Appendixes

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Appendix A

The Innovators: The Stories of Five Agriculturalists and Their Commitments to Land Stewardship

Introduction

Howard Hanford, Nicholas Cihylik, and Roger Gallup are farmers. Lazaro Urquiaga and Bob Skinner raise cattle. Ernie Brickner farms trees on eroded croplands. Each works the land, and cares for it, in his own way. These men are both similar to and very different from the breed that used cow, corn, and sweat to transform this land from wilderness to international power.

Skill is still the key, but hard labor is no longer enough. More than any other generation of agriculturists, these men have at their disposal a vast arsenal of technological help. How they use some of these tools to the benefit of their land's long-term productivity is the basis for five case studies (fig. A-1) conducted on farms and ranches in:

- Treichlers, Pat—no-till farming with Nick Cihylik,

Figure A-l .—Case Study Sites

SOURCE Office of Technology Assessment

- Jordan Valley, Oreg.–range rehabilitation with Lazaro Urquiaga and Bob Skinner.
- Edelstein, III.—conservation farming with Roger Gallup.
- Whitehall, Wis.—farm rehabilitation with Ernie Brickner.
- Fort Benton, Mont.—saline seep prevention with Howard Hanford.

Five examples could never accurately represent the staggering diversity present in American agriculture. Nor should the conclusions drawn from these studies be thought generally applicable to farmers and ranchers throughout the Nation. But these five illustrations offer insight into the use of land-sustaining technologies in agriculture. They provide a firsthand view of the many economic, cultural, environmental, and ethical considerations that affect a farmer's commitment to land stewardship.

The farmers profiled may not be "typical." Instead, each was chosen because he had a reputation for innovativeness and serious concern for the long-term productivity of his land. Each of the men runs a very different operation. They farm on different scales and show different landownership patterns—some rent, some own. They raise a variety of products—from cattle, corn, soybeans, wheat, barley, and safflower to timber—and cultivate less marketable potentials such as recreation, education, and esthetic qualities.

Yet despite the differences, these farmers and ranchers express a number of common concerns—desires for more current and better information to help them manage their operations; worries about money, indebtedness, and fair pricing; and concern about the future—both about their ability to maintain the quality of their land and their frustrations with governmental constraints on passing the land on to their children.

The purpose of these case studies is twofold. First, the studies illustrate a range of beneficial, often innovative, land-sustaining technologies and their appropriateness for certain situations. Second, the studies explore how farmers and ranchers make decisions about implementing land-sustaining technologies—what public and private advisors they use and what role economics and attitudes play in determining the technologies that will be used on the land. Because technology is increasingly the essential link between man and land, decisions regarding its use are fundamentally important to the short-term productive capacity of agriculture and the long-term productivity of the land itself.

NO-TILL FARMING-TRE9CHLERS, PA.

To the thin, life-sustaining layer called soil, water is both midwife and assassin. As midwife, rain coaxes green growth from seemingly barren ground and nurtures it. As assassin, rain can attack the soil, sweeping it away and degrading the land.

Erosion is an ever-present, natural process, yet when aggravated or accelerated by human activities, it can cause serious problems: hillsides stripped to bedrock, lost soil nutrients, degraded water quality, and reduced crop outputs. For farmers, the threat is real; erosion can steal a farm's wealth and bankrupt it.

Tillage—plowing, disking, and harrowing—are generally thought to be synonymous with farming, But these operations hasten erosion by leaving unprotected soil exposed to water and weather.

"Plow-disk-harrow. It's tradition and it's hard to break with tradition. " explains Nick Cihylik, 40, a corn farmer. "But tradition isn't always best. Some of my land is *17* percent slope; all of it is rolling. With the erosion I was getting I decided there had to be a better way. "

The better way he chose was "no-till," a reduced tillage system that eliminates all tillage passes and leaves a protective cover of crop residues on the land. Instead of turning the soil with moldboard or chisel plow, a no-till farmer's implements merely cut a narrow slit in last year's stubble and drop in seeds. Advocates purport that no-till not only reduces erosion but reduces energy use and labor requirements (thereby allowing a farmer to work more acreage), increases water efficiency, extends drought tolerance, reduces machinery investments, and gives a farmer more flexibility in timing his planting and harvest operations.

Photo *credit" OTA staff*

Nick Cihylik working in a no-till field on his Pennsylvania corn farm

No-till, however, is no panacea; potential disadvantages exist in that no-till can increase weed, pest, and disease problems, increase dependence on agricultural chemicals, reduce crop yields, and lower soil temperatures, thus delaying planting. That means a producer must think carefully before switching to no-till. Soil type, climate, terrain, type of farming operation, even the farmer's management skill, must be considered before a farmer converts to no-till.

"I started no-till 10 years ago, before anyone really knew much about how it would work, " Nick remembers. "1 was like a bumblebee that's too heavy to fly on the size of his wings but does anyway—I didn't know enough about the difficulty of no-till farming to be wary. "

Nick, who farms more than 1,300 acres in the hilly Lehigh Valley, rents almost all of his land, so traditional high-investment erosion controls, such as terracing, were out. Contour and stripcropping were not workable for his large, all-corn operation, either. So Nick went into no-till willing to sacrifice some yields for erosion control. But he did not have to. His yields are actually slightly higher now than before the switch.

"No-till is a deceiving word, though, because it says what you don't have to do. It should be called 'extra work farming, ' What you're doing is changing the type of work—and taking on a lot more management decisions, You've got to be organized way in advance, you have to do alI the soil tests, and figure out weed problems before they happen, and keep on top of your chemicals. "

Agricultural chemicals take on added importance in no-till farming because without tillage, weed and pest control is left entirely to herbicides and pesticides. No-till's development, in fact, lay relatively static between the first experiments in the 1940's until the 1960's when Chevron Chemical Co. introduced Paraquat, a powerful contact herbicide that kills green plant tissue (whether weeds or a sod cover), then is quickly inactivated because it binds with clay in the soil.

Nick turned to Paraquat, and Chevron, for help early in his switch to no-till. Unlike most reduced tillage initiates, Nick did not experiment with small acreage trials before jumping full force into no-till. In 1970 he tried one season with no-till soybeans, barely managed to produce enough to pay back the seed, and then gambled 500 acres all to no-till corn the next season.

"Getting into no-till was like a wedding night. You had no idea what you were walking into," Nick recalls of his sudden, large-scale trial. "After my first season, I wanted more information but nobody knew much to help so I went into it alone. "

It was a local Chevron representative who sat down with Nick and helped him lay out a thorough plan for his farm. Through the company Nick became involved in some of the first local and regional no-till conferences, meetings where early no-till farmers could trade stories and supposedly learn the latest about managing their new systems.

"Those first meetings were mostly advertising, but it was all we had. Ag extension didn't actively promote no-till, though they were willing to help where they could, " says Nick, who speaks highly of Pennsylvania State University and its current no-till research.

"Chevron and Paraquat are one. And Paraquat is no-till. It was in their interest to promote no-till; they got actively involved in my operation because they wanted an example, " Nick explains. "A successful example, And I needed the help. "

"Of course we had selfish reasons for getting involved, " interjects David Cote, Nick's Chevron representative and friend. "We make chemicals. We're a business and we want to show a profit. But our underlying concern is with the farmers' best interests—the economic and conservation benefits of no-till. We want to keep them in business because if the farmers aren't in business, a lot of us aren't, either. Selling isn't all we care about; we do tests and give advice about more than just Paraquat. It's sort of like the Santa in the movie 'Miracle on 34th Street. ' "

David and Nick recall that during the early years, Chevron may have been overly zealous to "convert" farmers, but the company straightened out quickly as they started looking at no-till as a serious, sustainable system of agriculture. If farmers were going to stick with no-till for the long-term, they needed a workable, economically viable system, and Chevron decided to help develop one. Also, as Pennsylvania State University and other public institutions became more involved in no-till research, farmers had other information sources to turn to for confirmation of Chevron claims. And as for converts, they've become easier and easier to find, so the hard sell has become unnecessary.

"With fuel prices what they are, all farmers are forced to look for alternatives," Cote explains, "and they're all looking at some point to reduced tillage. Not necessarily strictly no-till, but at least to reducing the number of tillage passes they make over a field. They've got to. "

In looking at no-till, either as a land-sustaining technology or a means to reduce energy costs, a farmer must be careful to consider the specifics of his operation in light of current knowledge about the management system. The first criteria seem to be environmental—whether no-till can be successful with his terrain, soils, and climate. In poorly drained soils, crop yields can suffer under no-till. And because a layer of crop mulch covers the soil, ground temperatures may remain cool in the spring and may delay planting. In short-season, northern climates, this delay can hurt yields. Some farmers will also have questions about the increased use of toxic chemicals and possible environmental repercussions.

The next thing a farmer might consider would be operational–is he willing to change the way he's been farming all his life and is he skilled enough to manage a no-till system successfully?

"You have to be a good conventional farmer to be a good no-till farmer," stresses Glen Ellenberger, Nick's county extension agent, now retired. "It takes extensive management—a precise use of chemicals, careful monitoring of pest and disease possibilities, soil tests, and planning. It's not a lazy man's operation. "

The environmental and technical pros and cons are only some of many factors that can influence a farmer's decision to try no-till. In general, the acceptance of any new idea or technology can be influenced by:

1. the relative advantage offered by the change,
2. the compatibility of the innovation with the farmer's needs and type of operation as well as his past experiences and his values,
3. the complexity of the change,
4. the degree to which the innovation could be experimented with on a limited basis, as it is less risky to move piecemeal into a new system than jump totally from old to new, and
5. the degree to which the results of a new technology or idea are visible to prove its value, For instance, the adoption of preemergent weedkillers was slow in spite of its relative advantage because there were no dead weeds for potential users to see.

In Nick's case, the long-term advantage offered by reduced soil erosion was enough to offset the increased managerial complexity, He acknowledges that his increased chemical use might cause environmental problems but feels that erosion is a more real threat, Because no-till slows runoff, he feels it also reduces the amount of his chemicals that slip away to contaminate waterways. But while no-till is gaining relatively rapid acceptance in

many parts of the country, few of Nick's neighbors have followed his lead. The reason is more sociological than technological.

