GRASSLANDS, COMMUNICATING THE BENEFITS

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Abstract

The multiple benefits of perennial agriculture , including forages and grasslands, for building soil quality, protection of natural resources, enhancement of biodiversity and wildlife, are well known to us, but little understood by the public. This is not a situation where "more education" would necessarily increase recognition. Rather, we must build in the public a desire for the enhancement of green space, clean water and air, and diverse landscapes that multiple purpose agriculture can bring. We seek such environments intuitively and now that much of the world's people are "trapped" in urban settings of steel and concrete, this desire is even more apparent.

Yet other forces continually work against using agriculture for such uses. Economic motives are at the base of the conflict. Grasslands seldom produce recognizable returns. It is important for grassland scientists to bring to the public forum the benefits of their unique approach, even while the agricultural world seems to be moving toward a grain-based economy. Such recognition is necessary if public support of conservation incentives are to become a part of agriculture. Rotational grazing offers one way around the economic issue, and will be discussed in detail. Other economic approaches involve government leasing and government recognition of environmental benefits (Conservation Reserve Program).

A concept gaining support involves carbon trading. This is payment to the land owner by public or private entities for conservation practices that sequester carbon, thereby reducing the carbon dioxide load in the atmosphere and slowing global climate change. Carbon trading could ultimately be endorsed in the Kyoto treaty, making carbon sequestration a part of national policies and a new way to support multifuctional agriculture.

The paper will discuss pros and cons of several management options that will require the use of perennial crops, grasslands in particular. Ways are also discussed to engage the public in the decision making process. The bottom line, however, is that in some way or the other grasslands systems often must be subsidized in the United States.

Introduction

"Coon Valley, in short, one of the thousand farm communities which, through the abuse of its originally rich soil, has not only filled the national dinner pail, but has created the Mississippi flood problem, the navigation problem, the overproduction problem, and the problem of its own future continuity". Aldo Leopold. 1935.

I write this paper from the vantage point of Central Iowa, United States. This is a region of nearly level recent glacial soils deep in organic matter, provided providentially by the native prairies and oak-savanna that evolved here some 10,000 years ago. These soils can be abused and still produce abundantly, as long as they are tiled for internal drainage. But abuse can not go on forever, even these great soils have lost over one-half of their top soil material to erosion in the 100 or so years of intensive farming.

I can travel south only 100 km and find soils from much older landscapes, because Ames Iowa is close to the southern tip of the recent glaciation. These more eroded surfaces also formed under prairie and forest. It is evident even to the untrained eye that these soils have undergone more erosion to the point that their productivity has been compromised. And to the west lie deep loess soils, susceptible to many abuses with formation of gullies as well as sheet and rill erosion. To the northeast lie an unglaciated area, showing steep gullies and canyons formed from geological erosion. This is the land surface that the rest of Iowa will become because of geological erosion.

The Coon Valley watershed is of great historical significance and a major beginning on our way to conservation education. There was a major push in the U. S. in the 1930's to 40's with the Soil Conservation Service to encourage adoption of soil conservation practices. Leopold (1947) wrote:

"Everyone ought to be dissatisfied with the slow spread of conservation to the land. Our "progress" still consists largely of …conservation oratory. The only progress that counts is that on the actual landscape of the back forty, and here we are still slipping two steps backward for each forward stride. The usual answer to this dilemma is "more conservation education." My answer is yes, by all means, but are we sure that only the volume of educational effort needs stepping up? Is something lacking it its content as well. I think there is and I here attempt to define it". He goes on to write "we have been too anxious for quick success, to tell the farmer the true magnitude of his obligations. Obligations have no meaning without conscience, and the problem we face is the extension of the social conscience from people to land"

My assigned topic for this session is "*Soil degradation and environmental pollution*." I took this as a cup half-empty and turned it to a cup half full. Rather than labor on the evident problems of soil degradation and pollution, which tend to be either some site specific examples or rather overwhelming national or global averages, I will emphasize where grasslands (forage, perennial grasses and legumes) are the key to bringing soil degradation and environmental pollution under control. I start with Leopold, because he had a ringside seat to the starting pangs of conservation of degraded lands, and because his wisdom rings true for the ages. I also emphasize ecological knowledge, or learning and facilitation (Rolins and Jiggins, 1998) to forward the cause of adoption of resource conserving grassland systems.

