

The Land Report

Perennial Wheat



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Cover: Scott Bontz, *Perennial wheat bred at Washington State University*

Back Cover: David Van Tassel, *Photographing perennial wheat for the cover*

Above: Christopher Picone, *Upright prairie coneflower, Ratibida columnifera*



Our Mission Statement

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.

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A Wheat to Hold Landscape Together: Breeding in Perennialism from Wild Grass

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The benefits of perennial wheat will be many: reduced soil erosion, reduced planting and tillage costs, and efficient water use. It has great potential for achieving a natural systems agriculture. A wheat that needs to be planted only once every three or four years would substantially reduce fuel, equipment, and seed costs. Not having to disturb the soil by planting will cut weed problems and hugely benefit wildlife, especially birds.

Perennial grain, and wheat in particular, is not a new idea. Russian scientists established large perennial wheat breeding programs around 1920. At the USDA from 1923 to 1935, W. J. Sando produced hybrids between wheat and the wild perennial wheatgrasses, *Agropyron*. Many of the progeny were perennials. In the 1940s, Coit Suneson and Warren Pope at the University of California at Davis specifically bred perennial wheat and found types that yielded to within 70 percent of the best annual wheats of the time. They also identified types resistant to stripe, leaf, and stem rust, and to various root rots. Ultimately though, the work in the United States was abandoned because of what was perceived as unacceptable yields and poor end-use quality.

Early efforts to develop perennial wheat were designed to reduce planting costs rather than soil erosion. More recent efforts have been directed at soil conservation.

In 1987, Jurgan Schultz-Schaeffer and Suzanne Haller at Montana State University released a perennial wheat line derived from Sando's crosses that has excellent survivability but produces small seed and is genetically unstable. Intermediate wheatgrass, *Agropyron intermedium*, a perennial species often crossed with wheat to develop perennial wheat, has been considered as a potential crop itself. Peggy Wagoner, of the Rodale Institute, found collections of *A. intermedium* with some croplike traits, but none had yields close to those of wheat.

The main source of perennial habit in wheat has been the wheatgrasses. These species have been used because of their wide adaptability, survivability, ease of crossing, disease resistance, yield potential, and threshability. We have made hundreds of crosses over the past several years between various collections of *Agropyron* and the best winter wheats at Washington State University. We also have in our germplasm collection hundreds of perennial amphiploids, lines that contain the entire genomes of both wheat and *Agropyron*, produced over the years by diverse people, including Sando and Suneson.



In general, previous attempts at perennial wheat were based on durum or spring wheat crosses to *Agropyron*. The goal in all cases was a hard red wheat. Hard red wheat has the high protein content needed for strong dough.

Market class is also an important consideration. Should a perennial cultivar be sold as bread wheat, noodle wheat, club wheat, soft wheat or feed wheat? Should the seed be red, white or blue? Yes, blue! Several of the perennial wheats produced in the 1940s had blue seeds. If the goal is to produce animal feed or another nontraditional wheat product, the blue seed color would be an easy way to identify perennial wheat and keep it from being mixed in with other types.

At this point we don't know which market class would be most appropriate for perennial wheat, but all classes are being considered, and the Western Wheat Quality Laboratory is already testing some lines. The easiest quality requirements to meet would be those of soft white wheat, which is used in pastry, or feed wheat. For sale through traditional markets, the main goal in breeding a perennial is to get wheat, not something "wheat-like." Our initial aim is to develop perennials that can be planted alongside and harvested with annuals. Growers currently seek the lower-yielding perennials for patches where erosion is worst. For the longer term, wheat designed to be

Above: Wheat breeder Stephen Jones, left, and plant pathologist Tim Murray in the wheat greenhouse

grown in a perennial polyculture would not have to bear such a strong resemblance to annual wheat. But it would need to be palatable and nutritious.

Although development and introduction of acceptable perennial wheat is not a new idea, none is grown commercially in the United States. Here are six reasons why past efforts failed:

Problems

1. *Unacceptable yields.* This is an overall result. All testing has been done in otherwise traditional wheat-growing systems. Perhaps there are situations where lower yield is acceptable.
2. *Survivability.* When perennial wheat fails to survive, it may be due to disease or some other stress. In other cases, it may be due to genetic instability.
3. *Genetics.* Poor choice of wheat parents. No modern cultivars. Nothing is known about genetic control of perennial habit.
4. *End-use quality.* Poor bread wheat quality. But no work has been done on soft wheat potential. Soft wheat quality requirements are much less strict than hard wheat.
5. *Cropping system management.* Perennial wheat will have different planting, fertilizing, weeding, and harvesting requirements. Very little work has been done, and none in polyculture.
6. *Education.* What is erosion reduction worth? Do we compare high production yield vs. perennial yield, or zero yield (erosion gullies or no stand) vs. perennial yield? Or, overall low or variable yield potential vs. sustained yield of perennials?

The Land Institute and WSU are working together on these problems.

Solutions

1. *Increase yield of perennial wheat by selecting the highest yielding individuals.* Perennial wheat lines are being tested in the field and greenhouse. Those now in the field are allowed to regenerate each year. New perennial lines are produced each year in separate projects. These new lines all are developed from crosses with the modern, high-yielding, winter wheat breeding lines. There are plots in farmer's fields in two locations as well. All trials are small-scale plots usually of single rows.

A true perennial wheat must regrow from the crown and produce a crop for several consecutive seasons. Some previous efforts at breeding perennials have failed simply because the wheat did not meet this basic requirement.

Another problem has been environmental. Perennial wheats do not do well in areas with cool, wet summers, which may not trigger the necessary summer dormancy. The main wheat growing areas of the country, however, have hot and dry summers, the best environment to induce dormancy.

Several programs have been successful in breeding perennial wheat. In most cases the breeding lines were

eventually abandoned because they did not prove profitable, primarily due to the annual decline in yield. Suneson produced several perennial wheats in the 1940s and 1950s. He determined that the main cause of yield decline was the loss of plants over the years. Survivability is a major selection criterion in our breeding program.

Suneson produced true perennials that yielded 70 percent of the best annual wheats for four years in a row. Fifty years ago, conservation of the soil was rarely considered in economic terms, so a 30 percent reduction in yield was viewed as unacceptable. Consequently these breeding lines were abandoned. Would a 70 percent yield be considered high enough today on marginal soils? Probably so. Is it possible to reach this same yield level when the comparisons are made to our modern cultivars over four years? It probably is, and one of our goals is to find out. Much of Suneson's collection has been lost. However, we have requested and received all of the existing lines, and they are growing in our fields and greenhouses.

2. *Genetic control and stability of perennial habit.* We know that most wheat-wheatgrass hybrids are perennial. These lines have all the wheat chromosomes and at least one *Agropyron* genome, for a total of 56 or more chromosomes. In the field we have lines derived from these hybrids with 42 to 56 chromosomes. These lines and the hundreds of additional lines go through genetic screening and characterization in the greenhouse and lab before going to the field. We use a microscope to determine the number of wheat and *Agropyron* chromosomes in each perennial line.

This is good old-fashioned genetics. There is no genetic transformation or other technique associated with genetic engineering. All of the genetic transfers that we use are sexual. That is, they involve pollen fertilizing eggs. We do cross species boundaries, within the grass family, but we do it in a way that has been done by humans for more than 100 years and has occurred in evolution for millions of years.

The result of our genetic work will be determination of the minimum number of chromosomes needed for the perennialism, and identification of specific chromosomes for that trait from *Agropyron* or other species.

When looking genetically at a trait such as regrowth, what causes the perennialism must be explained. The Land Institute and WSU are doing this work. It involves postdoctoral fellows, graduate students, undergraduates, and staff scientists. They seek when and where within the plant the decision to die is made. This is one of the most basic and powerful questions in all of biology. Why, when, and how do annual plants decide to die? Why, when, and how do perennial plants decide to live? We have the germplasm to figure it out and we are well on our way.

3. *Main disease pressures and germplasm resistance.* Graduate students are evaluating resistance to all prevalent wheat diseases. The danger of perennial wheat becoming a reservoir for diseases is very real. The bright spot is that



the wild species used for transfer of perennialism to wheat are also excellent sources of genetic resistance to virtually all of the wheat diseases. The initial goal in our work was to transfer valuable resistance genes from the wild wheats into our annual wheat varieties. The key is to maintain disease pressure during breeding. The genes are there; we just need to be sure that they get transferred from parents to offspring.

4. *End-use quality.* Early results from USDA quality labs show that the best use of our plants is as soft wheat. Work continues on all market classes.

5. *Management techniques.* Graduate students are investigating cropping systems for perennial wheat with minimum input and maximum erosion reduction, wildlife cover, and general crop health. This involves weed control, spring planting vs. fall planting, initiation of tillering, planting density, fertility, and straw removal. This is a new type of crop, and we need to learn how to grow it not just by itself but also in dynamic mixtures, and in blends of similar and diverse species. This work is being performed not only on the perennial wheats themselves but also on the wild wheats and distant relatives being used as parents.

6. *Education.* If we believe there are problems with conventional agriculture, then it is our responsibility to tell the general public why. The minimum that we can do is write letters to the editor and call broadcast media with praise or criticism, volunteer to give guest lectures, and reach government representatives. It might sound obvious and in a way silly, but it can work. This must be done so

farming and non-farming groups can understand. This is not always easy. What is the soil worth? What is wildlife habitat worth? What about clean air and water?

Unfortunately, we are often asked to put prices on these things. This is a prelude to tradeoffs and bargaining, and they set local, state, and national policies. No price can be placed on these and the other natural facets that we appreciate and require, and there should be no compromise. We need to convey that message as well.

Some of the main breeding challenges for perennial wheat will be to ensure early maturity and good threshability, and to overcome annual yield decline. But breeding is only one requirement of successfully introducing this crop. Much work will be needed on growing it. How often will it need to be replanted? What about fertilization and weed control? Which diseases will be most important? Will dormant plants escape diseases such as snow mold? What are the economic and environmental thresholds in this production system, and how do we measure them? If they are white wheats, can a grower harvest and mix the seed with traditional soft whites and sell without a price penalty? These are but a few of the questions that need to be answered.

Obvious alternatives to perennials such as no-till and direct seeding are techniques that are flawed, even when well-intentioned. The resurgence of the no-till movement is based on heavy use of herbicides. Replacing one system based on massive chemical inputs with another of similar requirements is unacceptable as well as counterproductive.

We view the ultimate incarnation of a low-till/no-till system as eliminating the planting process entirely. We also maintain a long-term vision of perennial polyculture as described in natural systems agriculture. The ideal result of our project will be the introduction of a totally new type of wheat.

Above: Christopher Picone,
the rolling wheat hills of
the Palouse in Washington,
1999



Wheat as Part of Soil Community: A History of Cooperation with Fungi

Christopher Picone

Incorporating wheat into Natural Systems Agriculture will require many types of research. The obvious first step is to develop perennial varieties. After that, we must understand how such a perennial grain will function in the agro-ecosystem, with its myriad interactions of pests, competitors, and mutualists. Here I will briefly discuss the history wheat has had with one group of mutualists, mycorrhizal fungi.

Mycorrhizae are soil fungi that benefit their plant hosts. They are best known as “biofertilizers” that absorb mineral nutrients from the soil and release them to plant roots. In addition, they protect roots against pathogens, such as other fungi and nematodes. And, perhaps most importantly, they bind soil particles into aggregates. They are a primary agent for improving soil structure. In return for these benefits, plants feed mycorrhizae carbohydrates, or sugars, from photosynthesis.

