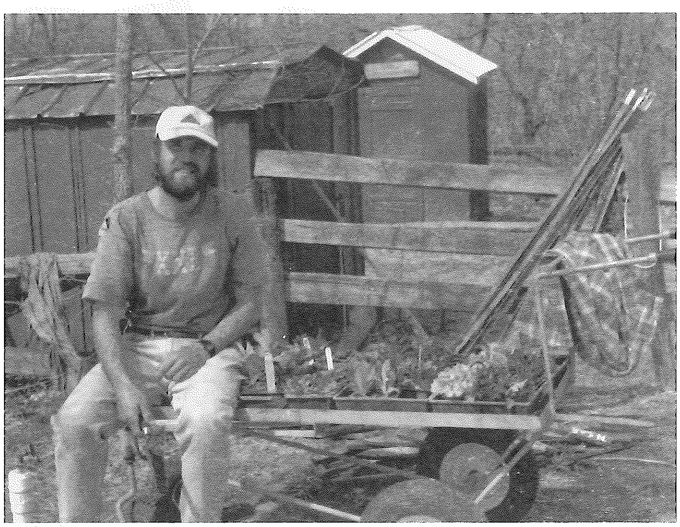
The Plains Indians use of the landscape was not stagnant or stable. Like the ecosystem itself, they were constantly adapting their ecological regime to changes in climate, species migration and cultural evolution. What remains unclear is to what extent these people influenced the prairie ecosystem with their hunting and burning practices. By the time these land-use patterns were observed and recorded by whites, they had already been changed by the advent of the horse. But there is still a question as to whether the horse caused a radical transformation of hunting and burning, or simply modified ways of manipulating the prairie that had long been established. When the whites began to trade and then to settle in the region, their impact was more direct. The Native land-use pattern first intensified to meet market demands, and then disappeared.

A Brief History of White Settlement on the Great Plains

Jim Boyd

Land, The Land, Homeland: that which we live on, that which we live from. Our use of land and our attitudes toward it help define our cultural traditions. A history of land settlement in the United States, and the Great Plains in particular, can speak volumes about the economic values that have shaped our country and which persist today.

The white European societies that established themselves on this continent were in most cases quick to replace the old feudalistic style of land tenure with a mixed system of private freeholds and State-owned lands. In the early years of American independence, the new state governments and the federal government, driven by expansionist interests, acquired immense tracts of land occupied by the Native Americans and claimed as territories by the English, French, and Spanish.



Jim Boyd

With an independent spirit and a vast frontier of cheap or easily acquirable lands rich in natural resources, the new nation grabbed all it could with the express purpose of getting it into the hands of private persons. In this way, the government could facilitate settlement of the continent and generate revenues to support itself and pay off war debts.

Privatization of land was the popular demand, and the State, as well as many who purchased land from the government, entered into the land business. From our very inception as a nation, land and its products were viewed as capital or commodities to be bought (or stolen) and sold as a way to make money, and used with very few restrictions. This cultural tradition has persisted to the present, and is arguably responsible for many of the abuses the land has suffered. If we are to create a sustainable human existence on this land it may be necessary to rethink our approach to exclusive and unfettered land ownership and use.

The physical basis for disposal of the public domain was provided by government land surveys that imposed a rectangular grid upon the landscape. The grid provided a way to partition the land into small, salable units, but it was constructed and imposed with little regard for natural topography. East-west base lines and north-south meridians were established bounding a series of square townships, six miles to a side, subdivided into square mile sections, further divided into quarter sections, and so on—with periodic corrections to accommodate at least the curvature of the earth. This facilitated locating, buying and selling parcels of land. Eventually all the land in the U.S. was included in the survey except the thirteen original states, Vermont, Kentucky, Tennessee, parts of Ohio, and all of Texas.

With the imposition of the grid and the establishment of regional land offices, the disposal of the large public domain had become institutionalized. Minimum tracts of 640 acres (later 160 acres) were sold at public auction at $1/acre and up, cash. In addition to these sales, large tracts of federal land were given to railroads as a way to subsidize a national transportation system. Also, state governments received sections of land to help finance public schools. Once the land was acquired from the government it could freely be bought and sold on the private market.

These land disposal policies were promoted as a way to facilitate expansion west and settlement of the new territories by small family farmers. But at $1/acre and with the minimum acreage sale restriction, it was primarily large investors who were able to purchase government lands and monopolize land holdings. The small family farmer often had to go to the land speculators to buy smaller parcels, at higher prices, and on credit. In turn, many of these first settlers also got into the land speculation game by staying a short time, making some improvements, selling off, and moving on to new homesteading opportunities further west.

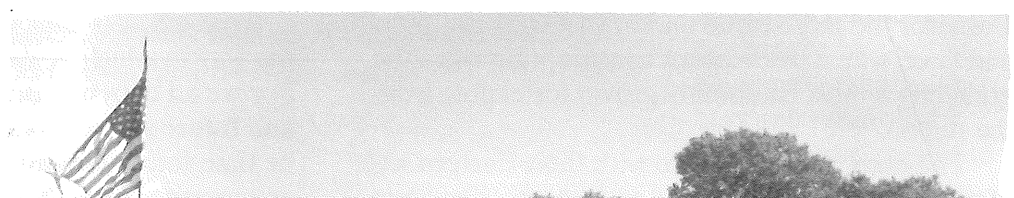
The Great Plains became a part of the systematic, continental land grab with consummation of the Louisiana Purchase in 1803 by president Thomas Jefferson. In 1854, after the Native Americans had been largely subdued and confined to shrinking reservations, the Kansas Territory was opened up and the westward expansion of white settlement continued. A few years later, the privatization of land was further accelerated by the passage of the Homestead Act and the Federal Land Grant Act in 1862.

The Homestead Act, in the spirit of Thomas Jefferson's agrarian ideals, was ostensibly an effort by the government to provide free land to settlers as a means of alleviating the bad economic conditions of eastern urban factory workers. An adult citizen could settle on 160 acres, reside on the claim for five consecutive years, and subsequently own title to the land in fee simple. But there may have been other motives and interests behind the passage of the Homestead Act. Large capitalized cattlemen and timbermen used provisions in the act to obtain valuable land at very low prices. And even though the intent of this act was to foster the build-up of communities of small farmers, which it did to a certain extent, it was not the primary means of land disposal on the Great Plains.

The Federal Railroad Land Grant Act of 1862 was another government policy designed to expand settlement into the new territories and promote commerce. To help finance construction of railroad lines, the federal government granted public lands to the railroad companies. They received every alternate section of land for ten sections in width along the constructed railroad line, or 6,400 acres per mile. The Kansas Pacific Railroad arrived in Saline County (which is were The Land Institute is located) in 1867, and was granted almost half the land in the county. The railroad companies actively recruited immigrants in Northern Europe and the Eastern United Sates to ride the train west and buy the land. Many sections of railroad land were also acquired by speculators dealing in real estate.

So, individual families and larger ethnic groups came to the Great Plains by wagon and train. Those wanting to own land acquired it through purchase from the government or land grant railroads and other private owners, and through the use of the homesteading process. Of the federal lands distributed between 1860 and 1900, 80 million acres were distributed through the Homestead Act, 108 million were sold through public auction, and 300 million acres were granted to the states and railroads. Together, land policies and railroads accelerated the pace of settlement. By 1870 the Kansas Pacific Railroad had reached Denver and by 1890 white settlement had reached the extreme western border of Kansas.

Small farmers were not the only ones attracted to the Great Plains. After the Civil War, the remaining buffalo in Kansas were slaughtered in large numbers, and the last of the Native peoples were



Along the Grid

forced to move to reservations in Oklahoma. With the buffalo and Native Americans gone and the railroads branching further west, longhorn cattle from Texas were driven over the Chisholm trail into central Kansas to be grazed on "free range" along the way and then exported to Eastern markets via railroad depots at Abilene, Newton, Wichita and other "cow towns." Inevitably, conflicts between farmers and cattle ranchers followed which resulted in the enactment of the Kansas Herd Law in 1871. This law allowed counties to restrict cattle grazing on the open range, requiring a rancher to herd his cattle or to fence his pastures and to pay damages if his cattle destroyed other people's property. Saline and Dickinson counties adopted this law in 1871, followed by other counties in the state. By the 1880's the invention of barbed wire allowed land to be cheaply fenced. Although most range was enclosed, the cattle industry remained an important part of the Great Plains economy, aided by the expansion of the railroads.


Kitchen shelf.

But the railroads also provided "sod-busters" with access to eastern grain markets via Chicago and other rising Midwestern trade centers. Businessmen, grain merchants, boosters, and railroad interests all promoted the settlement of the plains and cultivation of the land. The growing Eastern and European markets enticed farmers to raise cash grain crops. Corn, for the large cattle and hog feeding industry and later, wheat, for eastern consumption were the grain crops most commonly grown for export from the region.

The early pioneers came with their Eastern style of agriculture and the prairie sod was broken open. A rich and fertile soil was exposed in which crops could be grown to sustain their families. But the climate was harsh and unpredictable, and in the late 1800's many early settlers left Kansas, especially from the western high plains region, due to droughts, depression, and grasshopper invasions. But many stayed, persevered, and prospered, and the conflicts between the sod-busters and cowboys were steadily won by the grain farmers, with the cattle drives forced to move west. Smaller-scale cattle raising was integrated into a more settled pattern of land-use in central Kansas.

Undoubtedly, Eastern politics and Eastern markets had a profound influence on the nature and extent of white settlement on the Great Plains. And as with the imposition of a rectangular grid upon the landscape with little regard for its topography, eastern agriculture was imposed upon the land with little regard for its ecological limits. This established a hard-driving pattern of plains settlement and land use which would have grave consequences later on, in the erosion of both soil and rural communities.

White European settlement of the Great Plains is a fascinating example of expansionism and the independent, frontier mentality put into practice. Never before in history had so much land become available and distributed to private hands in such a short amount of time. It took a mere forty years after the opening of the Kansas Territory for white settlement to reach its western border.

The constantly growing demand for land and its resources, and the pursuit of higher standards of living fueled this takeover. And because the profit motive dominated the manner in which land was used, ecological considerations were subordinated. This would become evident in the 1930's with the dust bowl disaster and continues today with soil erosion, water and air pollution, and the like. Given this cultural heritage and its inherent potential for destruction, it is important for all of us to re-think the way in which private rights in land are defined. For we all depend upon the land for our survival, and future generations depend on it as well. It may be time for a new cultural tradition to emerge. This will require from all of us respect and reverence for the land, and a greater measure of collective responsibility for its care. It is important to remember what has been stated so well in the past: No one owns the Land, the Land owns us.

The Ottman Homestead

Jon Richardson

The craft of good farming has been lost by today's agribusinessmen, according to many critics of modern agriculture. This implies that in order to understand good farming we ought to look to the past. But what kind of farming, good or otherwise, we discover will depend on what part of the country and what time period we choose to look at. Our immediate predecessors on this land, the first European farmers of Saline County, probably never farmed with the ecological sophistication of the Amish. However, their farms were impressive in other ways that may be particularly relevant to the modern farm crisis. The farms that were established here between 1860 and 1900 often ran on a shoestring budget, yet were almost entirely self-sufficient and proved amazingly resilient in the face of frequent crop failures and steadily declining grain prices. These farms weathered crises that often send modern farms straight into ruin. They achieved this remarkable resilience by keeping their capital investment and costs low, by relying on a diverse mix of operations, and by producing for their own needs before selling grain on the national market.

Jon Richardson doing cover-class analysis

The town of Salina was founded in 1858 by William Phillips, an Eastern newspaperman who made an educated guess that the Kansas Pacific railroad (soon to become the Union Pacific) would route its line through the Smoky Hill River valley. Settlement here lagged until 1866, when the railroad officially announced that this would indeed be its route. With reliable access to Eastern markets ensured, a land rush followed, and most of the good land in Saline County was claimed by 1870.

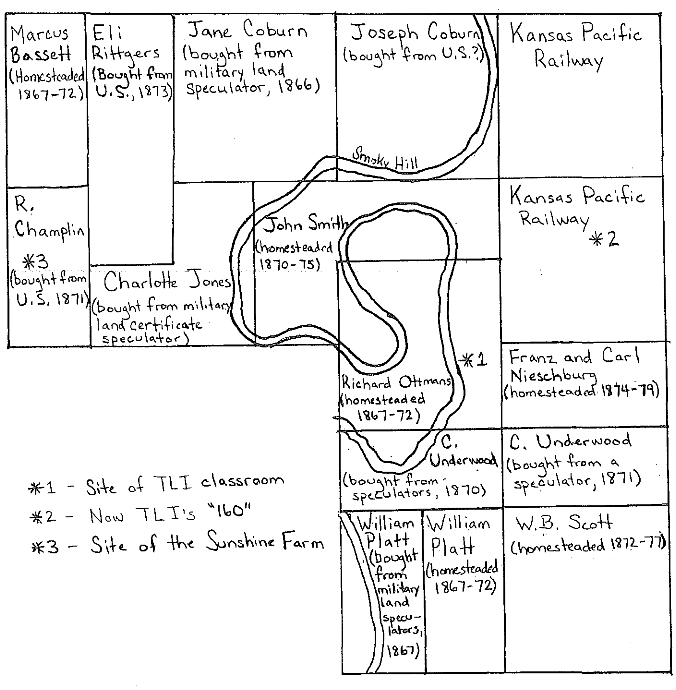
Most settlers arrived here with little money and material goods. Luckily, cheap land was available—from $1.25 to $3.00 an acre if bought from land agents, or for free if homesteaded. The settlers who homesteaded the land that underlies The Land Institute's classroom, Richard and Anna Ottmans, arrived in 1867. They situated their 160-acre claim inside an oxbow of the Smoky Hill River, to include plenty of riverside timber, about a hundred acres of good bottomland soil and, on the east side of the river, forty-odd acres of less fertile upland where the classroom now stands (see map p. 20). Their farm began with two horses and $50 worth of equipment—probably a steel walking plough, a harrow, a wagon, and various hand tools. Over the first few years they used rails, probably split from the trees on their own land, to fence in ten acres of prairie as pasture for their stock; and they gradually broke out the fertile bottomland, having about 50 ploughed acres by 1875 and 100 by 1885.