"Nick is different from his community, He's progressive and he stands out," explains Ellenberger. "He was born here, but he's not a native like his neighbors. They like clean, traditional fields, and no-till looks really messy, like you're not a good farmer<"

Despite their reputation for independence, the agricultural community has subtle and direct influence on farmers, even innovative farmers such as Nick. For instance, it is a rare farmer today who does not rely heavily on banks, credit associations, and the like for loans to make his operation work. And the power of the purse strings can control what a manager can and cannot do on his land.

"Our involvement in farm management is minimal. We don't tell a farmer to switch from corn to beans," says Alan Greiss, of the Production Credit Association Nick uses. "But we can refuse loans, either because we think a scheme is harebrained (like the guy who wants to buy Clydesdale horses to walk treadmills to generate electricity) or because the farmer has low equity."

In other words, though the bank has some money to risk, they tend to want to finance sure-fire ventures. This can have a large impact on young farmers who, unlike Nick, have not built up much equity and do not have longstanding reputations as good farm managers. Because initial investments are small in no-till, banks have less influence on farmers switching to no-till than on farmers wanting to try more capital-intensive new technologies.

"A well-managed investment in the land pays for itself in time, Maybe not tomorrow . . . I do have children interested in farming, and I'm glad for that. I have to start something for them," says Nick.

"Your land, your farm, is your life. You've only got so many inches of topsoil—when you have an opportunity to help it stay put, you do it. The chance may never happen again."

Nick broke with the plow-disk-harrow tradition because he felt his land would benefit from less erosive management. The system he chose to adopt —no-till—proved to be both agriculturally and economically sound, as Nick's erosion losses are negligible now and his yields are as good or better than ever.

No-till is in many ways a good example of an innovative, land-sustaining technology. It can be good for the land—used properly and in the right situations. It can be economically viable, again, when it is matched with operational and environmental dictates. No-till shows, too, that the solutions to our agricultural problems will not be quick in coming; rather, many of the promising new technologies are managerially complex and are more demanding of the farmer's dedication, as well as his skills. And no-till illustrates that it is possible, even practical, for a farmer to take his stewardship seriously and still succeed from an agribusiness viewpoint.

RANGE REHABILITATION-JORDAN VALLEY, ORE@.

The land around Jordan Valley, Oreg., is rugged and harsh—great expanses of dusty soil littered with rock and clumps of parched bunchgrasses. But it is valuable land. To the rancher, it is home to family and livelihood. To the Bureau of Land Management [BLM), this area—the Vale District—is a showcase of new range management ideas.

Ranchers such as Lazaro Urquiaga and Bob Skinner are part of a determined breed that settled this range despite the harshness. The isolation and the great distances that separate them from town and friends go unquestioned. They know the land, both its limitations and its potentials. They raise cattle because that is what the environment will tolerate. And that is what their families have done here in Jordan Valley for many generations.

Most of the land around Jordan Valley, and in fact 70 percent of Malheur County, is part of the Vale District of BLM–a 6.5-million-acre rectangle, 60 by 175 miles (100 by 280 km), in the southeast corner of Oregon. Such a strong Federal presence is not unique; in the Rocky Mountain and Pacific States (excluding Alaska and Hawaii), the Federal Government controls an average of 47 percent of all rangelands, whether through BLM, the Forest Service, or other agencies. In Oregon, 59 percent of the rangeland is managed by Federal authorities.

Photo credit" OTA staff

Lazaro Urquiaga comparing crested wheatgrass, an introduced species, with native forage

BLM, by law, manages its lands for the American people, trying to balance the environment's capacities with the needs of cattlemen, recreational users, wildlife, and other interests. For the ranchers who lease grazing rights from BLM here, the quality and availability of the range is no light matter. Cattle are the center of their world and have been for generations. So men such as Lazaro and his neighbor Bob Skinner are rightfully concerned about BLM's choice of management technologies for the range.

"This is some of the finest range you'll see in the Vale District, " Lazaro, 30, points out, But it wasn't always so, Over 11 years, from 1963 to 1974, $10 million poured into the Vale Rangeland Rehabilitation Program. It transformed the district into a showplace of range management and restoration experiments—innovative seedings, water development, fencing, brush control, and grazing systems, And for the most part, BLM staff and local cattlemen agree that the restoration program for the once-abused range is an avowed success.

BLM and the ranchers did not always get along so well. Their disagreement over the management of the Vale range, in fact, is what initiated the rehabilitation program in 1963.

"Nobody really argued that the range wasn't overgrazed, " remembers Bob Skinner, a 60-year-old Jordan Valley rancher who owns a sizable home spread and runs cattle on BLM land for 7 months each year. "It was the BLM's first proposal—to cut grazing an average of 58 percent—that got the ranchers to raise such a stink, That would've driven people out of business. "

The suggested reductions in grazing that angered Skinner and many of his neighbors were not the first of the Vale area's range controversies, Exploitive use of the range, especially around limited water supplies, probably began even before the homesteading boom of the 1880's, and by 1900 range deterioration was severe. Since the land was public domain–open to cattlemen, itinerant sheepherders, miners, and settlers alike—little could be done to stop the degradation and erosion. By law, the land belonged to all, Yet no one was responsible for sound land use.

Area residents were not oblivious to the growing problems. Oregon ranchers spearheaded the drive

for the Taylor Grazing Act of 1934, legislation designed "to preserve the land and its resources from destruction or unnecessary injury, to provide for the orderly use, improvements, and development of the range." The act marked the end of the open homestead era, but not the end of controversy.

Settled ranchers used the act to halt migrant sheepherders, whose herds would strip the range mercilessly. But the powerful ranchers who sat on the new Grazing Service's advisory board were not entirely altruistic; when it came to allocating grazing rights, they did so on the basis of past use and commensurate property, not on the carrying capacity of the range. So while the ranchers were eager to maintain their ranges to stay in business and sometimes buiIt fences, developed water, and even controlled sagebrush, for the most part they were interested in practical matters—low grazing fees and high profits from running as many head as possible.

By the late 1950's, the Vale range was in poor condition and everyone knew it. What neither cattlemen nor B I,M staff knew for certain, however, was how to save the range.

The easy answer was to reduce the herds. "There was no question that something had to be done, but not straight-out reductions," remembers Dominique Urquiaga, Lazaro's father. That action would have hurt more than just the cattlemen, Malheur County is cattle country, and indirectly everyone—bankers, merchants, and townspeople–was a part of the cattle industry, They all opposed drastic cuts. Grazing cuts were a threat to their economic livelihoods and to a century of tradition.

"The ranchers felt threatened, rightfully, by the proposed cuts," says Bob Kindschy, the Vale District wildlife biologist who has been at Vale through the entire project. "In 1962, a group of them got together and requested a congressional inquiry, which Congressmen Unman and Morse held here. BLM seized the opportunity to write up an alternative proposal—a plan to rehabilitate the range, We brought in all sorts of experts to present ideas and got everybody interested in a compromise appreach."

"Conservation is like apple pie; you can't be against it," he remembers. "The Congressmen took the idea back to Washington and pushed it through. And we got a chance to show that with cooperation and funding, you can do great things with deteriorating range."

"The thing that hits home hardest," Skinner adds, "is that now we're actually harvesting all the forage we pay for. If we went back to the way things were, well, first take 60 to 70 percent of the cattle out there and wipe them off the slate—the old range couldn't have supported them. Then take all the tangential impacts on town and the rest , . . the project was a success, alright."

Range is range because of its physical limitations; the land simply cannot support more intensive use. Ranchers and range managers learn to work within those limitations. Southeast Oregon, including the Vale District and the Skinner and Urquiaga ranches, is a dry, inhospitable environment. Precipitation averages only 7 to 12 inches per year, Vegetation is sparse; dependable surface water is scarce. Although there is some irrigated agriculture in the bottomlands, for the most part cows are the only viable "crop" for the environment.

Depending on the quality of the range, it can take from 2 to 5 acres of range just to support one cow for a month (called an AUM, or animal unit month). But rangelands, like croplands, can be improved through proper management. The question in Vale was where do you start? The Vale District encompasses almost 6.5 milIion acres [2.6 million ha). Not only cattle but pronghorn antelope, waterfowl, raptors, mule deer, hunters, and fishermen had to be accommodated under BLM's multiple-use mandate and its broad definition of land productivity. Obviously, there was no one "right" management technology for all that terrain. In fact, there was no way to actually treat the entire, immense acreage.

Instead, the district's plan was to intensively treat only part of the range—scattered tracts totaling about 10 percent of the land. They hoped that these treated sites, combined with overall sound management and some temporary herd reductions, would alleviate grazing pressures on degraded native range and give it time to recover. Some of the treatments—for instance, seedings of introduced grasses such as crested wheatgrass—were not expected to be permanent improvements, just stop-gap measures to provide good forage while the native ranges rested. It was an added plum, then, when during the course of the decade-long program the district staff discovered that the introduced seedings adapted perfectly, reproduced, and became self-sustaining pastures.

"We're trying for sustained yields. The grazing program's goal is to make the range available forever; we strive to manage for the long-term. We say we can graze this country and keep its productivity high and stable, for cattle and otherwise," explains Phil Rumple, a range manager. "If cattle are one bite ahead of the grass, you have to lower their numbers until they are one bite behind."

The mix of management practices and land treatments used differed among the 164 tracts designated for rehabilitation. Sites were selected by their potential for improvement, not degree of deterioration. Treatments were planned through the combined efforts of the district's range conservationists, wildlife biologist, and watershed engineers.

Brush control is an important first step in range rehabilitation. As native range is overgrazed, more and more of the desirable forage plants are eaten; what grows in their place are less palatable species. Once established, most brush species are extremely difficult to remove.

The rangeland disk-plow—a special tool designed with each disk mounted on an independent shaft for rough terrain—was developed early in the Vale program to help control brush. Big sagebrush—a common, unpalatable species—had invaded many denuded pastures and taken over, compounding the degradation. But two passes with a plow could kill 90 percent of the nuisance plants as well as prepare the ground for seeding.

Range managers also experimented with sprayed herbicides for brush control, but not without controversy.

"Paraquat could be a tremendous help here, but it's banned on Federal range, " explains Lazaro. "It's an economical way to control a burn—you spray the perimeter and then you can safely burn the area within the border. But we can't use it. "

"I wouldn't ignore legitimate environmental problems, " he adds, "what I don't understand, though, is why something is okay on private land but not on Federal. Is there a different safety factor for some reason?"