Some 80 to 90 percent of all plant species form some kind of mycorrhizal association. Mycorrhizae are probably the second-most abundant mutualists on Earth, next to the eukaryotic cell itself, with its mitochondria and chloroplasts derived from primitive bacteria. The plants that do not require mycorrhizae include many agricultural weeds, such as members of the Brassicaceae (mustards), Chenopodiaceae (e.g., lambsquarters), Amarathaceae (e.g., pigweed), Polygonaceae (e.g., dock), and Cyperaceae (sedges).

Is it a coincidence that so many non-mycorrhizal plants are agricultural weeds? Probably not. Agriculture

has traditionally created two conditions ideal for non-mycorrhizal plants. First, soil tillage breaks up mycorrhizal fungi and lowers their abundance. Plants that depend on the fungi for soil nutrients are put at a disadvantage. Second, fertilization adds free nutrients to the soil. With excess nutrients, non-mycorrhizal plants, which do not pay the carbohydrate cost for mycorrhizae, have an advantage over plants that are feeding fungi. Annual weeds love nothing better than a tilled soil doused with chemical fertilizers.

With this background, consider the case of wheat. Wheat is a cool-season grass, and this group typically is less dependent on mycorrhizae than other plant groups.¹ That is not to say cool-season grasses do not associate with the fungi — the roots of most species are typically infected — but they do not benefit much. Many species of cool-season grasses can grow equally well in soil with or without mycorrhizae. Some wild ancestors of modern wheat such as emmer and durum don’t need mycorrhizae. Others such as einkorn are quite dependent.

From this ancestry of mixed dependency, agriculture selected the modern species of bread wheat, *Triticum aestivum*. For several thousand years of selection, humans *increased* the mycorrhizal dependence of wheat. Old varieties and landraces of *T. aestivum* developed before 1950 are more dependent on mycorrhizal fungi than their wild ancestors. These dependent varieties include Turkey red, purple straw, and Mediterranean, as well as most Asian landraces. On average, their growth increases about 87 percent in soil with mycorrhizae. Low-input traditional

POST CARD

This space may be used for Correspondence.

Address only.



Wakarusa Kans.

Dear Friend,

How does this
look for wheat the
wheat is not doing
good here this year
it is too dry. I don't
think I will stay here
long to much wind & dust.
your friend Harry.

Mr. J. F. Geisler
Ellwood Co
Pa.

A post to Pennsylvania on
Kansas and its wheat—
the mark isn't clear but
might be 1908.

agriculture had selected plants that could produce well only as members of a soil community. Wheat relied largely on soil microbes to obtain nutrients.

Then came industrial agriculture and the Green Revolution. With the use of chemical fertilizers, modern wheat varieties were selected for their ability to yield well in nutrient-rich soil. Like the non-mycorrhizal weeds described above, wheat became less dependent on mycorrhizae. With high soil fertility, a plant can produce more by sending less sugar to root fungi and more to its grain. By selecting plants that yield best under high soil fertility, we increased yields at the expense of mycorrhizal mutualism. Production by wheat varieties developed after 1950 increases only about 34 percent with mycorrhizae, and half of the varieties tested do not respond to the fungi at all. We have isolated plants from their soil community and created botanical drug addicts, plants dependent on their fertilizer "fix."

One of the goals of Natural Systems Agriculture is to incorporate the natural systems of soil fertility into farming. One of the challenges to breeding perennial wheat will be to ensure that it can participate as a member of a healthy, interdependent soil community. It must make full use of the soil fungi and bacteria that can help it obtain mineral nutrients. This should not be difficult if we select varieties in a context of the ideal agro-ecosystem we envision for wheat: a perennial polyculture that receives no chemical fertilizers or pesticides.

A final note inspired by my experiments on mycorrhizal fungi at The Land Institute: living in community has its costs. I am growing sorghum in pots of soil that have mycorrhizae from native prairie and agricultural treatments as well as in pots of soil without fungi. Initially, the plants in sterile soil grow faster than the plants in living soil. The plants in living soil pay the price for joining the soil community because they provide carbohydrates to the fungi. The plants in sterile soil do

not have that initial cost, so they grow exceptionally fast. However, with time soil nutrients start to run out. The plants in sterile soil now have trouble finding enough minerals, but the mycorrhizal plants continue to grow thanks to the soil community in which they have invested.

In the same way, our human communities and networks cost us. We can all be much more successful in the short term by approaching the world as individuals: by putting the self first, by stepping on our neighbors, by putting our economic success ahead of our families, etc. Short-term gains are best accrued by not investing in the communities around us. But who will keep growing when the "soil nutrients" run out? Who will succeed when the crises come, as they always do? Those who have invested in their community.

I know it can be dangerous to take moral lessons from nature, but I think the plants and fungi are onto something here.

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¹In contrast, warm-season grasses are very dependent on mycorrhizae. Many species grow only if fungi are present.

To Die or Not To Die

David Van Tassel, Andrea Yoder Graber, Doug Lammer

Given the merits of perennial wheat, why are researchers from The Land Institute and Washington State University scrutinizing the biology of annual wheat? The answer is that no one seems to know what makes the biological difference between the two life cycles.

In some other groups of plants with both perennial and annual species, the perennials have some obvious differences, such as being woody or forming underground storage structures — tubers, rhizomes, and fleshy tap roots. Perennial and annual wheat-related plants, however, appear almost identical. If being a perennial involves no major changes in the plant's form and growth, how do the perennials manage to survive the winter? Conversely, why can't — or don't — annuals keep the option of regrowing in the spring? These questions are curiously new. Wheat has been studied in thousands of scientific experiments, but no one seems to have asked, "Why does the plant choose to die?" Or the more practical question, "When and how does it make this developmental decision?"

The first question, "Why die?", can be asked about all annual plants. Plant taxonomists agree that woody, treelike plants are the original seed plants, from which non-woody plants (like grasses) and annual plants later evolved. Perennial plants still dominate most of Earth's natural systems. There are many groups of plants that contain both annuals and perennials, suggesting that the annual growth habit has arisen independently many times. What is it about being an annual that could give a plant an advantage over closely related perennial types? The most common answer is that annuals can invest more energy and nutrients into seeds and fruits if they don't have long-lived roots, underground stems, or woody trunks to invest in. However, there are many perennials — mainly fruit and nut trees — that produce just as much seed and fruit per acre as annuals. The investment tradeoff answer doesn't seem like the only explanation. Maybe there are other costs of perennialism that we have not found. For example, perhaps annualism helps a plant population escape from diseases or parasites that plague perennials. Asking these questions will help us understand what constraints we might face in breeding high-yielding perennial grains.

The second question, "How and when do annuals decide to die?", must be asked separately for each plant group. In the case of wheat, one hypothesis is that annual kernels produce a death hormone that travels to the rest of the plant and tells it to die. Perennial wheat plants either do not produce this hormone or they do not respond to it. We have been conducting simple experiments to test this hypothesis. For example, we cut the developing seed heads off of groups of wheat plants at different stages of development. Some heads are removed as soon as they appear. Others are removed when they release their pollen, when the seed begins to form, when the seed is soft, and when the seed is fully mature.

If the death hormone hypothesis were correct, plants would live indefinitely if their heads were cut off soon enough. Instead, we saw that removing young heads brought death in a few weeks. Cutting promoted branching from the base, just as trimming a scraggly bush promotes branching and thicker foliage. The new tillers seemed to prolong the plant's life, but most of the tillers fail to reach full size, either dying prematurely or forming tiny heads when only a few inches tall. Removing the heads seemed to stimulate branching, but not to substantially alter the decision of the whole plant to die.

Is the plant simply running out of food, having invested so much in the kernels? This explanation does not explain why the new, green tillers, which can supply their own food by photosynthesis, do not seem able to grow normally. We wondered if the annual plants' root systems cease growing and cannot support new stems and leaves. However, a close look showed that each tiller, including new ones, produced its own root system.

Could it be that the annual wheat plant builds up toxic waste?

Does a "cellular clock" tick down more quickly in annuals than in perennials to eventually override the rejuvenating effect of clipping off the heads?

It is important to answer these questions because the answers could help speed the breeding of perennial crops. At the moment, the only thing breeders can do to distinguish between annual and perennial wheats is to put the plants in the ground and select those that regrow year after year. If we understood this phenomenon, plants might be screened directly in the laboratory, for example, by testing plants directly for levels of a "death hormone."

Knowing the biology of wheat annualism and perennialism will help us estimate how many genes are involved and where they are on the chromosomes. That will help in breeding out the undesirable genes.

In situations like this, where new genes have been introduced to wheat from a wild relative, eliminating undesirable wild genes can be more time consuming than obtaining desired genes like perennialism.

Is it suicide? Starvation? Poisoning? The verdict is still out on the case of these plants that look just like perennials but choose to die instead.

Excerpts from *A Short Season: Story of a Montana Childhood*

Don and Ann Morehead

The Ranch

Stretched below the jutting peaks of the Rockies, the rich grazing lands on the western half of the Blackfoot Reservation and the large federal tracts bordering Glacier National Park make ideal sheep country. Gentle hills mold the land where flat-topped, rock-bordered buttes rise off the plains like giant altars. Long before white settlers came, the Blackfeet, without horses or guns, found in these natural ledges, or *piskans* as they called them, perfect stages from which to stampede the buffalo. Sweeping between the buttes lie ancient glacial lakebeds, their borders outlined by steep ridges. These glacial beds grow the thick bunch and buffalo grasses that grazed the sheep and the migrating herds of elk, antelope, and buffalo before them.

The River

Late in the spring, the beavers cut the birches and willows that grow along the river to repair their dams and houses from the ravages of winter ice and mountain runoff. Their cousins, the muskrats, live up the steep banks in narrow tunnels hidden by chokecherry and gooseberry bushes. In early summer, the receding river supplies the mud swallows need to build their nests and opens access to fishermen and swimmers along its banks. Honkers and ducks fleeing the early autumn frosts farther north stop over in their migration about the time the rabbits' fur turns white. My father hunted both. When icy edges narrowed the river, a mink occasionally ventured away from the banks to sneak into the henhouse for a meal; otherwise we rarely knew they were there.

As a child, I became attached to the river and its meadows much the way the chicks that my father bought in flats like strawberries imprinted on those of us who tended them. I fished and swam in it and studied its currents — the sudden ripples over gravel beds, the fast shallow water, the quieter-moving deep, blue bends. In the heat of summer evenings, I chewed stems of timothy grass and watched dragonflies and stoneflies and mayflies perform their ballet above the slow water; flying ants and spruce bugs and mosquitoes swarmed and hovered along the banks.

Life Cycles

Life flows in metrical rhythms on a Montana ranch, where work is synchronized to the cadences of seasons

and cycles of life. Moving along to predictable tempos, we participated in each season, each cycle, and, even as we strained against the elements, found reassuring connections between the natural world and our human one. Standing apart from wilder creatures, we watched and sometimes interfered with their struggles for survival. Over those we had tamed, we held complete sway. But once in a while nature reclaimed power over us, compelling us to concede in a moment of humility.