Some neighboring farmers began with more stock, but few had much more equipment. Although one farm report editor calculated in 1862 that a thoroughly modern 160-acre farm required about $1,000 worth of equipment, in 1885, with their farm established and thriving, the Ottmans still reported only $50 worth of implements. The Smiths across the river had only $30 worth, and even rich Mr. Jones to the west, farming 320 acres, reported only $200 invested in implements. These farmers kept their equipment costs low by buying second-hand machinery, by sharing equipment with neighbors and relatives, by hiring custom crews to do their reaping and threshing, and most of all, by making do with far less equipment than the "experts" of the time considered necessary.

Once farmers had some land broken out, they faced planting decisions. Winter wheat was the most profitable crop per acre, if everything went well. Robert Muir, farming on the outskirts of Salina, recorded in his letters yields of thirty bushels an acre and more that sold at a dollar a bushel, from 1865 through 1880. However, wheat was vulnerable to many perils from planting in September through harvest in June or July—hard winters, spring droughts, and grasshopper swarms often damaged or ruined wheat harvests. Corn was a somewhat more reliable crop; planted in late spring and harvested in the fall, only a hard summer drought or grasshoppers would damage it much. Corn also yielded more than wheat, sometimes better than forty bushels an acre; but as it brought much less per bushel—sometimes less than twenty-five cents—it was usually used as feed for the farm stock rather than sold.

Most farmers also planted small acreages of other crops—oats for the horses, potatoes for the family, and sometimes experimental crops such as millet and sorghum. But one of the most important crops in Saline County was not planted at all. This was grass from tracts of unbroken prairie, which could be grazed directly as pasture or harvested in late summer for a nutritious and high-yielding hay. While prairie pasture or hay meadow was probably less profitable per acre than a wheat field, the only labor it required was fencing (for pasture) or harvesting (for hay). Then too, grass was a very reliable crop; only the most extreme drought would damage it. The harvested hay could be sold for cash, but was more often fed to stock on the farm.

First Settlers in the Neighborhood of The Land Institute, 1865 - 1875



Most years, the Ottmans planted about two-thirds of their ploughed acreage to wheat and one-third to corn, plus an acre or so of oats and an acre of potatoes. They also had ten acres of fenced prairie pasture, and cut fifteen tons of hay in 1885. Their allocation of cropland to wheat first, corn second and an acre or two of special crops was typical for most farmers in Saline County, and seemed to provide good crop security. Since wheat and corn had different growing seasons, it was less likely that one spell of bad weather or of grasshoppers would ruin both crops. In the occasional calamity years when neither came through, the grass at least could usually be relied upon to keep the working stock in hay and the family in milk and meat.

Besides the crops, there were of course a variety of animals without which these farms could not have survived. Besides the indispensable team of horses, the Ottmans kept two milk cows, two other cattle, nine hogs and an unspecified number of chickens at the time of the 1885 census. All of these animals made good sense for their farming and household economy. The milk cows required constant attention and good feed, but provided a supply of milk and butter. The beef cattle required little care and could feed themselves for most of the year on prairie pasture; and the pigs and chickens would eat kitchen scraps and other waste. During the winter, all of these animals might need some corn, but corn was usually plentiful.

Sometime before 1875, the Ottmans also began establishing what grew into a considerable orchard—several hundred apple, peach and plum trees and a lone pear. By 1885 they also had an acre of blackberry canes, an acre of sweet potatoes, and a vegetable garden. Most of their neighbors were similarly zealous in improving their farmsteads, planting orchards, berries, grapevines and woodlots according to their taste. A few enterprising families kept bees.

With their farms producing meat, milk, butter and eggs as well as the crops and garden produce, farm families needed little food at all from town, although they usually bought sugar, salt, white flour, coffee, and some niceties if they could afford to. The farm infrastructure likewise required few inputs that were not produced on-farm. Fencing, fuel and lumber came mostly from the woodlot, traction and transportation from the horses (which ate the grass, corn and oats). Most farms had just a few significant

Annual Report, Fiscal Year 1996

Board of Directors
(as of December 1996)

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(as of February, 1997)

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Rob Peters
Tina Ray
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Alice Sutton
Ken Warren
Jack Worman

Matfield Green:
Ron Armstrong
Emily Hunter

Financial Statements

Summary Balance Sheet
June 30, 1996

Assets	6/30/96	6/30/95
Current Assets	649,098	519,159
Property & Equipment	892,723	849,442
Pledges Receivable & Deposits	71,900	2,900
Total	**$ 1,613,721**	**$ 1,371,501**
Liabilities & Fund Balances		
Current Liabilities	19,762	27,506
Deferred Grants, Pledges	272,627	148,825
Fund Balances	1,321,332	1,195,170
Total	**$ 1,613,721**	**$ 1,371,501**

Statement Revenue & Expenses
Year Ended June 30, 1996

Revenue	6/30/96	6/30/95
Friends of The Land	111,836	95,611
Individual Grants	114,925	157,841
Foundations	389,741	277,041
Corporations	14,964	14,868
USDA	50,000	-
Interest	23,605	17,769
Miscellaneous	25,608	14,602
Total Revenue	730,679	577,732
Expenses		
Program Services:		
Education	109,440	82,311
Research & Conserv	79,050	95,642
Sunshine Farm	87,168	78,332
Interns	102,565	91,299
USDA, Pew, Arts	53,410	14,156
Matfield Green	59,214	35,997
Total Program	490,847	397,737
Support Services:		
Management, genl	42,505	48,408
Fundraising	71,166	69,613
Total Support	113,671	118,021
Total Expenses	604,518	515,758
Excess Revenue/Exp	126,162	61,974
Fund Balance Begin	1,195,170	1,133,196
Fund Balances, End of Year	$ 1,321,332	$ 1,195,170

Prairie Festival at The Land Institute

Please mark your calendar!

Presentations by many speakers, music, barn dance, poetry, art, food, fellowship, prairie walks.

If you are on the mail list for this *Land Report,* you will receive a registration invitation.

Annual Report

Natural Systems Agriculture

Can we solve the 10,000-year-old problem of agriculture? The tendency of all natural ecosystems is to increase their ecological wealth. All prairie, left alone, recycles its materials, sponsors its own fertility, runs on contemporary sunlight, and increases its biodiversity. Agricultural systems tend otherwise. Our long-term goal is to develop a biodiverse, perennial grain agriculture (a mimic of wild grassland ecosystems) that preserves soil, requires minimal or no fossil fuel inputs, yields adequately, and does not rely on harmful synthetic chemicals for fertility or pest management.

Highlights of Fiscal Year 1996

◊ The Land Institute celebrated its 20th anniversary.
◊ Publications continue to substantiate our assertions about the feasibility of Natural Systems Agriculture. Staff continued to publish papers on our research findings.
◊ New Research Assistant working with Jon Piper.

◊ **Developing Perennial Grains** In autumn 1995, data from 1994 and 1995 growing seasons were used to select the gamagrass stock to plant out in 1996. Criteria for selection included high seed yield and low disease level. Nearly 2,000 seedlings were transplanted into two field plots. In 1997 we will begin evaluating these plants for the next round of selection in 1998.
◊ **Perennial Polycultures** A study begun in 1991 has provided evidence for high seed yield in some perennials, overyielding in perennial polyculture, legume provision of nitrogen fertility, improvement of soil quality with time, and polyculture management of insect pests and plant disease.
◊ In Spring 1996 we established a new set of 5-year plots containing four perennial grain candidates: eastern gamagrass, Illinois bundleflower, mammoth wildrye, and Maximilian sunflower. The study's objectives are to measure seed yield of perennial grains in monocultures versus mixtures, examine weed biomass and weed species composition in perennial grain monocultures versus mixtures, and document changes in soil quality over several successive growing seasons.
◊ **Biodiversity Restoration** This experiment, begun in 1994, uses four initial diversity treatments containing from four to 16 perennial grassland species. This year we saw that weeds decline faster in high-diversity plots. Earlier we found that overall diversity, percentage of legumes and composites, and establishment success increased with initial diversity.

Sunshine Farm

The Sunshine Farm Research Program has been exploring the possibilities of farming without fossil fuels, fertilizer or pesticides by utilizing a combination of renewable energy technologies, innovative management practices and biological processes to raise crops and livestock. The Sunshine Farm is designed to fuel itself by sunlight, have tighter nutrient cycles, include soil-conserving perennial plants, and feature plant and animal diversity.

The program goal is to determine more accurate ecological and energetic costs for food. The currency we use is energetics, not dollars, because our system undervalues ecological factors or ignores them. The purpose is to help reduce our national dependence on non-renewable resources for long-term food security. Information from this program could be used to: aid farmers and researchers in making the agricultural transition to using renewable energy technologies, and to help farmers and politicians identify and formulate more effective agricultural policies.

Highlights of Fiscal Year 1996

◊ First Farm Field Day generated interest from farmers across Kansas in our renewable energy technologies and sustainable practices.
◊ Traction for farm operations from both Percheron draft horses and biodiesel tractor running on fuel from oilseed grown on farm. Tractor is used in some operations which require more power or to speed an operation when weather openings are narrow.
◊ Photovoltaic solar cells donated by Western Resources, our regional utility, are fully operational providing power for the farmhouse, barn, electric fence and water pump.
Research projects on the Sunshine Farm completed during this fourth field season:
◊ Crops harvested: grain sorghum, wheat, oats, alfalfa, sweet sorghum, pearl millet, cowpeas, sunflowers, soybeans, all in strip crops to provide nitrogen, reduce soil loss, control weeds, and manage pests.
◊ Integrated longhorn cattle with cropland by grazing yearlings and calves in fall and winter on strips of crop residue and legume cover crops (transfer manure to cropland). Rhode Island Red egg-layers (50) raised in portable hen house and create compost by scratching large amounts of old hay and straw. Broilers (75) raised in portable pen pulled through alfalfa strips to provide fresh feed and return nutrients to soil.

Saturday & Sunday, May 24-25, 1997

Feeding our world and having it too.
How can we combine sustainable farming and forestry with protecting biodiversity?

If you are not on the mail list for this Land Report, request program-registration:
Alice Sutton, The Land Institute, 913-823-5376, fax 913-823-8728, theland@igc.apc.org

Fiscal Year 1996

Matfield Green

Over 60 years ago, Aldo Leopold warned that two groups barely seemed aware of each other: "..one studies the human community, almost as if it were a separate entity, and calls its findings sociology, economics, and history. The other studies the plant and animal community and comfortably relegates the hodgepodge of politics to 'the liberal arts.' The inevitable fusion of these two lines of thought will, perhaps, constitute the outstanding advance of the present century."

At Matfield Green, our educational and research programs hope to offer imagination and information to help minimize dependence upon non-renewable resources and maximize possibilities for cultural innovation and adaptation in rural agricultural communities. When available twenty-five years from now, Natural Systems Agriculture will need human agricultural communities where livelihoods are consistent with what Natural Systems Agriculture has to offer.

We are not in Matfield Green to "improve" the town. That would be presumptuous. We are there to be in the context of a place that has been losing population, as well as environmental and social capital, since it peaked last century. Matfield Green seems a good place to gain clarity about the nature of the conflict between nature's economy and the human economy. The effort to discover how cultures can become economically and environmentally sustainable will be a very long journey.

Highlights of Fiscal Year 1996

◊ The **1938 grade school building** has been outfitted and renovated including electrical and plumbing systems, ceilings, painting, window screens and is being used for meetings and conferences.
◊ **Meetings** are regularly held in the school of the Tallgrass Prairie Producers Co-Op, four Elderhostel groups held programs there, Kansas Natural Resource Council held its annual meeting and will again. Board member Terry Evans collaborated with Chase County High School for a workshop, Seeing Homeland for students to explore land use through photography and writing.
◊ A study of the **ecological history** of Matfield Green and a portion of the surrounding creek bottoms and range was conducted, including GIS mapping. This gives us a base from which to draw meaningful boundaries and better understand the interplay of forces and the expenditure of ecological capital by human community.

Intern Program

We provide graduate level interns with a ten-month experience that splits indoor and outdoor work roughly fifty-fifty, balancing classroom learning, research and hands-on farm work. Recent interns have plowed fields with tractors and draft horses, planted experimental fields, managed cows and chickens in grazing and meat production experiments, and chopped firewood for stoves that heat the classroom. Interns also led tours for visitors, provided photographs and articles for *The Land Report* and help in development, publications, maintenance, library and seed room.

Academic instruction includes study of conservation issues, theory and practice in sustainable agriculture, and the ecology necessary to understand and contribute to the Land Institute's major goal — using nature as standard, to develop a grain agriculture which mimics the native prairie comprising perennials grown in mixtures.

Seminars involve students and instructors alternately presenting material for group analysis. The small class size of eight to ten interns ensures involvement and individual attention. We strive to develop critical thinking on broader issues of sustainability and readying students to contribute professionally and become effective agents for changing how the world farms.

We do not confer grades or degrees. The high quality of our interns, instructors and staff ensures a first-rate learning experience. Many interns go on to graduate programs or jobs in sustainable agriculture.

Intern Accomplishments In 1996

In 1996, interns worked with our ecologists to plant, maintain, collect data and prepare analyses on 10 field experiments.

They were:
breeding eastern gamagrass as a perennial grain,
perennial polyculture as an assembled plant community,
seed yield of four perennial grain candidates in monocultures and polycultures,
1996 strip cropping at The Land Institute's Sunshine Farm,
energetics for broiler production in a portable pen,
energetics for egg production,
effect of rotational grazing on plant species composition,
three soil quality experiments on the Sunshine Farm to analyze the effects of farming practices on soil quality.

