

Number 29

THE LAND REPORT

Spring 1987



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On the Cover

Patricia Boehner took the photographs on the front and back cover one spring morning during a three hour prairie ecology class taught by Jon Piper on the Wauhob Prairie and the 90 acre Prairie Reserve. Terry Evans made the print for the front cover.



At The Land

Spring Report — by Bobbins

Translated by Patricia Boehner

A lot of activity is occurring at The Land these days, and my view of it all is a little different than most, considering eye level for me is ten inches off the ground. I'm Bobbins, the Jacksons' five-year-old poodle mix, and I've been asked to give my perspective of this season's events. My eyes do not "see" as acutely as some, but my ears and nose are finely tuned to the sounds and smells of The Land which offer an abundance of stimuli to saturate these senses.

My unofficial job here at The Land is to oversee all the goings-on. I accomplish this task with dogly duty as is inherent in my species. But even with such a distinguished job, I'm treated like just one of the guys. I keep track of who enters the buildings, who comes out, who is new and who has been here before.

There is a new group of interns, and they always add a special buzz around the place. They come from different parts of the U.S. and have slightly different accents of their common language. Their educational backgrounds are as varied as their accents: biology, religion, physics, range management, economics, geology and environmental studies.

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Arts Associate.....Terry Evans
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1987 Agriculture Interns

- Patricia Boehner: M.S., Forestry, Fisheries & Wildlife, Univ. of Nebraska
- Perdita Butler: B.A., Geology, Carleton College, (MN)
- Douglas Dittman: B.A., Environmental Studies, Univ. of Kansas
- Jess Ennis: M.S., Agricultural Economics, Ohio State Univ.
- Randy Kempa: M.S., Plant and Soil Science, So. Illinois Univ.
- Bruce Kendall: B.A., Physics and Env. Studies, Williams College (MA)
- Amy Kullenberg: B.A., Biology & Religion, Kalamazoo College (MI)
- Roger Lebovitz: B.A., Science in Society, Wesleyan Univ. (CT)
- Veronica Mecko-Ray: B.A., Biology, Grinnell College (IA)
- Research Fellow (second year intern)**
- Mark Gernes: M.S. candidate, Biology, St. Cloud State (MN)

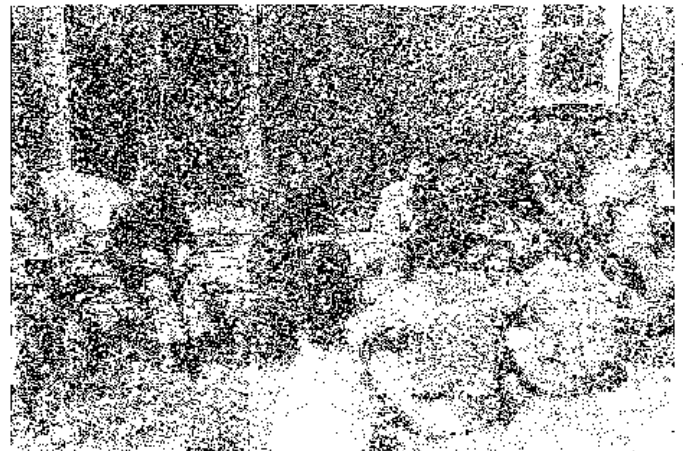
I typically start the day out on the porch of the classroom and listen to the birds chattering in their own language. Soon I see the first group of interns overtop the hill on their bikes. Having had to push against a south wind, their breathing is heavy, yet in "synch" with the sounds of a waking nature. Others come grouped in cars, and some come by foot, having walked about seven miles from town. I've learned to place myself at the front door of the classroom at the time interns and staff converge so that any free hands are compelled to pat me.

Occasionally, new faces and hands appear. As guests of The Land, they come to speak to the interns or to learn about the projects and programs offered here. I particularly like these visitor days because of the sound of new voices and the variety of smells from the potluck lunches held in their honor. Although I'm not allowed in the classroom, I get a pretty good idea of what was discussed inside because the interns carry the conversations and ideas out into the fields for further dissection.

A number of guests have come to The Land to see what is here and to share what they are doing. Maureen Hinkle, from the National Audubon Society in Washington D.C., gave us her insights on the business of lobbying in Congress and the Society's program for public education. Miguel Altieri from the University of California, Berkeley, gave a slide presentation on the application of agroecology using examples from other countries. Richard Wilson from the Dos Rios River Valley in northern California told how he had worked to help save a small community from being inundated with water from a state and federally backed water project of questionable necessity and purpose. Jerry Moles, from the Neosynthesis Institute in Sri Lanka, talked about forest gardens in Sri Lanka and the wisdom

of indigenous agriculture. Kansas State University Professor Cornelia Flora gave a seminar on the history of the capital crisis in agriculture and the impact of federal farm policy on farming systems.

More familiar faces and voices have returned to The Land for various reasons. Mari Detrixhe, formerly a student and research associate at The Land, updated the class on the world energy situation and U.S. policy. Paul Rasch, also a former Land student who is currently on the staff, presented the theories, efficiencies and applications of a variety of renewable energy systems and compared them with more conventional systems. Orville Bidwell, professor emeritus of Kansas State University, and member of The Land



Having lunch on the porch are (l. to r.) Rob Fischer, Bruce Kendall, visitor Richard Wilson, Randy Kempa, Jess Ennis, Amy Kullenberg, Jon Piper; (in foreground) Perdita Butler, Thom Leonard, Mark Gernes and Patti Boehner.



Jess Ennis, Peter Kulakow and Bobbins.

Institute Board of Directors, shared his knowledge on prairie soils and stressed the vulnerability of cultivated soils to erosion. Juli Kois and Michelle Cavigelli, 1985 Land interns, stopped by to participate in a warm-up session when they were in town to make last minute arrangements for the Kansas Organic Producers' annual meeting.

In addition to these new and returning guests, the regular staff fills most of the mornings with classes on ecology, plant breeding, genetics and how these disciplines relate to the components and character of a sustainable society. The rhythm of the voices during class discussions (as heard through the sliding glass door) is generally even and of moderate tone, with occasional interruptions of laughter or challenging remarks. After classes end around the mid-day sun, the interns and staff mill in and out of doors as they prepare lunches and stretch their legs. Between mouth-

fuls of peanut butter sandwiches and crisp Michigan Ida Red apples, debates often continue from issues raised during warm-up or class. At times, voices become tense and urgent as one intern presents an opinion or belief, but the ending tone is always one of laughter or camaraderie. My mind fades in and out of these conversations, as I'm usually concentrating on those pieces of unattended sandwiches or cookies. This tactic is employed only when the "jumping-up-and-down-and-make-a-fool-of-yourself- by begging" trick does not work.

The afternoons at The Land are a favorite time of mine. There are lots of people outside, and they are working on many different tasks. Afternoons begin with the clanging of hoes, shovels, wheelbarrows and buckets as the interns gather equipment for the field work. The distinctive odor of paint, varnish and newly sawn wood drift from the shop area. There are always odds-and-ends tasks to keep the interns busy on rainy days, like refinishing desks and painting signs. When the ground and sky are dry, however, work in the research plots, garden and prairies takes priority.

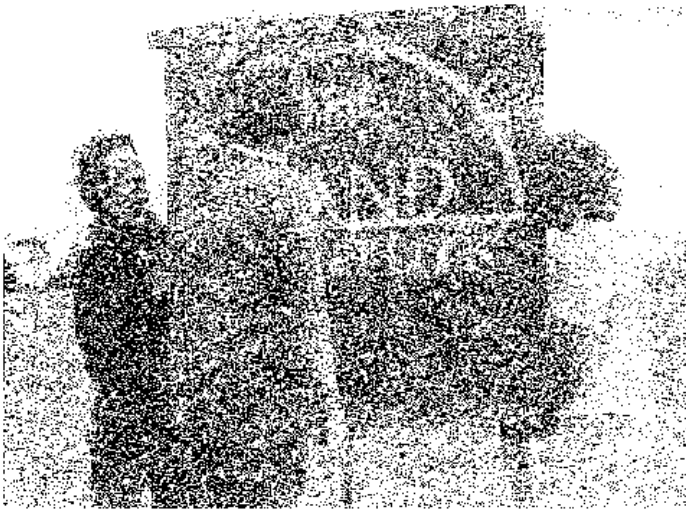
One project this spring was clearing the tenacious, thorned honey locust trees and woody underbrush from the edge of the Wauhob Prairie so that the prairie vegetation could again dominate. I avoided this project because the whining chainsaw was not kind to my ears. The buzz saw, attached to the Ford tractor and used to cut up the honey locust and hedge trimmings for firewood, was another noisy machine for me to avoid.



Veronica Mecko-Ray, Patti Boehner and Perdita Butler plant echinacea seeds in the greenhouse.

Thom Leonard and Roger Lebovitz mix soil.





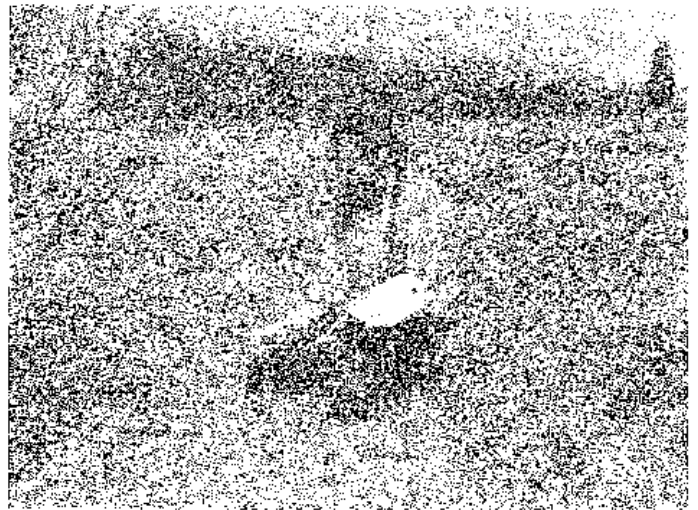
Doug Dittman levels new sign held by Jess Ennis and Bruce Kendall.

The greenhouse is usually a busy place at this time of year. In March and April the interns mixed soil and filled the flats outside on the porch adjoining the greenhouse. They planted, transplanted and watered inside the greenhouse. It was too crowded for me there, so I stayed outside even though I still managed to be underfoot. Both inside and outside the greenhouse, however, one can sense the heavy humidity, which seems to carry the smell of wet peatmoss and river sand. There is also the fragrance of the soil after being sterilized in the oven, which reminds my nose of the garden soil in August as it is "baked" by the sun.

Gardening afternoons are a special treat. The richness of the garden soil is expressed by the aroma of the organic constituents. On these days, Dana Jackson gets a chance to escape her office work to organize and oversee the planting and tending of the human food crops. She also has a wonderful way of keeping my dog dish full.

Next to the garden is the Herbarium which contains a sample planting of nearly 300 perennial plant species. The site offers colors and scents throughout the season as each species develops and flowers. The first flowers to open this spring were the pungent prairie parsley and the Easter daisy, which attracted frequent visits by interns and staff. Since the Herbarium is located between the classroom and the new office building, I pass through it frequently, as I keep people company while walking from one building to the other.

We spend most afternoons in the research areas of The Land. The interns and staff have been setting up the experiments. They prepared the soil for transplanting by rototilling (another noisy machine!) and laid out plots with measuring tapes and flags. At these times, I have an opportunity to get "closer" to the interns because of the squatting and bending required to do a lot of the work. I've found that placing one's body along the line of action



Patti Bochner takes data in the Herbarium.

(which may be a row of eastern gamagrass being dug up for transplanting) is bound to initiate a playful, wrestling response from the interns before I'm pushed aside. This technique is only good for a short while as getting the job done takes precedence over my entertainment.

There is always the unburned prairie nearby the research plots in which I can entertain myself. Stalking songbirds and rustling rabbits is a favorite pastime. Even though the previous year's growth of the prairie appears brown and lifeless in the early spring, I've found it abundant with life. It is also abundant with seeds and burrs, which have an affinity for my coat. Few long-haired mutts have the opportunity for access to a native prairie, however, so I can't complain.

Before I know it, the shadows from the standing tallgrass grow longer and, I hear the clanging of hoes, shovels, and buckets in wheelbarrows as they are carted back to the tool shed to be cleaned and put away. The voices of the birds and interns grow less urgent at this time of day, the laughter subdued, the songs quieter. The odor of human labor and dusty feet is stronger now, but it is mixed with the sense of accomplishment for a good day's work. The whir of the wind generator greets us as we near the buildings, and the bike riding interns look hopefully at the direction its tail is pointing to estimate the energy needed to pedal home.



New Members Elected to Board

At the annual meeting of The Land Institute on May 2, 1987, three new members of the board of directors were elected.

Mari Sorenson Detrix, Ames, Kansas, will fill the unexpired term of Richard Courter. Mari, a graduate in economics from Augustana College in Sioux Falls, South Dakota, was a Land Institute student and research associate from 1979-1981. She co-authored, with Diane Tegtmeyer in 1982, *Kansas Energy*, a three volume resource guide for community action. Mari served as executive director of the Kansas Natural Resource Council from 1983-1986.

Bruce Colman, Berkeley, California, was elected to a three year term. Bruce is an independent editor and publishing consultant who also writes book reviews for *The San Francisco Chronicle*. He formerly worked for Friends of the Earth and was the editor of the first edition of *New Roots for Agriculture* by Wes Jackson. With Wendell Berry and Wes Jackson, Bruce edited *Meeting the Expectations of the Land*, published by North Point Press in 1984.

The third new member of the board of directors will be Conn Nugent, Cambridge, Massachusetts. Conn has degrees in history and law from Harvard. He has worked for New Alchemy Institute, the Vingo Trust, and has been the executive director of International Physicians for the Prevention of Nuclear War for the past several years. On July 1, he will become Director of Five Colleges, Incorporated. He will be in charge of promoting and organizing collaborative activities among Amherst, Hampshire, Smith, and Mt. Holyoke Colleges and the University of Massachusetts.

The new directors fill positions held by founding members Bernd Foerster and Gordon Maxwell, who have served since October 21, 1976, and Richard Courter who joined the board in 1980.

Bernd Foerster is a professor and former Dean of the College of Architecture and Design at Kansas State University in Manhattan, Kansas. He has stimulated cooperation between The Land staff and faculty members at Kansas State University. Bernd presented a program on the preservation of historic architecture at the 1986 Prairie Festival and has advised The Land in designing our new greenhouse.

Gordon Maxwell is a Salina physician. His dependable attendance of meetings (even though his beeper might call him away), his clear attention to the business of The Land Institute, and, above all, his engagement in the ideas of The Land Institute have been of inestimable value to us.

Dick Courter, Salina busi-

Rodale to Speak in Salina

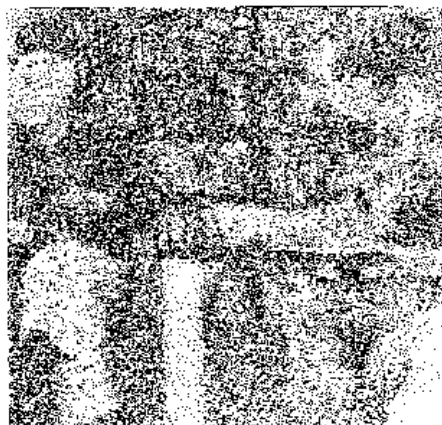
At the invitation of The Land Institute, Robert Rodale will spend a few days in Salina during the third week of June. In addition to serving as a visiting scholar in class sessions with students and staff, Mr. Rodale will meet with prospective leaders in the Salina community and also present a public lecture.

