Summary and Proceedings

A = RKLSCP

The Impact of Farming Methods on Soil Erosion

C Factor Workshop

March 1-2, 1988
Nebraska Center for Continuing Education
East Campus UN-L
Lincoln, Nebraska

Published
July 1, 1988

Summary and Proceedings
C-Factor Workshop
The Impact of Farming Methods on Soil Erosion

These proceedings were developed as part of the
Nebraska Natural Resources Commission's
State Water Planning and Review Process
Soil and Water Conservation Strategy

This workshop was co-sponsored by

Nebraska Natural Resources Commission
Soil Conservation Service
Institute of Agriculture and Natural Resources - UNL
Soil and Water Conservation Society
Agricultural Research Service
Cooperative Extension Service
Nebraska Association of Resources Districts
Agricultural Stabilization and Conservation Service
Department of Environmental Control

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STATE OF NEBRASKA

NATURAL RESOURCES COMMISSION

KAY A. ORR
GOVERNOR

DAYLE WILLIAMSON
DIRECTOR

July 1, 1988

TO: Participants in "C Factor Workshop - The Impact of Farming Methods on Soil Erosion", March 1 and 2, 1988, Lincoln, Nebraska

FROM: Dayle E. Williamson

SUBJECT: Transmittal of Workshop Proceedings

This is a copy of the workshop proceedings from the "C" Factor workshop held in Lincoln on March 1 and 2. I'd like to thank those of you who attended the workshop and helped to make it a success. It was our hope that the workshop would raise the level of knowledge of the roles of tillage systems, crop rotations, and residue management in controlling erosion. I feel we accomplished that purpose.

If there was a central theme to the workshop, it seemed to be that with passage of the State Sediment and Erosion Control Act and the Federal Food Security Act, we have entered a new era in our erosion control efforts. Under these new conditions our government agencies and farmers are under pressure to develop and implement conservation plans for almost all of our highly erodible croplands in Nebraska. Responding to these pressures will require a better understanding of the predictive soil loss models used to determine whether requirements have been met. It will also require a thorough understanding of the impact of farming methods on erosion levels.

A major theme of the workshop seemed to be the search for a proper balance between (1) crop management, (2) structural measures such as terraces, and (3) reversion of land to grass. It was apparent that in addition to economics the proper balance depends upon the land involved and the skill of the farm manager.

I personally believe that in this new era development of a sustainable low cost agricultural system will be one of the factors leading to increased competition in international markets for agricultural products. This will involve the best possible use of crop rotations, crop varities, pest management, tillage systems, and minimum input methods of maintaining soil moisture and fertility. It will also mean minimizing of off-farm impacts and maximizing long-term net profits.

These are just some of the thoughts which crossed my mind as I reviewed our efforts in the workshop. I hope each of you found the workshop to be a stimulating learning experience.

Dayle Williamson

Dayle E. Williamson
Director of Natural Resources

P.O. BOX 94876, LINCOLN, NEBRASKA 68509-4876, PHONE (402) 471-2081

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Organization

Speakers for this conference were not asked to provide papers or outlines for their talks. Many later did so upon request and those papers and outlines are included. Summaries were made from transcripts of the other talks. Those received minor editing and were reviewed by the speakers to allow any corrections they wished. The workshop included three concurrent discussion sessions. These were later summarized by the group facilitators and presented to all attendees. In those cases we have included a condensation of the points addressed by the group facilitator.

With one exception the papers in these proceedings are included in the order in which they were presented at the workshop. That exception is that the addresses by the two luncheon speakers are presented at the beginning of the proceedings.

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Acknowledgements

This workshop was co-sponsored by:

The Nebraska Natural Resources Commission
The Soil Conservation Service
The Institute of Agriculture and Natural Resources - UNL
The Soil and Water Conservation Society
The Agricultural Research Service
The Cooperative Extension Service
The Nebraska Association of Resources Districts
The Agricultural Stabilization and Conservation Service, and
The Department of Environmental Control

Special thanks go to Verlon K. "Tony" Vrana. Tony was instrumental in planning and organizing the workshop. His wealth of experience with both the Soil Conservation Service and as Chief of the Planning Division of the Natural Resources Commission made him uniquely qualified to help direct the effort. Tony retired at the end of March, but we hope and expect to see a great deal more of him in future conservation activities.