Annual Report

Education and Public Policy

The Education and Public Policy program is dedicated to the promotion of critical thinking about the issues of sustainability and inclusion of "nature as measure" as we search for increased sustainability. We seek to reach our constituents and citizens, from farmers to school children to policy makers. We employ *The Land Report,* visitor tours at The Land Institute, many presentations by staff every year in diverse settings, special events at The Land Institute, participation by interns and staff in community affairs, and a stream of writings which we publish in scientific journals, books, chapters in books, and magazines, as well as invited radio and journalism interviews.

1997 Interns

Caroline Brock, Cornell College, IA
(environmental studies and mathematics)

Alex Crockford, Michigan Technology University, MI
(biology)

John Guretzky, University of Nebraska-Lincoln, NE
(natural resources - environmental studies)

Jon Jensen, Luther College, IA
(philosophy and political science)

Douglas Haynes, University of Wisconsin-Madison, WI
(English)

Sarah Jack Hinners, McGill University, Montreal
(geography - environmental studies)

Andrea Leach, University of Texas, TX (ecology, evolution, and conservation biology)

Laura Weingartner, University of Missouri-Columbia, MO
(plant science)

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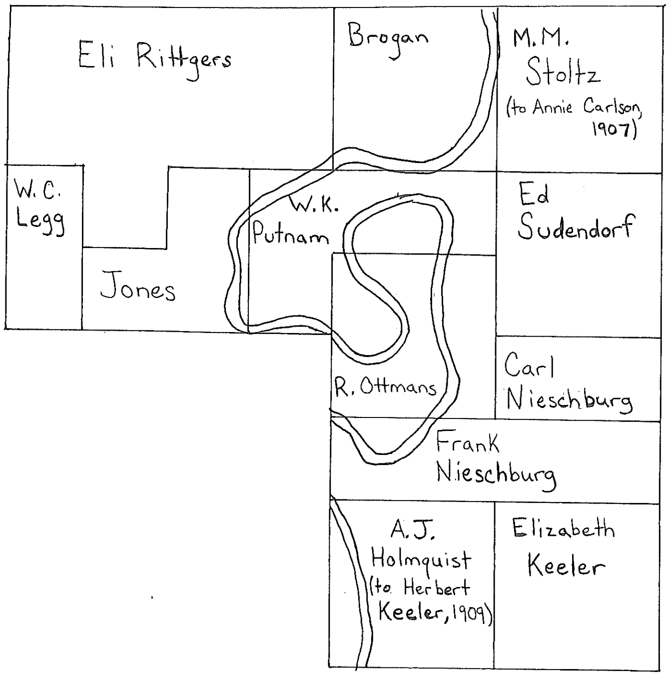
Land Owners - 1905

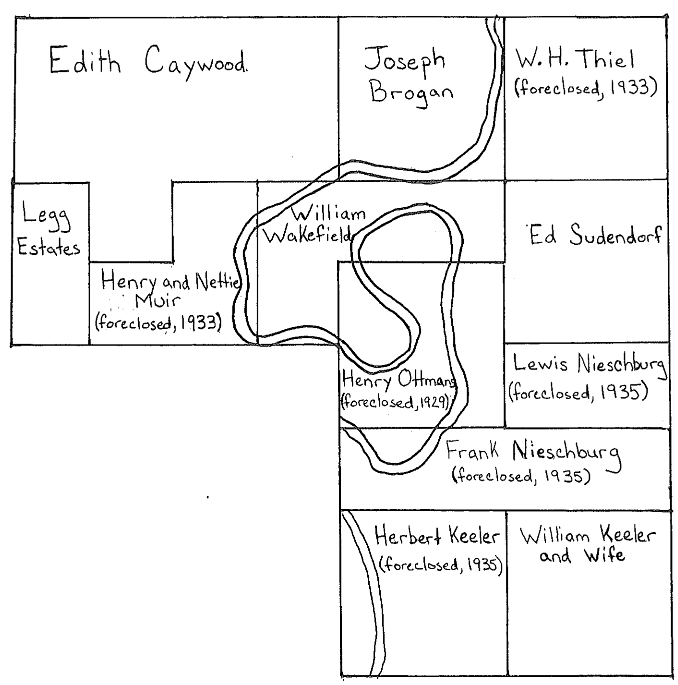


expenses: taxes, pay for the custom crews who reaped and threshed the wheat, and new implements every once in a while. Farmers occasionally bought seed grain, when they wanted to try a new variety or when their last crop had failed so completely that they lacked seed of their own for planting. They sometimes had to buy stock, when expanding their herd or when a needed animal died (though they sometimes had a colt or calf to sell, too). Between hired labor, implements, and stock, farmers were often in debt; but usually for small amounts, and most often to neighbors, relatives and implement dealers rather than to banks.

Given that their farms were arranged to produce nearly everything these families needed, it is tempting to classify them as "subsistence farmers" rather than "commercial farmers." However, they themselves probably recognized no such distinction. All of the farm's produce could be used on-farm, and all of it could also be sold, if it produced a surplus. In 1885, besides the approximately eight hundred dollars that the Ottmans may have earned on grain,[1] they sold a hundred dollars worth of garden produce, thirty dollars worth of wood, and twenty dollars worth of livestock. Other farms made good money on their milk cows and chickens; Nancy Muir was bringing in a dollar a day from butter and eggs in 1869. Poultry, dairy, and garden production (traditionally women's work) seldom grossed as much as the grain harvests, but provided a more steady cash flow throughout the year. Most of these sales were not on the "national market," but were part of a thriving local food trade between farmers and townspeople. Since railroad shipping costs often made goods brought in from the East prohibitively expensive, it made sense for both farmers and townspeople to get what they could close to home, whether by growing it themselves or by trading locally.

Farmers certainly did not settle here in order to become "subsistence farmers" who would remove themselves from the cash economy. The arrival of the railroad, with its guaranteed access to national markets, was the catalytic event in the settlement of the county. Settlers came with the hope that by working hard and enduring difficulties while continually improving their farm, they could eventually secure prosperity for themselves and for their children. This dream of prosperity involved a measure of self-sufficiency—milk cows, orchards and woodlots—but also a considerable measure of cash wealth. Robert Muir, for instance, wrote hopefully of buying a piano or organ for his musically-inclined son when he grew up. At the time, the goals of agrarian self-sufficiency and of middle-class wealth probably did not seem contradictory, although hindsight suggests that they were.

Land Owners - 1925



The first few decades of settlement in Saline County were not an easy time for farmers. Grain prices declined steadily up to the depression of the mid-1890's, and crop failures occurred with dismaying regularity. Yet few of the farms in this neighborhood failed or were foreclosed. The diverse crops were unlikely to all fail at once, the essential livestock could be fed on any combination of crops that came through, and the farm operations were arranged so that they could continue for years with virtually no cash income, if necessary.

In retrospect, it might be said that the one thing these farms were not built to survive was commercial success. The expanding markets and improving grain prices of the 1900's and 1910's encouraged farmers to pursue their dreams of wealth by expanding and intensifying their operations. Year after year of predictable prosperity caused many farmers to forget their habitual caution. In 1905, with two adult sons on the farm, the Ottmans were leasing an extra 160 acres of farmland in addition to their own 160. By 1915 Richard Ottmans had died, and his sons had given up leasing the extra quarter-section and turned instead to expanding their hog and cattle herds. In that year they were feeding at least a hundred hogs and thirty-eight cattle, far more animals than their own feed crops could support; so their overhead in feed grain must have been considerable. But the operation was ill-fated; they lost seventy hogs that year to hog cholera, and by 1925 the herds had dwindled to twenty hogs and no cattle. Through some combination of over-expansion, more expensive lifestyle, and perhaps poor management and bad luck, the Ottmans brothers went into debt. In 1924 they took out a mortgage for ten thousand dollars, and in 1929, that mortgage was foreclosed upon and the bank took their land.

During the years when favorable prices were leading the Ottmans to expand first their crop acreages and then their animal operations, neighbors all around them were intensifying their operations in various ways. Henry Muir, new owner of the old Jones place, had a major feedlot operation; the Neischburgs (to the southeast of the Ottmans including the land where the Krehbiel house now stands) were running a mixed dairy and beef herd on prairie pasture while also growing wheat; and W. P. Thiel, just north of where the Land's "160" is today, had a sizable dairy herd. All of these farmers were foreclosed upon between 1929 and 1935, unable to support their increased overhead and make loan payments in the soured agricultural markets of the Depression. Most local landowners who did *not* lose their land during the Depression lived in town and were not farmers.

Both in their successes and in their failures, the early farmers of Saline County have something to teach us. When they tried to increase their wealth by "modernizing," investing more capital and taking out loans in an attempt to produce more efficiently, they made themselves more vulnerable to the vagaries of nature and of the market. The values and expectations that led to this downfall were probably with the settlers from the outset. But it should be remembered, too, that their initial system of diversified farming lasted for thirty years, and supported over a thousand farmers in this county during that time. The farms they created here were probably not ecologically sustainable; even as diversified, largely self-sufficient farms, they would have had to face issues of long-term soil erosion. At the very least, they would have had to incorporate conscientious legume rotations and manuring practices such as those used by the Amish both then and now. But these farms, as originally established, were agronomically diverse, supplied a vigorous local food economy, and ran on locally available materials and energy. As long as they remained so, they were economically resilient in the face of many challenges.

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1. The year 1885 was unusual in that the Ottmans and most other farmers in the county had all their grain acreage in corn, probably following a bad winter that destroyed the wheat. Extrapolating from average corn yields and prices, I estimate the Ottmans could have made about $800. In an ideal year when they planted 70 acres wheat and 30 corn and both crops came through and sold at average prices, I estimate their potential income at closer to $1600; however, judging from journals and letters written during that period, ideal years were rare.

Bess Wauhob: Friend and Neighbor to The Land

Sheri Walz

Bess Wauhob is The Land Institute's next-door neighbor, and long-time friend. She owns most of two eighty acre parcels on either side of Water Well Road to the east of us. Some three decades ago, she sold the 28 acre southeast corner of her land to the Jacksons to provide a site for their home and later The Land Institute. She also leases us the "Wauhob Prairie" north of the road. Her association with this land goes back some 65 years, and she has seen the changes wrought in agriculture over that time. Her family knew the land's homesteaders, the Ottmans, who in turn knew Native Americans living in the area. Thus, through the memories of one Saline County resident, we have an account of one piece of land from European settlement to the present.

Richard and Anna Ottman homesteaded these 160 acres in Township 15, Range 2, sections 5 and 8 in 1867. Mrs. Ottman gave birth to five sons and a daughter while they lived on the land. According to Bess, Native people in the area were on friendly terms with the Ottmans. They traded skins with the Ottmans for flour, pots, and food. The Natives camped in a grove of timber by the water, near an oxbow in the Smoky Hill River. Often relics would appear after a rain on the freshly plowed ground of the Ottman fields.

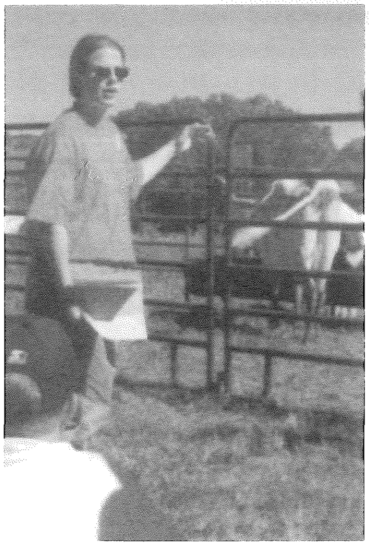
Bess Wauhob.

Flooding was a problem on this bottomland adjacent to the Smoky Hill River. The original house was destroyed by a flood in 1903. By then, Richard Ottman had died. Three bachelor Ottman sons began building a new pre-fabricated house for their mother, but she died before they finished it. They never did fully finish the house, but "bached" in it anyway. At least the new house did not flood, though once water did make it to the porch level.

The Ottman sons grew cash and feed crops such as wheat, corn, and alfalfa, but also provided for many of their own needs. Henry Ottman, one of Richard's sons, eventually married and lived with his wife and brother on the property. They had an extensive vegetable garden, and sold surplus vegetables in town. One of the Ottman brothers lived in California and sent fruit trees to the family. But the family fell on hard times in the 1920's and the remaining brothers finally lost the farm to foreclosure in the Depression.

County Commissioner L.A. Bickel purchased the Ottman land in 1932, after it had gone up for Sheriff's sale. He moved his family from Gypsum, twenty miles away, to the fertile bottomland adjacent to the Smoky Hill River where he had enjoyed many a fishing trip. He, his daughter Bess, and his second wife, Clyde, finished the house and lived in it. Bess remarked how at age twelve she missed the social life of Gypsum after moving to their new land. Bess' help was needed on the farm and she could not attend school. The weekly dances the family had once attended were too far away. There were neighbors with whom the Bickels could socialize, however. Trips to a neighbor's house for popcorn and conversation were common. Then there were trips to Salina six miles away, and church. The family used both horses and a car for transportation.

As a public servant and owner of a drugstore in Gypsum, Bickel did not have time for full-time farming. Therefore, his brother and his brother's sons helped farm the land the first year, commuting from Gypsum. His brother died before the first harvest was taken in, however, and Bickel had to find a new person to work the land. The Bickels practiced a diversified



Sheri Walz

mix of cash crops and subsistence farming. They farmed with six horses and two mules.

The fruit trees—apple, gooseberry, currant, cherry, peach, pear, plum, and quince—that had been planted by the Ottman brothers served the family well. The pear tree produced enough pears the first year to pay off their taxes on the land. Who could make such a claim today? Unfortunately, most of the trees were killed by a hard winter in the 1940's.

Bess was responsible for caring for the family chickens and cows. They had many hundreds of chickens, and six cows. The eggs were collected and cleaned by Bess each night, for sale in town. Bess was responsible for keeping the cows' water tank full if the pump failed. She also led the cows to their pasture across the river each day, and milked them. They sold the cream in town, and fed the skimmed milk to their hogs. The family raised hogs both for sale and for meat, and also supplemented their diet with fish and game.