Imaginative ways to deal with the many serious challenges facing communities like Salina will be the topic of Robert Rodale's talk Monday, June 22, 7:30 P.M. in room 201 of Peters Science Hall at Kansas Wesleyan. Rodale is the chairman of both the Rodale Press, which publishes a wide variety of periodicals including *Organic Gardening*, *Prevention* and *New Farm*, and the Rodale Institute, which seeks ways to help revitalize rural communities. Over the past year, the Rodale Institute has worked intensively with people of Greenfield, Iowa, to restore the economic and social health of their town. The premise behind the Institute's work, and the focus of Rodale's talk in Salina, is the potential for people to regenerate their communities, much as natural systems can often regenerate when temporarily disturbed.

Like Greenfield, Salina faces a formidable array of social, economic and environmental challenges, both now and into the twenty-first century. Bob Rodale will visit Salina to discuss these challenges and how they might be imaginatively approached.

nessman, designed the original Land Institute logo in 1977 showing our first wind generator. He also drew two covers for *The Land Report* during his term on the board. While president of the Smoky Hills Audubon Society and the Kansas Audubon Council, Dick fostered cooperation between those organizations and The Land.

The May 2 meeting concluded with the board of directors expressing deep gratitude for the dedicated years of service by the three retiring members.



Bernd Foerster and Dick Courter



Gordon Maxwell

Land Institute to Sponsor

"Planting in the Dust"

"Planting in the Dust" is a one-woman, one-act drama in which Annie, a young farm woman, reveals her connection to the land and the satisfaction of farming it right. Annie looks at the dust billowing up from her neighbor's tractor and struggles with a deep sense of loss. It's not just dust to her. It is soil that feeds people. It is land that has been in her family since pioneer days. She reflects on generations past, on what the soil and its caretakers have weathered. And she wrestles with the present, with the emotionally charged issues of farming today. All around her land is a commodity; soil and water are abused, farmers lose their land, communities wane. Against this backdrop of loss, Annie holds up an ideal of harmony within family and community, and with the land.

The Land Stewardship Project (main offices in Stillwater, Minnesota) has sponsored over two hundred performances of this successful drama in the states of Minnesota, Nebraska, Iowa, South Dakota, and Arkansas.

This coming fall, The Land Institute will sponsor performances of "Planting in the Dust" in Kansas communities.

Laura Clark, the actress who originated the role of Annie, performed the play at the 1985 Prairie Festival. Nancy Paddock, poet/playwright who authored the drama, led a discussion following that presentation. Nancy is also the co-author, with her husband Joe Paddock and Carol Bly, of Soil and Survival, published by Sierra Club Books in 1986.

The Land Institute has applied for a grant from the Kansas Committee for the Humanities to present this program in Kansas. If funded, we will start the project this summer. We will hire a coordinator to make arrangements for free performances in ten different communities and an actress to play the role of Annie. Nancy Paddock will come to Kansas to hold auditions for the role. The actress will earn a set fee for each performance.

Following the 25 minute dramatic monologue, each program will continue with a discussion led one of three humanists: Dr. Janet Juhnke, Professor of English at Kansas Wesleyan; Dr. Phyllis Bixler, Professor of English at Kansas State University; or Dr. Tom Isern, Professor of history at Emporia State University. They will enrich the discussions from their backgrounds in literature of the Great Plains, women's literature, and agricultural history of the Great Plains as they guide the audience into consideration of issues brought up by the play.

If The Land Institute does not receive funding from the Kansas Committee for the Humanities to support this project, we still plan to choose an actress and develop the

program. Organizations or communities wishing to sponsor the play would pay all or part of the expenses of each performance (\$200-\$250). If we do receive funding for ten free performances, we will also make the play available to other groups who are able to pay expenses.

Individuals or groups who wish to discuss arrangements to sponsor the play should contact Dana Jackson at The Land Institute.

Former Interns Work for Sustainable Agriculture

Doug Dittman

Although former Land interns can be found in many parts of the country in diverse jobs, four of the 1985 interns now work at regional rural centers promoting sustainable agriculture.

In January of this year, Steve Ela began his position as Executive Director for the Nebraska Sustainable Agriculture Society (NSAS). He was hired by the Center for Rural Affairs to assist the NSAS, and he works out of the Center's office in Hartington where one of their programs, the Small Farms Resources Project, is located. Steve is trying to establish local chapters of the NSAS throughout Nebraska wherever there is interest. These chapters will promote the precepts of "low input" agriculture, such as reduced chemical use, while encouraging erosion control practices. The NSAS was originally formed in the 1970's as an organic farming society. Steve hopes to expand the membership to include more conventional farmers.

Michel Cavigelli and Juli Kois went to work for the Kansas Rural Center a year ago to compile an economic analysis of organic farming. The Kansas Rural Center in Whiting, Kansas, does research on rural water issues, works with farm support network groups throughout Kansas and monitors legislation relating to agriculture and rural communities in the state legislature. In the past couple of months, Juli and Michel have both been involved with the effort to pass a bill in the Kansas legislature setting organic certification standards. They also recently took on the task of co-editing the newsletter of the Kansas Organic Producers.

Holly Winger took a position with the Kerr Center for Sustainable Agriculture in Poteau, Oklahoma in January 1986. The Kerr Center does research and serves as an agricultural information and resource center for the area. Holly has recently been named Economic and Energy Analyst. She will examine the inflows and outflows of nutrients on the French Farm, a project of the Kerr Center, and supervise energy design of buildings being remodeled and newly constructed at the Kerr Center. Holly is also associate editor of the Kerr Center newsletter.



Design Process for Greenhouse nearly Complete

Paul Rasch

In and of itself, a greenhouse may seem a rather innocuous bit of technology. Glass encloses a scrap of land, creating an artificial environment for plants. For the Land Institute, this offers a chance to perform research which is not possible outdoors, at least not in the winter. But the idea of a research greenhouse also brings with it the potential for controlled "growth chambers", where scientists can further isolate their work from the forces of nature. Over a year ago, we began to think seriously about the utility of adding a greenhouse to expand our research possibilities. As a community, we have sought to plan a greenhouse which is responsive both in form and function to the goals of the Land Institute.

In coming to grips with what we want in a greenhouse and how we will use it, the staff at the Land Institute has been meeting to discuss various aspects of the idea. Our key concerns have been to design, build, and utilize a greenhouse which is aesthetically pleasing, energy efficient and, above all, useful to us in our research. We also see the need for the greenhouse to be a durable structure which requires a minimum of operational maintenance. With these parameters in mind, we have begun working out the details of the greenhouse and are steadily closing in on an overall plan for its design and operation. Now comes the monumental task of working out the specifics for the structure.

The questions of aesthetics and practicality have weighed heavily in all of our discussions. We will build the structure near the recently-acquired office building, probably in a sheltered niche just south of the offices and to the west of the three metal buildings which were also part of the new land purchase. One of these buildings recommends itself somewhat as a headhouse, a very necessary spot for potting plants, mixing soils, etc.. But this building is, at best, rather unsightly, and we have generally conceded that it must either be extensively reshaped or be replaced by a more visually appealing structure. Another possibility for the headhouse is to make it an integral connection between the offices and the new greenhouse. The problem with this idea is that it would further reduce natural lighting in the already light-poor downstairs offices and turn a rather nice view into a rather poor one. Currently, we are discussing a combination of these two designs, pictured in this article.

The technical specifics of the greenhouse have presented us with a few difficult dilemmas. For instance, in order to make the greenhouse useful for research both now and ten years down the line, we need a structure which allows as much light as possible. But by optimizing light, we run the risk of greatly increasing our heat loss in the structure. In the last decade,

a number of innovative structures have been built to resolve the conflict between light and energy efficiency. Most of these greenhouses have glazing only on the south side of the structure, thus preventing severe heat losses during the night. For the purposes of growing most vegetable crops, such structures perform very well. However, the plants we will be growing require more direct and indirect sunlight than these solar greenhouses can consistently supply, owing to their reduced area of glazing. Another idea which we have explored is the use of low-emissivity glass which transmits a high percentage of visible light but very effectively blocks the flow of heat out of a structure (R-values of seven are readily attainable with low-e glass units). The drawback of these glass units for our purposes is that they screen out parts of the solar spectrum which are essential to the flowering of grasses.

A single simple solution to this dilemma of light vs. energy conservation has thus far eluded us. The best scenario we have struck upon is the use of a reasonably good glazing (i.e. high R-value and high light transmittance), in conjunction with a system of night curtains which would add extra insulation during the nighttime. Several glazings seem to offer relatively high light transmittance as well as respectable R-values at a good price. Unfortunately, both are made from petrochemicals by the likes of DuPont, Inc. The first is a product which uses two films of ultraviolet light-resistant material to give an R-value of 1.75 while transmitting 88% of the available sunlight into the structure. This product is available from an English company called Serac and costs roughly \$2.50 per square foot. The other alternative is a triple-walled polycarbonate material which has an R-value of nearly 2.5 but a light transmittance, when new, of only 70%. The principle technical shortcoming of both of these products is their degradation under sunlight. The double film product is a polyvinyl fluoride, which is strong enough to jump on when new, but which becomes brittle with exposure to sunlight, giving it a life expectancy of ten to fifteen years. The polycarbonate products are yellowed by sunlight, which further reduces their light transmittance and results in a lifespan of five to ten years. A product quite similar to polycarbonate is acrylic, which does not yellow but becomes quite brittle and vulnerable to hail damage. Alas, there are no easy answers to the glazing question.

The energy inefficiencies of a conventional greenhouse are not attributable solely to the poor thermal performance of the glazing. Another serious shortcoming is the lack of thermal mass, which serves to temper the wild swings between the sunny hot daytime and the cold

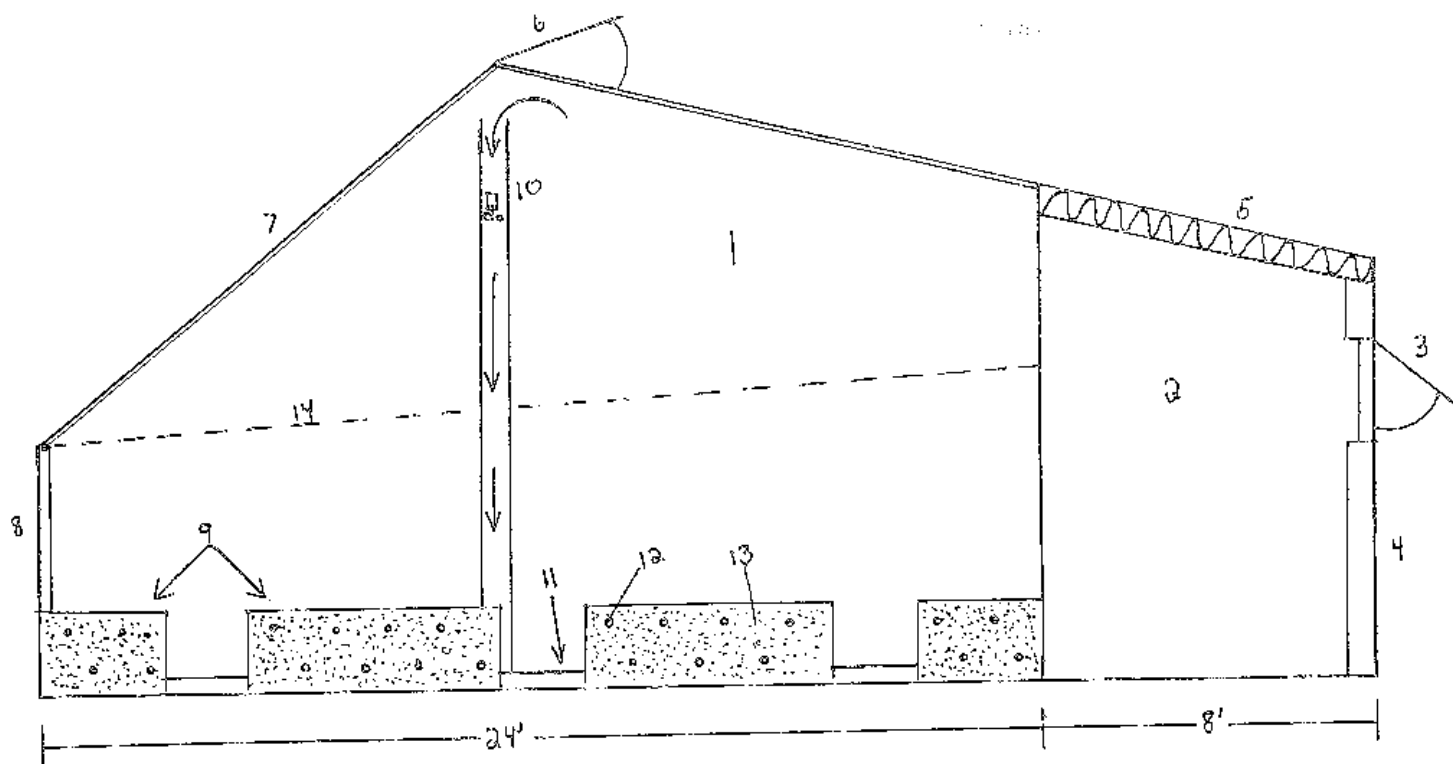


ILLUSTRATION EXPLANATION: The structure is divided into two parts: the greenhouse (1) and the aisle (2). The north wall of the aisle (4) will be a poured concrete wall, well insulated and earth bermed, with a vent window to facilitate evaporative cooling in the summer (3). The roof of the aisle will be insulated (5). The greenhouse will be glazed with a combination of Tedlar and Melinex films, stretched tight in an aluminum frame (7). The peak of the greenhouse will have a large roof vent to provide good

natural ventilation. The vertical south glazing will be of low-emissivity glass (8). Inside the greenhouse, four benches (9) will run the length of the units. These benches will be built of plywood and will double as a source of thermal mass for the recovery system, which will draw heat from the peak of the greenhouse (10) and distribute it via a plenum (11) and corrugated drainage pipe (12) into the crushed rock (13) located inside the plant benches. At night, we will draw a curtain horizontally across the greenhouse to reduce nighttime heat loss (14).

night. Since these greenhouses have little or no place to store the incoming heat, the air quickly becomes too hot and ventilation is required, even on a sunny winter morning. That same day, when the sun goes down the structure will quickly lose its heated air and the heater will kick in. A more reasonable approach is to provide a large thermal mass within the structure. During the day, this mass will heat up slowly and at night it will give off its heat to the plants. The efficiency of this heat-storing process can be enhanced by adding fans which pull air down from the peak of the greenhouse and circulate it through a storage medium like soil, rock or water. In our design, we will likely store the heat in the floor of the greenhouse, aided by a fan which will double as an air circulation device. A prerequisite of any heat storage system is proper insulation, which we will accomplish using common extruded styrofoam around the perimeter of the structure. As spring, summer and fall cooling of the greenhouse are also important, we expect to utilize this same in-floor storage system to help keep

things cooled down, by running cool air through the floor at night.

Despite our best efforts, the greenhouse will not be entirely energy self-sufficient. While we could probably build a structure to accomplish this, it would be prohibitively expensive. A possible source of backup heat would be a remote-sited array of solar collectors, which would heat hot water which could then be used to heat the greenhouse at night and on cloudy days. A second idea, which could even be used in conjunction with solar collectors, would be a high-efficiency wood burning boiler, which would likewise heat water which would then be circulated through EPDM tubing located just beneath the plants. By heating the soil rather than the air, significant energy savings can be realized. The EPDM tubing is expensive, but very durable and versatile.