Other individuals instrumental in organizing the workshop included:

Lloyd Mielke, Agricultural Research Service
Alice Jones, University of Nebraska Department of Agronomy
Bill Hance, Soil Conservation Service
Bill Powers, University of Nebraska Water Resources Center

Most of the credit must go to the speakers themselves. Their material was excellent. Speakers included:

Ron Hendricks, Nebraska State Conservationist, SCS
Jim Cook, Chief Legal Counsel, Nebraska Natural Resources Commission
Joe M. Bradford, National Soil Erosion Laboratory, West LaFayette, Indiana
Scott Argabright, Agronomist, SCS, Midwest National Technical Center
George R. Foster, Head, Agricultural Engineering Department, University of Minnesota - St. Paul
Alice Jones, University of Nebraska, Department of Agronomy
Roger Kanable, Agronomist, SCS, Nebraska State Office
William G. Hance, State Resource Conservationist, SCS, Nebraska State Office
Elbert Dickey, University of Nebraska-Lincoln, Agricultural Engineering Department
John E. Gilley, Research Agricultural Engineer, USDA-ARS, Lincoln, Nebraska
Arnold D. King, Head, Ecological Services, SCS, Fort Worth, Texas
George Ham, Head, Agronomy Department, Kansas State University, Manhattan, Kansas
Dick Thompson, Farmer, Boone, Iowa
Curtis Walker, SCS Resource Conservationist, St. Joseph, Missouri
Larry Ferguson, Chief, Water Compliance Branch, EPA, Kansas City, Missouri

Acknowledgements (Continued)

Special credit should go to the two luncheon speakers:

George Dunlop, USDA Assistant Secretary, Washington, D.C., and
Clarence Durban, President, National Association of Conservation Districts

Recognition should also be given to the moderators, facilitators, and recorders who participated in the meetings. These include:

Dayle Williamson, Director of Natural Resources (Moderator)
Russ Edeal, President, Nebraska Association of Resources Districts (Luncheon Introduction)
Steve Oltmans, Manager, Papio NRD (Moderator)
Jim Culver, State Soil Scientist, SCS, Nebraska State Office (Moderator)
Paul Smith, Resource Conservationist, SCS, Nebraska State Office (Group Facilitator)
Roger Hesman, Program Specialist, ASCS, Nebraska State Office (Group Recorder)
Ernie Hintz, Agronomist, SCS, Midwest National Technical Center (Group Facilitator)
Paul Zillig, Assistant Manager, Lower Platte South NRD (Group Recorder)
Lloyd Mielke, Soil Scientist, Agricultural Research Service (Group Facilitator)
Bill Powers, Water Resources Center, UNL (Group Recorder)
Gordon Kissel, Executive Director, Nebraska Association of Resources Districts (Moderator)
Verlon K. "Tony" Vrana, Chief, Planning Division, Nebraska Natural Resources Commission (Moderator-Speaker)

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SOIL AND WATER CONSERVATION STEWARDSHIP IN THE 21ST CENTURY

Address by George S. Dunlop, Assistant Secretary,
U.S. Department of Agriculture
(Luncheon Speaker)

I appreciate the warm hospitality you have extended to me, and thank you for your kind invitation to share this time with you today.

It is my honor to bring special greetings from Secretary Richard Lyng, and from Deputy Secretary Peter Myers. Both have contributed valuable leadership to the agricultural industry, and to soil and water conservation in particular. They join me in expressing our official gratitude to each and every one of you for organizing and participating in this workshop.

Let me say how proud I am of you -- and permit me to express the respect I have for the work you are doing for agriculture and for soil and water conservation. You are providing working proof of that wonderful admonition by the great William Jennings Bryan: "Destiny is not a matter of chance; it is a matter of choice."

Without question, this workshop, and your participation in it, is an important and substantial effort to identify the best and most appropriate choices that farmers and other land users can take to improve the soil and water resources in your communities, in this State, and ultimately in all of America. And, I for one, believe that the destiny of American agriculture, and, indeed the very health and prosperity of our nation, depends upon the success of these efforts and others like it across the country.