Burning, the method that historically kept the sage in balance, proved to be an effective brush control technique, too. In fact, areas that suffered either experimental controlled burns or wildfires had the lowest average density of sagebrush of any treatment,

To reestablish good pastures, a special rangeland drill was developed to drill seed into the rugged terrain. After many trials with a variety of grasses in-

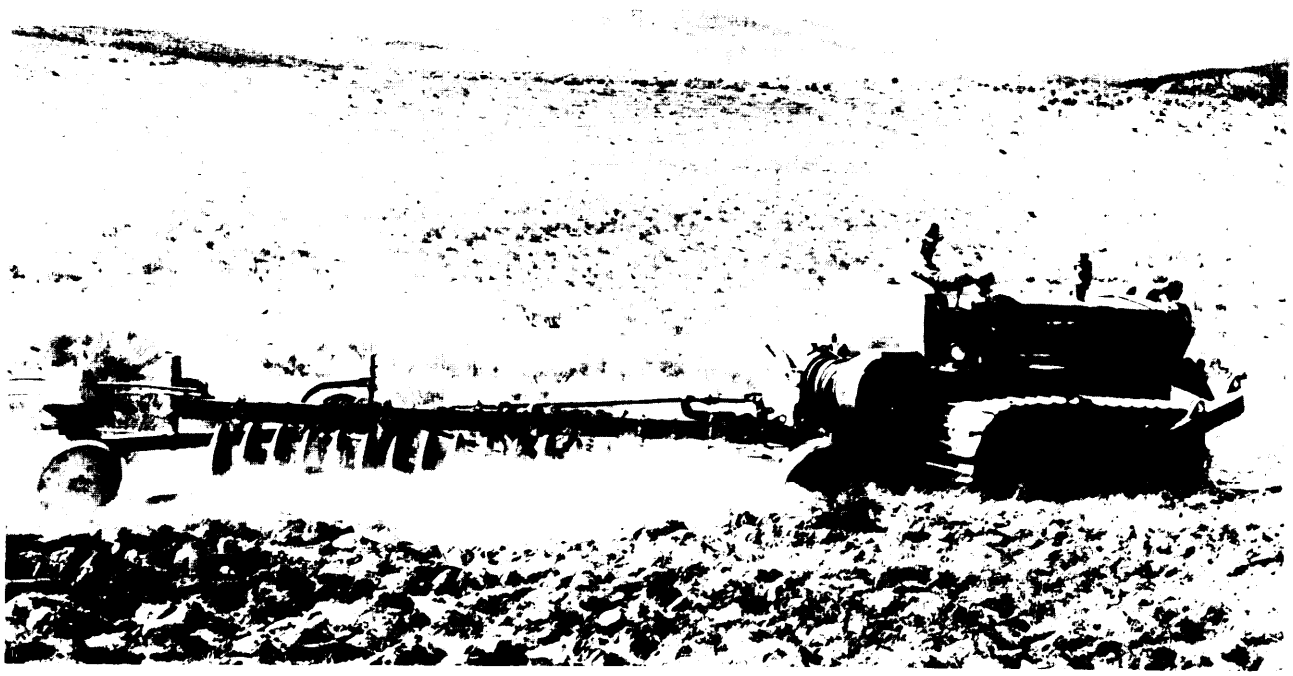


Photo credit. Bob Kindschy

Rangeland disk-plowing

eluding pubescent wheatgrass, tall wheatgrass, western wheatgrass, and various clovers, crested wheatgrass emerged as the most consistently successful grass to plant. Crested wheatgrass, a species native to Siberia and adapted to animal grazing, was greeted with some skepticism by area ranchers when it was first planted; some called it "macaroni grass" and belittled BLM for bothering with it.

"When the first seedings went in, some of us refused to run our cattle in them. We weren't going to run our cows in 'broom straw. ' " Skinner recalled. "Then Max Laurance, from BLM, came down in person and basically begged us to try a seeding. Once we'd tried it, you couldn't get us not to use it. It was that good, "

To various extents, the success of many of the treatments and the overall range management schemes used at Vale depended on water. Managing the range meant managing the land and water resources. For no matter how good the range—native or introduced—no cows will graze without adequate water. And, conversely, the cattle will concentrate, and often abuse, the range nearest available water. Grazing pressures were especially severe on fragile riparian environments and the many species of bird and animaI life that congregate there.

"A carpenter needs tools—a hammer and saw—to practice his trade. Similarly, seeding, fencing, brush control, and water developments are tools to allow intensive range management. You work with these tools to get a good distribution of grazing pressures," explains Vale Wildlife Biologist, Bob Kindschy,

Range managers use such tools together with their knowledge of animal and plant science to set up sustainable grazing systems. No longer do ranchers simply release cattle onto the growing pastures of early April and round them up with the first snow. Instead, they work with range managers to plan for the cattle to be rotated throughout the range, alternately using and resting pastures and enhancing the sustainable productivity.

Lazaro favors close working relationships between BLM managers and cattlemen who use the range, He thinks that both sides would benefit from a new' kind of policy regarding stewardship for the land—a way to encourage ranchers to make improvements on the Federal range.

"There is a 'stewardship experiment' in Challis,

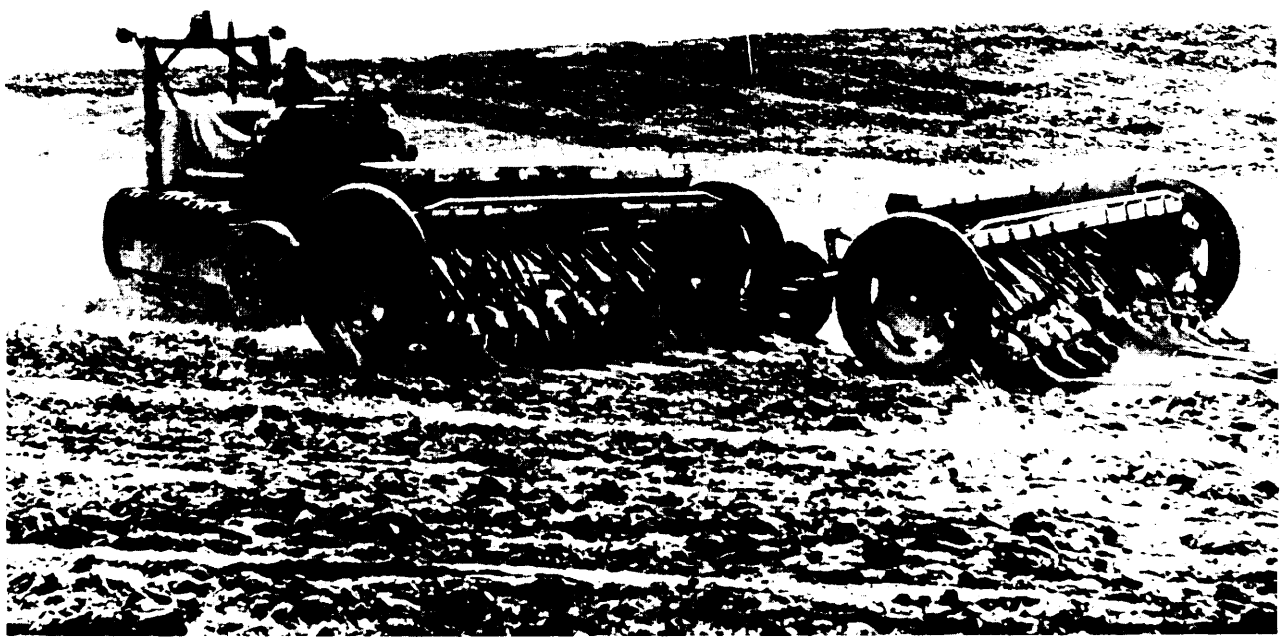


Photo credit: Bob Kindschy

Rangeland drilling of seed

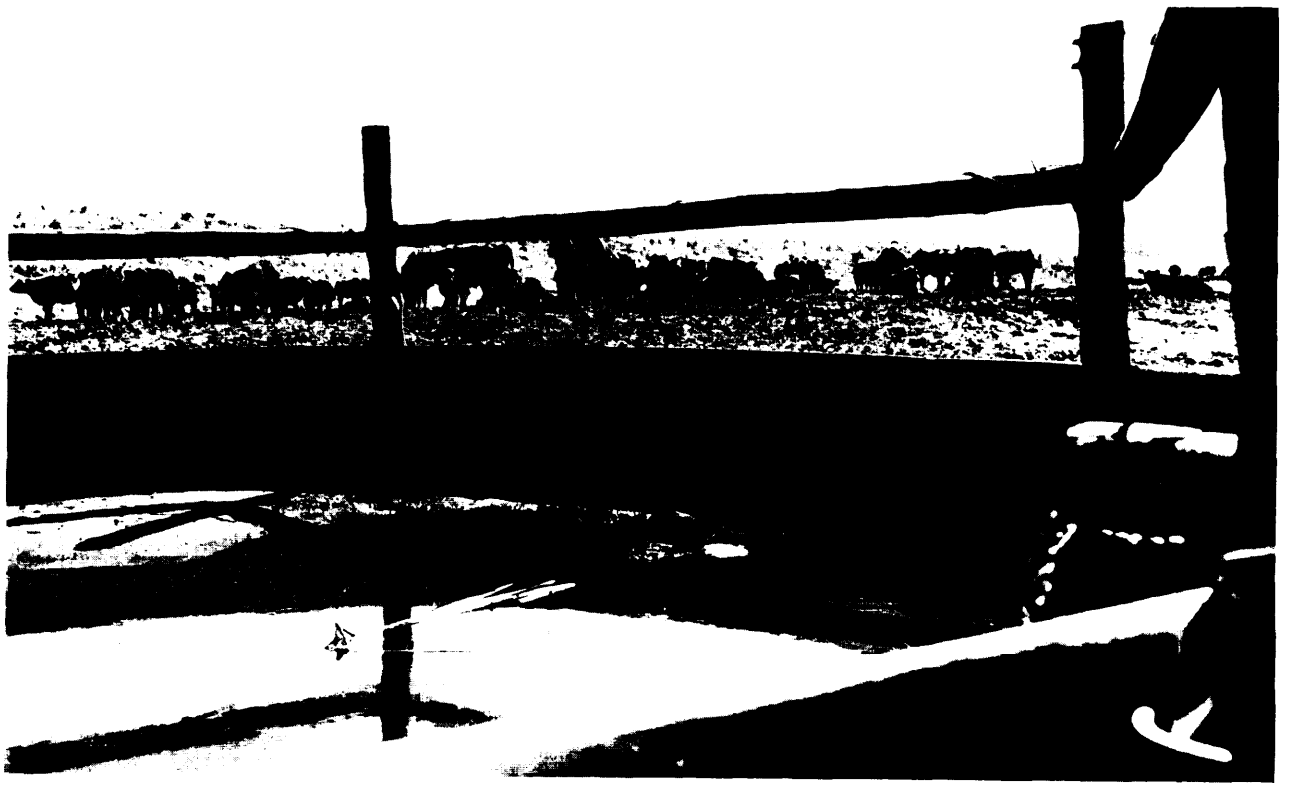


Photo credit' OTA staf

Developing adequate water supplies is essential to sound range management

Idaho, that shows what I mean, " Lazaro explains. "If the range supports 1,000 AUM, and a rancher improves that to 3,000 AUM, that rancher would get the extra rights, He'd still pay for them. This way you create more user involvement, more personal involvement, You'd need a written agreement, of course, so that you get a stable position on the range and a guarantee that you'd actually benefit from your labors. "