Late in the spring, when mountain runoff no longer swelled the river and a channel of mud caked the exposed banks, the swallows returned to the ranch. One May morning, a few birds would appear, darting from the mud flats exposed by the receding waters to the wide eaves and gables of the sheep shed. Within days, swarms of little red-brown workers with white striped heads would be frantically scooping mud into their mouths to build their nests. Their wings flapped as if to begin flight as they lifted tiny chunks of mud to shape into balls for their miniature bricks. Mid-flight between river and nest, they would dive to pluck up stems of dried grass or string to reinforce their curved walls of mud. Crafted as hollow spheres with small, tapered openings for entry, the nests tilted against the upper walls, each other, and the sides of the eaves. This sturdy architectural design sheltered first eggs, then newly hatched birds. Once the birds had built their nests and found sources of food and water, they began to lay their eggs and then settled in to protect them. They made only occasional day flights for food, seldom appearing before the sun had warmed the air. Those that had made fatal flaws in construction or carelessly entered and exited their nests lost an egg or two, or later a featherless chick, to the hard ground below. Lapses are not forgiven in the world of the swallows.

Tending Camp

Of all the things I did with my father, what I liked best was taking supplies to the herders and moving their camps to fresh grass. Passing through our log-framed gate with the Rambouillet skull wired to its arch early in the morning and heading out to the north range to tend camps, we stepped into another world. An expanse of grasslands spread out before us, more blue than green — bluestem, bluejoint, blue gramma and the needle grass that irritated the eyes of the sheep — coulees and high flat-topped bluffs, Crown Butte, Antelope Hill,

Horsethief Ridge and beyond it Chalk Butte. In early summer, tiny flowers — buttercups, shooting stars, forget-me-nots — dotted the slopes we drove past.

Further north the range became a Dakota-like badlands of white alkali flats where rainwater collected and dried in salty configurations. This was the same terrain, largely unchanged, where the Blackfeet tracked the last buffalo herds to supply the Eastern robe trade with pelts. Although the buffalo had vanished, the range was still a wildlife preserve, home to antelope and wild horses; badgers, coyotes, and gophers; field mice and jackrabbits; hawks and blackbirds and meadowlarks. It was also the winter domicile of our flocks. In the late spring, the sheep, which had been moved to Chalk Butte at the far end of the range, began their annual trek back, grazing their way across this pasturage to arrive at the ranch by shearing time.

On our way out to the sheep camps, we drove past herds of horses, the wild ones distinguishable by the stallions' flowing manes and long tails and the way they arched their necks to assert dominance over their harems of mares. Usually, several younger males and an older stallion or two would be grazing alone nearby, waiting for their time or understanding that it had passed. Even the Indians didn't attempt to break these lead males when they rounded up their own herds although they were often magnificent horses, athletic and fast. Wild horses eat a lot of grass, in dry years competing with the sheep for what pickings there are. If it had been a dry spring, my father, Jimmy, and one of our neighbors, Brian Connelly, would have rounded up as many bands as they could find and driven them to Sundance, where they were shipped off on railroad cars to become dog and cat food or shoe leather.

Shearing

After the shearer had reached through the burlap curtains to drag a sheep onto the stage, he trimmed first the legs, next the forehead, and then, with downward strokes, the chest and edges of the stomach. Once the chest was clean, the shearer cradled the sheep against his leg with one arm while his other hand directed the clippers upward from chest to neck, trimming the chin and the area behind the ears. Finally, he would lay the sheep down, first on one side, then the other, to peel the wool — yellowish near the skin — in long strokes from the buttocks, the back, and the neck. Once captured, the sheep always submitted passively to the shearing ritual.

Released at last, the denuded sheep would regain its unsteady feet and slip across the lanolin-slick floor to freedom. The shearer would hang up his clippers and slowly straighten out his back, stretching his neck and shoulders as he pushed the pile of fresh wool toward the front edge of the boardwalk with his feet. After adding a chalk mark to his tally, in a single continuous motion he



would part the curtains to pull the next sheep by the leg onto the wood planks as he leaned forward again into his swing.

Haying

My family's relationship with the Blackfeet was not limited to these events in which we were spectators. Like many local ranchers, my father leased land from individual Blackfeet owners in 40-, 80-, and 160-acre parcels that combined to make up much of the pasturage on the north range. When he went into Browning to renegotiate these contracts — the leases came up separately at staggered renewal times — he worked not with the Indian owners themselves but with Charlie Gerard, a member of the tribe, who oversaw its brokerage at the Blackfeet Agency. For an hour or so, the two men would pore over the rolled sectional maps that Charlie pulled out to determine which owners were due to be notified of renewals.

Out on the street again, the irony of a white man's easy access to cheap and plentiful land didn't escape my father as he walked past the poor descendants of the proud lords of the Plains. His method of telling me and,

Above: Don Morehead's parents at a sheep camp, 1937

I suppose, himself as well about the subtle tension that existed between the Blackfeet and the white ranchers who profited from their current lot was to remind me of the rock ledge he had once pointed out to me up the river from the ranch. There in the sandstone, an Indian had scratched his declaration: “June 15, 1894 James White Calf This is my ranch.”

• • • • •

We mowed the native grasses and wild clover and timothy that grew along the river and in the coulees on the east range. When the first settlers arrived here, these untouched fields had been chest high, almost too thick to walk through. We also mowed one field of alfalfa that we cultivated on the opposite bank. My favorite part of haying was the day or so we spent in the alfalfa field, because it was populated at this time of year by dozens of small creatures — rabbits and birds and mice. My sister and I came across a slaughtered nest of baby rabbits there one summer. After that and before I was old enough to be included as a member of the haying crew, I would run with her back and forth ahead of Charlie Cree Medicine’s mower to alert any small creatures nesting there to the havoc heading toward them.

The rake was one piece of equipment simple enough for me to operate, and by the time I was nine, I routinely took it over when James Spotted Eagle went off for his lunch break or was helping out on the haystack. On these occasions, my father hooked up the gentlest team to this wide, iron-framed machine with its curved sharpened rods that were raised and lowered to release the hay into neat windrows. With the horses’ reins tied to the seat in a loop knot, my hands were free to hold on as I slid a quarter way off to reach the pedal and trip the rake through its cycles.

After the hay had cured in windrows for a few days, it was time to bring the wagons out into the fields. The men used four-point forks to pitch the hay onto a net that covered the floor of the wagon bed. When the wagon was nearly full, one of the men would climb up and top off the load with a few final forkfuls. Once loaded, we could clamber on board for a ride to the stack, where Willie Chaplain would direct a boom that lifted the net full of hay from the wagon and dropped it onto stacks shaped like huge loaves of bread.

Lying back in the soft hay, I could look down on the muscles moving in the backs and shoulders of the horses, watch their heads swinging rhythmically from side to side. I would breathe in the sweet aroma of alfalfa or the stronger, almost musky tang of the dusty grasses from the range meadows and remove a sticky spine of Canadian thistle from my hand. As the wagon rolled over the washboard path on its way to the stack, I would close my eyes and read a tactile map of the terrain.

Leaving Montana

In the sheltered valley between the Bitterroot and the Sapphire ranges, the world felt smaller than it had east of the Continental Divide. Instead of miles of grass stretching to the horizon, land was tallied by the hundred acres here, mapped out neatly in fenced pasturage and fertile bottomland. A narrower sky faded earlier from day to twilight, slipped more willingly to darkness. Through the contracted landscape, seasons moved more gently, from April’s cloudy-blossomed files of apple trees to summer fields planted in mint and alfalfa and sugar beets, row-cropped plots of peas and beans and potatoes, by July, a patchwork of greens. Through the lingering autumn, jet trails of morning fog traced snaking paths of little streams across the valley floor and hung in the groves of cottonwoods along the broader Bitterroot, flowing north beside the highway from Darby to its lower reaches above Lolo. Shielded by mountain walls from bitter cold and howling, blizzard-driving western winds, the winter valley wrapped around itself, became a Christmas card of snow and silence.

The next morning when we set out again, a searing south wind was blowing across the arid plains that extended east from Denver into Kansas. The road stretched out, straight to the horizon, dipping and rising now and then to hug the contours of the land. Nothing about the parched landscape it traversed reminded me of the rich grasslands at home. Where this road would lead me, what lay ahead, I didn’t know, nor did the mystery of it stir me. We were simply moving on now, and I was resigned that a part of me at least would go along. For awhile, the rear window framed the Colorado Rockies, a prospect hazier in the August heat than the view I’d looked west to see each morning on the ranch, but still a piece of that same spine of mountains that anchored my remembered world. When they had disappeared, I settled down into my corner of the backseat beside my sleeping sisters.

The Need of Being Versed in Country Things

Wes Jackson

The last two lines of Frost's poem probably are not true. Countless city people not versed in country things wouldn't believe for an instant that the phoebes wept. Nature may have no sentimentality about human loss. It is probably Frost who is saddened when the murmur of the birds flying out and in through broken windows reminds him of the "sigh we sigh from too much dwelling on what has been." He has reason to be sad — observing the abandoned farmstead, knowing that others had been and that abandonment continues. We'll never know.

Both the meaning and the effect of Frost's poem hinge on being "versed in country things," and that is an art form. This connection between "country things" and art inspired us at The Land Institute to explore more deeply. Every year we host a Prairie Festival at the end of May — what one friend of mine calls "an intellectual hootenanny." The theme for Prairie Festival 2000 was "The Art of Living in Place," and I think Robert Frost would have enjoyed it, had he been able to attend. "The Art of Living in Place" — there are many interpretations of what that means.

One meaning for me is that one's farm (or tract house for that matter) is a canvas of sorts, a space where we can be participants in the Creation. The first rule for the Art of Living in Place is this: don't destroy the canvas. On a piece of land we do not want to destroy the topsoil. But globally, we humans haven't done so well at practicing the Art of Living in Place. During the last 40 years, nearly one-third of the world's arable land has been lost to erosion. Over the last 200 years of U.S. farming, an estimated 30 percent of farmland has been abandoned because of erosion, salinization, and waterlogging. Croplands in the United States lose soil at an average rate of around five tons per year from water and wind erosion. Half the fertile topsoil of Iowa has been lost during the last 150 years of farming and continues at a rate of about twice the national average. David Pimentel of Cornell University estimates that erosion in the U.S. causes about \$44 billion in damages each year. The International Food Policy Research Institute maintains that almost 40 percent of the world's cropland is seriously degraded, "a condition which could undermine the long-term productive capacity of those soils. ..." The Institute claims that soil spoilage already impacts the productivity of over 15 percent of the world's agricultural land.

Robert Frost

**The house had gone to bring again
To the midnight sky a sunset glow.
Now the chimney was all of the house that stood,
Like a pistil after the petals go.**

**The barn opposed across the way,
That would have joined the house in flame
Had it been the will of the wind, was left
To bear forsaken the place's name.**

**No more it opened with all one end
For teams that came by the stony road
To drum on the floor with scurrying hoofs
And brush the mow with the summer load.**

**The birds that came to it through the air
At broken windows flew out and in,
Their murmur more like the sigh we sigh
From too much dwelling on what has been.**

**Yet for them the lilac renewed its leaf,
And the aged elm, though touched with fire;
And the dry pump flung up an awkward arm:
And the fence post carried a strand of wire.**

**For them there was really nothing sad.
But though they rejoiced in the nest they kept,
One had to be versed in country things
Not to believe the phoebes wept.**

Not only is the canvas being destroyed, the artists' children are being killed thanks to the industrialization of agriculture. An Associated Press story alerts us that "More American children are killed while working on farms each year than in any other industry. Sixty years ago, family farms still covered the nation. Parents could at least try to ensure their children stayed a safe distance from dangerous machines and chemicals. But while farming has vastly changed to ever-larger, corporate-owned farms, the legal loopholes have not closed fast enough. Children employed in agriculture can work longer, at younger ages and in more dangerous jobs than in any other industry. Fatality rates among young farm workers dwarf those in other fields. Thirty-eight percent of all work-related adolescent deaths occurred on U.S. farms. More than half those fatalities involved tractors, most often while teens were driving."