A potential problem in our greenhouse is the depletion of carbon dioxide (CO_2) on sunny days. For conventional research greenhouses, this is seldom a problem, since they are typically made of glass which is lapped one pane on

the other, allowing a great deal of air, and hence CO₂, into the greenhouse. In a tightly sealed greenhouse, plants on a sunny day will consume most of the available CO₂, leaving them unable to sustain photosynthesis unless carbon dioxide is made available to them. One source of CO₂ is compost, which is part of the logic behind the composting greenhouse at the New Alchemy Institute. Another possible source of CO₂ is animals, although they would add considerably to the daily upkeep of the greenhouse. Perhaps a more practical idea for our purposes is to maintain a good bank of soil (which contains some CO₂-producing bacteria) in the greenhouse and/or use an air-to-air heat exchanger to bring in outside air without losing a tremendous amount of heat. One other possibility is to exchange air between the office building and the greenhouse.

From the discussion above, it should be obvious that we are still in the process of thinking out the greenhouse project. Slowly but surely, ideas are solidifying into a grand design, which is exciting in and of itself. But what is probably more exciting and interesting is the process of coming to terms with the challenge of designing an attractive structure which is not only appropriate to the specific needs of the Land Institute, but also responsive to the broader social imperatives which we face.



Paul Rasch, greenhouse design coordinator, is a former Land student (1980) and appropriate technology intern (1981).

ADDITIONAL NOTE: The Board of Directors voted at the May 2 meeting to employ F. Gene Ernst, AIA, architect from Manhattan, Kansas. Mr. Ernst will assist Paul with further site and building planning, prepare the construction drawings and specifications and evaluate and integrate the various operational systems and equipment.

James Scott Peterson

November 5, 1947 — February 17, 1987

Jim Peterson with Terry Evans founded the Prairie Festival in 1979. He was a Land Institute student (1978-78), but one who often taught us. A Ph.D. candidate in history at Rice University, Jim was working on his thesis about the irrigation history of the Arkansas River when he became ill from a brain tumor last fall. He died on February 17, 1987 in Burkburnett, Texas, where he and Jeanne Green (1979 Land student) and their son, Christopher Isaiah Peterson-Green lived.



When my eyes are shut
By peaceful death
No tears please.
No guilty eulogies,
Give me life-filled poems
Instead of flowers.
Yesterday your poem reminded me
of that
We will all be poets
Men and Women will sing the words
of pain and joy
In the still night
Like whales under the roof of the sea.

by Jim Peterson, 1978

New Roots for Agriculture

1987 Research Season Begins

Peter Kulakow

The early Kansas spring has provided a challenge to our field work as we venture into a new research season. A second mild winter allowed many plants to get off to an early start. Near record March rains ending with a hard freeze killed back much of the early plant growth. Yet, in the intervening warm and dry spells, we have managed to keep this year's research agenda on schedule.

As the research staff (Jon Piper, Peter Kulakow, Duncan Vaughan, and Wes Jackson) met in January, we formulated a preliminary five year plan for our research that guided our choice of the eleven experiments that will occupy us this year. We reaffirmed our commitment to the long term goals of uncovering principles of an ecologically sound agriculture and of contributing to a sustainable agriculture for the Great Plains prairie region. It was difficult to narrow our focus, but the general consensus was that by making greater progress on a few experiments we will lay a stronger foundation for reaching these goals. This year's projects will include:

1. Perennial sorghum: breeding and genetics
2. Patterns of seed yield in three herbaceous perennials: *Helianthus maximilianii*, *Desmanthus illinoensis* and *Leymus racemosus*
3. Survey of insects in prairie and research plots
4. Productivity and composition of the prairie
5. Soil nutrient dynamics
6. Investigations into a perennial polyculture of *Tripsacum dactyloides*, *Leymus racemosus* and *Illinoensis*
7. Effects of foliar diseases on growth and seed production in *Tripsacum dactyloides*
8. *Leymus* germplasm
9. *Desmanthus illinoensis* germplasm
10. Seed systems
11. Herbaceous perennial garden (The Herbarium)

Two projects involve close collaboration with researchers at other institutions. The perennial sorghum breeding program is part of a joint project with Paula Bramel-Cox, sorghum breeder at Kansas State University. The evaluation of effects of diseases on *Tripsacum dactyloides* (Eastern gamagrass) is part of a cooperative project with James Henson (formerly a Land Institute post doctorate) at the Kerr Center for Sustainable Agriculture in Oklahoma. In this experiment, plantings of Eastern gamagrass have been made at both the Kerr Center and The Land Institute to investigate the effects of different environments on disease incidence. Mary Handley will serve as consulting pathologist for this project at both locations.

Among our more ecologically oriented projects, several plantings at The Land have been established long enough for us to begin observing patterns of seed production over several years. This year we will harvest stands of Illinois bundleflower and Maximilian sunflower for the third year. The Leymus sward will be harvested for the second year. Studies on the productivity and composition of the prairie will continue for the second year in an expanded form. We will identify to species the



Amy Kullenberg, Randy Kempa, Patti Boehner and Jess Ennis transplant Eastern Gamagrass.

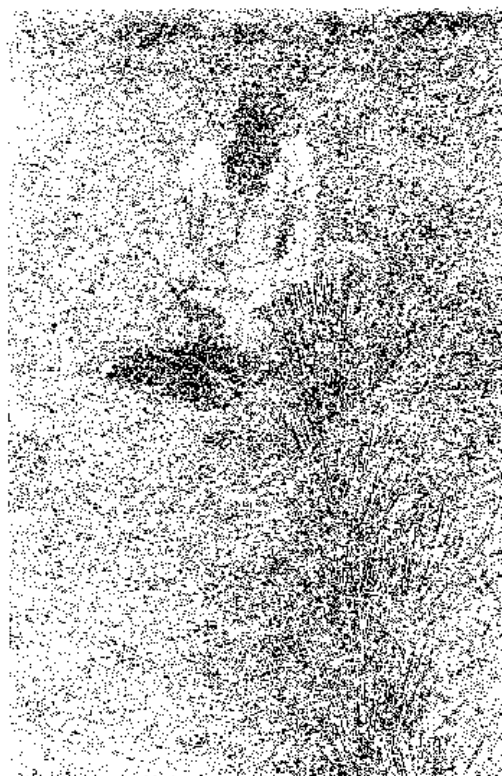


Peter Kulakow

plants sampled in this study. This will help us better understand how the prairie's resources are partitioned in time and space. We will also initiate a program to monitor the soil nutrient status of both the prairie and the research plots. Since this is a new endeavor, we hope to establish appropriate methods to monitor soil fertility.

Finally, we will emphasize the genetic preservation of our seed stocks and living plant collections. In the seed systems project, we will organize the handling and storage of our seed. Two other experiments will establish long term field nurseries for accessions of leymus and Illinois bundleflower. These plantings will facilitate evaluation and selection of plant collections for future breeding experiments. Another project will involve observation and management of the herbaceous perennial garden (the Herbarium) which was begun nine years ago by Marty Bender. The Herbarium now provides us with a living library of 270 winter hardy herbaceous perennial species, most of which are native to the prairie. It is most valuable for identifying and following the seasonal progress of prairie species.

Each ag intern has selected an experiment to follow closely during the term. At the season's end, the results will be presented in our annual **Research Supplement to The Land Report**.



Doug Dittman makes observations in the Herbarium.

The *Re*-search of Thoreau

Roger Lebovitz

"The re-searcher becomes in many ways like Thoreau in his walks around Concord."

Agricultural research conducted at the Land Institute is long-range and integrative in method, whereas conventional agricultural research focuses on short-term results attained largely with reductive methodologies. Researchers in conventional agriculture, as in industry, identify a single problem, seek a solution, find one and apply it. For agriculture, this process often creates more problems along with the solution. It fails in a practical sense. Also, in a theoretical, yet fundamental, sense, it does not constitute research as *re-search* or as a *re-searching*.

Although we too employ traditional scientific methodology, we seek to temper it with a complementary technique of *re-search*. The re-searcher makes observations with the goal of integrating them into a comprehensive vision or world view. We can only attain this goal through a deliberate search that attempts to include and build, rather than exclude and reduce. The means characterize the ends, and true discovery can only come through search.

The *Journal* of Henry David Thoreau offers a fine example of *re-search*.^{*} In his journal entries, Thoreau recorded thousands of intimate observations of the ecological life in Concord, Massachusetts. Donald Worster, in *Nature's Economy* (new edition, Cambridge University Press, Cambridge, 1985), has pointed out that the Thoreau of the 1850's, when the bulk of the journal was written, was substantially different from the more familiar Thoreau of Walden Pond. In this later time, Thoreau, living in town with his family, had settled down to the serious work of exploring Concord's history, not the history of its human inhabitants and their events, but of its woods, streams and ponds. It is in the post of inspector of snowstorms, noter of seasonal change and chronicler of natural history that Thoreau provides a model of *re-search* to the agricultural re-searcher.

You must be conversant with things for a long time to know much about them, like the moss which has hung from the spruce, and as the partridge and rabbit are acquainted with the thicket and at length have acquired the color of the place they frequent.

One reaches an understanding of the natural world through a kind of dialogue, much like an extended conversation among acquaintances. Through this process, repeated many times, one's knowledge becomes particular.

Details stand out in Thoreau's journal. They reflect both an ability to observe and a recognition of the need to observe in order to learn about one's locale. These qualities also belong to the agricultural re-researcher.

Steady fisherman's rain, without wind, straight down, flooding the ground and spattering on it, beating off the blossoms of apples and thorns, etc. Within the last week or so the grasses and leaves have grown many shades darker . . . How rapidly the young twigs shoot - the herbs, trees, shrubs no longer leaf out than they shoot forward surprisingly . . . Many do most of their growing for the year in a week or two at this season. They *shoot* - they *spring* - and the rest of the year they harden and mature, and perhaps have a second spring in the latter part of the summer or in the fall. The hedge mustard is out.

One result of this detailed looking is a certain familiarity with one's environment. This kind of familiarity, surprisingly, makes things already seen many times, seem new. It is precisely in the details of this discovery that the observer gains an understanding of connections.

Give me the old familiar walk . . . We'll go nutting once more. We'll pluck the nut of the world, and crack it open in the winter evenings. Theatres and other sightseeing are puppet-shows in comparison. I will Take another walk to the Cliff, another row on the river, be out in the first snow, and associate with the winter birds. Here I am at home . . . A man dwells in his native valley like a corolla in its calyx, like an acorn in its cup. Here, of course, is all that you love, all that you expect, all that you are.

When we use Thoreau's writings as a guide for re-research, we recognize the re-researcher as, fundamentally, a journal writer. This is not so much a technical distinction as it is the identification of a method. The re-researcher becomes

"One reaches an understanding of the natural world through a kind of dialogue, much like an extended conversation among acquaintances."

"To find out what it is the cropped field lacks, we must search the prairie many times."

in many ways like Thoreau in his walks around Concord. He employs the notion of a search as an outline of method. The goal of the work then becomes to look, to see, and from these observations make connections.

Here in Kansas, the prairie is our Concord. It is here where searching must occur, where the re-researcher must cover the ground again and again. To find out what it is the cropped field lacks, we must search the prairie many times. The journal that comes of this will help infuse prairieness into the cultivated field.

*Quotations in this article were taken from several volumes of the following edition: Bradford Torrey and Francis H. Allen, editors, 1906. *The Journal of Henry David Thoreau*, (Houghton Mifflin Co., Boston).



Perdita B., Doug D., Bruce K. and Jon Piper study plants on the 90 acre prairie reserve.

RESEARCH SUPPLEMENT READY

The staff and agriculture interns write reports on the results of experiments which are published in *THE LAND REPORT RESEARCH SUPPLEMENT*, edited by Jon Piper. The 1986 edition is now available. To receive a copy in the mail, send \$1.75 with the form below to *RESEARCH SUPPLEMENT*, The Land Institute, Rt. 3, Salina, KS 67401.

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Natural Connections

America's Rarest Gamebird

Amy Kullenberg

"Why is my alarm going off at three in the morning?" Doug Dittman asked himself as he stumbled out of bed in a semi-conscious stupor. Nearly an hour later, Doug repeated the question for our entire group of sleepy Land Institute interns. Indeed, why had our collective alarms rung, more or less collectively, at such an uncivilized hour? Furthermore, why had we all packed ourselves into a car which was cruising down a deserted eastbound I-70 in the middle of a starry and frozen Kansas night? Doug remembered for all of us: "Ah," he nodded, "the prairie chickens!"

Our drowsy group was making its way to the Konza Prairie Reserve near Manhattan, Kansas, to observe the annual spring booming of the Konza's greater prairie chicken population. "Booming" is the technical term for the "sequences of vocalization and behavioural displays of prairie chickens on their mating grounds," and is common among birds of the grouse family (Tetraonidae), to which prairie chickens belong.¹

Prairie chickens have been commonly named for their resemblance to the domesticated chicken as well as for their traditional habitation of the North American prairie. Taxonomically, all prairie chickens belong to the genus *Tympanuchus*, which refers to the drumlike air sacs located along the chickens' necks. At one time, four types of prairie chickens, identified according to specific differences and geographical variation, were found in the United States. The heath hen (*Tympanuchus cupido cupido*, L.), formerly lived along the northern Atlantic seaboard. Attwater's prairie chicken (*Tympanuchus cupido attwateri* L.), was indigenous to the Gulf Coast grasslands. The lesser prairie chicken (*Tympanuchus pallidicinctus*, Ridgway), inhabited the southern grasslands of Kansas, Texas, and southwestern New Mexico; and the greater prairie chicken (*Tympanuchus cupido pinnatus* L.), once flourished from Texas northward to Alberta, and as far east as Ohio.²

Of these four types, only two, the lesser and greater prairie chickens, survive in moderate

numbers. The heath hen has become extinct, and Attwater's prairie chicken has been preserved only in small numbers. Greater prairie chickens, which we were hoping to observe, now exist only in small and carefully monitored flocks in a few midwestern states. Fortunately, Kansas (along with Oklahoma, Nebraska, and the Dakotas), is one such state where greater prairie chickens can still be found, and the Konza Prairie Reserve provides an area where the birds can be preserved in an environment closely approximating their native prairie habitat.³

We were up and on the road at such a peculiar hour because the chickens "boom" most actively in the early morning. The preparatory instructions provided by Dr. John Zimmerman, professor of biology at Kansas State University, stated that we were to be in the observation booth (better known by avid avarians as a "blind"), at least one half hour before sunrise, which, for March 31st, was 5:42 a.m.

The booming itself usually refers to the activities of the male chicken preparing to mate, and involves a complex set of behavioral displays including tail elevation, wing flapping, foot stamping, head bowing, expanding of air sacs, yodeling, cackling, and flutter jumping. Males perform such antics in order to attract females to courtship, obtain a distinct mating territory, and establish a social hierarchy within the flock. Males demonstrating their social and physical superiority through booming activity are more likely to be chosen by a female mate, or, as there is some disagreement about which sex actually makes the selection, to mate with the hen of their choice.⁴

As we sat huddled in the blind, shivering with cold and anticipation, I recalled some of the literature I had read to prepare myself for the visit. One particular passage from Patricia Duncan's book, *Tallgrass Prairie: The Inland Sea*, in which she describes her first experience viewing the Konza chickens, came to mind. "As the faintest morning light appears, there is a flutter of wings right outside the tent, and I can barely see that thirty or forty chickens have appeared like magic."⁵ And no sooner had I recalled the passage, and the prairie chickens alighted on the lek.