Food preservation was important to the Bickels. Bess' step-mother, Clyde, had a large vegetable garden. The family produced enough for themselves, needy relatives, and sale in town. The Bickels had a cellar, but no deep freezer. Preservation methods were canning, drying, and salting.

Other ventures on the land were sometimes proposed by outsiders. One man from town kept bees and paid them honey in return. Another wanted to lease some of their land to build a campground and artificial lake. He built five cabins, and was going to plant zinnias around the lake and call it Lake Zinnia. Unfortunately, the hole he dug wouldn't hold water, and neither did the lease. He did leave some nice picnic tables, though.

When Bess was twenty, she married Loyd Wauhob. Her parents moved to town, while Bess and Loyd stayed on the farm. They continued leasing most of the land, because Loyd was not a farm boy. He worked at Swifts, a creamery and poultry house in Salina. Bess kept up the diversified farming practice with a vegetable garden, cows and chickens. She produced food for the family and brought in extra money with the eggs and cream. This lasted until World War II came along.

The war brought changes all over Saline County. Many farmers were forced to sell their land for two new army bases, and others went to war themselves. One small-town newspaper editor wrote, "The truth about 1942 small towns is that those who are left in them are too busy to do much more than keep them from falling apart." Loyd was called to the army. The Wauhobs had to sell their horses, mules, cows, and chickens. They rented the entire farm to tenants, and Bess moved into town to live near her step-mother (her father had died by this time). This began what was to be seventeen years off the farm, first due to the war and later due to Loyd's transfer with Swifts to Wichita.

Bess, like many women, had her first paid job during World War II. She was walking downtown by a restaurant, and stopped in for a bite to eat. While waiting, she noticed there was a huge stack of dirty dishes in back. The owners were busy, and had no time to do them. She asked them if they needed any help. When they replied yes, she went to the back and helped. She worked at the restaurant until Loyd returned and they moved to Wichita. She continued working at a restaurant in Wichita.

While in Wichita, the Wauhobs still had some interaction with their land. An oil prospector stopped by to ask about purchasing the oil rights to the land. After he had helped Bess wallpaper her bathroom, she sold him the rights.

Seventeen years after leaving, the Wauhobs moved back to the bottomland adjacent to the Smoky Hill River. They continued to lease the farmland. Commercial cash crops took over almost entirely, because small scale poultry and dairy operations could no longer compete with the new "factory" farming style. Bess, however, kept on with the garden, chickens and cattle for home use, until she broke her hip. One of Loyd's younger brothers helped them out with farm work. Later, her husband Loyd fell ill, and she cared for him until his death. Her cropland is now farmed in alfalfa and wheat.

The changes Bess Wauhob has witnessed during her life are echoed throughout Saline County and the Midwest. The drain of rural population accelerated by World War II, changes in farming methods, and the decline of diversified local agriculture are all national trends she has witnessed.

The downside of progress did not go entirely unnoticed. *The Echo,* a newspaper published in the small Saline County village of Brookville, was quite concerned about the decline of the small town and the small farmer. The paper published wood-block prints of local historic sites, oral histories of settlers being pushed off their land for the new army bases, and vehement editorials denouncing the changes in Saline County. At last, the editor was called to serve in the war. An editorial he wrote in 1942 displays his frustration:

> The past at least is secure. We have seen the cities, larger towns, suck us dry. How many college graduates came back, to *live* in Brookville?
>
> ...We have seen the automobile leech itself onto country and rural life–and only Detroit and motor row grow fat on Brookville's blood.
>
> We have seen security and comfort and character sold down the river, exchanged for a bauble we called "higher standards of living." ... Here entered an estrangement of the family with the *home*. (City people do not live at home; they eat, work, play, mourn, worship, either on the go or in establishments provided by that fiction, "a higher standard of living." ...They have little fifty-foot lot dogs, and few cats. No chickens; no cows. No *home.*).
>
> ...Add this to a slow de-population of the area west of town, where a dangerous centralization of land ownership is building, and you will find Brookville wanting customers, for its stores, its bank, its schools, its churches, its lodges...
>
> ...There may come a day when there is no building standing in Brookville. When there is no street, no fence, no porchstep...
>
> ...And some one will there be who ... will say, "Here they withstood artificiality for some time, and finally the last man died. And now, you see, the grass is coming back."

Wes Jackson, Bess and Loyd Wauhob at the dedication of the Wauhob Prairie, 1986

The current landscape of Saline county is far removed from the native prairie or even the diversified farms of the first generation of European settlers. Small-scale diversified farming has slipped away as did the ways of the Native people. The villages that depended on small-scale farming have disappeared as rural population declined. Salina is now the hub of Saline County, and the few remaining small towns hold on either as bedroom communities or as historical landmarks.

Interpretation of this transformation is far from simple. People who lived through these times, as did Bess, view many of the changes as benefits. Many were. But many of the benefits have turned out to be deceptive. Farmers steadily sacrificed self-sufficiency for commercialization and consumerism. Today, few farmers could supply most of their family needs on farm, or would want to. In the process they also lost their communities as farming became capital intensive and small-scale was no longer profitable. Today, Salina is the place where rural residents of the county go for business. Lastly, many farmers have lost their trade itself and the rural life that goes with it. Salina keeps expanding, consuming more farmland for its industrial, commercial, and residential zones. The land's value increases to a point where it is no longer profitable for farming, and farmers are priced off the land. Commercialization, despite its supposed benefits, has been the downfall of the rural way of life. And yet, most of those who still live and farm in the countryside regard these changes, sometimes enthusiastically and sometimes a bit uneasily, as the inevitable march of progress. Any attempt to restore vitality, people and *homes* sustainably to the Great Plains must acknowledge and deal with the complexity of this ambivalence, if it is to succeed.

Bess Wauhob died a few months after these interviews, in February, 1997.

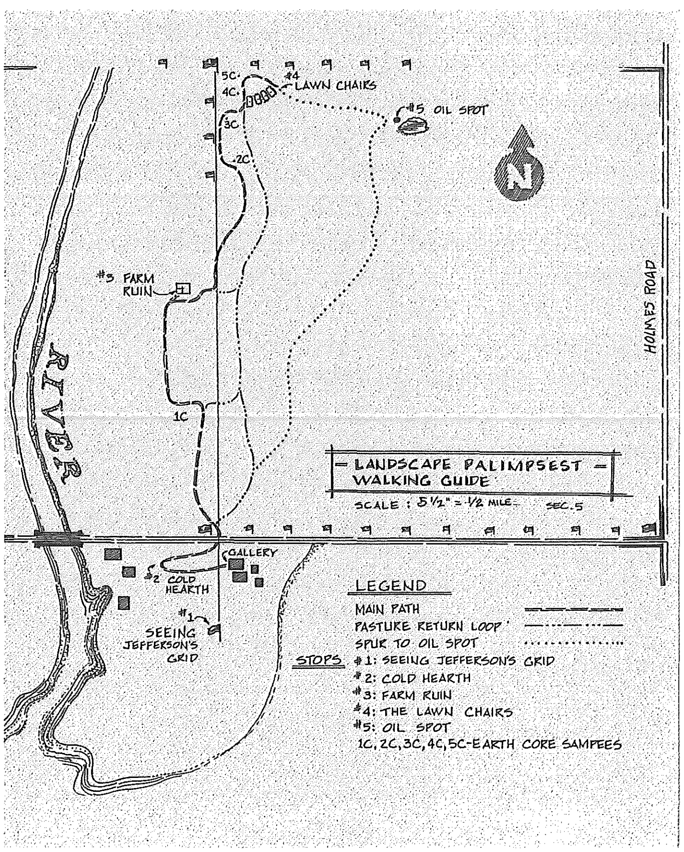
Landscape Palimpsest

Brian Donahue

The preceding articles are about the intertwined natural and human history of the land. This article is about art. What we see, how we respond to it, and the lessons that we draw obviously depend on what we "know" (consciously or unconsciously) about what we are looking at. Our response takes us into the realm of art, and its interaction with science, history and land use.

In my view, the primary form of landscape art is the inhabited landscape itself. What we see from the top of the hill on The 160 expresses very powerfully (for better or worse) the way our culture understands and cares for its land, in a great many particular ways. But this pattern only becomes slowly visible to those who have the experiences and knowledge to see it. Most of what can be seen is commonly overlooked. Deep insight into our familiar surroundings is something that most of us struggle towards all of our lives. Part of the work of The Land Institute, since the first Prairie Festival in 1979, has been an effort to improve our capacity to see in this way.

Traditionally when we speak of landscape art, of course, we mean something that depicts the landscape. One of the functions of such *representative* landscape art, the making of pictures (besides being



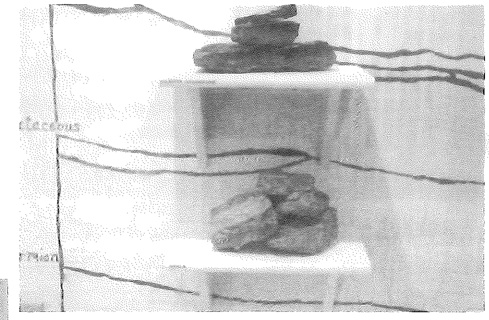
Harley Elliott at the "Cold Hearth"

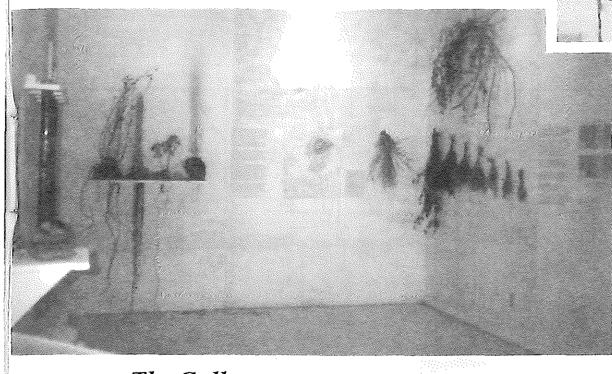
pleasing or stimulating), is to cause viewers to make connections with the landscape itself—to begin to see into it. Ideally, the relationship between landscape, artist, art, viewer and the landscape again should be a circle of improved perception and care. Reflecting and reinforcing the way we look at the world is an inescapable cultural role of art, whether all artists care to accept it as a responsibility or not. Perhaps it is better that some artists remain unaware of it, lest they become overly didactic. Other artists embrace this role more deliberately.

There are environmental artists who work with materials from the landscape itself, and often *on* the landscape itself, in order to draw the viewer's attention back to the story the land has to tell. Art of this kind dramatizes qualities that are imbedded within the view, and which might otherwise escape notice. Like any art, such environmental art is partly conceptual. The pieces of the work may be dispersed, and perhaps not even all visible at once. They must be assembled in the mind of the viewer, and then reapplied to the landscape as a whole. As part of their group research project into the ecological history of the Land's land, the 1996 interns worked with environmental artist Karen McCoy to create such a "landscape palimpsest." A palimpsest is a document which has been erased and drawn over several times, and that is certainly the case with the land here.

Karen, who is Chair of the Sculpture Department at the Kansas City Art Institute, attended a number of intern presentations last spring and received copies of their research notes on the history of the land. We brainstormed ideas about how to highlight these layers of history on the land itself, and then executed the piece in the midst of all the other preparations for Prairie Festival—which is one way to do art, I suppose. It certainly was intense. We mounted the piece again for fall Visitors Day, and led interpretive walks on both occasions.

The walk began in the Gallery, where Karen distilled our findings and displayed them graphically. Roughly speaking, each gallery wall represented a





The Gallery

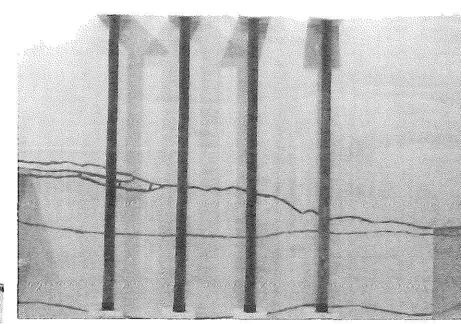
from wall to wall suggesting that these layers can never be entirely separated. Geology, soils and prairie ecology were on one wall; local plants used by Native American and maps of several tribes' territories on another; maps of white settlement and landownership on another; and graphs of recent developments in local farm sizes and crop production on the fourth. Much of this Karen drew with pigments made from local soils, giving the Gallery a strong feeling of being "of the land."

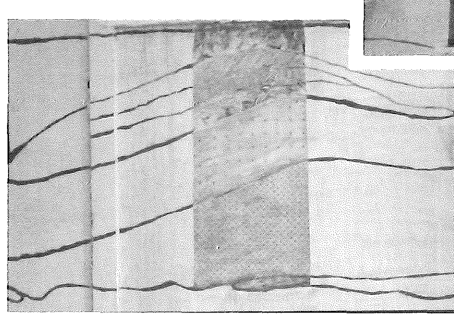
The walk went from the Gallery across the Land's property and then out to the hill on The 160, half a mile to the north (see map p. 26). I won't describe all of the elements depicted in the walk, but a few examples will give a sense of the way the piece was put together. Probably the most visible part of the work was called "Seeing Jefferson's Grid," and consisted of over 100 American flags. We flew large flags from the corners of The 160, and posted smaller flags along some of the property lines at intervals of one chain, or 66 feet. This recalled the rectilinear survey by which most of America west of Ohio was divided into private ownership a century and a half ago, and is still owned and utilized today. It is true that section roads and fencelines display the grid all the time (this is part of our permanent collection, you might say), but it was a bit startling to see the scale of it staked out so vividly.

At the site of the 2,000 year old Native campsite near the classroom, we constructed a "Cold Hearth." This was simply a small bowl in the earth in which a fire was burned and then extinguished. This circle was surrounded by a neat square of ground from which the sod was removed, whose corners were marked with small American flags. This made a telescoped but telling symbol of the replacement of one culture by another.