But there is more from another AP report. Teenagers in rural America are more likely to use illegal drugs than

those in big cities. Eighth graders living in the country are twice as likely as urban kids to have used amphetamines, including methamphetamine, in the last month. They are 34 percent more likely to have smoked marijuana, 50 percent more likely to have snorted cocaine and 83 percent more likely to have abused crack cocaine. Between 1990 and 1998, drug-law violations increased six times faster in places with fewer than 10,000 people than in cities with more than 250,000. There is more than drugs. The number of new AIDS cases increased by 82 percent in rural areas between 1994 and 1999 compared with 59 percent in large metropolitan areas.

It matters but little whether we are talking about economics or health, the industrial machine in agriculture wrecks its havoc. I will illustrate with two stories. They may seem unrelated, but intertwined between them are personal problems, health problems, economic problems and ecological problems.

The first story concerns a rural husband and wife, both 55 years old. They are parents of five children, grandparents of six. After college and teaching stints for both, they returned home to the family farm. These north-central Kansas farmers are religious, patriotic, and frugal. On that farm they raised as their best crop those five smart kids, all college graduates except the youngest, who graduates soon, all contributing members to society in healthy and productive ways. These youngsters were raised on farm chores and the traditional culture of rural Kansas.

None of those kids will likely return to a paid-for family farm. They, important cultural seed stock, are more likely to raise our couple's grandkids in a distant city or town. When this part of their story began, the couple could not afford health insurance. They have never made more than \$25,000 a year total. Off-farm work made it possible to slow the decline of their assets. Because of the latest downturn in the ag economy, they moved out of their deteriorating doublewide to find work in a larger town. Even though they always have had a large garden and raised and butchered rabbits, chickens, hogs, and beef, they're broke. Low hog prices, cattle prices, and grain prices make them one of thousands of families forced to leave farms and home towns, including aging relatives now in nursing homes.

Versions of this story have been told thousands of times, and thousands of times dismissed as an "economic reality," a consequence of economic determinism, the way the world is. Economists and others as well sit comfortably well fed as forensic scholars, one might say, who now and then call out the score — telling how many more losers have gone under or have quit. Those who fail are predictable casualties on agriculture's economic battlefield — mere statistics.

Twenty miles from our state's land grant university

lives another couple in their early 30s, both teachers, parents of two boys, one four years, the other a few months old. Both are graduates of Kansas colleges. They moved to this small town one summer to assume positions in local high schools. A week after they moved in, a neighbor, seeing they had a young child and were expecting another, handed them a notice warning that neither children nor pregnant mothers should drink the city water. A neighbor delivered the announcement — not a town official. Three members of one family — the small boy, a developing fetus, and the mother — were not to drink the local water. Although at-risk town citizens could obtain free drinking water in gallon jugs at the local grocery, the stock is often depleted requiring a 40-mile trip to town and return.

The woman's sister and her husband also have a small child. During a summer visit, the two families went to the local park. Two active kids ran, became hot and sweaty, and naturally approached the city park drinking fountain, which, of course, supplied polluted water. The drinking fountain had to be off limits to the children, but the parents had to say so; there were no posted notices. What's wrong with the water? Nitrates from "non-point-source pollution." The culprits could be either grain farmers or feedlot operators or, if both are present, probably both.

That 55-year-old husband and wife were once my students. I knew the parents of the man as early as 1954 because their oldest son was my friend. Two of their sons were my students. So I know the family. All are intelligent, efficient, honest, patriotic, devoted members of their community, their church and their schools. As former teachers and farmers, when these pillars left their home county more was lost than population statistics will indicate.

In story two, the woman teaches Spanish, her husband history and English in consolidated rural high schools. I know the mother very well, am getting to know her husband well. She is my younger daughter, he my son-in-law. Their children's cousin is my granddaughter. Her parents, who teach in a university in Iowa, can relate story after story about agri-chemical pollution throughout Iowa.

The lives of the 55-year-old farm couple and the couple in their early 30s are snapshots of American agriculture and of industrial culture in general. The total picture is larger than the visual range of any one person at any one moment. Both landscapes and people have suffered from unacknowledged and externalized costs. Ambiguity in accounting may be minimized by keeping the boundary of consideration greatly restricted, but as the boundary shrinks the irrelevance increases. For industrialized agriculture especially, the boundaries of consideration are narrower than the boundaries of causation. It may be cost effective for the farmer not to



rotate crops, or to use an herbicide instead of cultivation, but if one draws the boundary of consideration to include the ground water and health costs, then society's agricultural costs go up at least in the long term. The problem with the efficiency arguments is that corporations tend to measure short-term profits that ignore long term effects and act in some cases irrevocably even when faced by lack of data. Essentially everywhere we look in rural America are people living in war zones of sorts. The clear though short-term winners of this war are the agri-business corporations and their stockholders and the professional servants of agri-business in many of our colleges and universities. The losers include the condemned bystanders — small children or reluctant participants such as the low-wage-earning feedlot cowboys. These people are not mere statistics, although statistics show that they are not alone: too many of our Kansas' rivers and streams are not suitable for recreational use or drinking, and our lakes are considerably less clean than they need be.

Ancient armies had clear motives and triumphant returns when they poisoned the water supply or salted the fields of the enemy in the interest of the immediate goals of a campaign. The armies that poison our water today and force the evacuation of the long-term residents of rural America assume, as Shakespeare put it, "We can bestride this world like a colossus." Competitive corporate capitalism under current

charters is allowed to subdue or ignore nature and by small extension social injustice is a consequence of production.

Where do we begin? It is clear that, when we face the problems of rural America, be they pollution or mass exodus, operating with the idea of absolutes fails us. Ending dependency on exports alone won't save rural life nor will it happen very soon. Our export policy is rooted in colonial times, clear back to the first tobacco planted at Jamestown as an export crop. In a similar manner we cannot seriously oppose agricultural technologies. Few among us would reject Jethro Tull's seed drill (1701), or James Small's cast iron plow (1765), Andrew Meikle's threshing machine (1780), Cyrus McCormick's mechanical reaper and binder (1834), or Anna Baldwin's suction machine to milk cows (1878). Moreover, scientific discoveries, like technological discoveries, have positive results few of us would oppose. Mendel's laws of heredity, elucidated in 1865, are as important as the invention, early this century, of the Haber-Bosch process that fixes atmospheric nitrogen.

Above: Scott Bontz,
*Remnants of farm
buildings south of
Manhattan, Kansas,*
2000

No, it is the *convergence* of science and technology with the *expanded scale* of these developments, driven by an exploitative brand of capitalist economics left to itself, which collectively destroys options for future generations. Social and regional history combine with the lack of a sufficiently broad education that could assist us in knowing when enough is enough. Our *cultural* failure in this realm, rather than the adoption of science and technology, stands behind the 55-year-old couple leaving the farm for a city in Kansas. It also stands behind the unsafe water in the town my daughter, son-in-law and grandchildren left (they did not leave for that reason).

Knowing when enough is enough requires an artistic sense. Knowing when enough is enough would have prevented what we would eventually refer to as “industrialization of agriculture.” Great masterpieces are not great because their creators heaped more and more paint onto the canvas; they are great because of their creators’ sensibility of balance, appropriateness, and scale. We have seen the experiment and now we see that the industrialization of agriculture over the past 60 years has not promoted “the art of living in place,” which fits hand in glove with the need to be “versed in country things.”

Every now and then I enjoy visiting a place — an example that meets such an ideal — by reading a passage by Wendell Berry which appeared in *The Unsettling of America*.

Some years ago I frequently used to drive past a farm in a creek valley of narrow, scarce bottomlands and hillsides. ... The farm was small, mostly hillside, with a few narrow ridges and a creek bottom that could not have been larger than an acre and a half. In an area of semi-abandoned land, this farm was outstanding, not because of its “improvements,” which were old and few, but because it was clearly both well used and well cared for. It was farmed by an old man and woman and a team of Percheron horses.

Everything about the place was neatly kept. House and yard and barn always showed a resident pride. There was an orderly, abundant vegetable garden beside the house. The pastures were mowed every summer. The tiny bottomland where the old man grew his tobacco crop was cut into three or four pieces by waterways that were grassed and bridged. More than anything else, those little timber bridges bespoke the old man’s care; the usual thing would have been to drive regardlessly across such shallow drains and so wear the banks away.

Like Wendell, I found this place interesting — and for the same reason: “because it was a good marginal

farm and because it was obviously a relic, the lone survivor within hundreds of square miles of a kind of farm that had been commonplace only thirty or thirty-five years ago. And finally it, too, went the way of the rest of them.”

Wendell describes what happens when the art of living in place disappears, when those versed in country things die.

As I watched the old man’s farm, driving by it at intervals, I saw it suddenly begin to change. The yard began to look unkempt. Disorder began to spread around the house. The team of horses disappeared. I learned a little of the story. The old man had died. His wife had moved to town to live with her children. The house had been rented to people who, though they had technically become its residents, clearly did not *live* there. The farm also had begun to be used by someone who did not belong to it.

I had stopped once and talked a while with the old man. He was busy fixing a fence at the time, and though he received me courteously enough, he did not permit himself to be much interrupted. I told him that I admired his farm. He thanked me, but without enthusiasm, obviously having spent little time yearning to be complimented by strangers. I said his team of horses looked like a good one. He said that they did very well.

One morning after I had learned of his death, I stopped at the farm again — in his honor, maybe, or in honor of my own sense of loss. It was a gray, wintry day. The place looked and felt forgotten. It had gone out of mind. Absence was in it like a force. The barn was closed, empty, the doors tied shut by someone who did not intend to come back very soon. Peering in through a crack, I found that I was looking into a milking room with homemade wooden stanchions, unused for years. I knew why: it had become impossible to be a *small* dairyman. I spent some time looking at the old man’s horse-drawn equipment. Some antique collector had taken the metal seats off several of the machines; these had become bar stools, perhaps, in somebody’s suburban ranch house. For the rest apparently nobody now had a use. Examining the pieces of equipment, I saw that they were nearly completely worn out, patched and wired together like the fences and buildings, made to do — the forlorn tools of a man who had heirs, but no successors.

In a recent issue of *The Wall Street Journal*, front page, left hand side, with the stippled-in face complete

with a Pioneer Seed company hat, is Francis Childs of Manchester, Iowa, 60 years old. Mr. Childs has a target of 400 bushels an acre for corn this year. Last year, Mr. Childs posted 394 bushels per acre, breaking a 14-year-old record. The national average is a little over 100 bushels per acre. He is something of a hero to others, for according to the article, "At a lecture on a snowy night in the Iowa town of Waukon, all 132 seats in the Vets' Club are filled. Before he speaks, several farmers walk up to have their picture taken with Mr. Childs."

This farmer of 320 acres of the best land in the world is not my idea of a person "versed in country things." He is not an agrarian, nor an artist. Those who clamor to be photographed with him are probably pretty much the same. A member of the Practical Farmers of Iowa said Mr. Childs was "like an athlete on steroids." *The Wall Street Journal* featured him because of his success in industrial agriculture. He has helped set the standard — the escalating standard.