The practical, hands-on approach taken by this workshop is exactly the kind of work which needs to be undertaken to fulfill the challenge of assuring a profitable and environmentally sustainable agricultural production system as we move to the 21st Century. We need to tend to fundamentals. All of the soil and water conservation policies and plans and all of the environmental protection schemes devised in all of the statehouses and all the legislatures combined will not mean one whit, if practical and realistic management options that farmers can understand and appreciate are not at the very root of our effort.

What we are engaged in is a matter of proving that farmers and ranchers and foresters can use our natural resources -- the soil, the water, the sunlight -- to create wealth where it didn't exist before. We are proving that as we do this, we can actually improve both the quality and the quantity of our soil and water resources. So, we are engaged in stewardship. And we are engaged in science, and technology, and innovation. But we must always remember that our success depends upon the fundamentals of practical application and realistic management options which involve farmers and landowners in making their own decisions in a very personal and individual way.

Success of the new approaches to resource conservation depends on workshops just like this one. So, once again I thank you and congratulate you for undertaking this important and necessary enterprise.

FOUR TRENDS IN AMERICAN AGRICULTURE

Permit me to take just a few minutes to share with you four trends that I see unfolding -- four trends which serve as the context of our efforts to improve the quality of our natural resource base.

1985 Farm Bill is Working

First, with the enactment of the 1985 Farm Bill we now have in place the makings of a sensible farm policy. As one who had a hand in the writing of the 1985 Farm Bill, nothing gives me more satisfaction than to be able to report to you that, despite obvious shortcomings, it is working as intended by Congress and the Administration.

Although many farmers are not yet completely out of the woods, we are now experiencing a real, measurable and sustainable economic recovery in agriculture. The thrust of the current farm policy, as provided for in the 1985 Farm Bill, is for the marketplace to determine the value of production. And it is working.

Lost markets are being recovered. The U.S. share of world agricultural trade has risen to 45 percent, and our farmers are finding that we are getting about 95 percent of all new sales in overseas markets because our farm policies now make us more competitive. U.S. exports have already increased 18 percent in volume and 6 percent in value during 1987, with an additional 11 percent increase projected for 1988.

We are also opening foreign markets that had been closed to our farmers. This is due to the Administration's trade reform policy and the personal leadership of Secretary Lyng. Recently we were successful in bringing to conclusion a free trade agreement with Canada that may portend a further opening of global markets elsewhere. This month President Reagan began such an initiative with Mexico, and late last year Secretary Lyng was successful in getting the Japanese to agree to increase their annual quota for U.S. beef products by some 37,000 tons -- with an understanding that there will be more such increases over the next several years, as the Japanese undertake a broader reduction of import barriers.

But what is the bottom line for farmers and ranchers, you say?

The proof of the pudding is in the eating. And the eating is better than it has ever been. Net cash income for farmers in 1987 was $57 billion dollars -- the highest ever, and an increase on a national basis of 11 percent over the previous year. Of course, almost 30 percent of that income resulted from government payments, but that was anticipated as the transition is made from a farm policy that had the government determining value and supporting the income of farmers all over the globe through the loan rate. Now we have a more sustainable market-oriented farm policy providing its income support only to American farmers. The bottom line is that the 1985 Farm Bill is working, and it constitutes a sound policy agenda for seeing through the recovery in the agricultural sector.

Recovery in the General Economy

A second trend that is positive for American farmers is the recovery in the general economy, both in the USA and overseas. The United States is now in the midsts of the longest peacetime expansion in history. During the three years just ended more than 8 million new payroll jobs have been created. According to the Bureau of Labor Statistics, some 549,000 new jobs were created in the month of the recent stock market crash. And growth continues. In December, for instance, retail sales grew by a stunning 10.2 percent, and 306,000 permanent new payroll jobs were created in that month alone.

I could cite you a host of statistics in this regard, but will spare you that. The bottom line is that as real, non-inflationary economic growth continues in the general economy farmers and all rural Americans will benefit enormously. As President John F. Kennedy used to say, "a rising tide lifts all boats."