Benefits Of Grasslands

Soil Quality

Most of the ecological benefits of grasslands can be readily identified with improvements in, or maintenance of soil quality (Karlen et al., 1997, 1998) The concept of soil quality has been introduced as the integrative attribute of a soil to provide support for food and fiber production and provide ecosystem services (clean water, air, scenic beauty, wild life) (Doran et al., 1994; Keeney and Cruse, 1998). Healthy (high quality) soils are key to healthy ecosystems (National Research Council, 1993). Soils partition rain as runoff or infiltration and hence affect quality of surface and ground water, and the extent of topsoil erosion. Soils store and release carbon through transformations of organic crop residues and organic matter, they cleanse leachates of contamination, and buffer plant growth, storing nutrients and water. Soils are variable across landscapes. Advances in precision agriculture technologies are helping with the management and understanding of soils based on their unique properties and functions (Cheng and Robert, 1994).

Worldwide, soils that are formed under permanent deep-rooted grasslands are of the highest quality. But very few virgin grassland soils remain. Iowa, for example, has only retained a small percentage of its native prairies, and these as museum remnants.

Communicating The Benefits Of Grasslands

Erosion Control

Grasslands have long been recognized for their ability to resist soil erosion by water and wind.(Lowdermilk, 1953). Over the years the U. S. government has tried several approaches to control land erosion while removing cropland from production. The recent and most enduring program to date is the Conservation Reserve Program (CRP), which was designed to convert cultivated lands into grasslands. This program succeeded well, even though some lands were put in the program that were not highly erodible. The program operated on the basis of a long term rent or easement of the land provided the landowner followed strict rules including establishing grasses and not using the land for any gainful purpose during the 10 years of the lease. The lands were chosen on the basis of bids, and in general, landowners were paid rents ranging from close to local market value to much higher than market value. The pros and cons of the CRP program have been widely debated. But it has been popular, because it was financially attractive to landowners as a way to receive guaranteed income from fragile lands. The program has provided scientists and policy makers a look at ways to retire land and to determine its benefits to water quality, soil quality and wildlife (Karlen et al., 1998).

Maintaining topsoil by mininimizing soil erosion control should be of direct financial benefit to the farmer by by lowering input costs and increasing yields (Lowdermilk, 1953, , Larson, 1981; Larson et al., 1995). However, Crossant (1995) maintains that off farm costs of erosion (lowering water quality and quantity) is much greater that the on-farm costs of erosion. In his calculations, world-wide loss of productivity because of soil erosion is in the range of 0.5% per year (Crosson, 1995). This rate of loss of productivity seems insignificant, and so far has been largely masked by productivity. However, at a loss rate of 0.5% per year, it would take only 140 years for the productivity of the world to halve. A sobering thought when yields must increase by a factor of two to three to keep in pace with population needs.

The debate over the costs of soil erosion has resulted in greater focus on the off-site benefits from erosion control. Therefore, the costs of erosion control must be borne by society rather than the landowner. Soil erosion control will not happen to a great extent unless subsidized through incentives and programs such as CRP, or unless soil conserving technologies also are better than non-conserving technologies. An example of soil conserving technologies is no-till, which has gained considerable popularity because it saves fuel, time and equipment costs. Thus no-till and other residue control technologies have been well accepted.

Buffer Strips

The establishment of buffer strips along second and third order streams has long been recognized as a way to stabilize bank erosion and filter overland flow, removing sediment and some pesticides and nutrients. It is estimated that much of Iowa’s sediment contributions to impoundments and the Gulf of Mexico come from stream bank erosion.. But buffer strips are not a popular management tool on grain farms where land is taken out of production for no obvious benefit (Swanson et al., 1986). To address this issue, a long-term program by the Leopold Center and the Department of Forestry at Iowa State Univ. has evaluated buffer strip systems consisting of grass and fast growing trees (Isenhart et al., 1997). This program has given considerable data for establishment of buffer strips in the Midwest, and has helped the federal program move some of its CRP funds into environmental benefits. The programs have been done with research and demonstration of buffer strips,on operating farms This program again communicated the benefits of grass, and has helped set new federal policies for support of buffer strip establishment. Farmers can now rent the buffer strips to the federal government through the CRP program and can receive technical and financial assistance for establishment of the buffer strips.

Rotational Grazing

Henry A. Wallace, in 1940, stated:
"I have always had real affection for grass. It seems to stand for quietness and strength. I believe that the quietness and strength of grass should be, must be permanently a part of our agriculture if this nation is to have the strength it will need in the future. A countryside shorn and stripped of thick, green grass, it seems to me, is weakened just as Sampson was. An agriculture without grass loses a primary source of strength."
Henry A. Wallace Institute, 1992.

Wallace was just completing his service as U.S. Secretary of Agriculture. He is known not only for his agricultural leadership, but also for his role in the formation of the Pioneer Hi-Bred seed corn company.