Downstream from our Iowa super-farmer is the Hypoxia Zone in the Gulf of Mexico. This is the largest zone of coastal hypoxic bottom water in the Western Hemisphere, right in the midst of some of our nation's most important fishing waters, an area about the size of Connecticut. Because of low oxygen, mostly due to agricultural chemicals in the Mississippi drainage, the zone is dead and expanding. Those "versed in country things" would do more than see the connection between the hypoxia of the Gulf and record-setting corn yields. They would *feel* the connection as well.

The sigh we moderns sigh "from too much dwelling on what has been" is drawn in part from an analysis well articulated toward the end of the same piece by Wendell quoted above:

The curious thing is that many agriculture specialists and "agri-businessmen" see themselves as conservatives. They look with contempt upon governmental "indulgence" of those who have no more "moral fiber" than to accept "handouts" from the public treasury — but they look with equal contempt upon the most traditional and appropriate means of independence. What do such conservatives wish to conserve? Evidently nothing less than the great corporate blocks of wealth and power, in whose every interest is implied the moral degeneracy and economic dependence of the people. They do not esteem the possibility of a prospering, independent class of small owners because they are, in fact, not conservatives at all, but the most doctrinaire and disruptive of revolutionaries.

We all dwell on what has been, often without a sigh. When we dwell on the good examples, which show

us possibilities, we are given heart. Here is Wendell again: "the old man and his farm together made a sort of cultural unit, recognized and valued in this country from colonial times. And it is still a perfectly respectable human possibility. All it requires is the proper humanity." Wendell's analysis is, of course, correct, and thankfully we do have a few examples of good farmers who have practiced the art of living in place — Gene and Carol Logsdon and David and Elsie Kline in Ohio. The late Harlan and Ann Hubbard on the banks of the Ohio in Kentucky, the couple given higher visibility by Wendell in his book on them. Harlan a painter, Anna an accomplished musician, both fluent in foreign languages, built their place with their own hands, mostly from what they could find, and then sustained themselves from the river and their large garden. Theirs was a life of abundance, not nearly so austere as Scott and Helen Nearing's and with none of the self-righteousness one feels from Scott Nearing's writings. What is interesting is that the aesthetic sense of all of these good examples carries the potential for driving down prodigal consumption. This exercise of the aesthetic sense *necessitates* ecological contact and instructs us on how to achieve a spare use of nature.

Instead of leadership — accommodating aesthetic considerations with some eco-agrarian thinking from our colleges and universities — leadership toward a path that would help correct the problems, this is what I hear:

1. What's wrong with shrinking the number of people on the landscape? Why shouldn't farmers, like everyone else, have to play by the rules of the market? Why not weed out the "inefficient" farmers?
2. Food is safer now than ever because of the chemicals applied to our landscape and 2,4-D as a cause of non-Hodgkins lymphoma is one unfortunate tradeoff.
3. Soil erosion? We've had agriculture and soil erosion for 10,000 years. Human numbers keep growing, don't they? Sure, civilizations have come and gone, but in those regions there are as many or more people now as at the time those civilizations crashed.

Such questions, statements and the attitudes they represent are the product of isolation within the safe boxes of universities where knowledge is not forced out of the categories. The universities increasingly become places that feature questions for which there are answers. These cynical positions explain why so little effort has been devoted to a research agenda to deal with the problems. How else can we explain why there is no agenda that would reduce input costs, put more money in the pocket of the farmer, reduce the ecological impact of agriculture on the landscape and concern itself with the viability of rural communities? How else can we explain that the problems tied to *pesticides or nitrates in ground water* and the *movement of people off the land* are still not priorities for all — city, suburban and

country folk alike? The same agenda affects all of us.

Raise the issue of the loss of rural youth and the ensuing “loss of cultural capacity” and one is likely to be met with such answers as:

- “The world is changing.”
- “Many people who have not grown up on a farm are able to go out and be successful farmers and will do so in the future.”
- “Being ‘raised to farming’ may be a virtue, but even here this loss of our ‘cultural seedstock’ — as you ecological worriers put it — is relatively unimportant so long as even one percent have the desire to learn agriculture on their own.”
- “Humans are adaptable creatures and economic laws are derivatives of human nature dealing with reality.”

There are basic practical reasons for people being “versed in country things,” as the account I am about to describe illustrates. The story appeared in our local paper a few years ago as an Associated Press piece by Sarah Mae Brown, who described the following conditions in Kurilovo, Russia.

Each day, Nikolai and Galya Nikolinko arise in the dark and go about the business of making a living. They milk their cows, feed their pig, gather eggs from their chickens, tend their garden. They live off what they grow, and sell the rest for a few rubles here and there. From milk alone, they earn perhaps \$100 a month. And when the sun rises, Nikolai heads off from his simple wooden house to his long-time job as a welder in a state-run auto repair factory. For this, he earns nothing. ... People survive on their gardens and their wits, and the official economy primarily is a distraction. ... Across Russia, especially in smaller towns and villages, millions of workers have gone months without wages. Both the government and private employers have been unable — or unwilling — to pay them. Even retirees have gone without their pensions. Outsiders tend to ask how this is possible: how can a nation survive when its people are unpaid? Why would a worker show up for a job that offers no wages? Like many Russians, Nikolai Nikolinko — who hasn’t been paid in three months — doesn’t ask these questions. Why wouldn’t he show up for work? “Where would I go?” he said. “There aren’t any other jobs in this town. I’m too old to look for work in Moscow. This is a one-factory town; we have no other choices. And besides, what if the day I decide not to show up the managers start handing out wages?”

A crucial message — one never made explicit in the article — is that nature’s economy, in combination with

traditional culture, continues to feed the people and now subsidizes the industrial economy.

Try to imagine nearly anyone but the rich and the Amish going without wages in the United States for three months now that our traditional rural economies have been mostly undone. The collapse of the Soviet Empire represents the first major failure of the industrial mind. We should more or less ignore the differences between capitalism and the Soviet brand of communism for both systems have sought to concentrate power and in so doing greatly reduced the number of people on the land and in small communities.

Two important messages come through to me, messages of what we need to do to prevent the eventual likelihood of widespread social upheaval. First, we must aggressively consider ways to keep people on the land and in the small towns and second to imagine and implement ways to get more, but not all, people back onto the land and into more traditional relationships with sun, soil and rural community. Here is an immediate practical reason to be versed in country things. We don’t have to junk every accoutrement of the technological era, but during times of food crisis, history has shown that no one is safe whether they grow food or not.

Cultural arrangements of a diverse nature — not the industrialized pig or chicken factory — will insure our security. Whether we are talking about the huge feedlot beef facilities or a Central Valley of California-style agribusiness to provide our vegetables, both are brittle forms of food production. They combine key elements of the Soviet way which collapsed.

This has all been said before in many ways, and in this period of affluence it is easy to deny that anything can or will go wrong with our production system however well motivated our workers or reliable our machinery may be.

Whether it is the application of farm chemicals to our land and water, cutting of the tropical rain forest, or overhauling the architecture of our major crops and livestock genomes by introducing genes from long evolutionary distances, we see everywhere that the resilience of the important patterns in nature which support humanity is not infinite, that what we call cultural stability is more fragile than we have imagined, and that the small cascades of human calamity in the past become predictors for the future. Meanwhile we tend to ignore where true resilience lies. The Siberian welder and his family with their garden, pig, and chickens can teach us far more about a sustainable future than can the internet.

There has never been a golden era in agriculture. And as we acknowledge the domestic problems — drunkenness, spousal abuse, kids on drugs and more — there was and still is a cultural wisdom, an

agriCULTURAL wisdom derived from staying put, a wisdom gained no other way. Rural people, many rural people, even those with average or low intelligence, have and had a cultural handing-down of knowledge that *expanded* their intelligence. On the other hand, what we often see among intelligent people disconnected from the land is the use of their intelligence (often unwitting) for destructive purposes. High intelligence often multiplies brainpower in the wrong direction to create a kind of dumbness.

I want to talk a little about the “eco” part of the eco-agrarian mind. This requires us to begin with the question: what has happened to ecology as a popular movement? We seem to have given up on the challenge of developing ecological modes of production. Why should we? After all, nature’s ecosystems — prairies, forests, alpine meadows and more — run on contemporary sunlight and feature material recycling. Organic food production does exist, to be sure, but is not necessarily ecological. What seems to have supplanted the era of ecological awareness is lots of popular concern about human health. Endocrine disrupters becomes an issue. Health concerns range from dirty water and dysentery to accommodating the narcissistic who visit the organic boutique. The ecological point of view is lost in individual selfhood even before we get to how nature’s ecosystems have worked over the millions of years. What about the question: How do we live in this world? How do we relate to the things we take and use? How can we live more artfully? Instead, this current emphasis on health and longevity has moved everything ranging from Midwest soil erosion to Southern California soil salting and agri-chemicals everywhere off the agenda to be replaced by arguments about the costs and benefits of biotech. “Gee whiz” genetics reigns. We hope to clone hogs to produce organs for human transplant. Pigs are slated to become factories for hearts, livers, kidneys and more. Putting our concerns for health and kids center stage and relegating to off stage how the world is or works ecologically and evolutionarily, results in the paradoxical trivialization of both health and kids.

Most current agricultural and ecological thinking regards itself as progressive, and in one sense it is: very little of it can be enacted or implemented without ignoring or overriding our ancient human aesthetic sensibilities. C.S. Lewis said it very well in his book *That Hideous Strength*: “The very experience of the dissecting room and the pathological laboratory were breeding a conviction that the stifling of all deep-set repugnancies *was the first essential* for progress.” The array of industrial equipment on our farmsteads along with our pharmacopoeia of agricultural chemicals demanded a “stifling of all deep-set repugnancies” and this is what has accelerated the so-called progress in

high yield agriculture. The farm as a canvas where we can practice the art of living in place has been subsumed by the economic and technological imperative.

Finally, some thoughts of two soul mates who are also our best teachers. The first is from Leo Tolstoy who, before the Russian Revolution, wrote: “*To return to the old ways is not possible; only one thing is left for those who do not wish to change their way of life, and that is to hope that ‘things will last my time’ — after that let happen what may. ... the deception on which everything depends is wearing out.*” To call “what everything depends on” a deception, at first glance, may be too strong. Upon closer examination it may be even more true for us than it was at the time of Tolstoy. For whether we are talking about the automobile or Iowa corn, we *are* deceiving ourselves, at a minimum, by ignoring their ecological and energy cost.

America’s Tolstoy, our friend Wendell Berry, commenting on that farm in the Kentucky hollow, has this to say: “By the standards of orthodox agriculture, as well as by those of the present economy and culture, this old man and his farm were merely anachronisms, leftovers. The possibility of their existence would seem contemptible, not just to the majority of agriculture experts, but to the majority of influential people of their kind. And yet we must ask *why*. And we must be careful not to accept too hasty or easy an answer. For no matter what may be said by the current standards of economics or technology or cultural fashion about this old man’s life, there is still no legitimate way of withholding respect from him. ... Here was a man who worked until he died, taking care of himself and of his part of the earth.”

Our hope lies in that minority of people whose lives are less defined by economics than by beauty and the love which attends it. If agrarian thinking could replace industrial thinking one day, with technologies serving as agents rather than as masters, and if we, like the phoebes, can rejoice in the nest we keep, then we will see eco-T-shirts and bumper stickers and all the language of eco-hype only in museums. We’ll look back to this time as a primitive era which called itself the environmental movement before “being versed in country things” was widely realized.