These statistics demonstrate clearly and convincingly that the Administration's economic program has paid off, and most important of all, that we are still in the midst of an unprecedented economic expansion in America, despite the stories of doom and gloom that emanate from a news media that has never reconciled itself to any good news whatsoever.

Of course, these economic gains did not happen as if by magic or voodoo -- or as some would attribute to President Reagan's Irish ancestry, to the "luck of the Irish."

No, we recall William Jennings Bryan's admonition that destiny is the result of choice, not chance. The success this country has had in recent years has been the result of sound principles, painstakingly worked into effective policy. And the linchpin of these policy successes has been the same prescription offered by President Kennedy in the 1960's -- reductions in the tax rates on personal income.

Conservation Provisions of the Food Security Act

As a third trend which will have a profound impact on the future of agriculture, I call your attention to the conservation provisions of the 1985 Farm Bill. This constitutes, in my view, the single most important environmental legislation enacted in the past 50 years, if not ever. Moreover, it was enacted with the backing and leadership of farmers, ranchers, and other common-sense thinking people.

These conservation provisions are very practical and reasonable in their operation. They are based upon prudent use of our land and water resources, and provide tools to help farmers improve the environmental sustainability of our agricultural production system.

As you know, their emphasis is upon dealing with the undesirable aspects of soil movement, while improving water quality and wildlife habitat. It is impossible for us to overemphasize the degree to which these new conservation provisions are designed with the farmer and rancher in mind. If we do the job intended, and involve farmers in making the decisions best suited for their fields and their operations, we will do much to disprove the assertions of those who believe that a regulatory and proscriptive approach is the only way to achieve success. And I trust we remember that such voices are legion.

I do not believe the conservation provisions of the Food Security Act need to be difficult for farmers to deal with, and I challenge all soil and water conservation professionals to assure that it does not become difficult. We can achieve real, measurable, important, improvements in production agriculture by helping and showing farmers and ranchers the best ways to use their resources.

The bottom line is that there is no question that these new conservation provisions are going to have tremendous consequences for American agriculture. There will be more conservation practices established on 100 percent of the highly erodible lands -- and probably a whole lot of other lands to boot -- during the next 7 years than has been accomplished on 40 percent of the erodible lands during the past 50 years!

I predict that all of this will make American farming more competitive and more profitable as we focus on the quality of output rather than the quantity of output. An environmentally sustainable agricultural production system in the United States will add to our comparative advantage in the global marketplace while improving the quality of life in rural America. That is good news indeed!

The Information Age

As a fourth broad trend, I point to the arrival of the "Information Age" in Agriculture.

Change isn't new to farmers. Farmers and ranchers have to be the most adaptive and resilient people on earth. With the 1940's and '50's farmers witnessed the arrival of the "mechanical age," and gave up their work animals for good. With the sixties and seventies came more change -- the arrival of the "chemical age." Now the eighties and nineties promise to bring even more change in the form of a "biological age" -- and along with it what I call the "information age."

What does this mean, really? Well, the new farm policies now place increasing emphasis on the need for farmers to obtain the greatest possible value from each input. We will need to do all we can to obtain the lowest cost possible for each unit of production. Under previous policies, and even now to a significant extent, the emphasis has been on yield. Yield, yield, yield, always greater and greater increases in yield -- very often just to maximize federal program payments. Now, value and quality, and the bottom line of net profit, are the watchwords of a successful farmer. This trend will accelerate as farm programs provide less direct income support through a ratcheting down of the target price payments.

The amount of information available about our soil and water resources, about the agronomics of production, and about marketing and all the rest, is simply staggering in its proportions.

Farmers and those who service agriculture increasingly will be using computers to manipulate all this data and information, so as to give a clear picture of alternative ways to maximize profits in the marketplace, not just output for the sake of government payments.

For instance, farmers need information on soil types and conditions, the best crops for certain weather and marketing conditions, water movement and nutrient load, and on how plants use nutrients and react to pesticides. The computerization and digitization of all this data will allow the Soil Conservation Service and other agencies and organizations to make greater use of such information and to integrate it with relevant economic data, including information on prices, the costs of various inputs, and different cropping scenarios.