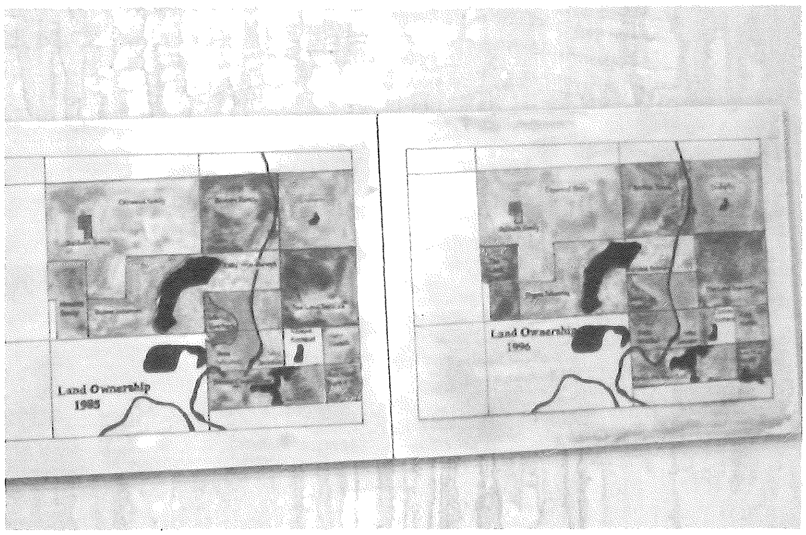
Just west of The 160, at the base of the hill on the edge of the river bottom, lies the foundation of an old homestead. The cellar walls were laid up with local Dakota sandstone. This was the 1870 homestead of the Smith family, whose farm tucked into the other side of the Smoky Hill river oxbow from the Ottmans' homestead (see map p. 20). Near the cellar hole stand two enormous cottonwoods that were planted (or retained) by the family when they settled, but the whole farmyard is now overgrown with hackberries and elms that sprang up after the farm was abandoned half a century ago (see front cover). We gained permission from the present landowner to cut a path through the poison ivy and to clear brush from the old walls, and erected a mock kitchen shelf with a motley collection of antique and modern appliances. Here was another layer of occupation come and gone.

Here and there along the walk stood soil samples in clear tubes, mounted on poles above the holes from which they had been lifted. In this way visitors could see the changes in the soils over which they trod. Near the top of the hill on The 160 were two samples showing a sharp change in virtually the same soil only a few feet apart—as Jerry describes in his paper, half a foot of topsoil was missing from the downhill sample taken inside the old wheat field,





compared to the unplowed prairie just above. Into the old plowbank we cut a series of "Lawn Chairs," upholstered with lush strips of domesticated sod. There you could sit looking out over the Smoky Hill valley with your back against the native prairie, and your feet dangling in the absence of soil where the ground had been broken and washed away.



A hundred feet or so above the lawn chairs is the top of the hill, protected from the plow by its cap of rocky Lancaster soil formed in Dakota sandstone. Even this patch of native prairie is changing—with decreased fire over the past century, small elm trees have invaded. Does this tell us that after thousands of years the land is "returning" to its natural, forested state; or rather that because the landscape is now segmented by cultivated fields and patrolled by fire trucks, natural fires can no longer spread as readily as before? This is the kind of complex question that we hope was on the mind of our audience as they reached the top of the hill.

Just past the crest of the hill, a flag marked the fence corner that is the northwest corner of our quarter section, and the exact center of Section 5. Half a mile due south one could just make out the flag at the southwest corner of The 160 by The Land Institute parking lot on Water Well Road, near the beginning of the walk. Across the bottoms and prairie upland to the southeast, the flag at the corner of Holmes Road was, to my eye, nothing more than a hint of red and blue. Turning to look in the opposite direction, one could see the northwest corner of the square-mile section far out in the ripening wheat fields of the broad bottomlands west of the river. We did not mark this corner with a flag, but one could pick it out easily enough at the end of a hedgerow of osage orange. Toward it marched the oncoming commercial and residential suburbs of Salina, and on that urban horizon, as a kind of artistic bonus, waved the basketball court-sized American flag that a local car dealer flew over his lot. An amazing amount of natural and cultural history was visible in bits and pieces just within the square mile surrounding the hill top—beginning with the square itself, discernable on the land.

We often boast that we live in an Information Age. We send record amounts of presumably important data record distances in record time, and the towers by which we do it now stud the horizon. We can gain instant "access" to plenty of useful information about geology, ecology and history on the Internet, but it is less clear that this information is reaching the earth in a helpful way. How many people whose heads are in cyberspace look down to see the smallest part of the dense information embedded in the ground beneath their feet? I suppose it would be naive to believe that if people looked for some of these things, they would immediately begin to treat the land better. But it might not be a bad place to start. Calling that to our attention is part of the function of art.

Matfield Green Conferences

The Land Institute has begun to hold workshops and conferences at the school in Matfield Green. Last March and April, Arts Associate Terry Evans ran a workshop called "Seeing Home Land" for Chase County High School students, with English teacher Denise Ulrich and Art teacher Peggy Lyon. The students kept journals, wrote essays and took photographs documenting various aspects of land use in Chase County—everything from energy sources, to cemeteries, to ranching. The students' photographs and excerpts of their writing were mounted as an exhibit at the school, and will travel to other parts of Kansas.

On May 3-4, 1996, we held a small gathering of leading experts to help us think through our "ecological community accounting" project for Matfield Green. The participants included Joel Cohen, Dan Luten, Sim Van der Ryn, and Bob Herendeen. Bob, a physicist with the Illinois Natural History Survey, will continue to work with us on this project.

On September 13-15, 1996, we held a conference concerning moral, educational and spiritual dimensions to resettling rural communities—the changes in attitude that must accompany the "nuts and bolts" of economics and ecology. The conference was sponsored by the Fetzer Foundation, and Art Zajonc (a physicist at Amherst, and Fellow of the Fetzer Institute) chaired the proceedings, together with Wes Jackson and educator Doug Sloan. Participants included many long-time friends of the Land and some new ones: Bob Herendeen again, Joe Hickey and Jim Hoy from Emporia State, Verna Kragnes from Philadelphia Community Farm in Wisconsin, Bobbi Oakes of Matfield Green, Paul Nachtigal and Toni Haas from the Rural Challenge, David Orr from Oberlin, Paul Theobold from the University of Wisconsin, Bill Vitek from Clarkson and Mary Berry Smith from Kentucky. The proceedings are being edited for publication by Mary Berry Smith.

This summer, The Land Institute and Emporia State University will be running a week-long workshop for public school teachers and administrators called "Discovering Place and Community: Bringing Rural Education Home." The workshop is supported by the Annenberg Rural Challenge. Its purpose is to encourage rural school districts to reorient their schools to educate young people *into* their communities, rather than *out* of them. The curriculum will be similar to that illustrated for Saline County in this *Land Report.*

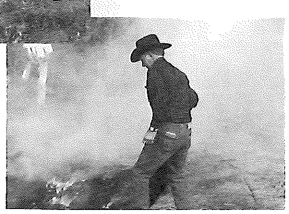
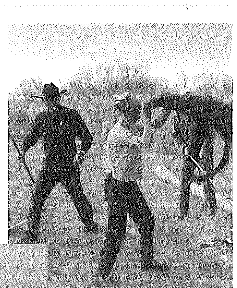
More conferences are taking shape, and the series will no doubt receive a more complete write-up in a future *Land Report.*

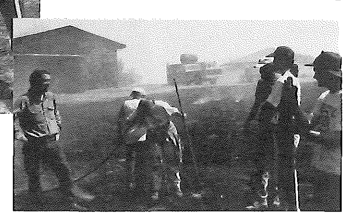
Changes at The Land

Brian Donahue

The Land Institute is happy to announce two additions to our staff. David Van Tassel will be our new plant scientist, coming on later this spring. David is completing his Ph.D. in Plant Biology at the University of California-Davis, where he has worked on genetics and mechanisms controlling flowering in plants. Rob Peters is our new Director of Education. Rob has a Ph.D. in Biological Sciences from Stanford, and has worked for over a decade for groups such as the Conservation Foundation and the Defenders of Wildlife in Washington, D.C. He is the author or editor of several books and reports, including *Endangered Ecosystems of the U.S.,* and *Climate Change and Biological Diversity.* You will doubtless be hearing more of these gentlemen in future *Land Reports.*

I am leaving The Land Institute after three very rewarding years, to return to environmental history and community farming and forestry projects in Massachusetts. I have greatly enjoyed my time in Kansas, and plan to stay involved with this outstanding organization.

Jack and crew burn the grass

Events

Fall Visitor's Day on September 29, 1996, brought Harley Elliott and Steven Hind back to The Land Institute. Harley and Steven were among the poets whose readings many felt were the highlight of last year's Prairie Festival. This time they were accompanied by improvisational cello work from Eugene Friesen, who last performed at The Land with Paul Winter at the 1993 Prairie Festival.

Eugene is completing work on his "Grasslands" composition, which will be premiered by the Paul Winter Consort here in Salina at the Smoky Hill River Festival on June 14. This composition has been commissioned, in part, by the "Horizons 50" group that supports the Salina Arts and Humanities Commission. The performance will feature a regional orchestra and chorus, along with the Winter Consort.

This year's Prairie Festival will take place once again on Memorial Day weekend, Friday May 23 to Sunday May 25. The theme will be "feeding our world and having it too," or how to find room for sustainable agriculture and biodiversity on the same planet. Among the confirmed speakers will be Under Secretary of State Tim Wirth, geographer Dan Luten, and dancer Joan Stone. Mark your calenders.

1995 Soil Quality on the Sunshine Farm

Lisa Mosca

Introduction

Long-term assessment of soil quality is an important part of the Sunshine Farm Project. No fertilizer, manure or hay/straw is imported from off the farm, but some feed is purchased for poultry and overwintering cattle. So, we have been monitoring whether the farm can supply its own fertility. Past studies have shown that energetic expenditures for soil improvement alone are a small part of the farm's energy budget (Gerwin 1994), which suggests that small changes in how we run our farm could provide important benefits in long-term soil maintenance.

Recent advocates for on-farm testing of physical and biological soil properties highlight the benefits of gaining information on soil structure, soil compaction, soil water-holding ability and percolation rates, and biological activity within different organismal populations (Doran and Parkin 1994). This (1995) is the third year that we have tested chemical soil properties, the second year for some physical and biological properties, and the first year we examined soil aggregation and soil respiration. As documented by these tests, the cost of a truly sustainable agriculture is indicated by the effort the farm must expend to maintain soil quality without outside inputs.

Materials and Methods

Sunshine Farm. The cropland consists of 50 acres of level bottomland 3 miles south of Salina, KS. The north half contains 55 crop strips and the south half, 70 strips. Each block of five strips is a replicate within the five-year crop rotations. The soil is mostly Cozad silt loam (coarse-silty, mixed, mesic Fluventic Haplustoll), so it was formed by flooding and is very fertile. The average annual precipitation is 74 cm, but this year we had a very wet spring with rainfall of 40 cm in May. The farm's drainage pattern extends from the mideast flowing northwest. The farm had been conventionally cropped, mostly in wheat prior to the Land Institute ownership, after which it became organically cropped from 1990 onward, the north in wheat and the south in alfalfa. We began strip cropping the north half in 1993 and the south half in 1994.

Wauhob Prairie. This site is never-plowed, formerly grazed native prairie. It is on shallow upland, Kipson-Cline silt loam soil derived from calcareous, silty shale, which would be poor for cropping, but supports a diverse number of native prairie wildflowers and grasses. It is one mile to the east to the Sunshine Farm.

Brome sod. This site is at the midwest edge of the Sunshine Farm on an adjoining parcel of land in a non-native smooth brome field. It has the same soil as the farm, and much gravel was added several decades ago.

Tree windbreak. This site is located at the northern edge of the farm and contains mainly osage orange and mulberry trees, with the same soil as the farm.

Conventional wheat field. This site was used for short-term testing and lies adjacent to the east end of the northern half of the Sunshine Farm, with the same soil. Each site tested in the neighbor's wheat field was directly east of a Sunshine Farm wheat strip and 10 m from the property line, for a total distance of 30 m between corresponding samples in the neighbor's wheat field and the Sunshine Farm wheat strips. The neighbor's wheat field has been continuously cropped, for at least eight years, mostly in wheat, but sometimes with a rotation of milo for weed control. From 1992-1995, it was planted to wheat. Chemical and fertilizer inputs were applied regularly.

Long term soil sampling. During March 21-25, 1995 soil samples for chemical testing were taken from each of the five strips in 6 blocks in the north half and 6 blocks in the south, for a total of 60 sites sampled on the permanent sampling sites fixed in 1993. In 1995, two depths were sampled: 0-30 cm and 30-60 cm. Samples were collected with 1.8 cm i.d. soil probes and were composited from three subsamples taken within 5 meters. They were immediately dried in a greenhouse. Samples were analyzed at the Kansas State University Soil Testing Laboratory for 9 chemical properties: pH, Bray Phosphorus (P), extractable Ammonium (NH_4), Nitrate (NO_3), exchangeable Potassium (K), Total Nitrogen (Tot N), total Phosphorus (Tot P), organic matter (OM) and cation exchange capacity (CEC). Details of procedures are given by North Dakota Experiment Station (1988).

In 1995 on the farm, prairie, brome and tree sites, we did on-farm tests of 4 physical soil properties (bulk density, water-holding capacity, water infiltration and soil aggregation) and a biological one (earthworms). On the farm, samples for bulk density were collected with soil probes from the same 2 depths and the same date as the chemical samples. During April 5-9, we measured bulk density, water holding capacity and infiltration rate with simple can methods described by Cramer (1994a,b). We sampled for earthworm abundance during June 2-5 by handsorting 3 soil samples that were 18 cm deep and 15 cm in diameter. Because we did not find any earthworms at the brome and prairie sites, we took extra samples. During June 7-15, we collected samples to test for soil aggregation, or more specifically, wet aggregate stability (Kemper and Rosenau 1986). The exact procedure we used is described by Grossman (1990). The samples, which were 7.5 cm in diameter and 7.5 cm in depth, were excavated using a hand trowel and were allowed to air-dry at room temperature prior to lab analysis.