Like magic the chickens swooshed onto the lek at 5:41 a.m., exactly 28 minutes before

sunrise. Although we couldn't see them clearly at first, we could detect their presence by the characteristic low-frequency "whoom-ah-oom" call (which sounds vaguely like a lower-pitched mourning dove, or the sound made by blowing over an open bottle top), audible in the background all during the booming ritual.

Looking at the Konza Prairie, with its chickens intact, gave me a melancholy feeling. How interesting it was to be hidden away in the blind spying on the chickens as they bloated their orange necks out to gargantuan proportions, ruffled their purple feathers up above their heads, and hopped away looking almost like bunnies from behind. How special it all was: last year's tall prairie grasses blowing in the wind, the stalks changing colors with the momentary progression of the sunrise, even the twinkling of the pre-dawn lights from Junction City.

But there was sadness in it as well—sadness that we've pushed the chickens onto a small facsimile of the habitat once expansively theirs, sadness in the fact that there are no longer some types of prairie chickens left, and sadness in the fact that humanity, as a part, is so estranged from the whole to which it belongs that we have nearly destroyed it with our notions of civilization and manifest destiny.

Walking back to the access road where we had parked the car, listening to the frozen earth crunch beneath my frozen feet, I recalled an article I had clipped from The Wall Street Journal (Feb. 3, 1987, p. 32) in preparation for the trip. "On the Trail of America's Rarest Gamebird" by Michael Pearce, which appeared barely a month before my visit to the Konza, described the pleasures associated with not watching, but hunting, lesser prairie chickens in southwestern Kansas. The article gave the following sportsman's account:

The hunter at the left of the line, the one who had yet to bag a bird, was quick to score. All watched happily as the flaxen dog gingerly retrieved the male prairie chicken to hand and sat proudly with the regal gamebird, America's rarest, in front of the successful gunner.

I turned around for a last gaze at the prairie, and thought to myself, "Somehow, they've missed the point."

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Untitled Poems by Jim Peterson

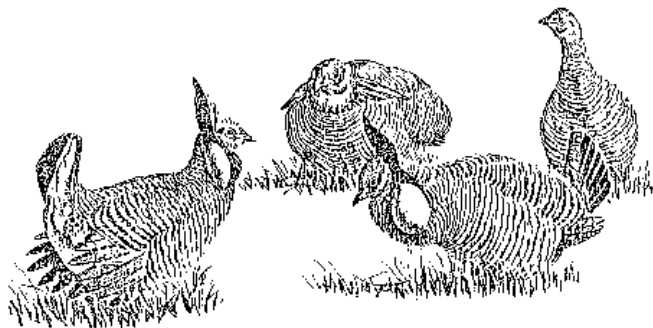
Dear ones
tonight consider Bert
a dog
deadbeat in the dog world
He comes to you
care of me
He was asleep in 100 degree weather
and died with his tongue
sticking out
his tongue was curled and purple on the edges
Bert was light
his body was easy to carry
bones hollow like a hawk's
Bert was probably a monk
in some other incarnation
a greedy abbot
His spirit was tested this time
as he died he dreamed of himself
happy to have lived.

Now he rots among the pruned limbs
of trees the coyotes tug at his bones
and sing their strange songs
His sagging muscles will make coyote meat
his curled tongue, coyote pups.

In the night the coyotes
sing of the legend of Bert
a dead beat in the dog world
who lapped water at the pond
and talked softly in the early morning.

* * * *

Stories make communities
As we, make ourselves
out of grass and trees
and the animals that haunt our dreams.
Shared events spun
out on warm afternoons
When memory flutters
close to vision.



Traditional Roots for Agriculture

The Grain Exchange

Thom Leonard

Traditional crop varieties of indigenous peoples, adapted to meet the unique requirements of culture and place, have been selected and bred by agricultural peoples over human and plant generations since the dawn of the agricultural era. Modern plant breeders have drawn on the resultant rich and diverse genetic information in developing modern agronomic varieties. Our agricultural gene pool is diminished when "advanced" high-yielding varieties are introduced to areas of indigenous agriculture, displacing traditional varieties (land races) with profound effect on both local agriculture and the diversity and amount of genetic information in the system. In addition to making the local agroecosystem more vulnerable and dependent upon inputs, the loss of locally adapted land races results in less material available for future plant breeding.

This issue of genetic erosion is usually addressed in the context of peasant cultures in remote places being overrun by the rampant spread of industrial society or of multinational, agrichemical seed corporations supplanting traditional land races with modern, chemical-dependent proprietary cultivars. How much genetic diversity has been lost right here along the tributaries in the Kaw River system, first when native farmers were displaced with the westward immigrant movement and again when advanced cultivars, varieties of corn belt dent, were introduced? Locally adapted varieties of both native and early immigrant farmers have been replaced by hybrid varieties with chemical and water responsiveness. Indeed, here in the Smoky Hill, Saline, and Solomon valleys, corn is hardly grown at all; hybrid "dent" (dent) corn just can't be relied upon to produce in our drier climate. While the yield of corn may have been increased, both its range and genetic diversity have been diminished.

This pattern has occurred throughout agricultural America. Part of the work of The Grain Exchange is to collect as many of these cultivars that still exist as family heirlooms or local favorites and make them available through a seed exchange.

In February of this year, coincident with the coming of the interns, The Grain Exchange moved to The Land Institute from Port Townsend, Washington, where I had spent a year working with Abundant Life Seed Foundation. During my time as a gardener with Abundant Life I began to lay the groundwork for the Exchange, which became a project of the Glorieta School in Carlton, Washington. By the end of the year, we had a hundred members, and we published the first

newsletter in January of this year. Port Townsend, with its maritime climate, proved to be a less than ideal home to the program. Our corn-growing project became of necessity "Maize for the Margins." It was chancey getting any cereal to ripen before the rainy season resumed in the fall.

While I was in Salina for a family visit in October, Wes and Dana Jackson invited me to move The Grain Exchange to The Land Institute. Since February, the Exchange has called the small solar office (formerly the battery shed) home. The Grain Exchange operates as a separately funded, independent project of The Land Institute. I get a certain ironic pleasure from telling visitors that I grow annuals here at the hallowed hills of perennialism, though, in truth, I believe that patches of locally adapted annual crops certainly will play a part in sustainable agriculture.

Pat Roy Mooney, who, through his work with the International Coalition for Development Action has been a leader in the genetic resources battle, and author of *The Law of the Seed and Seeds of the Earth*, maintains that the only way to preserve diversity is to use it. This belief is central to The Grain Exchange's approach to genetic preservation. We are creating a network of growers whose interest is not only in preserving genetic diversity, but, for many, extends to the growing of at least a portion of their staple grain. With members in western Washington, Maine, Florida, Nevada, Alaska, etc., we hope to assure genetic preservation by seeking, growing, and selecting varieties suited to our manifold desires, needs, and our many respective local environments, and exchange information concerning their culture and use.

Miguel Altieri, during his April visit to The Land Institute, spoke of the importance of *in situ* preservation of traditional agroecosystems, both to save complex traditional farming patterns from which we may design sustainable agriculture systems, and to preserve not just the existing genetic diversity of locally adapted varieties, but also the milieu of which they are a dynamic part. One of the goals of The Grain Exchange is to foster the growth of a diverse and dispersed agriculture in which cereals and other staple seed crops play an important part. In growing traditional varieties, suited to our local conditions and needs, we may begin to create *in situ* genetic preservation within the borders of the First World.

Growing from early spring plantings at The Land Institute and other Salina locations are seven varieties of naked-seeded oats, naked barley and wheat from the Himalayan valley of Zanskar (collected by an Exchange member), plus increases of einkorn, emmer, primitive barley,

and spelt from last year's Grain Exchange plantings in Port Townsend, Washington. Later plantings will include some thirty varieties of corn, including several Mandan, Potawatomi, Winnebago, and Cherokee varieties as well as several pre-Hybrid Era traditional Kansas cultivars, including "Pride of Saline," one which we are guessing may do particularly well here. If the crops are successful, seed of all of the varieties harvested by the Exchange this year will be available, at least in limited quantity, through the Exchange for the 1988 growing season.

The sources of seed for these Grain Exchange plantings include the USDA Plant Introduction Station in Ames, Iowa, and individual members' collections. A group of colored popcorn and Cherokee dent came from Carl Barnes's (Turpin, Oklahoma) extensive CORNS collection. Some cultivars we are growing this year have not been grown for twenty years. Our plantings of two others, a blue flour corn originally from what is now South Dakota and a Mandan yellow flour, may well be the largest of either variety in the last half-century. This will give us the chance to actually eat the corn and to offer seed to a much larger "audience."

Our interest and work is not limited to the crops and varieties mentioned above. An upcoming newsletter will include an article about small-scale rice culture in Kansas. Our first seed listing, published in March of this year, included offerings of buckwheat, amaranth, quinoa, all five economic races of maize (dent, flint, flour, pop, sweet), soybeans, flax, assorted wheats, rye, teff and sorghum: more than 100 varieties in 27 categories, offered by some thirty members in fifteen states and two Canadian provinces. These figures represent neither the total number of Grain Exchange members nor the full diversity that is represented by the Exchange. Total membership (not everyone has seed to offer) is 150 from thirty-five states and six countries. One Exchange member has a collection of several hundred

early-maturing soybean cultivars. Another has as many of wheat and barley. All Grain Exchange members are not small-scale farmers or gardeners; one farms over a thousand acres.

The Grain Exchange publishes a semi-annual newsletter and an annual seed list with member offerings. Basic annual subscription price is \$7.50 and entitles you to all regular Exchange publications and the privilege of listing wants and offerings with the Exchange, and requesting seeds from the listing. Canadian and Mexican subscription rate is \$10; all other foreign countries, \$15, all in US funds. Lifetime membership is \$250. All contributions above basic subscription price are tax-deductible. For a sample copy of the newsletter send \$2 to The Grain Exchange at The Land Institute.

Rediscovering Traditional Agriculture

Edward C. Wolf

The Worldwatch Institute

Agricultural research has been needlessly hindered for two decades by some pejorative attitudes toward traditional farming. Some scientists assumed that because peasant farmers produced low grain yields, their practices had little relevance to twentieth-century agriculture. Until recently, few researchers recognized the ecological and agronomic strengths of traditional practices that had allowed farmers over the centuries to maintain the land's fertility. In pursuit of higher productivity, many agricultural scientists overlooked the need for longterm sustainability.

Economic analysis of traditional farming reinforced the belief that traditional practices had little to offer in solving contemporary agricultural problems. In *Transforming Traditional Agriculture*, published in 1964, University of Chicago economist Theodore Schultz argued that peasant farmers were rational and efficient individuals who had reached the limits of their technologies. His conclusion: No significant increase in harvests could be achieved using only the resources and methods that traditional farmers had at their command. Schultz advocated investments in agricultural research, new technologies, and rural education that would allow traditional farmers to choose innovations to increase their productivity.

Many scientists and policymakers, however, saw traditional methods as an obstacle to be eradicated rather than a basis for introducing new seeds and farming methods. The food crisis in India and throughout Asia in the late sixties lent a sense of urgency to efforts to promote the Green Revolution. The strengths of traditional practices and the reasons for their persistence were swept aside. A report by U.S. President Lyndon Johnson's Science Advisory



Thom Leonard

Committee warned in 1966 that "the very fabric of traditional societies must be rewoven if the situation is to change permanently."²

Agricultural scientists have recently begun to recognize that many farming systems that have persisted for millennia exemplify careful management of soil, water, and nutrients, precisely the methods required to make high-input farming practices sustainable. This overdue reappraisal stems in part from the need to use inputs more efficiently, and in part from the growing interest in biological technologies. The complex challenge of Africa's food crisis in the early eighties forced scientists to reexamine what peasant farmers were already doing. Many researchers today seek to "improve existing farming systems rather than attempting to transform them in a major way," according to William Liebhardt, Director of Research at the Rodale Research Center.³

Traditional farming systems face real agro-economic limits, and can rarely compete ton for harvested ton with high-input modern methods. It is important to recognize these limitations, for they determine both how traditional practices can be modified and what such practices can contribute to the effort to raise agricultural productivity.

First, most traditional crop varieties have limited genetic potential for high grain yields. They are often large-leaved and tall, for example. These traits help farmers meet nonfood needs, supplying thatch, fuel, and fodder as well as food to farm households. Traditional varieties respond poorly to the two elements of agro-nomic management that make high grain yields possible: dense planting and artificial fertilizer. Despite these limitations, traditional varieties also contain genetic diversity that is

invaluable to breeders in search of genes for disease and pest resistance and for other traits.⁴

Second, peasant farmers often have to plant in soils with serious nutrient deficiencies, where crop combinations and rotations are needed to help offset the limitations. Many tropical soils, for instance, lack sufficient nitrogen to sustain a robust crop. Soils in vast areas of semiarid Africa are deficient in phosphorus. High-yielding varieties, more efficient in converting available nutrients into edible grain, can rapidly deplete soil nutrients if they are planted by peasant farmers who cannot purchase supplemental fertilizers.⁵

Traditional agriculture practiced under biological and physical limitations, often breaks down under growing population pressure. As rural populations grow, farmers try to squeeze more production from existing fields, often accelerating the loss of fertility. Or they may cultivate new, often marginal or sloping land that is vulnerable to soil erosion and unsuited to farming.

Nonetheless, traditional methods can make an important contribution to efforts to raise agricultural productivity. They offer what Gerald Marten of the East-West Center in Hawaii calls "principles of permanence." They use few external inputs, accumulate and cycle natural nutrients effectively, protect soils, and rely on genetic diversity. "Neither modern Western agriculture nor indigenous traditional agriculture, in their present forms, are exactly what will be needed by most small-scale farmers," says Marten. "The challenge for agricultural research is to improve agriculture in ways that retain the strengths of traditional agriculture while meeting the needs of changing times."⁶

Farming methods like the traditional agro-forestry systems of West Africa's Sahel region offer improvements in water-use efficiency and soil fertility that subsistence farmers can afford. Sahelian farmers traditionally planted their sorghum and millet crops in fields interspersed with a permanent intercrop of *Acacia alba* trees. *Acacia* trees fix nitrogen and improve the soil. In the Sahel, grain yields are often highest under an acacia's crown.

Fields that include acacia trees produce more grain, support more livestock, and require shorter fallow periods between crops than fields sown to grain only. *Acacia alba* naturally enhances productivity by returning organic matter to the topsoil, drawing nutrients from deep soil layers to the surface, and changing soil texture so that rainwater infiltrates the topsoil more readily. All of these benefits make farming on marginal lands more productive and profitable without requiring the farmer to purchase fertilizers year after year.⁸

Equally important, improvements in soil structure, organic matter content, water-holding capacity, and biological nitrogen fixation allow the most productive application of conventional fertilizers. Programs promoting acacia-based



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agroforestry could complement fertilizer extension in semiarid countries, agroforestry playing a role analogous to irrigation. Governments that have modest fertilizer-promotion programs may find that they can maximize the benefits from fertilizer by promoting agroforestry as well.⁹

Legume-based crop rotations and traditional intercropping systems share the advantage of husbanding organic material and nutrients much more carefully than modern monoculture practices do. While organic manures and composts contribute significant amounts of nutrients in their own right, they can, like agroforestry, also magnify the contribution of small amounts of artificial fertilizers.