This, in turn, will result in greater utilization of integrated farming systems, and give rise to what some call alternative farming, low-input farming, sustainable, or regenerative agriculture. But by whatever name, to the farmer it means changes:

* greater diversity of crops;
* entirely new crops;
* increased rotations of crops;
* more carefully integrated crop strips;
* biological pest controls;
* improved tillage practices;
* nutrient recycling;
* more targeted and prudent use of purchased chemical inputs;
* more careful irrigation management;
* avoidance of stream bank erosion;
* ways to profit from improved wildlife habitat management;
* increased attention to better surface and ground water; and quality.

The point is, under modern agricultural conditions -- as we undertake serious work to move our production system and way of life into the 21st Century -- those farmers who are going to be most successful will need more and better information management concerning all of these difficult and more sophisticated farming regimes than ever before.

I predict, therefore, a whole new farm service industry will develop and prosper, working in conjunction with universities, the Extension Service, the Soil Conservation Service, State Agencies, Conservation Districts, and the private sector in a vast array of technology transfer activities, which, in turn, will enable Americas farmers to prosper in a way that at the same time improves the natural resource base of the country. Thereby, this will increase still further the comparative advantage of the United States in the global economy while improving the quality of life in and opportunity in rural America.

But, I emphasize again, in closing, that these developments do not occur due to mysterious forces, or to voodoo, or to leprechauns. "Destiny is not a matter of chance; it is a matter of choices."

These things have or will come about because many of you have struggled earnestly to make tough decisions and difficult choices in the face of uncertainty and opposition.

So, this is what this conference and workshop is all about. Nebraskans have undertaken leadership that serves to inspire the nation to a practical and common sense approach to resource conservation.

I join with all others who feel strongly about good stewardship for our soil and water resources in paying homage to you for tending to this important business. I wish you Godspeed, and His loving care and guidance in all that you do.

THE IMPACT OF FARMING METHODS AND EROSION CONTROL

Address by Clarence Durban, President,
National Association of Conservation Districts
(Luncheon Speaker)
(Edited from Transcript)

We have seen, recently, a flurry of activity in the conservation programs that we have been involved in for some 50 years. I think developing an understanding and appreciation of the relationship between all involved, that those issues, between farming practices and erosion control, that you've been talking about here for a couple of days, is most certainly a timely topic. During the 50 year history of conservation districts and the Soil Conservation Service, we've enjoyed a somewhat remarkably successful three-way partnership between federal, state, and local governments. State and local government have been agencies working together with landowners to get some conservation practices on the land. It's been going on for a long while, but the pressures that are created by the changing social, political environment have added, I believe, another dimension to that conservation job, the conservation job that we, as folks involved day to day with it, are charged with. New federal and new state programs are bringing about a difference and a number of changes in the way that the relationships that I've referred to exists among those long-term and long-time conservation partners.

At the same time, we have many new conservation partners on the scene, and they, too, are asking and must be taken in account. Environmental groups, both on the state and on the national levels have had a strong voice in influencing soil and water conservation programs these past few years. That was not the case some 50 years ago. Traditionally, federal priorities have been the driving force in the conservation programs, but today, as state and local funding for conservation program increases, I believe it is even more important that this partnership be maintained and not only be maintained, but be strengthened. Cooperation in this partnership has been the cornerstone of its success for 50 years. We, as conservation districts and federal agencies that we have been involved with over these 50 years must continue in conjunction with the state agencies to work together.

Controlling soil erosion has always been the high priority with the conservation districts, but in the past two years, we have seen a dramatic increase in the public's awareness about how farmers use their land. The number of recently enacted federal conservation and environmental programs has served to heighten that awareness. States have been on the move with conservation work at the same time. There has been tremendous expansion in state cost-share programs, erosion and sediment control programs, urban program, and many others. Those new programs, along with the changes that we have seen in the long-standing ongoing program we've been accustomed to and the attention in particular that they are receiving, are having a tremendous impact. They impact the way we, as conservation officials across this country, are doing things, both in the farming community and in the conservation communities. The most significant change as has been addressed here these last couple of days, of course, came about with the 1985 Farm Bill. You're aware of the linkage between that farm bill and that it, for the first time, established a good link between land stewardship and those federal farm program benefits we have been so long been accustomed to.