Short-term soil sampling. During June 30 - July 27, we performed tests to examine some short-term effects of cropping systems and residues on microbial activity and concomitant mineralization of nitrate. Using techniques described by Doran (1995), we measured soil nitrate levels and soil respiration for 3 crops: four wheat strips in the north half of the farm; four 1994-95 alfalfa strips in the same blocks as the wheat strips; and four locations in an adjacent conventional wheat field across from our 4 wheat strips. During June 28 -29, the alfalfa strips were disked and planted to milo. The strips of wheat stubble on the Sunshine Farm were disked during July 1 -2. Our neighbor disked his wheat stubble on June 29. On June 30 at each site,

Table 1. Means and standard deviations (n=6) for 1995 soil properties due to 1994 crop effects that were significantly different and explicable.

Soil Property	Milo	Oats 1	Oats 2	Soybeans	Sunflowers[1]
NO_3-N: 0-30 cm (ppm)	5.45 ± 3.57 abc	3.27 ± 4.02 c	4.68 ± 4.00 bc	11.1 ± 4.96 a	10.5 ± 6.99 ab
NO_3-N: 30-60 cm (ppm)	4.60 ± 3.72 ab	4.18 ± 6.18 b	4.10 ± 3.45 b	7.58 ± 5.18 ab	12.2 ± 10.2 a

Means followed by different letters are significantly different ($p \leq 0.05$).
1) Strips were in alfalfa in 1993.

we measured water-holding capacity and used soil probes to obtain samples of 3 composited soil cores from 0-15 cm depth for nitrate and bulk density. During July 25 -27, we sunk closed chambers into the soil at each sample site and took soil respiration readings with CO2 detection tubes (Cramer 1994c). At this time, the milo seedlings were 9 inches tall, so the chambers were placed in the middle of the 40-inch spacing between the rows. Then to see how microbial activity would respond to rainfall, we added one inch of distilled water to the soil in the chambers and roughly twenty-four hours later took another respiration reading. We took soil nitrate samples along with the respiration readings. We also took samples for bulk density and soil water content, both pre- and post-wetting.

Data for long-term and short-term soil tests were examined by analysis of variance, with pairwise comparisons done by Tukey's test. The 0.05 level of significance was used throughout.

Results and Discussion

1994 crop effects on 1995 soil properties. We analyzed the effects of 1994 crops on the 14 soil properties in 1995 and found explicable significant differences only for soil nitrate at the 2 depths (Table 1). The soybeans and sunflowers (alfalfa in 1993) showed significantly higher nitrate levels than other row crops. Thus, nitrate levels were higher after legume crops.

Effects of prior cropping history. We found fewer significant differences in chemical soil properties between the north and south halves in 1995 than there were prior to the beginning of strip cropping in 1993 (Tables 2 and 3). This indicates that the effects of the different cropping histories in these halves during 1990-93 were decreasing over time. The chemical levels cannot be compared between 1993 and 1995 because the measurements were made at different depths which may include different bulk densities. The most obvious effect is the greater number of earthworms in the south half of the farm due to the lack of tillage since this field was in alfalfa during 1990-93. Earthworm counts provide indirect information on the diversity of soil decomposers that allows for continued activity under fluctuating soil conditions and that plays a predominant role in maintaining the fragile yet crucial balance between CO2 production and utilization in the biosphere (Doran et al. 1996).

Differences between the five sites. For the 5 physical and biological soil properties at the five sites, the prairie had the greatest water-holding capacity, and along with the brome site it had the greatest soil aggregation (Table 4). Soils with much aggregate stability are able to maintain a balance of air and water so as to promote nutrient cycling and root exploration, while resisting erosion and surface sealing. The treebreak showed the highest number of earthworms, while the prairie and brome sites showed no earthworms. Our shallow sampling would be less likely to detect the native worms at deeper depths in the prairie.

Effects of crop residues on soil respiration. In this short-term experiment, there were no significant differences in soil respiration among the 3 crops or between the 2 wetting treatments (Table 5). The mean for alfalfa in the post-wetting treatment was large enough that with more replicates it probably would have

Table 2. Mean and standard deviations (n=30) for soil properties on the north and south halves of the Sunshine Farm in 1995.

Soil Property	North	South
pH: 0-30 cm***	6.28 ± 0.23	6.56 ± 0.29
pH:30-60 cm	7.08 ± 0.40	6.99 ± 0.57
P: 0-30 cm (lbs.ac.)8	65.8 ± 36.2	47.2 ± 15.7
P: 30-60 cm (lbs./ac.)	28.4 ± 13.9	24.0 ± 13.1
K: 0-30 cm (lbs./ac.)	1832 ± 256	1620 ± 189
K: 30-60 cm (lbs./ac.)	1000 ± 200	970 ± 189
OM: 0-30 cm (%)	2.45 ± 0.42	2.38 ± 0.34
OM: 30-60 cm (%)	1.44 ± 0.26	1.45 ± 0.30
NH4-N: 0-30 cm (ppm)	3.91 ± 3.55	2.84 ± 0.60
NH4-N: 30-60 cm (ppm)***	4.15 ± 2.88	2.62 ± 0.65
NO2-N: 0-30 cm (ppm)***	3.26 ± 3.31	9.99 ± 7.18
NO3-N: 30-60 cm (ppm)***	2.01 ± 1.65	11.6 ± 7.90
CEC: 0-30 cm (MEQ/kg)	17.39 ± 2.61	16.0 ± 1.74
CEC: 30-60 cm (MEQ/kg)	15.9 ± 1.87	15.1 ± 4.01
Tot P: 0-30 cm (ppm)	383 ± 53.4	368 ± 23.1
Tot P: 30-60 cm (ppm)	417 ± 52.3	419 ± 21.4
Tot N: 0-30 cm (ppm)	1146 ± 178	1133 ± 155
Tot N: 30-60 cm (ppm)	743 ± 157	752 ± 153
BD w/soil probe: 0-30 cm (b/cm^3)	1.08 ± 0.15	1.07 ± 0.19
BD w/soil probe: 30-60 cm (g/cm^3)	1.09 ± 0.16	1.15 ± 0.23

*,p≤0.05 **,p≤0.01 ***,p≤0.001
[1]) n=180 for earthworms and soil aggregation.

Table 3. Means and standard deviations (n=30 strips) for soil properties on the north and south halves of the Sunshine Farm, before cropping system was begun (1993).

Soil Property	North	South
pH: 0-15 cm***	6.30 ± 0.29	6.71 ± 0.37
pH: 15-30 cm*	6.15 ± 0.27	6.37 ± 0.49
P: 0-15 cm (lbs./ac.)***	55.4 ± 38.2	22.4 ± 8.6
P: 15-30 cm (lbs./ac.)***	35.0 ± 20.4	17.8 ± 10.2
K: 0-15 cm (lbs./ac.)***	1124 ± 288	1008 ± 156
K: 15-30 cm (lbs./ac.)	872 ± 206	712 ± 111.2
OM: 0-15 cm (%)***	2.54 ± 0.56	2.07 ± 0.35
OM: 15-30 cm (%)***	2.24 ± 0.37	1.85 ± 0.39
NH4-N: 0-15 cm (ppm)	6.26 ± 1.43	5.78 ± 1.45
NH4-N: 15-30 cm (ppm)**	6.95 ± 4.49	5.43 ± 0.78
NO3-N: 0-15 cm (ppm)***	3.44 ± 1.59	1.83 ± 1.21
NO3-N: 15-30 cm (ppm)***	3.83 ± 1.66	1.43 ± 1.02
CEC: 0-15 cm (MEQ/kg)	16.5 ± 1.72	15.5 ± 1.50
CEC: 15-30 cm (MEQ/kg)**	16.7 ± 1.71	15.6 ± 1.54

*,p<0.05 **,p<0.01 ***,p<0.001

Table 4. Means and standard deviations for physical and biological soil properties that were significantly different between the crop strips in the north and south halves of the Sunshine Farm and 3 control sites.

Soil Property	North	South	Tree windbreak	Prairie	Brome
Water-holding capacity (g/g)1	0.33 ± 0.05 b	0.30 ± 0.06 b	0.36 ± 0.02 b	0.50 ± 0.04 a	0.32 ± 0.05 b
Soil aggregation (% volume of aggregates 1-2mm)2	28.8 ± 9.77 b	30.6 ± 6.42 b	41.7 ± 5.77 b	80.0 ± 10.0 a	83.3 ± 11.6 a
Earthworms2 (number/m^2)	0.20 ± 0.69 b	0.77 ± 1.21 b	6.00 ± 4.36 a	0.00 ± 0.00 b	0.00 ± 0.00 b

Means followed by different letters are significantly different (p≤0.001).

1) n=3 for tree windbreak, prairie, and brome sites; n=3 for north and south halves.

2) n=3 for tree windbreak, prairie, and brome sites; n=90 for north and south halves.

been significantly greater than those for the 2 wheat sites. The alfalfa strips were the only site that showed a significant increase in soil nitrate levels 3 weeks after disking compared to just before disking (Table 6). At the later date, the alfalfa strips and the conventional wheat field had greater nitrate levels than the wheat strips (Table 6). This is because the former is a nitrogen-fixing legume, and the latter received much commercial fertilizer. These measurements suggest that in the disked alfalfa strips there is more microbial activity and subsequent nitrogen mineralization which contributes to nutrient cycling. This confirms the use of alfalfa in crop rotations for improving soil fertility.

Conclusion

Physical and biological tests done on the farm provide information about the soil quality, especially used in conjunction with chemical lab tests. Assessing the quality of the soil on the Sunshine Farm and for agricultural systems everywhere is a complex process with many potential indicators. In their 1996 paper on soil health and sustainability, Doran, Sarrantonio, and Liebig explain this well when they suggest that soil health can be defined as " the continued capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain biological productivity, maintain the quality of air and water environments and promote plant, animal and human health. The challenge we face, however, is in quantitatively defining the state of soil health and its assessment using measurable properties or parameters. Unlike human health, the magnitude of critical indicators of soil health ranges considerably over the dimensions of space and time."

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Table 5. Means and standard deviations (n=4) for soil respiration (lbs. carbon/ acre/day) pre- and post-wetting at five sites on 7/25/95.

	Wetting			
Crop	Pre-wetting		Post-wetting	
alfalfa	67.7 ± 13.9	a	64.5 ± 44.5	a
wheat	65.5 ± 10.4	a	20.6 ± 15.7	a
Conventional wheat	49.4 ± 8.9	a	26.6 ± 11.2	a

Means followed by the same letters in a column are not significantly different (p≤0.05).

Table 6. Means and standard deviations (n=4) for NO3-N (lbs./acre) before (6/30/95) and after (7/25/95) disking the residues of 3 crops.

	Date	
Crop	Before	After
alfalfa strips	11.0 ± 10.1 a *	34.0 ± 12.2 a
conventional wheat	5.0 ± 2.4 a	22.1 ± 15.7 a
wheat strips	4.8 ± 3.1 a	7.1 ± 3.7 b

Means followed by the same letters in a column are not significantly different (p≤0.05).
*, significant difference (p≤0.05) between 6/30 and 7/25 readings within a crop.

1995 Rotational Grazing on the Sunshine Farm

John Curtis

Abstract
1995 was the first year of a rotational grazing system with a Longhorn cow-calf herd. In July, cover class percentages were measured in order to test the effects of rotational grazing on vegetative communities. Comparisons were made between grazed and ungrazed treatments at four different sites for 1995, and mean percentages from 1994 were compared with those from 1995 at the two sites that were intact prairie. The results showed that under this rotational grazing scheme, percent cover of both undesirable and desirable species had declined on the grazed, intact, native prairie sites, which is a desired effect.

Prior to the invasion of Indian lands by European-Americans, the great plains were covered by a rich and remarkably diverse mix of grasses and forbs naturally suited to the climate of the plains and to the native grazers. By far, the most significant of these grazers was the bison. Although reliable figures for the exact number of bison existing on the plains prior to the arrival of white settlers are unavailable, it's likely that the prairie supported many more bison than it currently does cattle (Flores 1991) while maintaining a vibrant and exceedingly rich plant community.

When white settlers reached the plains, they failed to adapt pasture management practices to local conditions. The cow replaced the buffalo as the dominant herbivore, open prairie became enclosed pasture, and cattle were often left to graze an area continuously throughout the year. When pastured in this way, cattle tend to select against good forage species and for both unpalatable native and weedy exotic plant species. The legacy of this low-management method has been degraded soils, decreased forage quality, and reduced species richness within the plant community over time.

In recent years, many ranchers and farmers have begun to experiment with a wide variety of pasture management techniques which fit under a rather broad category referred to as rotational grazing, short-duration grazing, or more recently as variable density grazing (Smith 1995). The idea is to graze a small section of pasture for a short enough period of time that there is no repeated grazing of favored forage species, but long enough that the cattle graze the less favored species as well. The grazed area is then left for a period of time so that the vegetation can recover.

Proponents of rotational grazing claim that under these pasture management schemes, range managers can halt pasture degradation and even increase forage production over time, while maintaining or increasing the stocking rate. The Sunshine Farm's rotational grazing experiment is designed to test the affect of a grazing rotation, adapted to the Land Institute prairie, on plant species composition.