Research in Burkina Faso illustrates the complementary effect. (See table.) This study looked at the contributions of straw, manure, and compost to sorghum yields with and without the addition of small amounts of artificial nitrogen. The results show that the most productive organic method, applying compost, can increase sorghum yields from 1.8 tons per hectare to 2.5 tons. Artificial fertilizer alone produced grain yields slightly higher than any of the organic practices. But the best result was achieved by combining compost with artificial fertilizer; this raised sorghum yields to 3.7 tons per hectare. The three organic practices increased the efficiency of nitrogen application by 20 to 30 percent. Given responsive crop varieties and small amounts of artificial fertilizer, traditional practices that cycle organic materials effectively would raise yields in the same manner.¹⁰

Some conventional analysts looking at the study would argue that fertilizer outperforms the organic practices. Yet exclusive reliance on fertilizer would sacrifice a significant part of the additional harvest. As French researcher Christian Pieri, who has worked in West Africa, points out, "Fertilization is a prime technique for increasing agricultural productivity in this part of the world, but in order to obtain a greater and lasting production it is indispensable to combine the effects of mineral fertilizers, the recycling of organic residues and biological nitrogen fixation, and also to optimize the use of local mineral resources such as natural phosphates."¹¹ Neglecting the local internal resources can undermine a farmer's investments in conventional inputs.

Intercropping, agroforestry, shifting cultivation, and other traditional farming methods mimic natural ecological processes, and the sustainability of many traditional practices lies in the ecological models they follow. This use of natural analogies suggests principles for the design of agricultural systems to make the most of sunlight, soil nutrients, and rainfall.

Shifting cultivation practices, such as bush-fallow methods in Africa, demonstrate how farmers can harness the land's natural regeneration. Farmers using bush-fallow systems clear fields by burning off the shrubs and woody vege-

Table: Complementary Effect of Artificial and Organic Fertilizers on Sorghum Yields in Burkina Faso, 1981

Treatment ¹	Sorghum Yield	
	without artificial Nitrogen	With 60 kg/ha Nitrogen
	(metric tons per hectare)	
No Organic Treatment	1.8	2.8
Sorghum Straw	1.6	3.4
Manure	2.4	3.6
Compost	2.5	3.7

¹All organic materials applied at a rate of 10 tons per hectare.

Source: M. Sedogo, "Contribution a la valorisation des residus culturels en sol ferrugineux et sous climat semi-arid." (doctoral thesis), Nancy, France: ENSAIA, 1981, quoted in Herbert W. Ohm and Joseph G. Nagy, eds., *Appropriate Technologies for Farmers in Semi-Arid West Africa* (West Lafayette, Ind.: Purdue University International Programs in Agriculture, 1985).

tation. Ashes fertilize the first crop. After a couple of seasons, as nutrients are depleted, harvests begin to decline, so farmers abandon the field and move on to clear new land. Natural regeneration takes over; shrubs and trees gradually reseed the field, returning nutrients to the topsoil and restoring the land's inherent fertility. After 15 to 20 years, the land can be burned and cultivated again.¹²

The bush-fallow system has obvious limitations. It requires enormous amounts of land, and when population pushes farmers to return too quickly to abandoned fields, serious environmental deterioration can result. Declining land productivity in crowded countries like Rwanda is testimony to this danger. But even disintegrating systems offer a basis for designing productive and sustainable farming practices.

Researchers at the Nigeria-based International Institute of Tropical Agriculture, for instance, have adapted the principles of natural regeneration in bush-fallow systems to a continuous-cultivation agroforestry system called alley cropping. Field crops are grown between rows of nitrogen-fixing trees; foliage from the trees enhances the soil organic matter, while nitrogen fixed in root nodules increases soil fertility. A high level of crop production is possible without a fallow interval. Traditional shifting cultivation provided the model for this system.¹³

Conventional research tools can also be used to overcome the agronomic constraints that have limited traditional systems to low produc-

tivity. For decades, crop breeders have tailored varieties to respond to high levels of artificial fertilizers, assured water supplies, and dense monoculture plantings. Working with the genetic diversity available in traditional crop varieties, they can apply breeding methods to produce varieties better matched to the conditions faced by subsistence farmers. At an Agency for International Development (AID) workshop on regenerative farming practices, Charles Francis of the University of Nebraska concluded, "A new generation of varieties and hybrids adapted to marginal conditions and to intercropping could be the start of a new revolution aimed at meeting the needs of the majority of limited resource farmers in the developing world."¹⁴

Traditional practices exemplify efficiency and the regenerative approach to agricultural development. Yet until recently, a kind of myopia has kept the research community from

recognizing the opportunities for agricultural innovations that lay in traditional practices. In West Africa, for example, 70 to 80 percent of the cultivated area is sown to combinations of crops in traditional intercropping systems. Cowpeas, one of Africa's most widely grown food staples, are always planted as an intercrop. But only about 20 percent of the research effort devoted to agriculture in sub-Saharan Africa investigates intercropping.¹⁵

As the African examples described here show, researchers can use traditional principles to develop new techniques that preserve the land's stability and productivity even as populations increase. Though traditional methods have limitations, they are not archaic practices to be swept aside. Traditional farming constitutes a foundation on which scientific improvements in agriculture can build.

(REFERENCES AND NOTES ON PAGE 24)

The Failure of Successful Agriculture in Mexico

Jess Ennis

What is the proper measure of a poor country's "development"? Is it the rate of economic growth? Is the ability of such a country to feed itself reflected in its agricultural growth rate? If so, then one would have expected to find Mexico sailing along, at least until recently, rather smoothly.

But Mexico is better described as sinking. Decades of substantial growth in both GNP and agricultural production have left the majority of Mexicans behind. This is not to say, however, that most Mexicans are insulated from their country's economic condition because, although most never have tasted the fruits of economic prosperity, they are certainly feeling the full brunt of their country's current economic woes: an inflation rate of 100%, a \$104 billion foreign debt, and a precipitous drop in the world price of oil, which accounts for half of the government's revenues and three-quarters of the country's export earnings.

The people hardest hit by Mexico's Crisis (spelled with a capital C in Mexico) are those living in rural Mexico. Of the Mexican families officially defined as poor in 1975, fully 75% of them were rural families.¹ The cruel irony in the countryside is that nearly 90% of rural Mexicans, the traditional food producers,² suffer from some calorie and protein deficiency.³ It is hardly any wonder that these people are migrating to Mexico City at a rate of 1,000 arrivals per day.

But how can this be in a country that for many years exhibited one of the world's highest rates of agricultural growth? To answer that, one must look closely at the nature of that growth and examine the historical development of Mexican agriculture.

MEXICO'S TWO AGRICULTURES

There are actually two agricultures in Mexico. There is the highly mechanized, capital-intensive, "modern" agriculture that produces Mexico's export crops and accounts for the majority of the country's irrigated farmland. In sharp contrast is the agriculture of peasant farmers who operate in rain-dependent areas and produce mainly staple crops for their own subsistence, along with some surplus for the domestic market.

It was chiefly the Mexican government's economic and agricultural development strategy, along with the technological innovations developed and introduced in Mexico by the Rockefeller Foundation, that molded Mexican agriculture into this classic bimodal system.

Since the 1940s, Mexican government policy has been to follow the path of the world's rich countries and industrialize. The Aleman administration (1946-1952) embarked upon a program of import-substituting industrialization and designed various government measures to promote domestic manufacturing of consumer goods and replace imports.

Agriculture was to play two key roles in Mexico's industrialization. First, agriculture was to provide cheap food to urban areas. The government began to subsidize the consumer price of staple foods, as it continues to do today, in order to stimulate industrial expansion. Cheaper food means a lower cost of living, which enables industry to pay a lower wage rate. This enhances industrial profit margins, and thus encourages industrial investment. Second, by exporting farm products, agriculture was to serve as an important source of foreign exchange earnings, needed in order to import machinery

and other capital goods essential for industrial expansion. World War II had already created a foreign (mainly U.S.) demand for Mexico's farm products, and this opening of the U.S. market paved the way for Mexican export agriculture.

To fully exploit Mexico's agricultural export potential, Aleman began to invest government funds in irrigation projects, mainly in the North and Pacific North. Heavy public investment in irrigation then continued through 1960s and slowed in the '70s when most of the land suitable for irrigation had already been developed.

Also in the 1940s, Rockefeller Foundation crop scientists set up camp in Mexico in order to develop high yielding varieties (HYV's) of corn and wheat that could be introduced into the Mexican countryside. The scientists developed those so-called "improved varieties" under highly controlled growing conditions in which water, synthetic fertilizers, and pesticides were applied as they saw fit. Thus, the HYV's were best suited to irrigated areas where stress from drought is not a problem and to growers who could afford chemical inputs. Unfortunately the scientists failed to consider the agro-climatic conditions and farming practices in areas without irrigation when they bred the new varieties. Under stressful growing conditions, the HYV's are usually not high-yielding at all, but in fact suffer more severely than traditional varieties.

Thus, the new breeds of corn and wheat were embraced mainly in the North where, with irrigation and increased use of agricultural chemicals and machinery, they fulfilled the promise of higher yields.

Because of the government's heavy investment in irrigation projects in the North, together with the introduction of the HYV's there, Mexico achieved one of the world's highest rates of agricultural growth in the '50s and early '60s.

Clearly, though, the public investment and scientific research, and the resulting growth in agriculture were not evenly distributed among Mexico's producers. Although roughly 90% of all public investment in agriculture was devoted to irrigation development between 1940 and 1965, 87% of Mexico's farmers had no access to irrigation by 1982.³

Although Mexico undertook an extensive agrarian reform during the Cardenas administration in the 1930's, scientific research and government investment and policy since then have favored the "modern," commercial sector and neglected the peasant sector. Perhaps it is not surprising that the commercial sector has developed to such an extent that, by 1975, large commercial farms, comprising a little more than 3% of the total number of farms in Mexico, actually produced 81% of the country's agricultural output.⁴

TOO LITTLE CORN IN THE COUNTRY

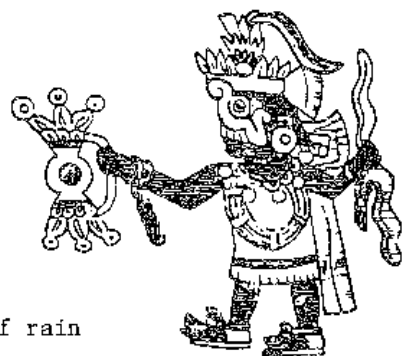
Mexico's agricultural development, although lopsided, did at least fulfill the goal of earning foreign exchange. Mexico became Latin America's leading exporter of cotton and its fourth leading exporter of coffee. It is a leading U.S. supplier of tomatoes and other winter vegetables, strawberries, melons, and cattle. For decades, Mexico maintained a positive agricultural trade balance, and proponents of the country's agricultural policy claimed that Mexico was successfully exploiting its comparative advantage in farm production.⁵

But in 1975, something happened unexpectedly, and, for the first time in history, Mexico became a net importer of food. Furthermore, the \$25 million agricultural trade deficit that year did not prove to be a mere one-year aberration.⁶ Rather, this deficit began to grow, and by 1981, Mexico's food import bill exceeded its agro-export revenues by over \$1 billion.⁷

The turnaround in Mexico's agricultural trade did not occur because of a drop in exports, but because of a dramatic increase in food imports -- mainly from the U.S. In 1979, U.S. agricultural exports to Mexico surpassed the \$1 billion mark for the first time,⁸ and by 1983, agricultural commodities accounted for almost a third of all of Mexico's imports, a proportion exceeded in the Western Hemisphere only by Haiti and Peru.⁹

The necessity to import larger and larger amounts of food arose because of a gap that developed between the demand for foodstuffs and the amount that Mexico produced, a gap that widened from both ends. While the demand for food grew rapidly, the supply actually declined.

The demand for food in Mexico has grown steadily for two reasons. First, there are simply more mouths to feed. In 1940 Mexico had a population of about 20 million. It is now home to about 80 million people. Then the country was predominantly agrarian, whereas today two-thirds of Mexicans live in urban areas, consuming food from the market. And although the population growth has slowed from an extremely rapid rate of 3.5% per year in the 1960s, it still speeds along at about 2.6% annually.¹⁰ Secondly, while the population was growing rapidly, aggregate income grew even faster. Between 1965 and 1976, gross domestic product grew at an average rate of 5.5% per year.¹¹ Generally, the poorer the country (or



Tlaloc,

Aztec god of rain

Yuum Kaax,

young Mayan god of corn.



family) the higher is its income elasticity for food (i.e., the proportion of added income spent on food). Unfortunately, although income increased per capita, precious little of that income growth trickled down to the poorest segment of the population. But even so, some portion of Mexico's increase in incomes was spent on food. Thus, because of substantial population and income growth, the demand for basic foods in Mexico increased rapidly.

Unfortunately, Mexico's staple food production did not keep pace with its growing food demand. In fact, farmland devoted to growing corn actually declined between 1965 and 1979, and the same was true for beans and wheat.¹² This paradoxical drop in supply, in the face of growing demand, arose mainly because of the government's pricing policies.

As mentioned earlier, one of the goals for agriculture was to provide cheap food to urban areas in order to stimulate industrialization. Because the government has maintained a ceiling price on basic staples, such as tortillas, the agricultural sector has been experiencing unfavorable terms of trade with the urban sector. The government, through its marketing agency, CONASUPO, is the country's main purchaser of staple commodities, and it has maintained a low price that it pays the farmer for those crops. In fact, adjusting for inflation, the farm price of corn began to drop steadily in the mid-60s; in 1982 it was 58% of the corn price in 1963.¹³

Naturally, low producer prices of staple crops such as corn create disincentives for raising staples for the market. Corn and sorghum thrive under similar growing conditions, but sorghum is more drought-resistant and is not subject to price ceilings. Thus, artificial price incentives unintentionally induced a shift by many growers from raising corn to raising sorghum (a livestock feed grain).

The widening gap between the demand for basic foods in Mexico and the amount the country produced had to be filled by importing food. In the latter half of the 1960s, Mexico imported a yearly average of less than 7,000 metric tons of corn.¹⁴ In the 1970s, however, yearly corn imports averaged over 1 million metric tons, and Mexico imported over 4.5 million metric tons of corn in 1983, almost all from the U.S.¹⁵ In 1982, imported U.S. corn accounted for 35% of Mexico's corn consumption.¹⁶

"SO FAR FROM GOD AND SO CLOSE TO THE UNITED STATES" — General Porfirio Diaz, President of Mexico (1876-1911)

Reliance upon the U.S. as a major supplier of food began to worry Mexican policy-makers, especially in light of U.S. rhetoric about "food power" and the "food weapon." Indeed, on several occasions the U.S. has visibly used food to exert diplomatic pressure. In the early 1970s, during the Nixon administration, the U.S. used the "food weapon" as one among a series of destabilizing measures designed to oust Chile's president, Salvador Allende. Soon after Allende took office, U.S. wheat shipments to Chile, which had covered as much as a third of the country's wheat consumption, slowed to a trickle. Immediately after Allende was murdered in a military coup in 1973, the U.S. opened the food floodgates to the new government of General Pinochet, granting soft credit for \$52 million worth of wheat and corn purchases.¹⁷

In a much more highly publicized maneuver in 1982, President Carter suspended delivery of \$2.6 billion of wheat sales to the Soviet Union, retaliating against the Soviet occupation of Afghanistan.

Thus, it became evident that Mexico's reliance upon the U.S. as an important supplier of food places the country in somewhat of a vulnerable position. Not only might Mexico have to make distasteful diplomatic compromises in return for stable supplies of U.S. grain, but reliance upon grain imports subjects Mexico's food supply to the vicissitudes of the international market, over which Mexico has no control.