For a long number of years, the National Association of Conservation Districts has supported the concept of conservation compliance as a way to stop subsidizing poor land management practices. When the Farm Bill programs were enacted, we saw that as one of the greatest opportunities since creation of conservation districts and the Soil Conservation Service in the 1930's. Those new programs, especially the Farm Bill conservation provisions, are also bringing about an increased public awareness of the relationship between farming methods, erosion control, and the need at the same time to be good stewards of the land.

Now that the linkage between conservation and commodity programs has been established, a substantial amount of a farmer's livelihood is in jeopardy, or may be in jeopardy, if he is not in compliance with those programs. For the past two years, I believe, we have just begun to grasp the significance of the task ahead. Even though there's a broad public consensus in this country, that conservation is good public policy, there are still many farmers in this country who are sceptical about being told how they're going to operate their land, how they're going to manage their resources, and that is the reason why, I believe, that conservation districts have a key important role to play in these programs and in these practices. District officials for many years have maintained close working relationships with farmers in the district, in fact, most of those persons are farmers or ranchers themselves. They know a great deal about the community, they know a great deal about the land in the district, they know even more about the farmers who operate those lands. Because of that role, I believe, district officials are in the unique position when it comes to influencing decisions to be made by the farmer about how he uses that land. Those districts have played an important role in helping to identify marginal and highly erodible croplands and encouraging farmers to protect them from erosion.

But even further than that, districts can help farmers in making decisions about how to protect their land from soil erosion. Under the Farm Bill's conservation compliance and Sodbuster programs, the conservation district has a responsibility for approving the farmer's conservation plan, although approving the technical integrity of the plan is the responsibility of the Soil Conservation Service. The conservation district has a different, but I think, a very important role in understanding and helping the farmer to understand that there are resource management systems, conservation systems, and alternative conservation systems that make up the bulk of their conservation farm plan.

Since there are often a variety of different farm alternatives that will help solve an erosion problem, I believe that the district is well suited to help the farmer decide which system suits best in his particular farming operation. We can help the farmer and we must also help the public in general understand the entire program, understand the effects and the impacts of the conservation plan and those practices and the effect they will have on the local resources. This type of understanding is important, I believe, in carrying out a balance of local conservation programs that is accepted and is understood by those who actually carry it out and put the practice on the land, the farmer, himself. I think, therefore, that the local districts can provide valuable insite when it comes to dealing with and resolving unusual situations that can't be addressed in manuals or by federal or state program rules and regulations. This is one of the key reasons why districts were written into the legislation in the first place, to help with the delivery and to help with the understanding of conservation programs and practices at the local level.

Ladies and gentlemen, my purpose here is not to try to sell you on the idea of conservation districts. I think you all have a very good appreciation of conservation districts and what they've been about for 50 years. But I would like to point out the role that they can play as leaders and as information providers in promoting an appreciation and an understanding of the importance of management practices in a complete farming operation. An operation, I believe, must provide for farming the land profitably and managing it wisely at the same time. In the past few years, we have seen the emergence of a much strengthened land ethic in this country. The American public has a heightened recognition of the consequences of mismanaging our precious natural resources, and it is this broadened public support that has enabled us to acheive a stengthened national conservation effort as witnessed by the enactment of the Farm Bill. Without that general public support and recognition of a problem, we would not have the opportunity to address some of the country's erosion issues that we have in this bill. That awareness has also been a driving force behind strengthened and expanded state programs such as your own erosion control law right here in the state of Nebraska. Every farmer in this country, I believe, has both an opportunity and he has an obligation to become a conservation farmer. Whether it's with a small plot or whether he farms 10,000 acres, along with the privilege of land ownership comes the responsibility of land stewardship. Because of the heightened environmental awareness that we are seeing, this country, by the American public, realizes poor land stewardship not only jeopardizes the land and its future productive capacity, but it also threatens the freedom and the right to enjoy, to own, and use private land.