Materials and Methods

The rotational grazing scheme is being done on a 100-acre pasture that has not been grazed since 1988 and was burned every 2-3 years since 1981. Nine Texas Longhorn cows were obtained in fall 1994 and given free access to the pasture during the winter. The grazing regime was begun in late May 1995 with the cows and their calves. Electric polywire was used to erect temporary fences for paddocks that were grazed for 2-3 days. During the first rotation in the first half of the growing season, roughly 80 acres of this pasture were divided into 24 paddocks. During the second rotation which began in early July, roughly 60 of the 80 acres were divided into 24 paddocks.

Four study sites were selected in 1994. Each site is unique in terms of vegetation, soils, aspect, slope and/or management history so that responses to grazing in different types of plant communities can be monitored over time. Sites 1 and 3 are intact prairie sites dominated by big and little bluestem. Site 2 is also on the unplowed prairie but shows signs of severe overgrazing in the past. Site 6 is on prairie that was former wheat ground replanted to native tall grasses, half in 1982 and half in 1986. Sites 1, 2 and 3 were burned 8 April 1994 and site 6, 30 March 1995. Parts of site 3 were burned by a neighbor's wildfire in May 1995.

At each site, we established multiple pairs of 5 x 5 meter, side-by-side plots, one of which is being grazed and the other protected from grazing by an exclosure. The plots were deliberately located where each pair visually had similar vegetative cover, which was later confirmed by statistical analysis of 1994 data on percent cover class of plant species composition (Tepfer 1995). This allows direct comparison of grazed and ungrazed plots within each pair in later years.

A cover class analysis was done at the four sites in July 1995, the second year of this seven- year study. Percent cover was estimated by examining the species present in four randomly placed 0.56 meter squared quadrants. Each species present was assigned to one of the six cover class categories based on the estimated percent of the quadrat it covered. These classes were 1-5%, 6-25%, 26-50%, 51-75%, 76-95%, 96-100%. The median value of the cover class of each species in each quadrant was used to calculate the mean percent cover for each species in each plot, transect, or site. Due to multiple layers of vegetation, percent cover can exceed 100%.

The species were grouped according to the categories annual, perennial, or biennial; warm season grass, cool season grass, legume, composite, or other forb; and desired or undesired. The undesirable category is made up of non-native invaders and native species that are considered indicators of overgrazing. The desirable category consists of native species that are not considered overgrazing indicators. Each site was described on the basis of the percent cover in each possible vegetative category.

Analysis of variance (ANOVA) was used to compare mean percent cover of vegetative category in grazed and ungrazed plots at each site in 1995. In addition, ANOVA was used to compare mean percent cover in 1994 and 1995 in grazed plots and then in ungrazed plots. Since the ratio of variance to mean was not constant across plots and residuals were normally distributed, square root transformation of data was not necessary for the analysis of variance, as is often recommended for cover counts (Steel and Torrie 1980).

Results

In 1995, at sites 1 and 3 (native prairie dominated by warm season grasses), percent cover of warm season grasses and desirable perennials was higher in the ungrazed plots than in the grazed plots, although the difference was statistically significant only at site 1 (Table 1). Likewise, for undesirable composites and undesirable perennials (mostly composites), percent cover was lower in the grazed plots when compared to the ungrazed plots at sites 1 and 3. However, at sites 2 and 6 (overgrazed and replanted prairie, respectively), these 4 vegetative categories were not different in the grazed and ungrazed plots.

In the comparison of percent cover in 1994 and 1995, there were no significant results within grazing treatments that were consistent across sites 1 and 3. However, there were one-year trends in percent cover between grazing treatments that were consistent across the 2 sites and that will require further statistical analysis to determine if they are significant or not. For example, undesirable composites, undesirable perennials and warm season grasses decreased in percent cover from 1994 to 1995 in the grazed plots but increased in the ungrazed plots at both sites [editor's note - later analysis showed that these trends were not significant].

Discussion

The comparison of grazed and ungrazed plots at sites 1 and 3 in 1995 show that the cattle are trampling and/or grazing undesired species as well as desirable species, which is a positive effect. It is not understood why this effect did not occur at sites 2 and 6, which were poorer quality prairie than sites 1 and 3. Comparison of 1994 data with those of 1995 show similar trends in the plots at both sites 1 and 3. The increase in the ungrazed plots is simply due to lack of grazing.

It is tempting to conclude that these desired effects are specifically the results of our rotational grazing regime. However, it is possible that the results would have been similar under a conventional management scheme, especially in the first year of grazing.

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Table 1. Mean percent cover ± standard deviation (n=3) for only vegetative categories with significant differences between grazed and ungrazed plots at 2 sites in the rotationally grazed Sunshine Farm pasture in 1995. See text for description of sites

	Site 1			Site 3		
Vegetative category	grazed	ungrazed		grazed	ungrazed	
Warm season grasses	83	93	*	95	109	ns
	8.3	6.6		8.4	10	
Desirable perennials	85	102	*	105	106	ns
	8.4	6.7		10	15	
Undesirable composites	5.9	15	**	19	31	*
	1.0	0.5		8.6	13	
Undesirable perennials	7.1	16	*	25	42	*
	0.6	2.1		12	20	

*,P<0.05 **,P<0.01, ns, not significant

1995 Cropping Systems on the Sunshine Farm

Doug Walton

Abstract

Strip-cropping research at The Land Institute's Sunshine Farm compares crop yields for narrow strip intercrops with Saline County dryland averages. Other major experiments have checked for overyielding between the inner and outer rows of two adjacent annuals, milo and soybeans, in narrow strips and also between a perennial legume, Illinois bundleflower (IBF), in a narrow strip adjacent to a strip of milo. Sunshine Farm crop yields have generally fallen well within one standard deviation of mean yields for conventional dryland crops in Saline County, except for alfalfa and sunflowers. Alfalfa has been difficult to establish on a consistent year to year basis, and sunflowers had serious pest damages by migrating blackbirds and head-clipping weevils. No differences were found between inner and outer rows in either milo or soybeans. There was also no difference between inner and outer rows of IBF; however, within the milo adjacent to IBF, inner rows yielded significantly higher than outer rows. This underyielding is likely due to an observed suppression of the milo by the adjacent IBF plants.

Introduction

Plant communities in nature, and particularly in prairie ecosystems, feature high species diversity and low soil loss, among many other traits (Piper and Soule, 1992). Industrialized agriculture has simplified native ecosystems to fields of individual plant species. Multiple cropping systems, however, attempt to restore to the field some of the complexity found in nature. Multi-species methods have likely been in use since the earliest stages in the evolution of agriculture and crop domestication (Plucknett and Smith, 1986). The growing of two or more crops simultaneously in the same field, or intercropping, is still widespread throughout many tropical countries (Vandermeer, 1990). The possible benefits from such systems include lowered soil erosion, increased biological diversity, greater pest and disease management as well as maintained or increased crop yields (Piper and Soule, 1992; Francis et. al., 1986).

We have been monitoring the crop yields in the rotations on the Sunshine Farm and comparing them to the dryland averages for Saline County. I will discuss why some crops have not yielded well in the rotations.

Strip cropping research at the Sunshine Farm involves two different experiments, both in their second field year of measuring yielding patterns between adjacent strips of current and potential crops. The first experiment involves two annual crops, milo and soybeans, grown in sixteen pairs of adjacent strips throughout the farm. The second experiment entails the introduction of a Land Institute perennial legume candidate, Illinois bundleflower (IBF) [Desmanthus illinoensis], into a single 4-row strip next to a milo strip. This project represents our earliest attempt to assess the feasibility of integrating perennial grains into a farming system. The objective is to determine whether perennials should ultimately be grown within separate fields or as part of a strip cropping regime on a sunshine farm of the future.

In both experiments, we measured for overyielding by comparing seed yields from the inner and outer rows of each adjacent crop, with inner rows resembling a monoculture and the outer rows, a polyculture of the two crops.

Table 1.
1993-1995 Sunshine Farm crop yields and Saline County dryland averages

Crops	Sunshine Farm 1993	1994	1995	Saline Co. dryland[a] {mean ± std. dev.}	Years averaged
Grain sorghum (bu./acre)	38	72	36	47 ± 19	1980-1993
Soybeans (bu./acre)	14	32	20	24 ± 11	1984-1993
Wheat (bu./acre)	---	27	25	30 ± 8	1980-1993
Oats (bu./acre)	35	39	53 71[c]	44 ± 11[b]	1988-1993
Sunflowers (lbs./acre)	---	703	319	977 ± 222[b]	1990-1993
Alfalfa (tons/acre)	1.2	1.7	1.8	3.2 ± 1.5	1980-1993
Forage sorghum (tons/acre)	---	9.1	3.1	3.4 ± 1.5	1980-1984

a) Kansas Board of Agriculture 1980-1993.
b) Average for central Kansas district.
c) This was the yield from 13 strips of volunteer oats.

Materials and Methods

The Sunshine Farm cropping system includes 50 acres of level, non-irrigated bottom-land, composed of Cozad silt loam soils (Fluventic Haplustolls). The average annual precipitation is 29 in.. Approximately 39 in. fell from October 1,1994 through September, 1995, with 27" of rain between May and August, 1995. Prior to the initial start-up of the farm, winter wheat had been grown in the north half the cropland for 4 years, and alfalfa had been grown in the south half for 4 years.

Crop yields and losses

Grain yields for entire crops were determined either by weigh wagon or weight at the elevator. Hay yields were computed from the number of harvested bales and the average weight of 10 bales. Sunflower losses were censused on November 3, prior to harvesting, at the middle and west and east ends of each strip. The percent loss to migratory blackbirds was estimated by fifths in each of 15 heads at each census site. Fifty plants were censused at each site for complete head loss, due either to the head-clipping weevil or to stalk lodging.

Annual strip-cropping

Except for the perennial/annual interface experiment, the Sunshine Farm crops are grown in two five-year crop rotations used in both the north and south halves of the farm. One rotation is milo, soybeans, oats, sunflowers and cowpeas, while the other is milo, soybeans, oats, alfalfa and alfalfa again. These crops are grown in 120 adjacent strips, repeating every five strips, with each strip cycling through the rotation. The strips are 13 ft. 4 in. wide with 40 in. rows all running east/west and ranging from 560 ft. to 1240 ft. in length. All of the milo strips on both halves of the farm contained the same variety of milo, while two varieties of soybeans were planted on the north half. Five strips were planted in Pioneer variety 9391, which is slightly later maturing and has a slightly higher disease resistance than variety 9362, which was planted in three of the strips. Within each pair of milo and soybean strips, seeds were hand collected from the inner and outer rows of both crops within a sample area five ft. long. The sample areas were chosen based on good crop cover to avoid planting gaps.

Perennial/annual strip-cropping

For this experiment, two 900 ft. strips were utilized on the north half of the farm. One strip contained three accessions of Illinois bundleflower which were planted during April, 1994 in a split-block design, with three blocks of each of the three accessions. Accession 318 is known to be high yielding and was collected from Ellsworth County, Kansas. Accessions 1143 and 1131 are both non-shattering varieties collected in Arkansas and Oklahoma respectively. The 318 and 1143 also tend to grow in a somewhat prostrate manner. Within each of the nine 50 ft. plots, three 5 ft. subplots were delineated for hand-harvesting. IBF seeds were harvested during August and September of 1995. The milo was planted in late June in a former soybean strip and was hand-harvested next to each IBF subplot in mid-October.

In both experiments mean seed yields from the inner and outer rows were compared by analysis of variance (ANOVA) using GLM (SYSTAT). Where significant differences were found, a Land Equivalent Ratio (LER) was calculated for overyielding.

Table 2.
Yield loss for 1995 organic sunflowers on the Sunshine Farm

Strip	Fraction seed loss per head by blackbirds mean ± d. (n=15)	Complete head loss: Fraction of 50 plants mean ± d. (n=3)	Percent loss due to: Headclipping weevil	Percent loss due to: Stalk lodged by wind (stem rot, stem weevil)
S0-1	0.49 ± 0.23	0.49 ± 0.17	89	11
S1-1	0.48 ± 0.22	0.27 ± 0.17	66	34
S2-1	0.45 ± 0.23	0.29 ± 0.09	68	32
N6-1	0.60 ± 0.23	0.24 ± 0.21	97	3
N7-1	0.41 ± 0.19	0.33 ± 0.08	80	20
N9-1	0.41 ± 0.16	0.20 ± 0.28	87	13
N10-1	0.41 ± 0.18	0.26 ± 0.04	82	18
N11-1	0.40 ± 0.21	0.15 ± 0.04	96	4
grand mean	0.46	0.28	83	17

Actual yield = 319 lbs./acre

$$\text{Potential yield} = \frac{\text{Actual}}{(1\text{-bird loss})\ (1\text{-complete head loss})} = 820 \text{ lbs./acre}$$

Results

Crop yields and losses

Organic crop yields on the Sunshine Farm during 1993-1995 have generally fallen well within one standard deviation of mean yields for conventional dryland crops in Saline County (Table 1). Two exceptions have been alfalfa and sunflowers, the problems to be discussed later. The systematic survey of sunflower losses found an average of 46% seed loss per head, due to migrating blackbirds, while 28% of the plants were completely missing their heads, mostly due to the head-clipping weevil (Table 2).

Annual strip-cropping

No significant difference (P<0.05) was found between the inner and outer rows of any of the adjacent strips (Table 3). This was the same outcome when looking for a row effect within either variety of soybean (Table 4), as well as when checking for a row effect within the two crop rotations (Table 5). Further analysis, not shown on the tables, also indicated no variety or rotation effect on either crop.

Annual / Perennial Interface

T-tests found no significant differences (P<0.05) between inner and outer rows of IBF within any of the three accessions (Table 6). However, we did find a highly significant difference (P<0.001) between the inner and outer rows of IBF within all three accessions (Table 6). Unfortunately, this row effect is in the direction of underyielding, with much lower yields in the outer row of milo relative to the inner row, within each accession. This is evidenced by the milo's minimal contribution to the LER value within each accession (Table 6). Further analysis, not shown on Table 6, found that the inner and outer rows of accession 1143 were significantly higher than the respective rows of the other two accessions.