To increase water availability at Vale and hence broaden the cattle's range and widen management options, BLM staff built a number of new wells, pipelines, and reservoirs. But they had more than cattle in mind,

In keeping with BLM's multiple-use mandate and their commitment to diverse and sustained land use, BLM planned for wildlife as well as cattle when they developed water. "Noodle bowls, " for instance, are hilltop water catchments fed by springs that distribute water by gravity pipelines to surrounding pastures. Range managers keep these reservoirs open through the dry season, even when cattle are on other ranges, for the benefit of wildlife, Another wildlife watering device, called a "guzzler" or "bird bath," is a small catchment and tank that stores precipitation. More than 30 have been built on the range, strictly for wildlife. This way all the life on the range gains from the restoration.

The various range treatments and rotations are not without their shortcomings. Managing for multiple uses inevitably causes some conflicts. Sometimes change itself—no matter how benign—is resisted in favor of tradition. Even the physical management techniques—seedings, plowing, and brush control methods—can cause problems. Plowing at the wrong time can bury native, desirable seed too deep to grow. Planting only one species can eliminate the diversity needed for wildlife browse and shelter. New fences, even those built with an unbarbed bottom wire to reduce hide cuts on antelope, can kill some animals who charge unaware into the obstructions. And controversies over fire and herbicide use seem unlikely to subside.

Problems arise, too; Bob Skinner points out that it is not uncommon to see game, whole herds of

Photo credit OTA staff

BLM experimental range showing a reseeded section v. native grasses. Note predominance of unpalatable sagebrush on left

deer, from the BI.M range feeding heartily on nearby, privately owned alfalfa.

Vale's experiments have not solved every problem on the range, but the work done there has provided other range managers with some new and useful tools, They have learned what grasses to use in seedings, how to manage riparian areas more carefully, and how to diffuse grazing pressures, improve forage, and incorporate wildlife needs early into the management strategy. And, importantly, the Vale Range Rehabilitation Program proved that severely degraded range could be improved and maintained without undue local hardship—given support, knowledge, and cooperation.

The lessons learned at Vale can guide sound range use elsewhere in the intermountain-type ranges—the "cold desert steppe" rangeland that extends through Oregon, Washington, and parts of Montana. Some broader lessons, too, are transferable to different types of range throughout the Nation.

Though the major thrust of work at Vale has ceased, the district stands as an example of sound resource management. Research continues—experimentation with new grasses, new fencing techniques, sophisticated grazing systems, and the like—but slowly. The work makes Vale an important record of what can and cannot be done for deteriorating rangelands.

Like the other case study sites, the Vale District illustrates that sustaining land productivity requires a greater, and sometimes more laborious, sense of stewardship. It requires more managerial skills, more openness to change, and often more financial and philosophical commitments. But unlike most farmers, the Vale ranchers do not hold primary responsibility for managing their range. Decisions about how technology will be used to restore and maintain the grazinglands and accommodate the many, sometimes competing demands rest with BLM, And responsibility for careful use is shared by the more than 400 ranchers who run cattle on the "commons." Such joint stewardship poses special problems; it calls for cooperative planning and a strong sense of commitment from all the people benefiting from the shared resource.

"The BLM is a stabilizing influence on the range and is necessary, " Lazaro says, "The idea of local control is misleading because realistically you still need the same people—watershed people, range specialists, wildlife people. But what we do need, all of us here, is a stable relationship with the Feds. That would be an important step toward better range use. "

CONSERVATION FARMING-EDELSTEIN, ILL.

It was a powerful piece of paper that lured Joseph Gallup halfway across the country, from Connecticut to Illinois, in the 1850's. And it is that same property deed that ties Roger, his great-great-grandson, to crazy-quilt contour farming on hilly land while just 2 miles down the road his neighbors plow straight rows on level fields, fence row to fence row.

For Joseph and his wife, those 200 acres of rolling grassland and woodland were just what an 1850's pioneer family needed. The soil on the nearby prairie was rich and deep, but drainage on that level land was poor. Besides, there was no easy way to breakup the root-bound prairie sod, And a homesteading farmer needed timber close by for building, fencing, and fuel; prairie land was treeless.

It would take the steel-moldboard plow, drainage technology, and a transportation system to lure the next wave of settlers out onto the prairie" a plow to turn the heavy soil, drainage to carry off water formerly taken up by prairie grasses; and roads and a railroad to haul in fuel, lumber, and other supplies. Once the prairie was tamed, its farmers found themselves on top of some of the richest farmland in the world. But in the meanwhile early settlers such as the Gallups stayed near the prairie fringe—along the rivers and in the hilly, wooded lands.

Today, 43-year-old Roger and his father, Dwight, sometimes wish their farm were out on the flatlands their neighbors till. But it's too late to move. The Gallups' equipment, their buildings and storage facilities, and their way of farming are tied to their own land. "Besides," Roger says simply, "this is home. "

Roger; his wife, Sharon; and their children, Renee and Loren, live in a big, sturdy brick house built by Roger's grandfather, a man who clearly planned to stay. Two miles west, on the edge of the farm, Roger's father, Dwight, and his wife, have built a modern ranch-style home—the kind you see more and more on the farmscape.

Next to Dwight's house looms a massive steel grain storage bin, the elevator at its peak connected to smaller bins by metal pipes splayed out like the legs of a giant spider. The Gallups can store up to 60,000 bushels of grain here until the market price

Photo credit: OTA staff

Roger Gallup checking wagonload of corn

is to their liking. Much of the Gallups farm lies between Dwight's new house and his son's place. The Gallup land, now 860 acres, is part of twin bands of rolling topography, 4 or 5 miles wide, that edge the Illinois River. Water running off the flatlands converges and gains momentum near the river, carving gentle hills in the landscape. Slopes here range as high as 13 percent.

Until about 1960, this land supported a variety of livestock: dairy and beef cattle, hogs, sheep, and poultry. The steepest hillsides were maintained in permanent pastures. Only the more gentle slopes were plowed and planted to annual row crops such as corn and small grains, Even this modest acreage of row cropland was "rested" by regularly returning the fields to pasture and hay crops.

But cornbelt farming has undergone a major change in the last two decades, and Roger and Dwight had to change their operation to keep in the black.

Today the Gallups grow cash crops—corn, wheat, and soybeans—and nothing else. "We gradually moved away from livestock," Roger says. "We simply reached a point where there was no return on cattle. More livestock would be better for overall U.S. productivity and for the land, but the returns for stock compared to crops just don't justify the switch for most farmers. "

So the Gallups plowed under the green hillside pastures and planted row crops. But with the slopes laid bare much of the year, the Gallups faced a major problem—erosion.

Though erosion is partial to sloping land, it nibbles away flatland fields, too. But flatland fields are blanketed with a thick layer of topsoil–glacial till covered with loessial (windblown) particles and enriched by organic matter from thousands of years of prairie growth. So on flatland the annual thievery is more subtle; it can be masked by improved crop varieties and heavier fertilizer applications.

When the Gallups' hillsides were protected by perennial pasture, erosion was easier to handle. They controlled grazing intensity and held back runoff with fence wire and straw barriers strung across waterways, But row cropping leaves whole hillsides vulnerable, so Roger and Dwight have to take major erosion control measures. They plow and plant on the contour rather than straight up and down the slopes so that each furrow catches and holds runoff. They do plow in the fall, but with