The economic "benefits" of high yielding grains, mechanization of the forage industry, and the incessant movement to larger dairy and beef farms meant that grass and legumes became stored forage for confined livestock while many farmers abandoned livestock altogether. The words of Wallace and others went unheeded in the U. S. for over 4 decades. Farmers, particularly in Wisconsin but also in Iowa and other Midwest U. S. states, realized that they stood little chance of continuing as owners and operators of dairy and beef farms under the pressure of increasing industrialization. They began to look at an alternative, sustainable method for handling forage and soon realized that the New Zealand rotational grazing (also known as management intensive grazing, intensive rotational grazing, and Voison-controlled grazing management) methods could be adapted to U. S. conditions. They reinvented an agriculture based on the "quietness and strength" of grass.

It was not coincidental that this was the time when "sustainable agriculture" moved from an academic exercise to a full-fledged farmer-driven movement. This movement occurred outside of academia. As detailed by Hassanein and Kloppenberg, (1995), the development and information transfer of rotational grazing was done through knowledge exchange with graziers. A unique way of learning, the "pasture walk" was developed. As Hassanein and Kloppenberg (1995) point out this was actually social movement, as has been many other aspects of sustainable agriculture. Eventually Extension agents and university researchers were part of the knowledge-sharing network. Importantly, knowledge generation, while benefiting from research, is based on horizontal local knowledge.

The Leopold Center for Sustainable Agriculture at Iowa State University, as one of its first multidisciplinary programs, adopted a fledgling rotational grazing group in southwest Iowa. It was midway through the Conservation Reserve Program (CRP) and already there were concerns that the fragile southern Iowa landscapes now preserved in grass would soon revert to row crops. Cow-calf beef raising was a reasonably profitable way of using grass in the region, but many farmers had succumbed to row crops during low beef price times, and then moved land into CRP. Experience had shown that standard grazing methods were inefficient, produced low gains, and were not sustainable during dry weather. A community group approached the Center to help initiate a demonstration-research program on rotational grazing.

A decade later, grazing clubs are common. Rotational grazing systems are no longer a mystery, and rotational grazing has created a stable economy that does not degrade the soil or water. Each farm has its own system. Fencing, watering, grass-legume mixes, over wintering on cornstalks, efficiency of gain and other important issues were evaluated at in joint farmer-university projects (Barnhart et al., 1998). But farmers controlled the research agenda and as a result communication flourished.

Would this have happened without the Leopold Center? It probably would because the technologies are relatively simple. But the Center was able to accelerate much of the experiments and to facilitate groups that wanted to become active. Partnerships were developed, and the many institutions and groups, including the academics and extension people, learned from each other. As Gerber (1992) put it so well "*for farmers an intuitive understanding of relationships among multiple variables, their confidence in their own observations, and the apparent success of practical solutions produce experiential knowledge that may have more immediate utility than scientific knowledge*". Rolins and Jiggins (1998) define this process as the development of ecological knowledge.

Rotational grazing continues to gain strength in the dairy industry. Rather than maximize production per cow, the standard goal of scientific based cow management, rotational grazing adopts a different outlook, reducing stress on the manager, lowering risks, needs for capitalization, and when adapted to seasonal milking, providing a much improved quality of life.

Alleviation Of Global Warming By Sequestration Of Greenhouse Gases

Concern has risen over the past decade regarding global climate change caused by greenhouse gases. The primary gases, carbon dioxide, methane and nitrous oxide, are increasing in the atmosphere at an alarming rate. Fossil fuel production and transport, the chemical industry, the construction industry (cement manufacture), deforestation and agriculture represent the major sources of these gases. The atmospheric concentration of carbon dioxide, methane and nitrous oxide are increasing at 0.5%/yr, 0.75%/yr and 0.25%/yr, respectively. (Lal et al, 1998). Methane and nitrous oxide have a much greater global warming potential per molecule than does carbon dioxide.

A number of excellent reviews of the role of agriculture as a source and sink of greenhouse gases have recently been published. All agree that agriculture is a major source of atmospheric gases through land clearing, land use changes, and normal agricultural activity. Lal et al (1998) estimate the combined radiation forcing from agriculture at 34%. However, output varies widely depending on land uses, climate and management systems. Land clearing, largely now limited to the tropics, is a political and social as well as technical issue. Arable cropping contributes nitrous oxide from nitrogen fertilizers and animal wastes, and carbon dioxide from soil organic matter and plant residue degradation. Methane comes primarily from rice paddy culture and from ruminant animals. Lal et al (1998) estimate that annually in the United States, about 1,442 MMTCE (million metric tons carbon equivalent) are released. About 43 MMTCE are released from agricultural activities in the U.S.