REPAIRING AGRICULTURE

In order to move Mexico toward self-sufficiency in basic foods, President Lopez Portillo (1976-1982) began an ambitious agricultural program in 1980 called the *Sistema Alimentario Mexicano*, or SAM. Through this program Lopez Portillo sought to achieve self-sufficiency for Mexico in corn and beans by 1982 and in other basic grains by 1985.

Lopez Portillo also apparently realized that the growth in the government-supported, capital-intensive commercial farm sector had left most of the rural population behind. So the SAM program was also intended to raise staple grain production and income in rain-dependent peasant agriculture and to improve nutrition in the country's most chronically undernourished areas.

The fundamental strategy of the SAM program was to provide price incentives for producing staple crops. Of the \$7 billion that the government planned to spend on the program from 1980 through 1982, \$4 billion was earmarked for elevating support prices.¹⁸ The guaranteed price for corn more than doubled during those years, and producer prices for beans and wheat rose nearly as much.

Through the SAM the government also lowered input prices on government-sold fertilizer and improved seeds and lowered the interest rate on

short-term credit for basic food production.

The SAM program, which lasted for 32 months, seems to have been at least a qualified success.¹⁹ Producer subsidies, intended to raise incentives for growing basic foods, appear to have done so. The area devoted to raising basic grains jumped to a record level in 1981. Yields also increased, and production of basic grains reached an all-time high that year.

There appears to be little doubt that the SAM program of raising producer incentives did indeed promote an increase in basic food production. There is considerable doubt, however, that those increased incentives actually reached their intended beneficiaries — namely, peasant producers in rainfed areas. It appears that the subsidies mainly benefited the commercial, irrigated sector. For example, despite the fertilizer subsidy, fertilizer use declined by at least 6% in seven rain-dependent states while it increased dramatically in the irrigated North.²⁰ While corn production tripled in Sonora (in Northwest Mexico) from 1980 to 1981, it actually declined in four states characterized by small-scale, rain-dependent agriculture.²¹ Thus, although Mexico did increase its production and lowered its import bill for basic grains, the growers who were better off to begin with captured the program's benefits.

Why did the SAM subsidy program fail to improve the lot of peasant producers for whom the program's benefits were ostensibly targeted?

First of all, it is probably not rational for a peasant family to adopt "Green Revolution," yield-increasing technology. Technological packages including improved seed and chemical fertilizer are better suited to irrigated areas. Given the proper amounts of water and nutrients, the improved seed varieties developed by the Rockefeller Foundation do outperform the local varieties raised in the same manner. During dry conditions, however, the performance of "improved varieties" drops drastically, and locally adapted varieties suffer less. Thus, technologies with profound sensitivity to drought are far riskier for farmers who rely on erratic rainfall than for those who have irrigation. Crop failures for subsistence growers are likely to cut right into their food consumption, which may already be inadequate.

Secondly, peasant growers typically raise crops in polycultures (e.g. corn, beans, and squash in the same field), which helps to keep pest populations in check. Such a system is incompatible with Green Revolution monocultural techniques which make use of herbicides that would kill bean and squash plants as well as weeds.

Thirdly, peasant farmers commonly distrust government programs and the government agents who try to convince them of those programs' merits. They may also wish to avoid going into debt, no matter how favorable the credit terms may be.

If Mexico is a typical example, as it appears to be in many ways, then developing, promoting, and subsidizing Western-style, "modern" agriculture in the Third World is probably an ill-advised strategy. Instead, greater attention could first be devoted to answering the question, "How is farming done there now?"

It is only by being sensitive to and recognizing the wisdom in traditional farming methods, developed over generations and adapted to local conditions, that more good than harm may be hoped for in attempts (by governments or others) to improve the lot of peasant farmers.

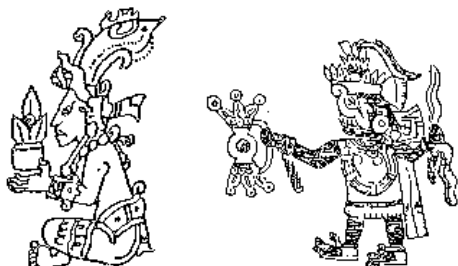
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This article was a paper presented by Jess Ennis, Land Institute intern, at the International Studies Association/Midwest Conference, Indianapolis, Indiana, in November 1986 and at the Institute of Latin American Studies Student Conference, Austin, Texas in April 1987.

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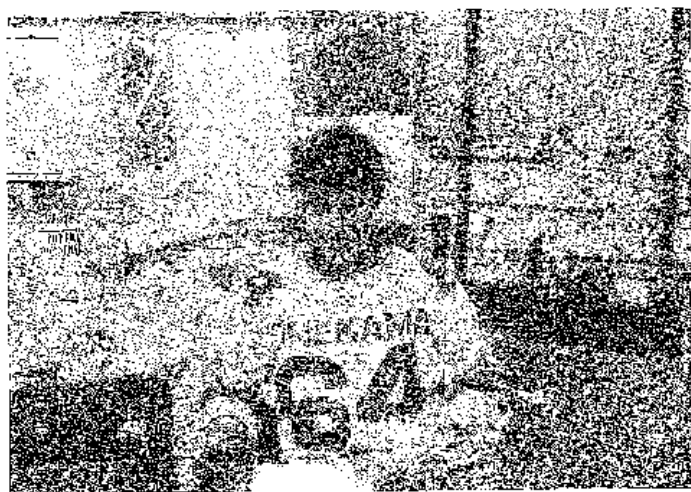
Agriculture Intern Program

For the past five years, The Land Institute has offered ten internships in sustainable agriculture for a 43-week growing season term beginning in mid-February and ending in mid-December. Grants from The Joyce Foundation and the Jessie Smith Noyes Foundation pay stipends of \$100 a week for living expenses. Students find their own housing in Salina, prepare their own meals, and carpool or bicycle the 5-8 miles from Salina to The Land. Everyone works in the large organic garden and all share the produce.

The Land admits students of any race, color, national or ethnic origin. Applicants should be college graduates or upper level undergraduates with good health and stamina. For more information, call (913) 823-8967.

REDISCOVERING TRADITIONAL AGRICULTURE REFERENCES AND NOTES

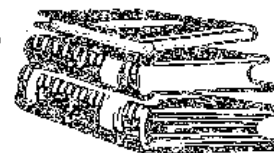
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Intern Amy Kullenberg in the classroom.



Jess Ennis and Maureen Hinkle



Green Fields Forever: The Conservation Tillage Revolution in America

by Charles Little, Island Press, 1987.

Reviewed by *Maureen Hinkle*

Charles Little has written a highly readable book about farmers who are innovative in farming, positive and secure about the future, and profoundly caring about their way of life. While writing about these farmers the author undertook, initially, a critique of conservation tillage. By the end of his journey, it became a "celebration" as he travelled around farm country observing farmers who jump out of the pages as real life heroes and heroines.

Their stories are full of rich images of the Palouse, the midwest corn belt, and the Southeast. A rain in Pike County in southeast Alabama on March 12-13, 1986, is described: "like standing directly under Victoria Falls...it was a turd floater." Little quotes farmers talking about compaction: "...no agricultural region can escape the perils of compaction...compaction goes so deep into the soil...Some of the grain buggies have 80,000 pounds on one axle. That's probably making the Chinese squeak, it's compacting so far down." (p. 122)

Throughout the book the innovativeness of these farmers is impressive. Drylander Mort Swanson's Old Yellow is a huge, no-till seed drill of a kind right out of Rube Goldberg. (p.68) Old Yellow can plant on a fifty percent slope in the Palouse. After Swanson rearranged his tool bar with paired rows, and deep banded fertilizer between the narrow rows, wheat yields increased by thirteen percent and winter barley by nine percent. Swanson's paired row planting feeds the crop (wheat) and starves weeds, and has the potential for cutting herbicide use fifty percent. Success comes "by applying his brains to the practice of agriculture rather than his backside to a tractor seat." (p. 103)

Little's celebration of conservation tillage concludes like a born-again convert to conservation tillage as he compares it to the internal combustion engine a century ago. (p. 191) He tells us it "may finally help bring about that most elusive goal for farming in America -- prosperity and stability-- which Jefferson envisioned for his American 'statesman'." Conservation tillage "may even rejuvenate the moderate-sized farm category by its economics of scale and may bring respect to the farmer as a professional, expected of lawyers, physicians and CPA's," and encourage farmers to stay on the farm, stemming the exodus of farmers. A true believer, Little states that conservation tillage can provide a fulcrum, an "organizing

principle," to help creatively meet the challenges of the structure of agriculture, rural life, and the whole economy of the United States.

In addition to this startling conclusion, I found three specific points which detract from this otherwise informative book. First, I am perplexed that Little characterizes environmentalists' concerns about herbicides as "missing the basic ecological point of it all." I believe that to the extent that conservation tillage maintains the natural integrity of the soil and adheres to basic ecological principles, it benefits farmers and our environment to the optimum.

Second, no new farming technique has been adopted so swiftly in the history of agriculture as has conservation tillage, Little tells the reader. The reason, he says, "is an astonishing array of new herbicides (over 100 compounds have been introduced since World War II) are now available to American farmers which are almost directly substitutable for cultivation, three-quarters of which is done to keep down weeds." (p. 14) The doubling of herbicide use in the past decade has brought a dramatic increase in residues of herbicides detected in ground and surface water, municipal water supplies and tap water. This is a risky trade-off.

Third, although conservation tillage is now employed on approximately one-third of cropland, it is probably only needed on a maximum of 200 million acres for erosion control. Thirty-seven percent of cropland is simply not eroding above tolerable levels. The most erodible acres should probably be put in the new Conservation Reserve, or planted to pasture, hay or wildlife habitat. Conservation tillage is, as Little observes, evolving, and in my view it should evolve where it is needed and where it can be employed without unnecessary risk to environmental quality or human health.

Finally, I find it strange that at page 183, Little claims the Conservation Reserve "isn't working" because "the farmer shouldn't take a hundred dollars an acre for land he may need to use for planting." (It's \$210/acre of corn on top of his bid in fiscal year 87.) How can fields be green forever on inherently erodible land devoted to intensive row cropping? Little's conclusions and single-solution approach to agriculture unfortunately mars the core of his narrative, which of itself is wonderfully informative and highly interesting.

MAUREN HINKLE, THE REVIEWER, visited The Land Institute in March. She is a lobbyist for the National Audubon Society, specializing on issues relating to pesticides in the environment.

New Books

Thom Leonard

Altars of Unhewn Stone: Science and the Earth

by **Wes Jackson**. 176 pages, 6 x 9. Cloth \$19.95, paper \$9.95. Available in July in bookstores or from the publisher, North Point Press, 850 Talbot Avenue, Berkeley, California 94706. The following description is excerpted from the publisher's spring catalog.

Science in modern times is increasingly becoming an esoteric enclave for a select few, a domain of formulas and jargon as remote and impenetrable for most of us as medieval metaphysics. In *Altars of Unhewn Stone*, Land Institute co-director **Wes Jackson** restores the critical link between science and cultural wisdom, showing that recent findings support traditional attitudes about farming, land and resource use, and the interrelations of cultural and biological communities. In this new book he issues an urgent call for a new view of contemporary agricultural problems, arguing that agribusiness interests have appropriated scientific contributions piecemeal, overlooking the larger picture and destroying much of what our traditional farming had respectfully preserved.

The essays vary from sustained and careful analyses of agricultural and scientific concerns to brief and often amusing discourses, sometimes eulogizing the beauty and wisdom of the salsala, the prairie tumbleweed, at others times attacking "pre-Copernican minds of the space age."

Jackson calls on us to recognize the underlying causes of current problems before it is too late. The solution, he argues, lies in an agriculture that does not break up human or biological communities, that minimizes soil erosion and reliance on chemicals and fossil fuels, that preserves the information contained in the genetic codes of plant and animal species now threatened with extinction. Jackson advocates an agriculture that is whole and healthy, sustainable and sustaining.

PRAIRIE: IMAGES OF GROUND AND SKY

by **Terry Evans**

with introductory essays by
Wes Jackson and Gregory Bateson

72 pages, 10 X 11 1/2", cloth, \$19.95
AVAILABLE IN MANY BOOKSTORES and from the
University of Kansas Press, 329 Carruth,
Lawrence, Kansas 66045, Ph. (913) 865-4154



Edible Plants of the Prairie:

An Ethnobotanical Guide

by **Kelly Kindscher**. 272 pages, illus. 5 1/2 x 9 cloth \$25.00, paper \$9.95. Available from the author (Rt. 2, Box 394, Lawrence, Ks. 66044), in bookstores or from Kansas University Press, Lawrence, Kansas 66044. The following description has been excerpted from the Kansas University Press spring and summer catalogue.

Based on plant lore documented by historical and archaeological evidence, *Edible Plants of the Prairie* relates how 122 plant species were once used as food by the native and immigrant residents of the prairie. Written for a broad audience of amateur naturalists, botanists, ethnologists, anthropologists, and agronomists, this guide is intended to educate the reader about wild plants as food sources, to synthesize information on the potential use of native flora as new food crops, and to encourage the conservation and cultivation of prairie plants.

By writing about the edible flora of the American prairie **Kelly Kindscher** has provided us with the first edible plant book devoted to the region that Walt Whitman called "North America's characteristic landscape" and that Willa Cather called "the floor of the sky." In describing how plants were used for food, he has drawn upon information concerning tribes that inhabited the prairie bioregion. As a consequence, his book serves as a handy compendium for readers seeking to learn more about historical uses of plants by Native Americans.

The book is organized into fifty-one chapters arranged alphabetically by scientific name. For those who are interested in finding and identifying the plants, the book provides line drawings, distribution maps, and botanical and habitat descriptions. The ethnobotanical accounts of food use form the major portion of the text, but the reader will also find information on the parts of the plants used, harvesting, propagation (for home gardeners), and the preparation and taste of wild food plants.

Kelly Kindscher is a former Land Institute student, currently living in Lawrence, Kansas, and working on a book on medicinal plants of the prairie. He is advising The Land Institute on a project to establish gardens of native edible and medicinal plants as an extension of the Herbarium.

Our Role in the Evolution of a Land Ethic

Dana Jackson

We named this organization "The Land Institute" when we incorporated in 1976 because it was to be a school at The Land. When Wes and I purchased the property in 1970, we referred to it as "the land." (I have since been amazed to find out how many other people first referred to their country places as "the land"!)

While we were building our house, we explored the river, and nearby fields and became acquainted with the plant and animal inhabitants. Out of a growing sense of place, we made "The Land" a proper name.

However, in 1976, we did intend for the title of the organization to imply more than the place where we started a school. It seemed important then to be reminding and teaching any who would listen that all physical resources for life came from the land. American confidence in human cleverness and invention was leading us to believe we could get along without nature, and our society was bent on destroying the long term ability of the land to support a variety of life and culture.

An "institute" has been defined as an institution for advanced education or "an organization for the promotion of some estimable or learned cause," (*Webster's Third New International Dictionary*). Our program for agricultural interns and search for sustainable agroecosystems qualifies us for the first definition. But we are not promoting land, *per se*. We are promoting an estimable cause, a right human/land relationship, although we cannot define precisely what that is.