Disussion

Crop yields and losses

Alfalfa yields have been low because we have been establishing it on an unorthodox schedule. Usually, farmers in the Great Plains raise alfalfa for 4 or more years. This allows them flexibility to start a new alfalfa field elsewhere on the farm when they judge that there is adequate soil moisture in a given year and that the weather will allow them sufficient time to prepare the good seedbed needed for this small-seeded crop. Although a few farmers have grown alfalfa on a shorter rotation (e.g., Smolik et al. 1995), we are finding it difficult to get good stand establishment every year in a rotation because the necessary soil moisture and the time to prepare a seedbed is not always available.

Organic sunflowers are proving difficult to raise. The main reason is that the ancestor of domestic sunflowers, the weedy annual sunflower, is common in the Great Plains. Botanists recognize them as the same species, *Helianthus annuus*, and they have the same insect and diseases. Thus, sunflowers are being grown where its insect pests and diseases were already prevalent, and as a result, sunflowers have more insect and disease problems than other major crops (Al Schneider, production specialist, NDSU). All the other major grain crops in the U.S. come from other countries, which is one reason they do better here as organic crops, than do sunflowers. In fact, the breeding of the large, one-headed sunflowers that we see in our fields and gardens occurred in Russia and was most likely aided by the weedy *Helianthus annuus* not being a native species there (incidentally, sunflowers are the only native plant of the U.S. to become a major world-wide food source).

In conventional production, sunflowers are planted in mid-late May, but in organic production, planting is delayed until early July to avoid damage by the sunflower head moth, a major sunflower pest. However, this later maturity has left the crop vulnerable to migrating blackbirds in 1994 and 1995, perhaps aggravated by the farm being only 2 miles from Salina and the common observation that migrant blackbirds spend much time in the vicinity of cities. Since Dr. Jerry Wilde (KSU, entomology) found fewer sunflower head moths in our crop strips in 1994, our plan in 1995 was to plant in early June to avoid the blackbirds, but the cool, wet spring delayed planting until June 28, with subsequent damage by blackbirds in the fall. Another strategy to deter blackbirds might be to put up balloon scarecrows such as the one in the photograph of Fred Kirschenmann, a ND biodynamic/organic farmer, in the article on sustainable agriculture in the December 1995 issue of National Geographic. There is no simple biological control for sunflower head moth or head-clipping weevil, but the latter might be controlled by labor-intensive removal of fallen heads from the fields, which can contain the overwintering weevil eggs.

Conventional production of sunflowers has been successful because insecticides are used (no foliar fungicides have been registered for use in North America against sunflower diseases) and only small acreages have been planted thus far, compared to that for the major grain crops. As the sunflower acreage is increased in the future, the magnitude of infestation by insects and diseases will clearly increase and could possibly become serious enough to make organic production impossible.

Table 3. Seed yields (bu./ac.) {mean ±standard deviation (n=16)} of inner and outer rows of soybeans and milo in adjacent strips throughout the farm.

CROP	INNER ROW	OUTER ROW	
Soybeans	30.67 ± 7.45	32.56 ± 7.12	n.s.
Milo	67.30 ± 11.29	66.48 ± 12.18	n.s.

n.s.=not significant at 0.05 level by ANOVA for randomized complete block design.

Table 4. Seed yields (bu./ac.) {mean ± standard deviation (n=8)} of inner and outer rows of two soybean varieties and milo in adjacent strips on the north half of the farm.

	SOYBEAN VARIETY 9391			SOYBEAN VARIETY 9362		
CROP	Inner Row	Outer Row		Inner Row	Outer Row	
Soybeans	27.63 ± 6.54 (5)	29.48 ± 7.05 (5)	n.s.	28.07 ± 2.54 (3)	29.38 ± 6.40 (3)	n.s.
Milo	67.40 ± 9.20 (5)	66.99 ± 5.21 (5)	n.s.	56.07 ± 2.79 (3)	62.19 ± 20.11 (3)	n.s.

n.s.=not significant at 0.05 level by ANOVA for split-block design.

Table 5. Seed yields (bu./ac.) {mean ± standard deviation (n=4)} of inner and outer rows of soybeans and milo in adjacent strips for two crop rotations on the south half of the farm.

	ROTATION 1(a.)			ROTATION 2 (b.)		
CROP	Inner Row	Outer Row		Inner Row	Outer Row	
Soybeans	34.44 ± 10.13	39.54 ± 7.64	n.s.	32.66 ± 8.19	31.80 ± 3.05	n.s.
Milo	7.166 ± 16.73	69.78 ± 14.27	n.s.	71.25 ± 8.17	65.77 ± 14.06	n.s.

n.s.=not significant at 0.05 level by ANOVA for split-block design.
(a.) milo, soybeans, oats, sunflowers, cowpeas
(b.) milo, soybeans, oats, alfalfa, alfalfa

Table 6.
Seed yield (grams) {mean ± standard deviation (n=6)} of inner and outer rows of milo and three accessions of IBF in adjacent strips.

IBF Accessions:	318				1143				1131			
CROP	Inner Row	Outer Row		Outer/2 Inner	Inner Row	Outer Row		Outer/2 Inner	Inner Row	Outer Row		Outer/2 Inner
IBF	131.46 ± 31.64	154.13 ± 38.55	n.s.	.59	213.15 ± 34.67	266.72 ± 88.07	n.s.	.63	215.01 ± 52.19	201.99 ± 55.78	n.s.	.47
Milo	408.19 ± 123.19	118.90*** ± 106.83		.14	633.50 ± 85.85	386.47*** ± 100.10		.31	373.63 ± 66.97	108.79*** ± 67.47		.15
LER				.73				.94				.62

n.s .= not significant at 0.05 level;***;P.,≤ 001

$$LER = \frac{A_p}{A_m} + \frac{B_p}{B_m}$$

Annual strip-cropping

The absence of overyielding between the milo and soybean strips has no clear explanation. Weeds along strip interfaces could have reduced outer row yields, even prior to cultivation. This is a common problem found among other researchers and farmers using narrow strip intercrops. It is also plausible that the ridges of soil which have formed between the narrow strips may have caused seeds in the outer row to be planted at incorrect depths and thus reduced the germination rates in these rows. Gaps between plants of up to 10 ft. frequently occurred throughout all the crops on both halves of the farm. Whether or not this happened more frequently in outer rows is uncertain. This might be a topic requiring further analysis during the next crop year.

Perennial/annual strip-cropping

The underyielding in the milo was foreshadowed by field observations early in the milo's growth, when we had noticed that the IBF was physically overhanging and possibly crowding out some of the milo seedlings. A systematic survey on Aug. 22, two months after the milo was planted and two months prior to its harvest, indicated a noticeable stunting of milo in the outer rows adjacent to IBF accessions in all three blocks. This apparent suppression was more noticeable in the milo adjacent to accessions 318 and 1131 and less so in the milo next to accession 1143, as confirmed by the statistical analysis (Table 6). The survey also found that there was no noticeable stunting of outer row milo plants adjacent to Eastern gamagrass plots in any of the three blocks. This eliminates the possibility of a ridge effect between the two strips. The observed crowding effect might also be related to water competition between the IBF and milo. Water stress was evident in the stunted milo plants, as indicated by a "rolling," or curling up of the milo's leaf edges. This notion could be further studied through soil moisture analysis during future growing seasons.

The fact that the milo next to IBF accession 1143 yielded significantly higher, in both rows, than it did next to the other two accessions, is of interest (Table 6). It thus appears that not only were the outer rows of milo next to 318 and 1131 suppressed in some way, but that the inner rows next to these two accessions were also affected, relative to the inner row of milo adjacent to 1143. This accession effect might indicate a superior IBF variety for future plantings. However, in light of the negative row effect between milo and Illinois bundleflower, it is unlikely that these two plants would be grown together in narrow strips on a sunshine farm of the future.

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Annual Reports, Perennial Work

A board member says she is energized by the resilience of The Land Institute in its —she didn't call it doggedness, but we can— doggedness. It's romantic to think our perennial prairie had infused us with dogged habits: not giving in readily, persistence, stubbornness to hang on through droughts and deluges.

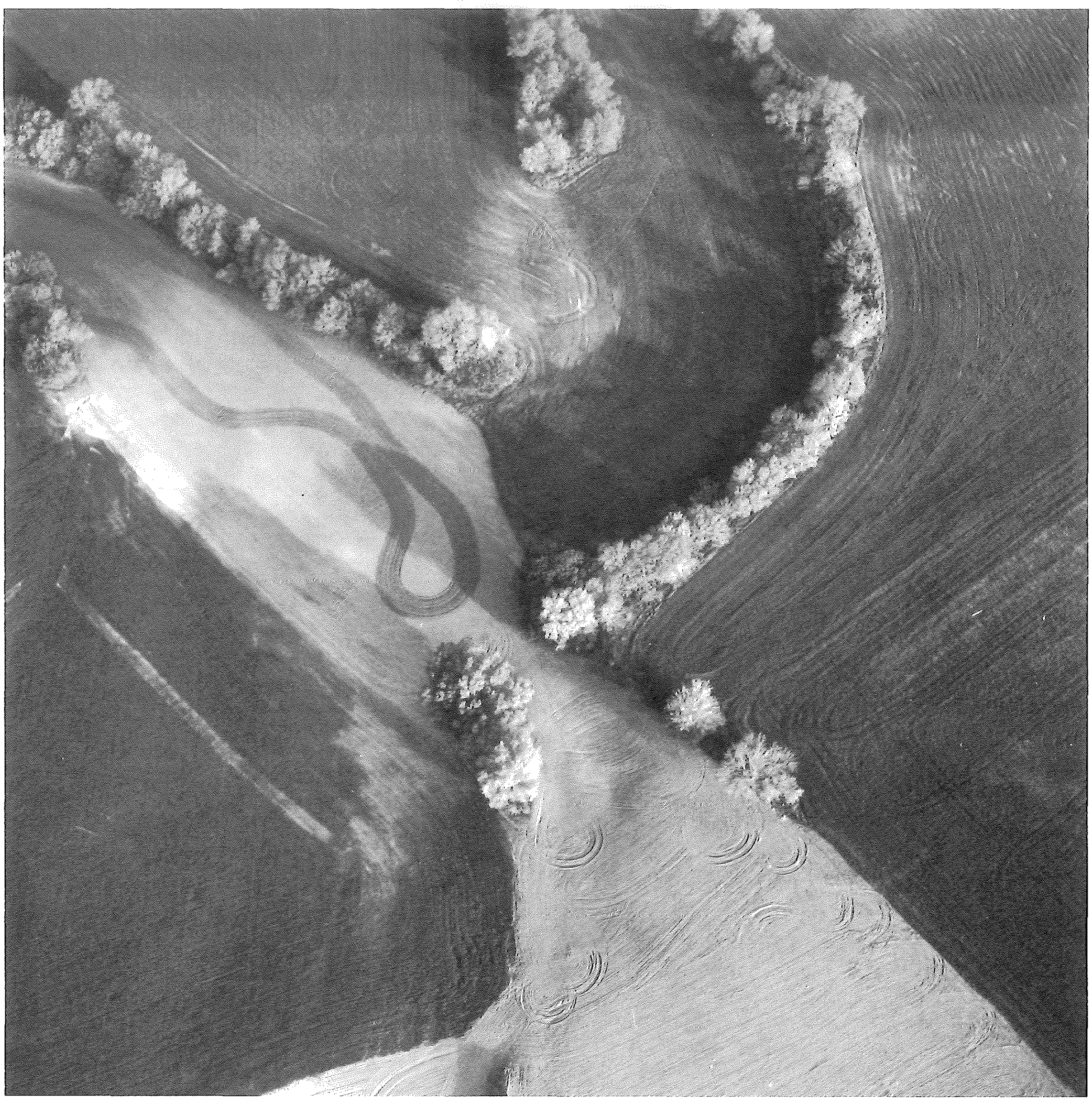
Yet Friends of The Land have a right to know that their gifts accomplish something beyond persistent personality — some substance, please. Annual reports feature goals accomplished, seldom tell of the goals unreached, and nearly always remain silent on failures.

Following publication of a set of scientific papers, we declared that experimental results had removed some theoretical obstacles to the feasibility of Natural Systems Agriculture. It now appears that with enough dogged research and development, farms of mixed perennials could grow grains to feed humans. There is promise that when humankind no longer ignores the biological costs of chemical contamination, dependency on off-farm energy, and soil erosion, perennial systems will be a better bargain than current farming methods. So we have attained some goals: positive answers to several of the basic biological questions that guide our research.

The goal for the next research phase is to dramatically increase our staff. Our low-budget history of small yearly increments in research results is insufficient to the urgency of developing working perennial agriculture. Each year's soil erosion squanders irreplaceable ecological capital, soil which will be crucial to meeting ever-increasing demands for food. Our attempt to gain support from Congress and the US Department of Agriculture to address this fundamental problem of agriculture at the roots ultimately fell short, a failure from which we learned much. We have been turned down by some funders we had thought might provide major backing — this falls into the category of goals not yet reached. Dogged, we continue.

We call for a group of talented and dedicated researchers to work together under the canopy of ecology, people intimately involved in each others' disciplines, making this "marriage" in which ecology applies itself to practical agronomy and agronomy incorporates ecology. Eminent scientists have generously offered to serve on an advisory team to help think through our scientific questions and to lend their credibility and criticism to our assertions as we reach for major funding. Our aim is to build a larger research team at The Land Institute, linked to leading scholars and their graduate students across the country.

The innovation that you support at The Land Institute is more than a way to provide food without undermining its source. It incorporates the thoughts of countless good people struggling to act in the world as a part of its natural processes, rather than as dumb subjects of economic constructs. We'll probably never know all the sources and influences of this philosophy, so it may not be accounted in an Annual Report; yet it may be the most important thing we could accomplish. What we always know is that you, perennial readers of the *Land Report,* make it possible for us to expect that in our children's lifetimes there could be a new agriculture which will serve them and the land as well as both deserve.



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