Historically, clearing of grasslands for croplands has released a large store of carbon dioxide and coincidentally nitrous oxide. There of course is no way of estimating how much carbon dioxide was released during the settling of the developed countries during the last one to three centuries (or more in the case of many older nations), but it must have been considerable. Estimates are that the organic matter of the U. S. soils declined 50 to 70% during the first 50 to 70 years of cultivation (Lal et al., 1998).

This loss has been accompanied by major changes in the landscape, waters and social dimensions of the country. Leopold brought up the issue of economic decline when he spoke of Coon Valley. At issue then is if the soils of the world can be rebuilt while maintaining and increasing food and fiber production. The evidence is not there to affirm that such a goal could be met without government intervention. Best management practices such as minimum tillage might help, but most tillage interventions build carbon very slowly and losses through tillage can occur rapidly.

A gleam in the eye of policy makers and farm leaders came from the Kyoto treaty (Schneider, 19980. This treaty was soundly denounced by many conventional farm groups as causing increased fuel prices. The concept of carbon trading, actually offering either government or private incentives to farmers to change practices in ways that would sequester carbon, (carbon credits) has recently been proposed and is in the early stages of trial in Iowa. In theory, soil carbon sequestration would be encouraged by paying farmers for these practices. It would be a win-win situation, farmers get incentives, soil is built, groundwater pollution is decreased, and the rate of global climate change declines.

Many obstacles remain for carbon trading between industry and agriculture to become operational and to actually bring about improved farming practices. The science is shaky at best, carbon builds slowly in soils, can be rapidly lost with changes in farming practices, and monitoring and verification will present major challenges. Duxbury (1994) took a dim view of the use of soils to store organic carbon while others, in particular Lal et al (1998) have a much more optimisitic outlook. The latter authors estimate that the U. S. agriculture has a high potential as a carbon sink. Importantly, conversion to grasslands would be a major part of any carbon reduction strategy over the next 20 to 50 years. In other words this is a policy that can buy time.

This issue is going to be difficult to communicate. At present it is largely an economic issue, and relies on national and global policy instruments as well as cooperative governments. However, any program involving establishment of grassland ecosystems should include a data component to verify accumulation of organic C. But it is not the sort of thing that stirs a farmers heart. There have to be other reasons to convert to grassland ecosystems.

Sourcewater Protection

Interest is rising in the possibility that cities whose water comes from a given watershed might be ahead to simply buy or at least subsidize their watershed to practice conservation and water quality protection measures. Grasslands will be a major part of this strategy.

Energy Production

The use of biomass as a source of energy, either from combustion or conversion to ethanol, has been under study for several years. While corn grain currently is superior for ethanol, and wood for combustion, there are technologies available that will permit grass, even with its higher water content and lower bulk density, to compete. There are a number of economic and technical barriers to overcome, but the concept is quite powerful. While a number of grasses have been studied, switchgrass seems to be the preferred species (McGrath, 1991; Keeney and Deluca, 1992).

This is clearly a win-win situation, fragile soils can be devoted to energy production, soil erosion would be controlled, wildlife will benefit, and dependence on fossil fuels will decrease. As with any other land use, economics plays a driving role. At current energy prices, grass biomass energy is not competitive with fossil fuels or wind power, indicating that some subsidies may be required.

Conclusions

This brief discussion shows that there are many ways that grasslands can lower soil degradation and protect the environment. It comes as no surprise, at least to me, that economics continues to drive land use decisions by the farmer. Few can afford the luxury of using grasslands for environmental protection without some outside payment by society for the benefits received. All policies must look at the financial issues, and must be landscape wide in their assessment.

References

Barnhart, S., D. Morrical, J. Russell, K. Moore, P. Miller, and C.
Brummer (1998). Pasture Management Guide for Livestock Producers.
Pm-1713. Iowa State University, Ames.

Cheng, H. H. and P. C. Robert (1994). Precision farming for a sustainable agriculture. Pp 247-249. In Sustainable Agriculture and the Conservation of Agro-Ecosystems. Proc. Intl. Workshop, Nat. Inst. Agro-Environmental Sciences, Tsukuba, Japan.

Crosson, P. (1995). Soil erosion estimates and costs. Science **269**:461-463.

Doran, J.W., D.C. Coleman, D.F. Bedzicek and B.A. Stewart (eds) (1994). Defining Soil Quality for a Sustainable Environment. SSSA Spec. Publ. 35, Madison, WI.

Duxbury, J.M. (1994). The significance of agricultural sources of greenhouse gases. Fertilizer Research **38**:151-163.