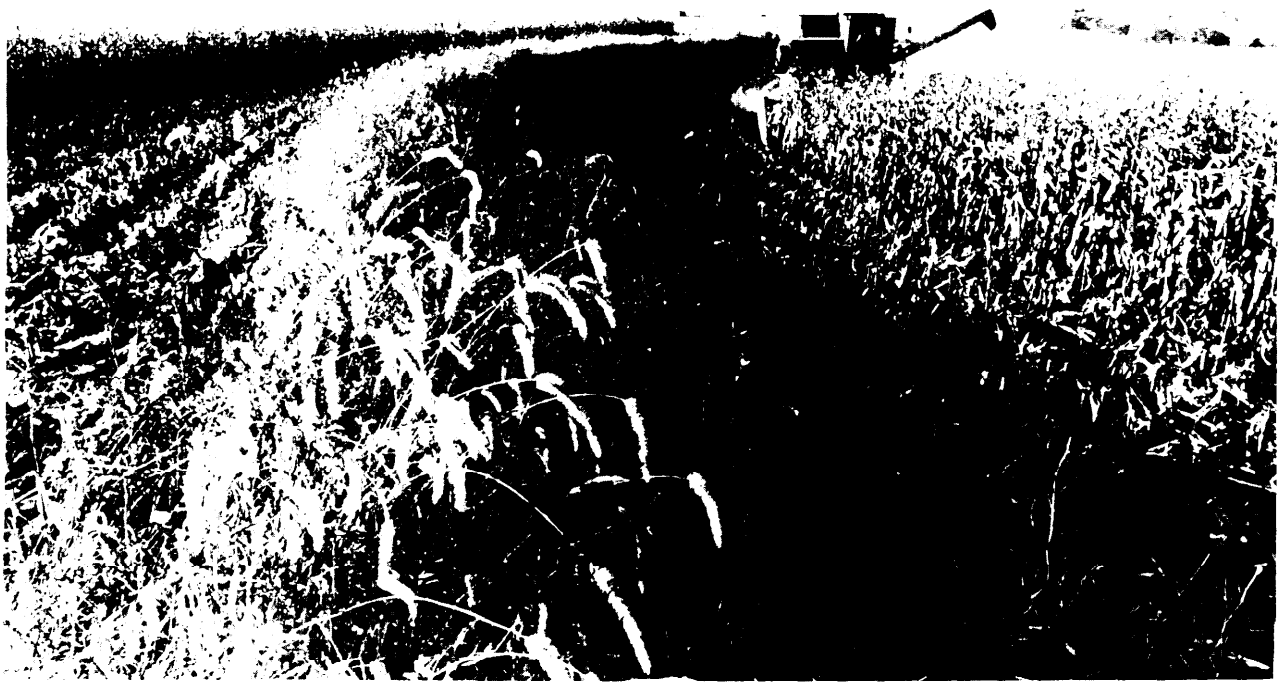


Photo credit OTA staff

Combining corn along a terrace that follows the contours of the Gallups' hilly Illinois land

a chisel plow, which fluffs up the soil, leaving air spaces in the top layer and trash on the surface, Chiseling can leave more than 2,000 lb of residue on an acre of cropland. That is enough to reduce soil erosion by roughly 50 percent on sloping land.

Another necessary conservation measure has been more difficult and more costly. Contour farming, even with conservation tillage, is not enough to hold the soil on the steeper slopes. For better protection, Roger and his father also had to construct terraces on much of their land, Terraces are steplike soil embankments bulldozed up along the contour of a slope. Like individual furrows plowed on the contour, the terrace is designed to hold back and slow runoff, but on a much larger scale.

Roger says terraces will last about 15 years with proper maintenance. During the last 5 years, the Gallups put in nearly 7,000 ft of terraces covering about 100 acres. Though these new barriers are broader and more compatible with larger equipment than old-style terraces, they still limit the width of field implements the Gallups can use and are awkward to maneuver around, especially where rows converge. And terrace farming is not so profitable as flatland farming.

"Take all our waterways and terraces . . . they're completely wasted land, " Dwight complains. "We can't crop them, yet they're taxed just like the rest of the land. And it takes more fuel and roughly twice as long to farm terraced land. "

Terraces are expensive, In Illinois it costs an average of $200 to $400 to protect an acre with terraces. But the Government will pay up to 75 percent of the construction cost, which Roger thinks is an equitable arrangement. "The general public has to accept both some of the responsibilities and some of the costs in return for the long-term benefits of soil erosion protection and improved water quality. "

For Roger and Dwight, terracing is more than a costly project that may pay off some day. It is part of their land ethic—the craft of farming. For less successful farmers, however, terracing and land stewardship can be unaffordable luxuries. "Hundreds of thousands of acres that are now in row crops should not be because the soil erodes too easily, " says Harold Dodd, president of the Illinois Farmers Union. "But a farmer has to put every inch of land into those kinds of crops just to make ends meet. " And he is encouraged to do so by a Nation that depends on his produce to help pay rising energy costs and to add muscle to diplomatic policy,

Bankers will not finance terracing if a farmer is short on available cash. And many landowners will not sink money into expensive land-moving projects that promise to protect long-term productivity while contributing nothing to immediate profitability.

Roger points out the dilemma faced by a tenant farmer working land he knows should be terraced. The traditional sharecropping agreement between tenant and landowner assumes that the owner is responsible for long-range improvements. "And if the land is owned by an elderly person who has no children to inherit it, " Roger asks, "how could you honestly convince her (or him) to invest in a long-range improvement like terracing? In this case, the land is strictly an investment–a retirement fund. " The tenant, on the other hand, has no incentive to pay for improvements because he has no assurance the rental agreement will be lasting.

Simple conservation tillage is a less costly technique that offers varying degrees of erosion control, depending on the slope, soil type, and amount of residue left on the surface. But conservation tillage has tradeoffs. With moldboard plowing, the share actually folds over the top layer of soil, burying crop residue, insect eggs and larvae, and disease-carrying micro-organisms. Chiseling, when done properly, merely "stirs" the soil. Insect eggs and weed seeds, as well as soil-protecting crop residues, remain on the surface, so the farmer may have to increase the rate of his pesticide applications. Chiseled soil can take longer to warmup and dry out in the spring, too. And for farmers accustomed to tidy, trash-free fields, chisel plowing is hard to accept just on the basis of appearance.

Roger looks forward to the day when he can abandon a few terraces in favor of no-till farming. (See previous case study in this appendix for full explanation of no-till farming.) Right now he is willing to give it a try on a field or two, but he is not ready to tear out his terraces. "We're waiting for the machinery manufacturers to perfect the equipmerit, " Dwight says. "And for the chemical companies to come up with more herbicide flexibility in a no-till system, " Roger adds,

Looking into the future, Roger sees two innovations that may rescue soil-conserving farmers from dependence on terracing or no-till. Someday it may pay to seed rye from an airplane as a winter cover crop and as green manure, Roger projects. Or a perennial biomass crop with soil-holding and income-generating capacity may be developed.

Changes in technology are never without costs, Roger says. First, it is costly to purchase new technology. Second, adopting a new cropping system is an anxious time for the careful farmer, so it is

costly in frayed nerves. Finally, unfamiliar technology invites management mistakes. For instance, the advantages of the chisel plow are lost unless the farmer knows how deep to set the chisels for his particular soil type and moisture and for the horsepower of his tractor. And he may overcompensate with herbicide for the extra weeds he expects the chisel to leave.

A farmer must keep abreast of technological advances. Traditionally, his most trusted sources for information are his fellow farmers. When two farmers meet the conversation invariably turns to farming. They compare notes on new tillage equipment or a new herbicide combination, or perhaps a modification one has made in an implement. Roger, like most farmers, also turns to other sources including equipment and fertilizer dealers or pesticide and seed company representatives. He reads agricultural publications, mostly in the winter, and for particularly confounding problems he may turn to experts at the University of Illinois.

But the advisor Roger turns to most often is his father. "I sound out ideas and decisions with Dad," Roger says. Dwight brings together not only the experiences and insight of a lifetime, he adds to that a wisdom that accumulates in a family that has stayed put for generations.

Though some farmers may not seek the banker's counsel, the costs of new technology, compounded by inflation and formidably high interest rates, have made the bank the farmer's business partner. For Midwestern farmers, the credit line has become the umbilical cord that ties them inextricably to various financial institutions. These institutions put them in business and keep capital flowing to meet operating expenses and investments in land and equipment. The credit leverage enables banks and savings and loan establishments to assert powerful influence over the farmer's investments, his grain and livestock sales, even his management decisions.

What has kept many farmers afloat, and what has pumped money into farm expansion, is equity—equity from land that tripled in value in the 1970's as a result to a short-lived leap in grain prices, farmers competing for land, and rival investors seeking a hedge against inflation,

"The trend today is toward larger farms," Dwight says, with a hint of nostalgia. "There is no other way it can go. It used to be a family could live on 160 acres. But today you couldn't afford machinery with just 160 acres.

Since 1950, the acreage of the average Illinois farm has doubled. Nationwide the average farm size is now about 420 acres. A recent USDA study[1] projects that if current trends persist, the middle-size farm will be nearly obsolete by the year 2000.

It is hard to say which comes first with farmers: more land or the technology to farm more land. Roger points out that sometimes it makes sense to buy bigger equipment with the intention of finding compensatory land. Few can borrow enough money and service the debt on a simultaneous acquisition of additional land and, for example, a $100,000 combine needed to cover more territory. Instead, expansion usually takes place in a seesaw fashion—first land, then equipment, then land, and so on, or vice versa.

Illinois Farm Business Management Records[2] shorn' that reach ine and labor costs per acre decline up to about 800 acres. For example, machinery costs on a 214-acre grain farm run roughly $62 an acre; on a farm four times bigger they run about $53 an acre. Labor costs averaged $53 per acre on the smaller farm; on a farm four times bigger, they ran an estimated $24 per acre, less than half as much.[3] The Gallups use larger equipment to farm their expanded acreage, but it takes roughly the same number of management decisions and equivalent amount of labor to farm 850 acres as it would to farm half that much land.

Net return after taxes also favors farm expansion. Taxes do not rise as fast as income. Farmers such as the Gallups are in a better position than small farmers to use investment credit and to depreciate equipment faster. Likewise, the implement dealer can give a big farmer a better deal because he buys more, And it is easier for the larger landowners to borrow money and get lower interest rates.

Another reason why a farmer may feel obligated to increase his acreage is if be wants to pass on enough land to allow more than one of his offspring to get a start in farming, "I don't want my kids to think they have to farm to please Dad," Roger admits. But just in case, he is making sure there will be enough land to split into two viable units,

This year Roger and Dwight will farm 860 acres. By cornbelt standards that is moderate acreage. Roger waited 20 years to annex land to the 500-acre farm his father had established, but it was not lack of money that held him back. Because Roger's land

[1] U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, technical bulletin No. 1625, William Lin, George Coffman, J. B. Penn, "U.S. Farm Numbers, Sizes, and Related Structural Dimensions: Projections to Year 2000."

[2] 1979 Summary of Illinois Farm Business Records, Extension Circular No. 1179.

[3] Wilken, Del, University of Illinois, agricultural economist.

is valued at over $3,000 an acre, and because he is known as a skillful farm manager, his credit line can stretch to cover a land purchase. What postponed the investment was the scarcity of nearby farmable land for sale. (Gallup's equipment is too big to conveniently move cross-country.) While he waited, Roger leased the land he needed.

In some cases, a farmer recognizes the home property is too small to provide income for both him and an offspring who wants to farm. And heavy debt makes land sale the only way to retire securely. For other families, inheritance taxes prove more than the sons and daughters can afford. So they must sell some, or most, of the land to retain the rest, If the remaining unit is too small to generate a living, it must be rented out or sold.