Aldo Leopold tried to describe that relationship in his memorable essays about land in *The Sand County Almanac*.¹ He defined land broadly, dispelling notions that the word only referred to the ground we walk upon, or the space between cities. He presented the pyramid as a symbol of land (p. 251) and described the food chains which begin when plants capture energy from the sun. His definitions reflected the influence of economics and physics on ecology when he used the expression "land mechanism" (p. 251) and referred to soil microorganisms as "cogs and wheels" (p. 191). On the other hand, he spoke of the land "organism," (p. 190) a biological concept. In the essay titled "The Land Pyramid," he defined land in both biological and mechanical contexts:

Land, then, is not merely soil: it is a fountain of energy flowing through a circuit of soils, plants and animals. (p. 253)

In searching for a way to help people connect more responsibly to land, he used the



expression "land community" (p. 240). With this human, sociological image in mind, he defined conservation as "a state of harmony between men and land" (p. 243). To have this harmony, humans must stop defining land solely in economic terms. The evolution of a land ethic depends upon making decisions about land use based on whether an action tends "to preserve the integrity, stability, and beauty of the biotic community" (p. 261)

Thinking about the proper human/land relationship is the explicit focus of our 1987 Prairie Festival.

A land ethic changes the role of *Homo sapiens* from a conqueror of the land-community to plain member and citizen of it. It implies respect for his fellow-members, and also for the community as such. (p. 240)

This quotation from the *Sand County Almanac* appears on our Prairie Festival invitation, to make connections between the bicentennial of the U.S. Constitution and the centennial of the birth of Aldo Leopold. The connections can best be expressed in questions: How did we define land when this country was new and possessed an enormous frontier? What did our concept of citizenship bequeath to us and require of us? What new visions of land and citizenship do we need in order to continue inhabiting this section of the earth called the United States?

Many other definitions and questions will challenge the minds of Prairie Festival participants in the speeches, workshops and discussions addressing the 1987 theme, "Citizenship and the Land Ethic," some of which will be described in the summer issue of *The Land Report*.

When the Prairie Festival has passed, The Land Institute will still be learning and teaching about land. We want to be a part of that "thinking community" Leopold referred to, involved in the evolution of the land ethic (p. 263).

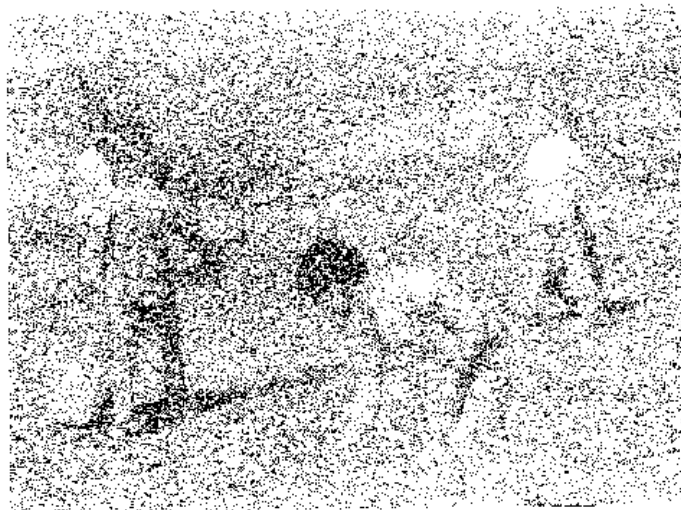
The research program at The Land Institute developed out of a what Leopold called a "discontent" with scientific agriculture (p. 260) Modern, high production agriculture has a dark side: fossil fuel dependency, soil erosion, chemical fertilizer and pesticide contamination of streams and groundwater, and the loss of farm families and rural communities. Through our research, we seek to develop an agriculture which can provide human sustenance for a long time into the future, an agriculture which is healthy for the entire land community.

The Land Institute curriculum for interns includes readings which stimulate discussions about the human/land relationship. Interns also take part in the physical work of healing land scarred by an insensitive agriculture. Each group helps with steps to repair the badly eroded land on the 160 acres we own across the road. In 1983 we planted prairie grasses on a hillside wheat field north of current experimental plots. The bluestem and Indian grasses were tall and thick last fall, and this spring interns helped burn the hillside. The replanting of prairie species last spring on other former wheat fields should begin to show results this summer. Terraces and prairie plantings will eventually stop erosion on the strip from the river to the top of the hill across the road. This spring, interns cut out thorned locust trees on the edge of the Wauhob Prairie to give native grasses and forbs a chance to dominate again, allowing the Wauhob Prairie to expand.

We must also be concerned about how land is used beyond the perimeters of our property. The negative consequences of conventional agriculture are serious and must be addressed: soil erosion, soil compaction, groundwater contamination from agricultural chemicals, erosion of farmers and rural communities from the land. We must not ignore the negative consequences to the land caused by our growth economy: construction of parking lots for malls and shopping centers on prime agricultural soil, underground burial of toxic chemical wastes from production of consumer products, oil exploration and development in wilderness areas, the conversion of rainforests in Central America into grazing land so that we may buy millions of cheap hamburgers in the U.S.

The end results of bad land use create painful awareness; the early steps are less noticeable. What is most difficult to address, but what must be changed, is the cultural frame of mind which understands land solely in economic terms and leads to short-sighted decisions about land.

In the past few months, Kansans have been concerned about the real possibility that low-level radioactive wastes will be buried under the farmland of our state. In efforts to stop the construction of the Wolf Creek Nuclear Plant several years ago, Wes Jackson argued that we would have no moral arguments against the burial of radioactive wastes in Kansas if we were producing them ourselves. Then we were afraid



Wes Jackson, Rob Fischer, Doug Dittman and Thom Leonard sow native grass seed.

that the federal government might use the abandoned salt mines in Lyons, Kansas, for high-level radioactive waste storage. The potential damage to groundwater and good agricultural land from leaks and contamination seemed a foolish risk. But Wolf Creek became a reality, and both high-level and low-level wastes now accumulate at that plant. To comply with federal law requiring each state to set up a low-level radioactive waste dump as a member of a regional compact or individually, Kansas joined a compact with Nebraska, Oklahoma, Arkansas and Louisiana in 1982. The Dames & Moore Engineering firm hired by the compact named *eighteen* counties in Kansas as having potential radioactive dump sites, all on agricultural land, even though Kansas produces the smallest amount of radioactive waste. Oklahoma, which produces the largest, had no locations named as possible sites. It is up to the developer, the company given the contract to handle the wastes, to choose the specific dump site based on information from this study.

Many Kansas citizens objected to this process once they became better informed. The compact had withheld the results of the Dames & Moore site study, but the Kansas Natural Resource Council obtained the results and made them public. Citizens of North Central Kansas, who organized to prevent the burial of wastes in Kansas, publicized the records of spills and problems occurring at other radioactive waste sites managed by one of the developers vying to get the job in Kansas and emphasized the potential dangers to Kansas.

The Kansas state legislature voted to ban the burial of radioactive wastes in our state, but did not vote to withdraw from the compact.

Those most concerned with this issue lived in counties with sites chosen by the Dames & Moore study. That dangerous wastes produced as far away as Louisiana could be dumped in Gove County, which produces no radioactive waste,

seems completely unjust to Gove County people. But society says, "Put the dangerous stuff where there are fewer people who could be affected--now." And society also is saying, through the economic system, that we do not need as many people on the land growing crops, that the accelerated unsettling of rural areas, like Gove County, is "natural." Our grazing land and farmland seems destined to be sites for storage of radioactive wastes. Thus urban populations make decisions, unaware or unconcerned that they are jeopardizing the long-term ability of the land to produce food, fiber and fuel for their descendants. With much the same perspective, farmers who plant continuous corn on hillsides and allow soil to erode are not concerned enough about the needs of future generations. We need a national consensus about land, understood by both rural and urban people, an ethic of land use which encompasses the problems of soil erosion as well as radioactive waste storage. We might then base land use decisions from the perspective described by Aldo Leopold.

Examine each question in terms of what is ethically and aesthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. (p. 261)

In 1972-74 I worked on the League of Women Voters' national land use study with the Sacramento, California League. We used an essay by Daniel B. Luten, (University of California, Berkeley, geography department) called "Empty Land, Full Land - Poor Folk, Rich Folk" in our study materials for all members. The following excerpts state so well our problem with land use in the United States:

...We came, poor people, into an empty continent. We devised resource management policies for an empty land and for poor people. Now the land is full, and we are rich beyond earthly precedent. Our needs have changed and, ever faster, still change. But we have failed to adapt, to invent resource policies to keep up. And so we stretch, warp, patch, wire up, lick and promise. But it won't work..."

In three centuries the United States has changed from an empty land to a quite full land. Once, if we wanted work done we dammed a rill and diverted its water. Once, if we wanted to get rid of anything, we threw it into the river, confident it would never be seen again...Once if we plowed up and down the hill and our cropland washed away, we moved on to new land. When men wanted land we gave it to them...

In recalling that period, think, please, in terms of systems of widely dispersed families and settlements. One man's actions did not disturb his neighbors; he was not a part of his neighbors' significant environment. The boundaries of their systems did not overlap...

But times change. Our technological capacity to change the face of the earth grew beyond all precedent. Our numbers too. We began to rub against each other. Cattlemen quarreled with sheepmen for a place on the range, that once infinite range. One man's sewage becomes another man's drink...

This simply says that in a full land, what one man does affects his neighbors. Each man is now a part of his neighbor's significant environment. The subsystem boundaries overlap endlessly. The entire resource system seems to encompass all activities, to be continent wide.²

The greatest resistance to land use restrictions can be found in sparsely populated areas where individuals do not see this as a full land. As far as they can tell, individuals can still do things on their land which will not affect neighbors. Yet, "the entire resource system seems... to be continent wide." These areas are affected by the fullness of urban areas, as exemplified by radioactive waste dump siting.

At The Land Institute, we will observe the bicentennial of the U.S. Constitution and the centennial of Aldo Leopold's birth by stimulating discussions about land, here among staff and students and in the larger community. We want to influence the cultural concept of land. Aldo Leopold recognized the need for such mental engagement (p. 263).

The evolution of a land ethic is an intellectual as well as emotional process. Conservation is paved with good intentions which prove to be futile, or even dangerous, because they are devoid of critical understanding either of the land, or of economic land-use. I think it is a truism that as the ethical frontier advances from the individual to the community, its intellectual content increases.

To engage in this intellectual process, The Land Institute is aptly named!

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1. All of the quotations are taken from the following edition: Aldo Leopold, 1966. *A Sand County Almanac*, (Ballantine Books, New York).
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Farm Policy for the Long Term



Mari Sorenson Detrixhe

The Harkins-Gephardt "Save the Family Farm Act," which would limit overproduction of wheat, feed grains, cotton, rice and soybeans, is an important turning point in our nation's agricultural policy debate. It confronts the prevailing produce-more philosophy with the assumption that producing less will improve our agricultural economy. Billions of dollars from the sale of farm commodities, priced to reflect the cost of their production, would infuse new life into the gasping farm sector; thus it would "save the family farm."

Yet, among those who welcome this change, important questions remain. The bill focuses on short-term benefits from curbing overproduction; the long-term effects on farmers and the land are a secondary concern. Increasing net farm income would be a major benefit, but several unintended impediments to equitable income distribution and organic farming could also result from enactment of the bill in its original form.

A farmer's ability to secure the net income benefits of higher food prices may be lost in the future, directors Marty Strange and Don Ralston of the Center for Rural Affairs argued in January of this year. As land changes hands, buyers will bid up its price to reflect the land's new income-producing potential.

"Eventually...the benefit of the higher commodity prices the program offers will be absorbed in higher land costs for every farmer, except those who received the original quota (right to produce) from the government. For everyone else, the quota will become just another expensive input that must be purchased."¹

Furthermore, the bill as originally drafted would disrupt the rotation schemes of organic farmers or limit their marketing options. Crops in rotation have not been recognized as valid uses of set-aside land. Organic farmers who already set aside about 30% of their acreage for alfalfa or clover would be required to take additional land out of production and rotation to qualify for the program under the Save the Family Farm Act. Because it is mandatory that a farmer enter the program to obtain the certificates needed to sell program crops, organic farmers would have little choice but to feed their grain to livestock.

Fortunately, amendments encouraged by Texas Agriculture Commissioner Jim Hightower and others may prevent or minimize these unintended effects.² Farmers with approved rotation and conservation plans would be able to obtain marketing certificates without additional set-aside under an amendment called the Rodale

Amendment. And through a series of special provisions, land speculation and concentrated ownership would be discouraged, with preference given to "family farmers" in rental and land sale arrangements. Clearly, though, this approach adds to the record-keeping and bureaucracy. In addition, for every amendment, it is possible that new, unintended harms may ensue.

Are commodity programs the best way to support diversified agriculture and organic farming? Do they provide equal opportunities for people to farm and own farm land?

The use of commodity programs to lower farm production may slow the desired transition to a more diversified and healthy agriculture. Farmers will tend to grow the few, eligible grains if they want to receive the certificates which ensure higher crop prices. Joe Vogelsberg, organic farmer and chairman of the Kansas Organic Producers, is concerned about the farmers who plant wheat or corn year after year. "Can they ever change that (with this program)? It seems to me that it ties us into our existing crops and the existing way we farm."³

The United States is overproducing grains, at a great loss to the fertility of much of our land. We are severely damaging the land's long-term productive capability when we permit the irrevocable loss of topsoil and its chemical sterilization. In our farm policy debate lies an opportunity to view the needs of the land as essential criteria for controlling production. A new agricultural policy could begin to replace this fly-high, crash and burn land ethic with one of long-term survival value by focusing on the *quality* as well as the *quantity* of land to be removed from production. Poor quality land could be targeted for permanent grass cover or rotation farming, so that actions to improve net income would also improve the health of agriculture for years (centuries) to come.

The responsibility for a healthy and diverse agriculture rests not only with policy-makers, but with all of us as farmers or consumers. Farmers can rotate crops, minimize their chemical, energy and water inputs, improve the diversity of their farms, and carefully consider appropriate uses for their hilly and erodible lands, while simultaneously improving their net income. Likewise, consumers can purchase fresh or locally grown foods to hold down their food costs while also benefitting from healthier, less processed food. Such options should not be precluded (better yet if they are encouraged) by farm policies and particular farm bills.

Still, the Harkins-Gephardt Bill is "a good vehicle to air out a lot of these issues," as director Bred Bentley of the Kansas Rural Center points out.⁴ It provides a refreshing counterpoint to the production and gross income emphasis of nearly all farm bills to date.

We stand at a critical juncture in the world of agricultural policy where the failure of past policies is painfully obvious. Now is the time to nurture a new ethic which values a healthy agriculture. Conservationist Aldo Leopold recognized the evolutionary nature of ethics when he noted that what is at one time considered a matter of "economics" and expediency (he cites slavery) may later come to be viewed as fundamentally wrong. Leopold believed that an ethic must evolve in the conscience of the people, and gradually Americans are coming to realize that it is not right to rape the earth or strangle the livelihood of those who grow our food.

The actions of Thomas Jefferson 200 years ago illustrate the value of preserving an evolving ethic in our formal social contracts. Were it not for his insistence that the Bill of Rights be included with the Constitution, we would be a

less democratic nation today. Likewise, as our agricultural ethic evolves, we must incorporate it into our farm policy and not view that policy as merely a matter of short-term expediency.

Great leaps forward in American history spring from times of turmoil. With proper nurturing, the pain of this crisis might give birth to a new form of farm policy which values both the people and the land which provide our food.

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4. Telephone conversation with Fred Bentley, May 5, 1987.

The Land Needs People

Wes Jackson

To continue to justify the industrialization of agriculture and the loss of people from the countryside, now that the results and consequences are all around us, is immoral.