Scott Bontz,
*Old oriole nest in
budding tree at
Homestead National
Monument, Nebraska,
2000*

Food Engineers' Credibility Gap and the Public's Acquiescence

Farmageddon: Food and the Culture of Biotechnology

Brewster Kneen

New Society Publishers, 1999. 231 pages, \$16.95.

Brooks Anderson

Brewster Kneen is by now a widely recognized and respected analyst of food systems. His latest book, *Farmageddon*, is a provocative contribution to the growing body of evidence that a free market generates economic selection pressures that favor employers and producers who ruthlessly exploit land and labor.

Farmageddon, a work that is part investigative journalism and part moral philosophy, empowers the reader in several ways. Kneen brings us up to speed on many recent developments in the field of genetically modified food. He provides in-depth background on the development, regulation, and marketing of bovine growth hormone, the Flav'r Sav'r tomato, and the New Leaf potato.

He uses such case studies to reveal a disturbing credibility gap that plagues agricultural biotechnology companies. Kneen exposes a contradiction that unfailingly characterizes such companies: their marketing and public relations staffs profess ideals and intentions that the companies' lobbyists and research and development technicians demonstrate no awareness or understanding of. The Monsanto Company, he argues, provides one example of such schizophrenic or disingenuous behavior. Monsanto, which boasts a motto of "food, health, hope," files bankrupting lawsuits against small dairy processors that label products made from milk produced with the help of genetically modified bovine growth hormone. Monsanto understandably fears that most, if not all, consumers will favor milk that was produced without bovine growth hormone. So, although Monsanto insists that it favors fully informed debate, the company aggressively deploys its intimidating legal retainers, financial resources, and political influence to deprive the public of, first, scientific testing and regulation of its product, and, second, the right to an informed choice of whether or not to purchase and consume that product.

Kneen's book is empowering also because he admonishes the public for relinquishing responsibility for food production and the regulation of food safety to market forces, big business, and increasingly compliant governments. Kneen's rigorous scrutiny of the track record of agricultural biotech companies leads him to conclude that society's faith that the profit motive and free market forces will deliver the safest, most rational, and most efficient of all possible food systems is unfounded. This insight leads

him to advocate a radical, yet traditional, approach to food production: systems that are diverse and decentralized.

The only weakness of *Farmageddon* is that Kneen does not coherently address the very serious problem of population growth, which biotechnology's enthusiasts repeatedly use as moral leverage to justify their work. For example, I recently attended a conference in the Indian city of Bangalore where an employee of Unilever assured people that agricultural biotechnology is the solution to India's challenge of feeding 1.6 to 1.8 billion people by the year 2040.

There simply is no reason to believe that biotechnology will have any substantial positive effect on the availability of food. Agricultural biotechnology businesses have failed to develop any technique that significantly increases food yield, despite decades of research and the expenditure of hundreds of millions of dollars. Moreover, biotechnology companies have no genuine interest in feeding the hungry, who are, in almost all cases, hungry because they are poor. Kneen rightly asserts, "We should not be fooled into believing that the intent of engineering the seed ... is to feed the world or save the environment; it is to gain control and create dependency." The importance of Kneen's book is that it dispels the myth that biotechnology will feed the world's growing human population, a myth that generates a very dangerous complacency about population growth and its effect. Unfortunately, Kneen appears to suffer from this complacency.

Society has to address the very real challenge of reducing population, as well as the perhaps even more difficult challenge of moderating the consumption patterns of affluent people. Kneen can undoubtedly help us to face such challenges if he devotes a future book to describing and analyzing in detail the structure and functioning of the alternative food system models that he advocates.

This review appeared in The Land Stewardship Letter, Vol. 18, No. 1. Brooks Anderson, a 1989 Land Institute intern, lives and works at Annapurna Farm, a 135-acre organic farm that is a part of the international, experimental township called Auroville, in Tamil Nadu, South India. For more information on Brewster and Cathleen Kneen's coverage of agribusiness and food issues, see www.ramshorn.bc.ca.

How We've Managed to Ignore Ecological Collapse

Paradise for Sale: A Parable of Nature

Carl N. McDaniel and John M. Gowdy

University of California Press, 2000. 208 pages, \$17.95.

Curtis Runyan

In 1976, *National Geographic* magazine declared that Nauru, a country barely six times the size of New York's Central Park, was the world's richest island. Today, this remote volcanic island in the middle of the Pacific is a wasteland. For the past century, the high-quality phosphate deposits that once covered it have been strip-mined and shipped, largely to Australia, for fertilizer. Four-fifths of the island is now a dry desert of limestone pinnacles. These ancient coral spires, which for thousands of years provided refuge for migratory birds and their deposits of phosphorus-rich guano, stand as a ghostly reminder of the lush tropical forests that once grew above them.

Before the 20th century, the fish from local reefs and the fruits and sap of native coconut and pandanus trees sustained a vibrant culture for more than 100 generations. The annual rainfall on the island fluctuated sharply, from levels twice as heavy as the average annual deluges in Brazilian rainforests to the levels found in the deserts of the southwest United States. Because the island was wholly dependent on rain for its fresh water, Nauru was subject to frequent droughts. These constraints forced the Nauruans to develop strict customs that kept their population below 1,000 to avoid shortages and famine. Today the narrow coastal strip around Nauru is home to more than 10,000 people, and virtually everything — water included — is imported.

In their book *Paradise for Sale*, Carl McDaniel and John Gowdy undertake a remarkable exhumation of the biological, psychological, and economic factors that landed the Nauruans in the straits they are in today. And what they find is not a simple tale of an ancient culture forcibly colonized and left poorly equipped to deal with an encroaching global economy, but a worldwide phenomenon of human disconnect from nature's warning signals of ecological excess. Like archeologists unearthing the answer to an ancient puzzle, McDaniel and Gowdy sift through the remnants of fallen cultures around the world to try to answer a simple, but essential question: what is driving us to live beyond Earth's limits despite the compounding ecological and social warning signs?

Mathis Wackernagel, author of *Our Ecological Footprint*, estimates that we are burning through so much

oil, clearing so many forests, washing away so much topsoil, and paving over so many natural systems that it would take an additional planet to keep us living sustainably.

Researchers are now compiling an extensive body of data tracking where we get our resources from and where they end up when we discard them. Several new indicators, such as the "rucksack" and the "footprint," have been developed to further clarify just how large an effect individuals, communities, and nations have. According to Wackernagel the average U.S. citizen uses about 10 hectares — 25 football fields worth of land and water — to support his or her lifestyle. The average Indian requires less than one hectare.

Much less energy, however, has been devoted to charting why this drive to consume such huge amounts has occurred. Through a series of anthropological investigations, *Paradise for Sale* tackles this question head-on.

After Nauru received independence in 1968, phosphate sales brought in tens of millions of dollars each year, helping the smallest nation in the world accumulate perhaps the largest per capita fortune. Only one-third of the island had been mined under Australian control, and the people of Nauru chose to press forward with the lucrative extraction. With this wealth, the island was catapulted into the lifestyle of televisions, washing machines, toaster ovens, and automobiles.

These changes came with a large price tag, though. High rates of obesity, diabetes, and traffic accidents give Nauru the lowest life expectancy in the Pacific — while there is just one road, an 18 kilometer loop circling the island, every family owns at least one car. And, as was bound to happen, supplies of phosphate have dwindled. Mining will only be viable for another five to 10 years.

Threats to the island's future are not just ecological in nature. Financial examinations show that the government has grossly neglected and mismanaged the billion-dollar fund that was supposed to secure the nation's future for generations. Prospects look dim for the Nauruans, who have squandered away most of the wealth of resources available to them.

But this is not the end of the story for Nauru.

Unlike their distant neighbors in the Pacific on Rapa

Nui — Easter Island — whose culture and beliefs led them to decimate its rich forests and wildlife and leave in their stead a trail of ghostly statues, the Nauruans lived well for thousands of years, despite droughts. Their cultural practices reinforced long-term survival: they produced sheets of copra from coconuts for times of famine, maintained a small population to live within the island's limits, and protected biodiversity to maintain the island's ecological resiliency.

McDaniel and Gowdy use the Nauruan tale, together with their observations of Mangaia, Tikopia, and several other islands and regions, as the basis for pulling together an important piece of the ecological puzzle: cultures with greater constraints in their environment — sometimes scant water, short growing seasons, poor soil, etc. — have often developed more sustainable civilizations than their well-endowed counterparts. This seems counterintuitive at first. But living on the ecological edge leaves little room for error: wash away too much topsoil in a high mountain region with a short growing season, and next year your family doesn't eat. "The lag time between environmental abuse and negative feedback must have been short," write McDaniel and Gowdy, which "... enabled these cultures to respond in timely fashion to feedback from their fragile ecosystems."

Meanwhile, cultures living in ecologically resilient regions in many cases have not fared so well. The extensive forests, rich soils, numerous species of sea and land birds, and other biological riches on Rapa Nui provided an ecological cushion that allowed the islanders to insulate themselves from nature's feedback. Evidently, religious concerns over the construction of the giant statues for which the island is known took precedence over long-term ecological monitoring. Forest clearing, biological invasions, population growth, and other ecological strains progressed slowly, but steadily, over generations. Throughout an individual's lifetime, the changes would not seem drastic. But by the time the alarms had sounded — the forests were completely cleared, most native species were wiped out, and the population had crept up to nearly 10,000 — it was too late.

Rapa Nui happens to be one of the most remote areas ever inhabited, and so did not have available another significant loophole that can allow people living in even the most biologically impoverished regions to ignore ecological feedback: trade. For most nations, it is possible to "borrow" from neighbors, allowing compromised ecosystems a new lease on life, so to speak. To underscore the point, McDaniel and Gowdy revisit the saga of Europe: "Much of the last 1,000 years most Europeans were undernourished, disease-ridden peasants." As late as the 20th century the average height and lifespan of a European was less than that of their ancestors thousands of years earlier. The European model was in serious decline until the discovery of the New World, they note. "By exporting their excess population and importing materials from the rest of

the world," write the authors, "Europeans temporarily evaded the limits of their ecosystems."

So what will it take to persuade people to pay attention to the warning signals — the rising toll of extinctions, climate change, widespread hunger and poverty, declining fisheries, and degraded land? *Paradise for Sale*, thankfully, offers no simple solutions. Instead the authors sketch out a sober and intricately detailed picture of the initial steps that are needed to reorient a world economy that disregards the Earth that sustains it. And they hold no punches in their critique of the Western-economic worldview that has entrenched itself around the globe: "Our world civilization and its global economy are based on beliefs incompatible with enduring habitation of the earth: that everything has been put on earth for our use, that resources not used to meet our needs are wasted and resources are unlimited, that rewards must be related to economic production, that people are exclusively selfish and acquisitive, that scarcity and inequality are natural conditions, and that the biosphere is a subset of the economy."

Using their carefully crafted case studies as a microcosm of a worldwide malaise, McDaniel and Gowdy plot a revolutionary — but feasible — new course for humanity, one aimed at living within the Earth's means.

- They outline strategies for reconfiguring our economic system along the principles of "strong sustainability" — using renewable resources at rates that allow regeneration, keeping waste flows at a level that can be assimilated, and extracting nonrenewable resources only at a rate that allows substitutes to be found.

- They emphasize the power of recognizing that, as pervasive as it is, the Western economic worldview is simply one way of seeing the world. Solutions to many of our ecological dilemmas may be found in the diversity of human thought. For example, the authors note that "among the Indians of eastern Canada a craving for material objects is considered a disease." Just as we aim to protect biodiversity to ensure ecological resiliency, cultural diversity must be preserved and equity issues made a priority.