Still another factor encourages the established farmer to add to his holdings. U.S. tax policies allow the big farmer to buy land and write off a big chunk of the cost. "We give enormous subsidies, carefully hidden in the tax code, to persons who are sheltering income, " said former Agriculture Secretary Bob Bergland. "That's one of the major reasons why young people have an impossible time buying land in competition with people who can pay more for the land than it's worth as an income producer. "

The complexities of big farm management have risen with the costs. When labor shifted from man to machine, it brought about many changes in agriculture. Thirty years ago the Gallup work force was larger and more elastic than it is today. It included three families, a full-time hired man, and a crew to help at harvest time. The modern Gallup farm is almost twice the size it was 30 years ago, yet it supports only two families. Now Roger and Dwight alone do most of the work, with help as needed from a seasonal hired man, the Gallup wives, and Roger's two children—and, of course, the equipment. When Dwight was a boy, 10 draft horses provided the power. Today Gallup's fleet of tractors and the implements they pull have the power of hundreds of horses and do the work of dozens of men.

As the complexities of management have grown, farmwork patterns have changed, The farming Roger and Dwight knew as boys was based on livestock; it was 365 days a year of chores. The year's work on today's cash crop farms is squeezed into 6 or 7 hectic months of plowing, fertilizing, planting, cultivating, crossing fingers, repairing equipment, and harvesting. Much of the rest of the year is spent maintaining equipment and buildings, marketing the grain, and planning the next season's work. Dwight recalls that when he was a boy there was no ''off-season, even in winter, When all the other work was done, there was always firewood to cut.

"I'm glad those days are over, " says the 67-year-old, semiretired farmer. "I mean, the other day it was snowing and blowing, and I could just sit in the house, warm and cozy, and watch TV. "

"Yes, but the pressure is just as bad, " Dwight's wife, Hazel, interjects. "With all the modern equipment, you still have the responsibility to maintain every thing."

Maintenance was not much of a problem in the past. For the most part horses maintained themselves, although you had to set aside a sizable portion of your land for their feed. But with the blessing of modern equipment comes the burden of maintenance. Roger and Dwight must be expert motor mechanics, welders, sheet metal workers, machinists, and much more. With the large amount of land that they must work in a limited time and with limited manpower, there is no time to take a broken-down tractor to the dealer's shop. And you cannot afford to keep a spare piece of expensive equipment on hand. So repairing and maintaining modern farm equipment probably is the single most important part of farming. Roger's enormous maintenance shop is a steel structure, resembling a Quonset hut, big enough to hold the combine and a couple of tractors.

Economics dictate that a farmer must closely match equipment size to crop acreage. Equipment that is too small may not cover enough ground during the critical period dictated by weather, soil conditions, or the sensitivities of a particular crop. Older equipment is, generally, more prone to breakdowns that can cut yields. On the other hand, a farmer who is overequipped is wasting capital-that is, unless he intends to offset his equipment size with more acreage. But if a crop fails or the grain market plunges and his credit line snaps, the farmer's overextension may get him in trouble.

John Fuelbirth, farm loan advisor with Herget National Bank in Pekin, Ill., says, "Farmers tend to be conservative. But they want to spend too much on machinery. And the investment tax encourages them to spend it. "

In the past, farm efficiency has been gaged too often by the amount of food a farmer could produce, no matter what the energy or resource requirements. Rut the Gallups, and people like them, recognize that, in order to sustain production rates in the long term, the definition of efficiency must include the protection of the root source of this

bounty-the land itself. The future's challenge is to improve and spread soil-saving technology with the same energy with which our forebears opened up this land, and to encourge farmers to adopt a land stewardship ethic—by making it pay.

FARM REHABILITATION-WHITEHALL, WIS.

From the ridgetop, the deep gouges in the slope look like soft, tree-covered folds. But a closer inspection reveals the unmistakable scars of decades of abuse.

Eighty years of farming this western Wisconsin land had almost destroyed it. A parade of owners and occupants had stripped the hilly land of its protective vegetation and fertility with cows and row crops until yields dropped so low that the land could no longer support the farm families. By the late 1950's the hillsides were bare except for an occasional gnarly old oak. The farm stood abandoned and what poor soil remained was washing away at a fierce rate.

Poor-quality land such as this often gets swallowed up by bigger farms. The ridges are cropped, the slopes pastured, and the farmer is content to let productivity limp along.

But this Whitehall, Wis., farm is different. It was purchased in 1959 for *$25* an acre by a man who said he wanted "a place to plant some trees. " And that he did. To date, Ernie Brickner has planted 160,000 trees on those 229 acres. The 70-year-old planted 135,000 of them by machine and carried another 35,000 up the steepest slopes and planted them by hand.

"It wasn't easy, " Ernie admits. Some of his slopes approach a 45-degree angle; they were skirted by the glaciers that scoured and smoothed other regions of the State.

Before man shaved the surface and began cultivation, prairie grasses dominated the landscape. They gathered nourishment from the soil and, in turn, enriched and protected the land.

Then came a procession of farm families, each trying and failing to earn a livelihood from what Wisconsin Department of Natural Resources forester Ed Godel calls a "two-story farm. " The upper story—the ridgeland—and the lower story—the valley–-were planted to row crops; the sloping land in between was pastured by some of its caretakers and cropped by others.

It was a malevolent partnership of man and nature. Man planted his row crops on cleared hillsides and grazed his livestock on wooded ones. The tilled soil often lay bare to the forces of erosion. Livestock tramping on the wooded hillsides ate away protective underbrush and packed the spongy soil into a hard, inpenetrable surface. As these pastured slopes lost their ability to soak up water, runoff from spring rains stole soil and flooded the valleys below.

Photo credit OTA staff

Ernie Brickner pruning a red pine to encourage straight, knot-free growth

The only way to transport grain down from the ridgetop fields was along a horse trail—called a dugway. It was so steep that even teams pulling empty wagons had to be rested three or four times on the way up the incline. This discouraged hauling manure up to fertilize the ridgeway, so the fertility gradually ebbed.

The land's history speaks of the failure of nine owners and four renters to generate income from the craggy terrain. And the deep gullies, some big enough to bury a barn, reveal the damage incurred by unrestrained use of agricultural technology,

Ernie says the land would have been easier to manage as a farming unit had it been parceled out according to natural boundaries, such as creeks and ridges, instead of the surveyor's 1 inc. But Wiscon-

sinwas part of the Northwest Territory, so farms were laid out in 160-acre squares.

Butwhen the land is planted to trees, nature's boundaries do not prove so formidable. With the help of Godel, his county forester, Ernie prepared a detail cd plan for the land. The men plotted where the pine plantations should stand, where the black walnuts should be planted, and which hardwoods Ernie would cull and which he would preserve for wildlife food and habitat or save for eventual harvest.

In drafting the plan they considered soil type and slope; market value for tree species; time span before trees would reach marketable age: and, most of all, Ernie's dream for the land.

His (Ream was much bigger than planting trees ['or timber production. A former teacher and superintendent of schools in Whiteh all, and Iater education officer in charge of a youth conservation program in the Superior National Forest in Minnesota, Ernie used forestry projects to excite boys disillusioned with classroom learnin:. Ernie returned to his Buffalo County land steeped in multiple-use philosophy toward woodland management.

With his submarginal acreage he could put the concept to a rigorous test . He would plant, (: ull, thin, and prune trees not just for timber production but for water-quality control downstream, wildlife habitat, recreational use, and-his special interest—educational opportunities.

In just 22 years, he has succeeded. He thinned his pine plantation 2 years ago and sold the immature trunks for posts, poles, and pulp. He left the pine tops and trimmings on the ground as cover for grouse and rabbit. He has cut "weed" species and damaged hardwood trees to leave more sunlight, space, water, and nutrients for their more commercially valuable neighbors. From the cuttings, some logs *are* made into railroad ties or shavings for livestock bedding; others become firewood.

But Ernie is careful to leave a few "wolf" trees and "(1en' trees standing. Wolf trees are the giant old patriarchs of the forest, ancestors to many of the naturally propagated trees, Den trees are often hollow and dying, but they are still valuable to Ernie for the shelter they afford wildlife.

In fact, Ernie's forest is a wildlife paradise; hickor] and walnut are the squirrels' delight, Then there are raccoons, fox, ring-necked pheasant, hawks, even eagles. Ernie has counted at least 35 species of songbirds on the property.

The wildlife, in turn, draws bunters, Under Wisconsin's Forest Crop Law, Ernie agrees to open his land for hunting and pays a severance tax on harvested timber in exchange for a property tax deferral. But with or without the law, Ernie has no desire to hoard his woodland. It is open year-round, by permission, to hunters, snowmobilers, skiers, hikers, berry pickers, and birdwatchers.

Ernie probably gets the greatest joy out of the educational value his woodland provides. " I really get a lot of pleasure out of walking through here and telling people what I know about forest management . . . especially the kids. " Ernie remembers the thank-you note he received from one young visitor who had trekked the hills and fi relanes with his seventh grade classmates: ''I really like your \\'oods," the boy wrote, "especial)' the fire escapes.

Ernie is willing to share his pro pert} with neighbors and friends and with groups of all sorts—environmental organizations. church groups, community clubs, 4-H 'ers, farmer groups, professional and student foresters, conservation classes, and the like.

Perhaps the most important use of Ernie's trees, in the long run, is to protect the land base from erosion and to keep water and nutrients from flooding the lowland fields down the valley. Moreover, Ernie's land no longer contributes to the sedimentation and eutrophication of water downstream to Trempealeau River and, ultimate}', the Mississippi.

Ernie's woodland. however, is a small island amidst farm fields and wooded pastures that spread on all sides. It is not that trees are scarce in Buffalo County—roughly 40 percent of the land is wooded. What is in short supply is woodland fenced off from the munching and stomping of dairy cattle.

Dairying is big business in this part of Wisconsin. "And the milk check is the thing that the farmer is interested in right now," says Brickner. " He's not too interested in what will come off that land 30 or 40 years from now. '

"Big farmers-successful farmers-are tied up in their farming activities " says forester (10(1(:1, "They have little time for woodland management."