Two chilling statements from the print media recently remind us of the long stretch ahead if we are to begin to turn the problem around. In a piece entitled "The Idiocy of Rural Life," which appeared in the December 8, 1986, *New Republic*, author Jeffrey L. Pasley, a native of rural Topeka, concluded his piece with the following: "Given the conditions of life on the family farm, if ITT or Chevron or Tenneco really does try to force some family farmers off their land, they might well be doing them a favor." Another fellow Kansan, John Marshall of the Harris News Service, wrote in a recent column, "Family farming...has outlived her use in the scheme of food and fiber production." These cruel conclusions surely are the products of hard headed realists, who are, according to Wendell Berry people who "use a lot less information than is available."

I won't propose any quick changes because most quick changes offer little in the way of staying power. Instead, I want to argue in favor of promoting a tendency in a different direction. Because of over-production now, we have some slack. We don't have to think in terms of gross production and gross income. We can begin to focus on sustainable agriculture and net income. We can begin to think of the arrangements which will promote sustainable agriculture.

We have seen that because our culture has made production the bottom line, that the resultant capital intensive mass production has contributed greatly to the farm crisis. Prices are

now low and inputs remain high. We have seen that, in spite of our assumptions, agriculture does have a connection to nature and to us and that we can't assume otherwise without putting the production capability of our terrestrial dowry and our own health at risk.

If we are to place agriculture back on its biological feet in order to meet the expectations of the land and the bona fide needs of people, I believe we must help the farmers who are still on the land and who want to remain on the land to stay. Once we have reversed the exodus from the countryside, we need to make it possible for even more people to return to the land and to our rural communities.

There are two main reasons for having a high rural population: first of all, *the land needs lots of people*; and secondly, of equal importance, *the culture needs a large and strong rural population*.

The reason the land needs lots of people is that if the productive capacity of the land is to survive, farming cannot be an industry or even an ordinary business. Farmers are working with that which is potentially renewable and life-sustaining, while industry is dependent on a completely extractive economy. Most of the rules for the renewable economy are of a fundamentally different order from the rules of the extractive economy. Since sustainable farming falls outside the realm of industry, land is not a resource in the sense that chrome or oil or rock phosphate are resources. When the non-renewables are gone, if we have properly cared for the land, it can still sustain our civilization. If we are to begin to move farming away from the category of industry (again, not all at

Farmers are working with that which is potentially renewable and life sustaining, while industry is dependent on a completely extractive economy. (CONT'D., PG. 35)

Will the Cornbelt be Relocated?

Ecological and Agricultural Effects of Increasing Atmospheric Carbon Dioxide

Jon Piper

During the last decade, climatologists and environmentalists have become increasingly concerned about changes in the composition of the earth's atmosphere brought about by recent human activity. A large part of this concern focuses on the dramatic 35% increase in the concentration of the gas carbon dioxide (CO_2) over the last century, and the consequences this rise may have for agriculture in particular and life on earth in general. Although the effects of changing carbon dioxide concentration on ecosystems are less perceptible in the short term than are the effects of acid rain or toxic waste, the ecological consequences of this change may be nearly as severe over the next century. The essence of the problem is its subtlety.

THE ROLE OF CARBON DIOXIDE

Unlike most atmospheric pollutants, carbon dioxide is a natural product of respiration by all organisms on earth. It is part of the earth's carbon cycle which links plants, animals, and decomposers with the oceans and atmosphere. Carbon dioxide is a trace component of our air, presently constituting less than 0.05% of atmospheric gases, the rest being mostly nitrogen and oxygen.

Despite this relatively small concentration, however, all life is ultimately dependent upon carbon dioxide. It is essential for the process of photosynthesis, in which green plants form glucose (a six-carbon sugar) from atmospheric carbon dioxide. Glucose is used both as a building block for carbohydrates and as an energy source for forming proteins, fats, and vitamins. Through photosynthesis, then, plants form the support system for the rest of the biosphere.

Carbon dioxide also contributes to the climate control that makes life on earth possible. Solar energy arrives here as a mixture of various long- and short-wave forms. Short and visible wavelengths penetrate the atmosphere and strike the earth's surface. Some of this energy is absorbed and the rest is reradiated as longer-wave radiation (heat). Because carbon dioxide and a few other trace gases are opaque to long-wave radiation, this heat cannot pass back through the atmosphere and is retained. In fact, the earth's surface is about 30°C (54°F) warmer than it would be without these gases. This is similar to what happens in greenhouses, where heat builds up due to the retention of long-wave radiation by glass.¹

THE INCREASE OF CARBON DIOXIDE

We know that in recent decades there has been an increase of carbon dioxide in the earth's atmosphere. Samples of ancient air

pockets in glaciers indicate that, prior to the Industrial Revolution in the mid-1800s, the concentration of atmospheric carbon dioxide was around 260 parts per million (ppm) or 0.026%. But largely through the widespread burning of fossil fuels, liberation of soil carbon via intensive agriculture, and tropical deforestation, carbon dioxide has risen steadily to its present concentration of 350 ppm. Although the composition of the atmosphere has changed during earth's history, this increase in carbon dioxide over the last hundred or so years is unprecedented. And, at the present rate of increase, atmospheric carbon dioxide concentration will double by the year 2050. Because carbon dioxide affects directly both plant growth and global temperature, a drastic change in its abundance could affect all life on earth.²⁻⁶

Nearly all scientists agree that a doubling of atmospheric carbon dioxide could lead to a two to four degrees C (3.6 to 7.2°F) rise in the earth's average temperature, bringing about the so-called "greenhouse effect". Moreover, this effect could be exacerbated by other gases (most notably nitrous oxide, ammonia, methane, and chlorofluorocarbons) being released through human activity. This increase in global mean temperature could severely alter seasonal temperature and rainfall patterns and partially melt the polar ice caps, raising sea level by 0.7 to 5 m (2.3 to 16 feet).⁷⁻⁹

Some scientists refute this scenario, however. For example, the climatic models devised by Sherwood Idso at Arizona State University suggest that the temperature rise will be minimal, as low as 0.26°C . Rather than warning of impending disaster, he and his colleagues stress the possible boon to agriculture an increase in carbon dioxide would provide and contend that the current rise in carbon dioxide level should not be suppressed. Yet, although differing in the extent of change predicted, all models devised so far suggest that the largest temperature increases will occur near both poles in autumn and winter and that midcontinental areas will be drier in summer.^{10,11}

Because carbon dioxide supply often limits photosynthesis, a higher concentration of carbon dioxide could stimulate plant growth and increase agricultural production. Plant scientists have found that increased carbon dioxide increases growth rate, flower number, and seed size, and alters timing of reproduction in some natural systems. And, across an array of grain and vegetable crops, agronomists have observed accelerated maturity, higher nitrogen-fixation rates in legumes, and a general yield increase of 33%.¹²

Moreover, because both uptake of carbon dioxide and loss of water occur through the same

pores (stomata) in plants, higher carbon dioxide concentrations would mean less water would need to be transpired from leaves to obtain carbon dioxide. Botanists refer to this as increased water use efficiency. Hence, the ability to withstand drought may increase with elevated carbon dioxide levels. Greater water use efficiency and drought resistance have been displayed by both weedy annual grasses and various crops under elevated carbon dioxide. For example, at Duke University, Alejandra Paez and associates found that tomatoes used water more efficiently when grown under 675 ppm carbon dioxide, which is roughly double the present concentration of this gas.^{13,14}

EFFECTS ON NATURAL SYSTEMS

Obviously, effects on climate and plant productivity can translate into major effects at the levels of the plant community and the ecosystem. For example, increasing productivity of mountain forests in Nevada has been pegged to the rising carbon dioxide level. Also, Arthur Zangerl and Fakri Bazzaz found that biomass of an annual weed community was 38% greater with a doubling of carbon dioxide concentration. Effects on the tundra ecosystem could be severe. The work of Dwight Billings and his Scandinavian colleagues suggests that the temperature rise from a doubling of atmospheric carbon dioxide could change the tundra from a net consumer to a net producer of carbon dioxide and thereby destroy the integrity of the ecosystem by increasing rates of litter and peat decomposition and lowering permafrost levels.¹⁵⁻¹⁷

Secondly, because carbon dioxide concentration does not affect all species equally, increasing amounts could change the mixture of species in the plant community and patterns of succession. For example, warm-season (C_4) plants (e.g. big bluestem) are less sensitive to higher carbon dioxide levels than are cool-season (C_3) plants (e.g. bluegrass). Hence, the species composition of the prairie, which is composed of both warm- and cool-season plants, could be radically altered as C_3 grasses and forbs come to dominate. Similarly, patterns of replacement could change if some species are more susceptible to drought than others during succession. Studies conducted in a forest community in Illinois indicated that hickory would increase relative to tuliptree on upland soils and sycamore would replace maple in lowlands if carbon dioxide were doubled. Changes in community composition can influence patterns of herbivory, where plant species differ in food value, and pollination, if flowering patterns change greatly.¹⁸⁻²⁰

Lastly, in some plants, the extra carbon dioxide is stored as starch in leaves, thus changing the carbon-to-nitrogen (C/N) ratio of the plant material. If the additional carbon dioxide fixed increases C/N ratio of plant material, then litter may decompose more slowly, and nutrient cycling rates within ecosystems could be altered.^{21,22}

EFFECTS ON AGRICULTURAL SYSTEMS

In addition to the disruptions of natural systems cited above, changing carbon dioxide concentration could affect major grain crops. researchers at Kansas State University in Manhattan showed that, with a doubling of atmospheric carbon dioxide, sorghum increased its total weight 34% and yield rose 31%. Moreover, sorghum required 24% less water to produce the same amount of grain as the control. Under similar conditions, corn has shown a 48% increase in total biomass and a 50% increase in ear weight. Lastly, agricultural scientists have found that doubling carbon dioxide increases soybean biomass 63 to 79%, yield about 30%, but seed protein declines 6%. The increase in crop water use efficiency may reduce irrigation in the future and enable some marginal arid lands to be brought into production. Unfortunately, most of the studies showing increased yield under high carbon dioxide concentrations failed to examine the effects of an associated rise in air temperature on these crops.²³⁻²⁶

Both the distribution and impact of weeds could change significantly, depending on their sensitivity to carbon dioxide level. Cool-season crops could compete better against such C_4 weeds as amaranth. Conversely, many annual C_3 weeds could be enhanced relative to such C_4 crops as corn, sorghum, and sugarcane.²⁷

Effects of increased plant tissue C/N ratio on insect pests are difficult to predict. For example, larvae of the soybean looper ate 30% more leaf material from plants grown under 650 ppm carbon dioxide than from controls. At first sight, then, one would expect an increased C/N ratio to increase plant damage by herbivores, offsetting the increases in plant productivity due to higher carbon dioxide. However, slower growth rates of soybean pests, resulting from lower nutritive value of high-carbon plants, can increase the insects' susceptibility to natural enemies. The final result may be a greater net benefit to less nutritional plants, although this remains to be tested.^{28,29}

Globally, an increased greenhouse effect could displace major agricultural zones by shifting climatic patterns. Greatest warming would occur near the poles whereas the largest changes in precipitation would be between 30° S and 30° N latitude. For example, the U.S. Corn Belt could shift to the northeast as summer temperatures become too high for corn and soybeans in Missouri, Iowa, Illinois, and Indiana. Moreover, even a 2° C warming could further reduce the already limited water resources in the western states. Finally, rising sea level could eliminate large rice-growing areas on deltas in south and southeast Asia.³⁰⁻³²

SHOULD WE WORRY?

Tropical moist forests represent only 7% of the earth's land surface, yet are being destroyed for wood products and pasture at a prodigious rate. Each year we are losing irrevocably about 92,000 km² (35,500 mi², an area the size

of Indiana) of tropical forest. Additionally, a similar-sized area is heavily disturbed by shifting agriculture and selective logging. At the present rate of conversion, complete destruction of the tropical forest, and attendant massive losses of soil carbon, will have occurred by the year 2135.³³

Is increasing carbon dioxide a mixed blessing? If it increases without a concurrent global warming, then we could observe significant increases in overall plant productivity, with benefits greatest in semi-arid areas. However, if the projected warming does take place, as most atmospheric scientists believe will happen, it could have severe implications for both natural and human-managed systems, especially in temperate zones. Prevailing uncertainty in climatic models does not mean that the problem can or should be dismissed, as future changes in climatic and ecological patterns resulting from altered atmospheric composition are inevitable. Unfortunately, because these changes are unprecedented, we have little idea how much change is environmentally tolerable.

Worldwide, the annual emission of carbon as carbon dioxide stands at 5 billion tons, or about 1 ton for every person on earth. In the U.S., however, we are releasing annually about 5 tons of carbon per capita, primarily through the combustion of oil and coal. The potentially catastrophic results of rising carbon dioxide level compel us to change our patterns. We need to reduce greatly our consumption of fossil fuels, retain soil carbon through less intensive cropping, and cease the rapid destruction of tropical forests.³⁴

The Land Institute has entered this process by promoting energy conservation and working for a future run more on sunlight and less on fossil fuels. We are researching an agricultural system based on mixtures of perennial crops, which, by requiring only infrequent plowing, should reverse the loss of soil carbon and actually increase organic matter in the soil.

In the final analysis, humans (U.S. citizens in particular) need to reduce their intensive consumption of global resources.

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(THE LAND NEEDS PEOPLE, CONTD. from pg. 31.)
 once), we will need to work toward what I have called elsewhere, a high-eyes-to-acres ratio. By this I mean we will need lots of people watching and working the land. Equipment will have to be scaled downward to accommodate the natural fertility of the land, its soil structure, rainfall patterns, contours and slopes. How a piece of land lies will dictate its pattern, for example, rather than the perimeter of the field.

The land will need lots of people because the land will need lots of thought applied. Optimum crop rotation schemes will have to be worked out so that insects, pathogens and weeds can be controlled or managed and so that nitrogen fertility can be restored through biological means rather than by using natural gas as a feed stock for nitrogen fertilizer. None of these goals can happen soon, but as a matter of ordinary prudence, we can begin to work on a different trend.

I realize that what I propose may run counter to current economic considerations because the time required to work our fields has been reduced through the use of the industrial world: tractors, combines, pesticides, fertilizers and so forth. But while we have been saving time, insufficient attention has been paid to the fact that this time savings in our fields has resulted in serious ecological costs, most notably soil erosion and polluted soil and groundwater.

The culture needs a large and strong rural population. In the New Republic article mentioned earlier, "The Idiocy of Rural Life," the Topeka native author argues that farmers have several skills they can offer society, skills

that make it possible for them to seek work elsewhere, ignoring that the source of those skills was the farm itself. No mention was made that some of those skills were partly the consequence of the training, discipline, moral development and special brand of independence that life on a farm, especially a diversified farm, requires and teaches. Our culture should not allow this source of national strength or character to disappear.

There is another reason for maintaining a strong rural culture and economy. During the depression of the 1930's, nearly everyone in towns and cities had relatives on the farm. This connection made them less vulnerable to hunger, even though they had little or no money. We have no guarantee that a similar depression will not visit us again. There should be tethers from lots of farm families to the towns and cities.

As rural schools and churches have closed, as rural baseball has become a thing of the past, devotees to the industrial imperative continue to dictate new terms always with "economic reality" as the justification. Economic reality is a concept that enjoys the status of a hybrid between natural law and religion. Maybe we could not have known in the past that the lens of economics is too flat, but we know it now and are beginning to learn that this loss of people from the land is more a failure of culture than anything else.

This article is part of a statement presented to the Kansas State Board of Agriculture and its Secretary and Commission on the Future of Kansas Agriculture by Wes Jackson on January 7, 1987. It was published in the March 1987 issue of the The Kansas Farmer.



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