- And they propose setting aside a third to a half of the Earth's landmass, together with numerous aquatic habitats, to begin to halt biodiversity loss.

McDaniel and Gowdy acknowledge that it will not be easy: "Perhaps we need some catastrophe to set us firmly on the path," they fear. But it doesn't have to work that way. "The world's cultures are in a tumultuous period because the old myths of economic growth and never-ending material progress are no longer believable, but the new stories have not yet been culturally enshrined," the authors conclude. This exceptional book takes us a giant step closer to making these stories of a secure future a reality.

Curtis Runyan is assistant editor of World Watch. This review appeared in the May/June 2000 issue.

A Brave Rescue and a Rough Ride

*Here is a tale rich in details and language of the rural,
from the chapter with the title above in R.D.*

*Blackmore's "Lorna Doone: A Romance of Exmoor."
The 1869 historical romance's setting is northern
Devonshire, England. Its teller and protagonist is a
farm boy.*

It happened upon a November evening (when I was about fifteen years old, and outgrowing my strength very rapidly, my sister Annie being turned thirteen, and a deal of rain having fallen, and all the troughs in the yard being flooded, and the bark from the wood-ricks washed down the gutter; and even our water-shoot growing brown) that the ducks in the court made a terrible quacking, instead of marching off to their pen, one behind another. Thereupon Annie and I ran out to see what might be the sense of it. There were thirteen ducks, and ten lily-white (as the fashion then of ducks was), not, I mean, twenty-three in all, but ten white and three brown-striped ones; and without being nice about their color, they all quacked very movingly. They pushed their gold-colored bills here and there (yet dirty, as gold is apt to be), and they jumped on the triangles of their feet, and sounded out of their nostrils; and some of the over-excited ones ran along low on the ground, quacking grievously, with their bills snapping and bending, and the roof of their mouths exhibited.

Annie began to cry "dilly, dilly, einy, einy, ducksey," according to the burden of a tune they seem to have accepted as the national ducks' anthem: but instead of being soothed by it, they only quacked three times as hard, and ran round till we were giddy. And then they shook their tails all together, and looked grave, and went round and round again. Now, I am uncommonly fond of ducks, whether roystering, roosting, or roasted; and it is a fine sight to behold them walk, poodling one after another, with their toes out, like soldiers drilling, and their little eyes cocked all ways at once, and the way that they dib with their bills, and dabble, and throw up their heads and enjoy something, and then tell the others about it. Therefore, I knew at once, by the way they were carrying on, that there must be something or other gone wholly amiss in the duck-world. Sister Annie perceived it, too, but with a greater quickness; for she counted them like a good duck-wife, and could only tell thirteen of them, when she knew there ought to be fourteen.

And so we began to search about, and the ducks ran to lead us aright, having come that far to fetch us; and

when we got down to the foot of the courtyard where the two great ash-trees stand by the side of the littler water, we found good reason for the urgency and melancholy of the duck-birds. Lo! the old white drake, the father of all, a bird of high manners and chivalry, always the last to help himself from the pan of barley-meal, and the first to show fight to a dog or cock intruding upon his family, this fine fellow, and a pillar of the state, was now in a sad predicament, yet quacking very stoutly. For the brook, wherewith he had been familiar from his callow childhood, and wherein he was wont to quest for water-newts, and tadpoles, and caddice-worms, and other game, this brook, which afforded him very often scanty space to dabble in, and sometimes starved the cresses, was now coming down in a great brown flood, as if the banks never belonged to it. The foaming of it, and the noise, and the cresting of the corners, and the up and down, like the wave of the sea, were enough to frighten any duck, though bred upon stormy waters, which our ducks never had been.

There is always a hurdle six feet long and four and a half in depth, swung by a chain at either end from an oak laid across the channel. And the use of this hurdle is to keep our kine at milking-time from straying away there drinking (for in truth they are very dainty) and to fence strange cattle, or Farmer Snowe's horses, from coming along the bed of the brook unknown, to steal our substance. But now this hurdle, which hung in the summer a foot above the trickle, would have been dipped more than two feet deep but for the power against it. For the torrent came down so vehemently that the chains at full stretch were creaking, and the hurdle buffeted almost flat, and thatched (so to say), with the drift-stuff, was going see-saw with a sulky splash on the dirty red comb of the waters. But saddest to see was between two bars, where a fog was of rushes, and floodwood, and wild-celery haulm, and dead crow's-foot, who but our venerable mallard jammed in by the joint of his shoulder, speaking aloud as he rose and fell, with his top-knot full of water, unable to comprehend it, with his tail washed far away from him, but often compelled to be silent, being ducked

very harshly against his will by the choking fall-to of the hurdle.

For a moment I could not help laughing; because, being borne up high and dry by a tumult of the torrent, he gave me a look from his one little eye (having lost one in fight with a turkey-cock), a gaze of appealing sorrow, and then a loud quack to second it. But the quack came out of time, I suppose, for his throat got filled with water, as the hurdle carried him back again. And then there was scarcely the screw of his tail to be seen until he swung up again, and left small doubt, by the way he spluttered, and failed to quack, and hung down his poor chest, but what he must drown in another minute, and frogs triumph over his body.

Annie was crying and wringing her hands, and I was about to rush into the water, although I liked not the look of it, but hoped to hold on by the hurdle, when a man on horseback came suddenly round the corner of the great ash-hedge on the other side of the stream, and his horse's feet were in the water.

"Ho, there," he cried; "get thee back, boy. The flood will carry thee down like a straw. I will do it for thee, and no trouble."

With that he leaned forward and spoke to his mare — she was just of the tint of a strawberry, a young thing, very beautiful — and she arched up her neck, as misliking the job; yet, trusting him, would attempt it. She entered the flood, with her dainty forelegs sloped further and further in front of her, and her delicate ears pricked forward, and the size of her great eyes increasing; but he kept her straight in the turbid rush, by the pressure of his knee on her. Then she looked back, and wondered at him, as the force of the torrent grew stronger, but he bade her go on; and on she went, and it

foamed up over her shoulders; and she tossed up her lip and scorned it, for now her courage was waking. Then, as the rush of it swept her away, and she struck with her forefeet down the stream, he leaned from his saddle in a manner which I never could have thought possible, and caught up old Tom with his left hand, and set him between his hostlers, and smiled at his faint quack of gratitude. In a moment all three were carried downstream, and the rider lay flat on his horse, and tossed the hurdle clear from him, and made for the bend of smooth water.

They landed some thirty or forty yards lower, in the midst of our kitchen-garden, where the winter-cabbage was; but though Annie and I crept in through the hedge, and were full of our thanks and admiring him, he would answer us never a word until he had spoken in full to the mare, as if explaining the whole to her.

"Sweetheart, I know thou couldst have leaped it," he said, as he patted her cheek, being on the ground by this time, and she was nudging up to him, with the water pattering off from her; "but I had good reason, Winnie dear, for making thee go through it."

She answered him kindly with her soft eyes, and sniffed at him very lovingly, and they understood one another. Then he took from his waistcoat two peppercorns, and made the old drake swallow them, and tried him softly upon his legs, where the leading gap in the hedge was. Old Tom stood up quite bravely, and clapped his wings, and shook off the wet from his tail feathers; and then away into the courtyard, and his family gathered around him, and they all made a noise in their throats, and stood up, and put their bills together, to thank God for his great deliverance.

About the Authors in this Issue

Stephen Jones is head of wheat breeding at Washington State University. **Tim Murray** is a plant pathology professor. **Doug Lammer** is a post doctoral researcher sponsored by The Land Institute. **Steven Lyon** and **Pamela Scheinost** are graduate students. **Andrew Haydock** is a doctoral student and Land Institute graduate fellow. **Cindy Cox** is a recent master's degree

graduate in crop science. **Xiwen Cai** is a cytogeneticist. **Christopher Picone** is a Land Institute research scientist. **David Van Tassel** is a Land Institute research scientist. **Andrea Yoder Graber** is a Land Institute research assistant. **Don** and **Ann Morehead** are Friends of the Land and academics who live in San Francisco.

Research for Natural Systems Agriculture (NSA)

Search for Perennial Sorghum

Out of several hundred, eight sorghum hybrid plants survived the winter and regrew.

The population is derived from a hybrid perennial sorghum crossed back to a high-yielding, Kansas-adapted grain sorghum developed by Kansas State University. After crossing annual and perennial sorghum types, most of the next generation are usually annual. Only a few have the right combination of genes to form the underground stems, rhizomes, that allow them to regrow the next year.

In 1998 our intern Kelley Belina made the original cross between the tetraploid perennial sorghum, derived from the perennial weed Johnson grass, and the diploid grain sorghum. In the greenhouse, research assistant Andrea Yoder Graber is screening about 4,000 additional plants from this population to find perennial individuals. The perennial plants of this spring and any new perennials from the current screening will again be used to make hybrids with the grain sorghum. Repeated backcrossing will be necessary to produce plants that have lost all Johnson grass traits except for perennialism.

New 66-plot Experiment

We are comparing two kinds of plant diversity: simple diversity of species, and diversity of “functional groups,” plants that share similar ecological roles. This study compares three functional groups: shortgrasses, tallgrasses and prairie wildflowers. It tests whether or not mixtures are more resistant than monocultures to insects and disease.

When and How Does Annual Wheat Decide to Die?

Research assistant Andrea Yoder Graber tested the hypothesis that heads of annual wheat produce a “death hormone.” If they do, cutting heads off early should eliminate the hormone and allow the annuals to live indefinitely. Clipping the heads early prolongs the plants’ lives, yet they eventually die. We are trying to develop and test new hypotheses. For more, see the story in this issue.

Long-term Agro-ecological Plots

Institute scientists Chris Picone and David Van Tassel are designing long-term agro-ecological plots, consulting with a committee of university researchers. The plots will eventually cover more than 100 acres of Land Institute land.

The objectives:

- 1) Document the slow process of soil restoration that we predict will result when cropland is converted to perennial polyculture.
- 2) Contrast this with the effects on soil of more conventional agriculture.
- 3) Try variations in perennial polyculture design, searching for the most successful in the long term.
- 4) Set up convenient plots for additional researchers to use in future experiments.

Mycorrhizal Fungi

Mycorrhizae are a critical part of the soil community. Recent Land Institute studies are assessing how these fungi are affected by agriculture, especially tillage and low plant diversity. This work will help us understand how Natural Systems Agriculture can restore an optimal soil community.

Preliminary evidence indicates that tillage dramatically reduces mycorrhizae diversity. For example, at the Sunshine Farm the average number of species per soil sample was about 7.5 in perennial plots and 4.3 in annual tilled plots. Of approximately 25 species found at The Land, the least common five are virtually eliminated from tilled soil. Several others appear unaffected.

Plots with perennial crops can recover high fungus diversity and most native fungus species after only a few years without soil disturbance, an encouraging note for establishing perennial agriculture.

Surprisingly, plant diversity has no apparent effect on fungus diversity. In fact, monocultures of a few species, such as Eastern gamma grass and Illinois bundleflower, fostered fungus communities that were often more diverse than those of polycultures. Moreover, fungus diversity in such monocultures was at least as high as in the native prairie. For mycorrhizae, plant identity may be more important than plant diversity.

We have launched a two-year study to assess whether associations between plants and mycorrhizae depend on a plant’s functional group, species identity, or both. An experiment in pots will identify the distinct fungus communities associating with 23 species of warm season grasses, cool season grasses, legumes, and composites. These are the same four plant guilds that make up the native prairie, and thus they will form the backbone of Natural Systems Agriculture’s perennial polyculture. The results of this experiment will demonstrate which combinations of plant species are required to foster optimal fungus species.