It is estimated that up to 50 times more runoff flows from grazed woodland than from ungrazed woodland. Ernie says grazing creates a threefold problem: soil compaction, loss of undergrowth, and damage to established trees.

The average dairy cow weighs about 1,400 lb. That weight, *concentrated* under the hooves, *exerts* a great force on the soil, Under repeated pressure, soil particles are compressed until, eventually, the earth can neither absorb rainfall quickly nor leave adequate passageway for roots.

Also, cattle have a penchant for tender undergrowth. They eat the more desirable young trees, such as maple and oak, and leave undesirable species, such as black locust.

"By eating shrubbery that's necessary for the accumulation of humus, cattle are eating prospective mulch, " Ernie says. In ungrazed woodland, soil acts like a sponge, absorbing and holding water. And, healthy trees consume more water and keep the water table lower,

"And frost doesn't penetrate as deep under thick mulch. " Consequently, more melting snow can seep into the soil.

A healthy understory also softens the impact of raindrops on the soil. Direct hits by these drops can gouge out soil particles. "On unprotected land, I've seen chunks of soil 4 or 5 ft across—peat soil, it's lighter and will float-torn away in my valley and float all the way down to Independence and wash out into the pasture where the floods were coming down, enough in one big chunk to fill a manure spreader, to say nothing about the smaller pieces that are torn away. "

Farmers often solve the flooding problem not by treating the cause but by bandaging the wounds. Wing dams built into hillsides impound runoff and can prevent flooding.

"These dams hold the water back so it doesn't cut down through their farms and do the flooding right on the farm, " says Ernie. "But it would be a waste of my money for me to build dams. The water stays right on these wooded hillsides. "

Most agronomists and foresters agree that it is usually best to divorce tree-growing from cattle-raising. University of Wisconsin forester Dr. Gordon Cunningham points to research that shows that good-quality open pasture yields about 30 times more protein than wooded pasture.

Foresters and ardent tree farmers such as Ernie espouse a simple remedy for reducing runoff and improving timber quality: keep the cows out and harvest the trees when they are ready. By doing so, a landowner can gather firewood and harvest quality timber. "Mother Nature has lots of time, " Godel insists, "and the woodland damage will repair itself if you take the cows out. "

"Trees aren't nearly as demanding of nutrients as agricultural crops, " Godel explains. "A tree has an extensive root system. And unlike an annual crop that concentrates its nutrients in the grain head which is removed in harvest each year, a tree keeps adding organic matter to the soil."

But unlike the annual payback that dairy cows and row crops offer, a tree is slow to bring a financial reward, In fact, it will be beyond Ernie's lifetime when the walnuts he planted and pruned yield their precious veneer. And it wasn't his sons that he had in mind when he planted them . . . it was their children.

"Growing trees makes you farsighted," Ernie says, "You have to look to the future when you plant trees. "

Besides the economic value of the trees, Ernie wants to hand down to his children and grandchildren a place to enjoy the things that would have fulfilled him,

"I've enjoyed the woods throughout my life—hunting and fishing—and that's what has given me the feeling of stewardship toward the land. "

Some woodland owners think of management and preservation as at cross purposes, To them, culling trees and harvesting mature timber destroy the pristine quality of a forest, But Ernie's woods offer ample testimony that you can manage woodland for both esthetics and timber improvement. And such management can greatly enhance the productivity of U.S. lands.

Although the net annual timber output has increased 56 percent in the last 30 years, according to Rexford Resler, vice president of the American Forestry Association, the Nation's forests are only producing about three-fifths of the net growth per acre that could be obtained with proper management of natural stands. But few people see the potential.

"Most intensive woodland management on private lands is done by someone who makes his income from another source, " Godel points out. People such as Ernie Brickner who are firmly entrenched in the conservation ethic are not tied to the land for immediate income . . , they often make the best stewards and managers of timber acreages, he says,

Ernie remembers that 20 years ago you could stand on the ridge and look down on bare hillsides eroded by decades of unwise farming. Today the steep slopes and valleys are cloaked with trees—pine, spruce, birch, and other hardwoods.

Ernie's dream has been to reclaim some dying land, reforest it, and make it valuable again—valuable not only for the timber it can produce but for wildlife, recreation, and education. His commitment and dedication epitomize the forces driving the land ethic emerging in American society,

SALINE SEEP CONTROL-FORT BENTON, MONT.

When farmers on Montana's Highwood Bench real ized that they were losing 20 percent of their land—20 ()()() a[;res-the} got angry. Enough is enough. So some 75 of them gathered one night in 196{1 and decided it was time to act.

The culprit was not the Government. It was not land speculators. It was nature, gone slightly awry. Saline seeps—recently developed outcrops of wet, salty soils on nonirrigated lands-were breaking out and spreading on man}' of their fields, more than ever before, and rendering the land infertile. No one was certain why, or what to do to stop them. The farmers decided it was high time to find some answers.

Howard Hanford relates the history of the Highwood Alkali Control Association (HACA) with some pride—his father was one of the organizers and Howard himself has been chairman of the group. And it was the HACA's initiative—they taxed themselves to support needed research-that brought State, Federal, and local people together to work on a problem of increasing severity and importance for Montana and much of the northern Great Plains.

"All the farmers around here had seeps. Everybody knew that they got bigger in wet years, that they were progressively getting worse, but nobody put things together, " explains Howard.

The story of saline seeps is a mire of geologic, hydrologic, and technological variables. It is an example of the role that technology, in this case crop management, can play in both causing and resolving resource problems.

"The Highwood Bench south of Fort Benton was one of the first areas in Montana to really suffer the effects of saline seeps, " explains Dr. Marvin Miller, a hydrogeologist with the Montana Bureau of Mines and Technology. "They had 20,000 acres in salt in 1971. "

Many factors can foster the formation of saline seeps on individual sites, but two elements play key roles: local geology and summer fallow crop management. Summer fallow (sometimes called crop-fallow) is a traditional crop management scheme

Photo credit OTA staff

Howard Hanford using soil moisture probe to assess the available moisure supporting his growing barley crop

used almost exclusively on the Montana plains since the major land openings of the 1940's. The system is designed to conserve moisture in dryland regions where precipitation is not adequate to guarantee successful continuous crops. Under summer fallow, the farmer crops half his land each year and leaves half fallow, alternating cropped and bare strips each planting, The unplanted strips accumulate moisture in the soil to be used by the next season's crops, But this common crop management technology has proven inappropriate for the terrain.

Advantages of Summer Fallow

- Higher yield per planted **acre.**
- More stable production.
- Higher **soil water content.**
- Greater supply of available nitrogen **in the soil.**
- **Aid in distributing the farmers' work load.**
- **Reduction of insect and disease problems.**

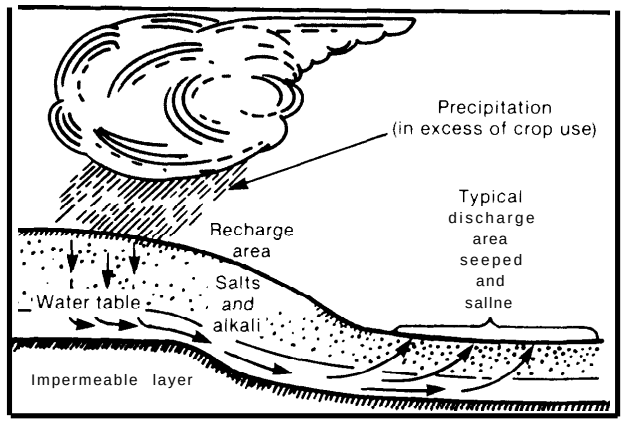
Disadvantages of Summer Fallow

- **Greatly increased wind and water erosion.**
- **Increased air and water pollution.**
- **Lower soil water storage efficiency.**
- **Lower water use efficiency.**
- **Greater soil fertility decline under certain soil and management conditions.**

The saline seep problem arises because summer fallow can work too well, When more water is stored than the following crop can use, moisture builds up in the soil. This water then infiltrates through the soil and reaches an underlying, impermeable layer of shale [see fig. A-2), Here the water accumulates, creating a "perched" water table (a secondary water table perched above the normal ground water level). Because of the nature of the soils, the water picks up numerous salts during this process, Eventually the salt-laden water migrates downslope, Where it breaks to the surface, either in lowlands or where the shale outcrops, a saline seep forms. As more and more water accumulates, the seep grows.

"Right now we have about 200,000 acres of farmland forced out of production by seeps, over 80,000 acres in Montana alone. And that's totally unusable. You can't even farm across it because your machinery will stick in the mire, " says Dr. Paul Brown, a USDA soil scientist who, until his retirement, was the backbone of seep research in the region.

Figure A.2.— How Dryland Saline Seepage Occurs

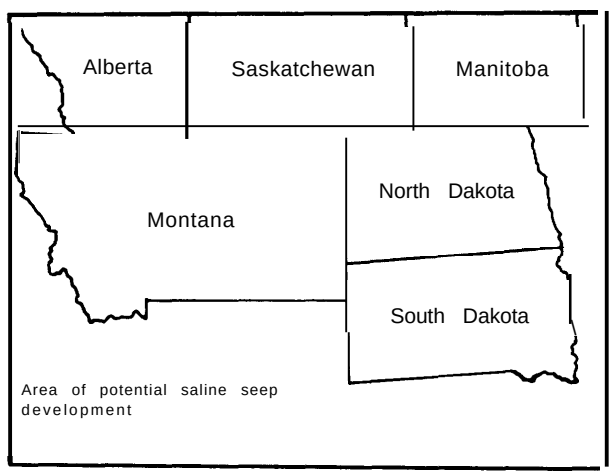


SOURCE Dryland Sallne Seep Control AGDEX 518-5 Alberta Ag Ext Offices, 1979

"The problem affects a whole geologic region including much of Montana, South Dakota, North Dakota, Wyoming, and Canada's prairie provinces, with seep acreage growing by about 10 percent a year," he adds (see fig. A-3).

More than the land is degraded by saline seeps; the salinization has disastrous effects on water quality as well. Local ponds no longer support fish in the Bench area, and the few residents who still maintain cattle must truck water in because farm ponds are far too salty to drink. And as a headwater recharge area for all the downstream States in the Missouri River Basin, the implications of Montana's seep-caused water pollution could be serious.