Gerber, J.M. (1992). Farmer participation in research: a model for adaptive research and education. Amer. J. Alternative. Agric. **7**:118-121.

Hassanein, N. and J. R. Kloppenberg, Jr. (1995). Where the grass grows again: Knowledge exchange in the sustainable agriculture movement. Rural Sociology **6**:721-740.

Henry A. Wallace Institute for Alternative Agriculture (1992). Henry A. Wallace: Champion of a durable agriculture. Annual Report.

Hillel, D. (1991). Out of the Earth: Civilization and the Life of the Soil. The Free Press, New York, 321pp.

Hughes, J. S., D. L. Hoag and T. E. Nipp (1995).The Conservation Reserve: A survey of research and interest groups. Special Publication No. 19. 44pp. Council for Agricultural Science and Technology. Ames, Iowa.

Isenhart, T.M., R.C. Schultz, and J.P. Colletti (1997). Watershed restoration and agricultural practices in the midwest: Bear Creek in Iowa. Chapter 19. In J.E. Williams, M.P. Dombeck, and C.A. Woods (Eds.). Watershed Restoration: Principles and Practices. American Fisheries Society.

Karlen, D.L., M.J. Mausbach, J.W. Doran, R.G. Cline, R.F. Harris and G.E. Schuman (1997). Soil quality: A concept, definition and framework for evaluation. Soil Sci. Soc. Am. J. **61**: 4-10.
Karlen, D. L., J. C. Gardner, and M. J. Rosek (1998). A soil quality framework for evaluating the impact of CRP. J. Prod. Agric. **11**:56-60.
Keeney, D. R. and T. H. DeLuca (1992). Biomass as and energy source for the Midwestern U.S. Amer. J. Altern. Agr. **7**:137-144.
Keeney, D, and R. Cruse (1998). The connection between soil conservation and sustainable agriculture. In Adv. In Soil and Water Consv. (F. J. Pierce and W. W. Frye, eds.) pp. 185-194. Ann Arbor Press, Chelsea, MI.
Lal, R., J.M. Kimble, R.F. Follett and C.V. Cole (1998). The Potential of U.S. Cropland to Sequester Carbon and Mitigate the Greenhouse Effect. Ann Arbor Press, Chelsea, MI. 128 pp.
Larson, E.A. (1999). Bear Creek project just keeps rollin' along. Leopold Letter 11, No. 3. Summer 1999. p. A4.
Larson, W.E. (1981). Protecting the soil resource base. J. Soil Water Consv. **36**:13-16.
Larson, W. E., M. J. Mausbach, B. L. Schmidt, and P. Crosson (1995). Policy and government programs in soil and water conservation. .1995. In Adv. In Soil and Water Consv. (F. J. Pierce and W. W. Frye, eds.) pp. 195-218. Ann Arbor Press, Chelsea, MI.
Leopold, Aldo (1935). Coon Valley: An adventure in cooperative conservation. In Flader, S. L. and J, B. Callicott , edPp218-223. The River of the Mother of God and other essays by Aldo Leopold. The University of Wisconsin Press, Madison, WI.
Leopold, Aldo (1947). The ecological conscience. In Flader, S. L. and J, B. Callicott (eds). Pp 338-345. The River of the Mother of God and other essays by Aldo Leopold. The University of Wisconsin Press, Madison, WI.
Lowdermilk, W.C. (1953). Conquest of the land through seven thousand years. Agricultural Information Bulletin 99. U. S. Department of Agriculture. Wash. D. C.
McGrath, D. (1991). Grass as a source of fermentable carbohydrate for ethanol production. Irish J. Agr. Res. **30**:121-128.
McDowell, H., J. Lewandrowski,., R. House, and M. Peters (1999). Reducing Greenhouse Gas Buildup:Potential impacts on farm-sector returns. Agricultural Outlook, Economic Research Service/USDA. August 1999. p. 19-23.
National Research Council (1993). Soil and Water Quality: An agenda for agriculture. National Academy Press. Washington DC. 516 pp.
Roling, N.G. and J. Jiggins (1998). The ecological knowledge system. P. 283-311. In N. A. Roling and M. E. A. Wagemakers. Facilitating Sustainable Agriculture. Cambridge Univ. Press. United Kingdom.
Schneider, S.H. (1998). Kyoto protocol: The unfinished agenda. An editorial essay. Climatic Change **39**:1-21.
Swanson, L. E., S. M. Camboni and T. L. Napier (1986). Barriers to adoption of soil conservation practices on farms. Pp 108-120. In Lovejoy, S. B. and T. L. Napier, eds. Conserving Soil, Insights from Socioeconomic Research. Soil Consv. Soc. Amer, Ankeny, Iowa.