For more about mycorrhizae and wheat, see the story in this issue.

Natural Systems Agriculture Advisory Team

Staff members Van Tassel and Yoder Graber visited NSA Advisor Stephen Jones at Washington State University at Pullman, where he is a professor, to see perennial wheat in the field, to review the greenhouse work, and to discuss NSA research.

NSA Graduate Research Fellowship Program

The program has succeeded in several key respects. First, we have approximately equal representation of fellows from ecology and agronomy departments. NSA is distinctive in its emphasis on drawing from both of these disciplines. Second, the research projects initiated by the fellows are relevant to the long-term research agenda for Natural Systems Agriculture. Every major category on our long-term agenda is represented by at least one fellow. Two fellows are working in agroforestry, which is outside The Land Institute's NSA agenda but within the global NSA paradigm.

Fellowship Awards

Fellowship awards were announced May 1. Fellows are **James Byun**, agronomy and plant genetics at University of Minnesota-Twin Cities, working on nitrogen fixation; **Carol Gordon**, agronomy at University of Maryland, working on legume-grass relationships; **Katherine M. Howe**, zoology at University of Washington, working on grassland ecosystem invaders; **Melody Ng**, ecology, evolution and behavior at University of Minnesota, working on pathogens and insect pests; and **Robin Sears**, environmental research and conservation at Columbia University, working on seedling ecology and management.

NSA Short Course for Undergraduates

In our second short course June 16-18, students and staff discussed agronomy and agriculture and interdisciplinary scientific approaches. Students represented Kansas State University, University of Kansas, University of Montana, Marlboro College, University of Missouri-Columbia, Carleton College, and Northland College. Their discussions and questions were excellent. The interchanges resulted in a lively and educational weekend, and we hope some of them will seriously consider this new kind of agricultural research for their graduate careers.

Research Achievements of NSA Fellows

Charles Mitchell's work with internationally recognized ecologist Dave Tillman shows that native grass species grown in species-rich mixtures have lower levels of fungal disease than those in species-poor situations. This confirms one of the key predictions of NSA: mimicking the species diversity of natural systems is the best way to avoid disease problems.

Mitchell also showed that nitrogen fertilization increases foliar fungal disease levels for many prairie plant species. Again, this finding supports our analysis that high-input agriculture demands ever-greater inputs. Adding fertilizer may require adding fungicide.

Controlled burning during the dormant period can reduce disease levels. This discovery may help us understand and use fire in maintaining the productivity of many natural systems.

Corey Samuels spent her graduate years programming a computer as part of her dissertation work based in part on data from Land Institute research plots.

These are long-term ecological research areas that Samuels helped establish when she was a Land Institute intern. Each year, the plant communities in these plots have been characterized. Samuels helped take this field data for several years.

She put the data from the entire time of the study into a computer model of ecological community assembly. This model is based on the starting conditions — species diversity, soil productivity, etc. — and upon the history of invasions and extinctions before the study.

It could help build a larger model that we want for designing stable, productive systems. This larger model would help us tailor seed mixes for each farm field based on cropping history and site characteristics such as soil type and climate.

Dana Blumenthal believes that perennial plant systems such as NSA polycultures are a key to controlling noxious weeds in the landscape.

He hypothesized that weed epidemics occur primarily because so much of our landscape has been disturbed and tilled. Native prairie can out-compete weeds, but by constantly tilling and poisoning weeds, we create the environment in which they thrive. In contrast, NSA proposes to fill the landscape with prairielike fields. Blumenthal's data show that restoring prairie vegetation controls a broad spectrum of weeds. He says the weed control value of NSA "is not likely to be limited to just a few weed species."

In one experiment, Blumenthal investigated ways to re-create a prairielike soil using sawdust to control weeds in the first few years while perennial plants are establishing. His results may directly lead to a change in the way that we establish experimental perennial polycultures.

Sunshine Farm

The eighth field season of the Sunshine Farm project is in full swing. Next calendar year, 2001, will complete the data collection. During 2001 and 2002, the massive database will undergo a final analysis and be prepared for a book to make project results widely available.

Sixteen Longhorn Calves

The farm's longhorns, grazing on 160 acres of native prairie grasses, were the first subject of conversation in the office most April mornings. Unassisted cows birthed 16 healthy calves. The appealing scene now in midsummer on good prairie grass is a herd of 18 cows, 16 calves, 14 yearlings, and a bull.

Papers

We reported last issue on three papers, all of which are now in print. One or more of them soon will be available on our web site. Six other papers are moving toward publication or are in the data analysis stage.

Rural Community Studies

Reading the Landscape of Home

Our June 16-19 teacher workshop was introduced in the last issue. Twenty-three teachers from three school districts in our consortium attended Reading the Landscape of Home, a model of interdisciplinary, place-based education concerning watersheds.

Fieldwork included studying upland and lowland prairie plants, sampling soils, mapping streams, and testing water. Teachers gathered in our Matfield Green schoolhouse for discussions of water quality, public health, archeology, geology, and art of the Kansas landscape. They wrote journals indoors and out. They will prepare study units and projects to use in class.

Success came from the camaraderie of dedicated teachers reviewing mutual interests. Stimulation was added by presenters from several universities, other high schools, the state geological survey, the state departments of health and environment and parks and wildlife, a graduate student intern, the Kaw Valley Heritage Alliance, Land Institute scientists, local residents, and our education director. Comfort came from good food and a beautiful ecosystem. Welcome came in a potluck with the community. Reward is the rededication of good teachers to the excellence of a life's work.

A major grant is funding teaching materials and expenses for projects proposed by teachers, as well as teacher training and renewal in the three consortium school districts.

We emphasize place-based education, and we foster ever-richer community-school cultures that build on a goal of greater ecological sustainability.

Student Projects

In the **Flinthills School District's** Cassoday School, the children in kindergarten through grade two transformed a weedy city lot into a Prairie Park across the street from the Cassoday Cafe and a short walk from school. The children worked with 24 community volunteers and signed their work with stepping stones that recorded their names and handprints.

The district high school students planted a 500-tree windbreak just south of their school. Next year the project continues: they will replace five acres of European grass with native plants to restore their site as a tallgrass prairie. This will become their outdoor classroom for research and prairie management.

Chase County high school students researched the history of their courthouse from materials outside the school and will provide videotapes of their findings for visitors to the courthouse in Cottonwood Falls.

Chase County elementary students landscaped with

native plants and limestone walls near the main school entrance. With Zilia Estrada, a University of Michigan graduate student intern to The Land Institute's Rural Community Studies, the children studied and devised strategies to repair erosion of their playground.

In the **Baldwin School District**, fifth-graders of the Marion Springs Elementary School turned to poetry writing after a year of keeping journals of their observations of flora and fauna in the school's outdoor environmental center. Several poems were published in an anthology, *A Celebration of the Midwest's Young Poets*. Other students planted a Native American garden that they will harvest in the fall.

The Vinland Elementary children in a tiny village studied their community history and brought together parents and others to celebrate their Founder's Day. Out of that came their inspiration to create, with the help of a local artist, a school mural of the town's history.

Staff

John Mai started June 1 as facilities manager. A native of WaKeeney, Kansas, he holds bachelor's and master's degrees in botany from Fort Hays State University. He bills himself as a shade tree mechanic, has ample knowledge of farming, and will assist the Sunshine Farm and Natural Systems Agriculture research.

Aaron Peck is here for the summer as a maintenance worker. A recent graduate of Bethany College, he will attend Loyola University in Chicago to study theology and ethics. He has proven to be an adept painter (of buildings) and good handyperson.

Scott Bontz is here for the growing season as a volunteer. He is a Friend of The Land from California, has worked as a journalist, and for us has done many jobs, from baling hay to editing *The Land Report*.

Public Events and Notices

Prairie Festival

Prairie Festival 2000, "The Art of Living in Place," welcomed more than 350 participants, presenters, and guests.

The arts have played a prominent role in past festivals, but this was the first whose theme was art. It was organized by board member and arts associate Terry Evans.

The event was a weekend of ideas about art rooted in ecological values and pointed us toward a "community life at once prosperous and enduring," where "people, land, and community are as one," as The Land Institute's mission statement says.

The ideas presented expressed two important directions in eco-art: activist art as shown by Lucy Lippard, and beauty as discussed by Greg Conniff. Kati Kormendi showed examples from both directions. Ways of seeing and thinking about American landscape came from Merry Foresta and Bob Sayer. Don Worster and Brian Donahue gave us rich ways of thinking about and being of American

land and landscape. Participating artists were Joan Lederman, Jesse Sedler, and Scott Jost, and poets Harley Elliott, Twyla Hanson, Patricia Traxler, and James Thomas Stevens. Saralyn Hardy and Wes Jackson brought us to the heart of caring about our home landscapes. Musician John Walker and the Saturday night barn dance added to the festivities.

Half of those who attended represented Kansas and the balance 28 other states.

This Prairie Festival made a strong statement for the expression of ecological art in local places and its history.

Presentations

Staff members made presentations to a variety of audiences: the Kansas Academy of Sciences annual meeting, Kaw Valley Mycological Society, Kansas City Public Library program, Earth Day at Kansas City Kansas Community College, San Juan College distinguished scholar lecture series, local radio interviews about our Prairie Festival, a Yale University conference called The Good of Nature & Humanity: Connecting Science, Religion and Environment, the Luddite

Conference, and a Hastings Institute meeting called Systems Thinking and the Land Ethic. Wes Jackson led a three-day graduate course, Land and Community, at Northern Arizona University.

Visitors

Satish Kumar of Schumacher College, England, met with staff and then in the evening in a public presentation. Poet Pattiann Rogers joined staff and friends for lunch and conversation. She was in Salina to participate in the Poetry Series. Ole Faergeman of Denmark, an NSA advisor temporarily working at the University of California-San Francisco, talked to staff about his work and interest in Natural Systems Agriculture.

We also enjoyed groups of college students and professors, people attending a regional church group meeting, some on road trips across the country, National Science Foundation fellows from the Konza Prairie Summer Research Program for Undergraduates (12 fine students and professors), a Kansas State University plant pathology professor, and one from Allegheny College interested in rural education.

Audio Tape Order Form

Selected recordings from

PRAIRIE FESTIVAL 2000

"The Art of Living in Place"

Presented by The Land Institute • Salina, Kansas • May 26-28, 2000

Qty.	Session Title	Speaker(s)
	Saturday, May 27	
___ S1	From Forest to Sea*	Joan Lederman & Jesse Sedler
___ S2	Far Afield—How Landscapes Affect Our Lives*	Lucy Lippard
___ S3	Reclaiming The Commons: On Beyond Suburbia	Brian Donahue
___ S4	The Poetry of People and Place	William Kloefkorn
	Poetry Round Robin: Harley Elliott, Twyla Hansen, James Thomas Stevens, Patricia Traxler	
	Sunday, May 28	
___ SU1	Communicating Art with Nature as Measure*	Panel: Bob Sayre, Scott Jost, Katherine Kormendi
___ SU2	The Legacy of Landscape Photography	Merry Foresta
___ SU3	Down the Great Unknown	Don Worster
___ SU4	Landmarks Versus Monuments	Saralyn Hardy
___ SU5	The Need to be Versed in Country Things	Wes Jackson

*These tapes are visually enhanced with contact sheets of slides shown during presentations.



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