Figure A.3.— Northern Great Plains Region, Showing Area of Potential Saline Seep Development



SOURCE Saline Seep in Montana, Loren L Bahs, ecologist, Marvin R Miller hydrologist, 1979

When a seep first breaks out, it can look innocuous—just a small, wet pothole you have to skirt with the planter, Generally, farmers do not even realize they have a problem until a seep grows to a quarter acre or so. But depending on the site, saline seeps have grown as large as 200 acres, and that is a substantial amount of land to lose. During dry weather, seeps look something like black bathtubs with white salt rings—that is how much salt can actually accumulate on the surface as the seep water evaporates. Most seeps will be barren, almost swampy. Sometimes Kochia, a salt-tolerant weed, will grow around the edges, but most plants cannot live in such a saline environment.

"Montana farmers have an inherent disbelief that excess water could be a long-term problem on their land, " Dr. Miller says. After all, theirs is a notoriously dry climate. And they grew up with stories of the great droughts, the giant dust clouds, and the many who were forced ''bust' by the lack of water. So it can take some convincing to show certain farmers that too much water could be a problem.

Howard Hanford was one farmer who did not need convincing. The 1,500 acres that he farms with his wife, two small children, and one full-time hired hand is a model of what can be done to stop and reclaim saline seeps.

To give visitors a feel for his land, Howard sometimes invites them to lunch atop his flat grain bin. From there, you get a sweeping view of his ocean—an ocean of grain, still richly green, undulating in the winds. His fields stretch, seemingly unbroken, all the way to the base of the Highwood Mountains to the north.

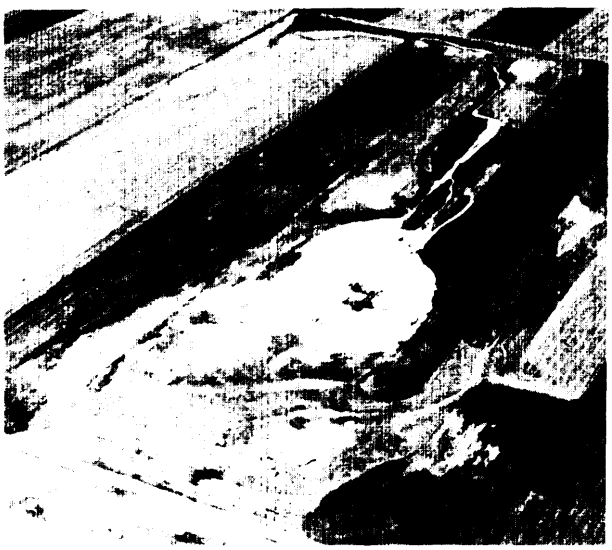


Photo credit: OTA staff

Large saline seep broken out on traditional summer-fallow land in Montana

The fact that the growth goes unbroken is notable; the alternating strips of fallowed land so common on the Montana landscape are missing. Under the cropping management system Howard uses—flexible cropping-whether he plants or not is dictated by the environment rather than by tradition. It is a system that makes Howard an innovator in the fight against saline seeps.

Flexible cropping, as the name implies, casts aside fixed cropping patterns. Instead, this method calls for the farmer to decide whether to plant or fallow a field based on the actual amount of stored soil moisture in the root zone and the average growing season precipitation,

"Measuring soil moisture is pretty easy with the soil moisture probe that Paul Brown invented, ' Howard claims. The probe is a simple tool-a solid metal rod with a small auger at the tip. The farmer merely twists the rod down into the ground; when the pushing gets difficult, the probe has reached the bottom of the moist soil layer. The auger then brings up a small soil sample,

For example, wheat needs about 9 inches of soil water. If the average rainfall is 6 inches, there needs to be 3 inches of stored soil water available to raise a good crop. If adequate water is not available, farmers using flexible cropping are still free to leave the field fallow.

The new system's flexibility extends to what crops are grown, too. Beyond the region's usual wheat and barley crops, this system includes rotations with alfalfa and oil seed crops such as safflower and sunflower. Such crops use more water and draw it from deeper in the soil, and so play a special role in the management of seep recharge areas.

By taking full advantage of all available moisture, flexible cropping allows farmers to grow' more crops because they no longer leave half their land fallow. "Of course, it's not so simple as doubling your acreage and doubling your income. Some 20 percent of your land may be in sunflower or safflower, which don't generate the same income. And you don't plant as much wheat and barley, " Dr. Miller explains, "But you have an advantage-five crops for five markets. If one market is clown, you still have four others. "

But perhaps more importantly, flexible cropping helps farmers prevent saline seep formation. By managing both soil and water more carefully, Montana's farmers can avoid losing land-and productivity-to seeps.

But there are tradeoffs. First and foremost in many farmers' minds, flexible cropping demands more work in planning and in operating the farm.

"My 1,500-acre farm in summer fallow would be a cinch, " says Howard. "With continuous crops, you need more manpower, more equipment. You have to move fast; you've got 2 weeks to plant all your acreage. You've got to harvest it all before some hailstorm lays the whole crop flat. " This need for speed often urges farmers to bigger equipment and therefore added investments.

And because the system is flexible, it requires more managerial decisions: planning to avert potential seep problems or reclaim existing ones, testing to monitor moisture and fertility, extra commitment to combatting weeds and diseases, and special efforts to find markets for hay and oil seed crops in a region tuned to a small-grain economy.

In long-term economics, saline seep causes deflated land values, higher operative costs, lost crop income, lost tax money to the State, and lost wheat to the Nation. But seep control methods such as flexible cropping cannot succeed if the costs of control exceed the cost of doing nothing. So far, the new cropping pattern seems relatively successful,

"The successes up here on the Bench are important examples for the rest of the State, " Dr. Miller comments. "These people have a genuine sense of concern for their land, a pride. "

In Chouteau County, which includes the Highwood Bench, more than 60 percent of the farmers are involved in seep control. Overall in the State, however, total involvement is closer to 1 percent. The high acceptance in Chouteau is because the Bench was the original focal point for seep research and control and because of the strong presence of HACA and local, State, and USDA/SEA-AR specialists.

To promote seep control over a wider area, the Triangle Conservation District, including 10 seep-prone counties, was formed. The strength of the district's efforts are its field personnel—people such as Ted Dodge and Jane Holzer who spend their time traveling in the district, meeting with farmers, and

Photo cridit OTA *staff*

Dr. Marvin Miller checks a well, monitoring subsurface water levels

discussing strategies for their particular problems.

"We work farm by farm, " Mr. Dodge explains. "After a farmer applies for our help, we go out for an on-site visit. We'll map the seeps, drill a grid of wells to determine water movement below the ground, determine where the problem recharge and discharge areas are, and help with planning control measures. "

Proximity and visibility give real boosts to farmer acceptance of seep management. ''Our biggest draw is the drill rig. You get that out in one man's field and all his neighbors will appear, like a parade, to follow along and watch, " Mr. Dodge recalls, The district almost always receives more applications after that.

Land lost to saline seeps is difficult to reclaim. "You can't just clean up after the problem, you have to prevent it, " explains Dr. Brown. But experts have made progress i n designing management schemes to prevent seeps and even bring some degraded land hack into USC.

First, the cause of the seep needs to be eliminated. To do this, the field team traces ground water movement to find the fielc] or fields that are accu - mulating water. Since most seeps break out within a few hundred yards of their recharge area, the mapping is relatively localized. It is helpful that the scale of cause and consequence is so small; very often, seep recharge and discharge areas are on the same farm, making control easily When seep problems do cross properity lines, it can be more difficult to convince both landowners to participate in the cleanup .

"Generally, though, we've had really good luck getting neighhors to work together to mutual advant age, says Ms.Holzer.

Once the cause is determined, the prevention option chosen most often is to recrop the offending field with deep-rooted, water-loving perennials—for example, alfalfa. The hay crop will act as a sort of sponge, soaking up moisture from deep below the soil. The plants' leaves wick the excess water away into the a i r. Once the water regime is stabilized, the farmer often can return the field to more profitable crops as long as he monitors moisture levels carefully and alternates grains with high-water-use oil seed crops and hay. Some recharge areas, however, may have to remain in pasture or revert to natural grasslands to guarantee seep pretvention

When the flow of excess water is stopped, existing seeps should stop growring. But they are unlikely to disapear. Sometimes, as the seep area dries, the farmer can begin planting the edges of the patch with salt-tolerant crops and gradually bring it back into production. Many large seeps, however, cannot be reclaimed with present methods.

"Controlling seeps requires a delicate balance, " Dr. Miller says. "A little mismanagement , . . and you could be right back where you were.

"The more progressive farmers are beginning to realize that they can't farm just by what on the surface, adds Herb Pasha, the president of the Triangle Conservation District.

"We're learning that the technological fix often brings unforeseen consequences, " says Dr. Miller. "For seeps, the hardware approach said 'if you have a problem with too much water, drain it. ' But that doesn't work, We tried draining an acre seep to reclaim it; what we did was create a 5-acre seep further downslope. "

"We have to look at the consequences of our actions first; you don't forge ahead without thinking ahead, " he adds,

"It's one thing to define the problem; it's another to get solutions established on the land, " says Dr. Brown.

For some, and not just the scientists, continued research is the key: "As long as that goes on, we keep learning, " Howard Hanford insists. "That's why HACA was formed. But it's hard to get the Government to understand us; letters go back and forth, but we can't sem to connect. When Paul retires, I hope we don't lose our research base-there's too much more that needs to be done. "

"A farmer is not your average character, " Howard explains. "He is a little bit stubborn and stuck in his ways. A n article i n some paper won't convince him. He needs to see the field personnel, to see proof. "

Proof in the field is especially important when some long-accepted practice such as summer fallow is in question. Saying it is an inapriate technology is not enough; the alternative--flexible cropping-must be opened to scrutiny, tested, and refined for practical use, After all, it is not unreasonable for farmers to ride with proven methods, even if they have certain negative repercussiojn, if the alternative is an unknow n.

Maintaining land productivity will be a continueing challenge for American agriculture one that can be both enhanced and hindered by technology. As illustrated in Fort Benton, the most sustainable methods may not always be easiest. But when the threat is highly visible, salty potholes swallowing the land-and the people are truly concerned, farmers and agriculture, and do change