As evidenced by the new conservation compliance provisions of the Farm Bill, the American public has made it very clear, I believe, that it will not allow the abuse of this nation's land resources. We have our first taste of conservation compliance with this 1985 farm program. I fear that if we do not demonstrate a strong committment to our land stewardship ethic, the American public may put more stringent regulations on than the American farmer can survive with. My fear of that is not nearly as great as mother nature's reaction to our abuse of the resources of the land. We can pressure our resource base only so far before mother nature will strike back, and when she does, it is often with a vengance and with a mercy for none. I'm sure that I need only mention Ethiopia to bring that point home.

Speaking to farmers and conservationists as we have here today about the need for a strong soil stewardship ethic is somewhat tantamount, I know, to preaching to the choir, but Americans have enjoyed unparalleled prosperity since World War II, and in some ways, I believe, this has spoiled us as a society. I believe, however, that in the past few years, we have begun to move away from that notion, from the engrained notion, it seems, that resources, including our soil, are unlimited, and in some cases we have begun to realize that they are not even renewable in the practical sense. We, as farmers and conservationists, are finding that these changes in the way we view our resources are presenting us with a number of challenges in which we must respond. It's often difficult to break with some of these seemingly tried and true ways of the past, ways of farming that have been engrained in us for a number of generations, but I must praise the American farmer, for I firmly believe that we are seeing a move toward a sustainable agriculture in this country. In fact, in my view, that is a central theme for this very conference; the impact of farming methods on erosion. For as in the not so distant past we often tended to concentrate on structural practices to control that erosion, we are now looking more and more toward working with with the land to control erosion there rather than fighting against it with a structure. In my own lifetime, I have witnessed and been a part of many changes in how we think about conservation farming. Years ago when I started farming and working with the land, a farmer would have been considered remiss, even sloppy, if his fields were not clean-tilled. Leaving residue on the land rather than plowing it under was almost unheard of those days. Today, conservation tillage, leaving crop residue on the ground, protective cover is one of the most popular and most effective tillage practices in this country. In fact, some form of conservation tillage is practiced on nearly one-third of the cropland in the nation.

But the new land ethic really goes hand in hand with what you have been discussing here these last couple of days. Understanding the land, the dynamics between production and conservation, is the first step in developing that ethic. Isn't it great that we, in this country, can speak about the economics of soil conservation in the country as opposed to the absolute necessity to practice conservation.

At this point in my comments, I had expected to make my debut as a professional speaker and use some slides. However, the federal government and USDA and some of those other folks that we have in Washington at times, with the confusion that sometimes goes on there, returned to West Africa the set of slides from my recent trip there in November. They were developed in Washington and sent back to Africa. They are probably in my office today, but nevertheless, they haven't gotten back here.

That experience, in visiting in a country that absolutely must practice conservation in order to live, is different than the kind of opportunities we have with the unparalleled resources that we have in this country. It's high time, I believe, that we take seriously, as those folks have just begun to take seriously, the conservation issues that they face in that country. I visited there for about ten days, at the request of the Gambian government in West Africa. The purpose was to dedicate the first soil conservation district on the continent of Africa. In this particular area of the Gambia River, the salt water intrusion from the Atlantic ocean, as the rainfall pattern had changed in the upland end of that river, was causing the river to overflood and salt out the rice patties. For ten years or more, the rural people in that country and in that particular part of that country were starving; and it's difficult except for those of you who have been there in those kinds of situations to realize that transportation is terrible. You can't move that much food from one place to another. But things changed with the appointment of one Soil Conservation Service technician, in the person of Harvey Metz, who was an Area Conservationist in this state some few years back. He organized the people with the use of two native Gambians who were trained here at this University, and now work with the local people. In the last four years, they have finally gotten the first structure, built on that river. As a result of that first structure, several others were built, not without much frustration on Harvey Metz's part and some other folks because of the lack of a knowledge of how to cooperate among themselves, and between the tribes of that country.

Without going into a lot of detail and taking a lot of your time, I would say to you that as I traveled about following the dedication ceremony and obviously when the vehicle in which they transported me around the countryside drove up to a rice paddy where the women were picking the rice one straw at a time, I was a minority. I was recognized as the guy from the states. I was recognized, even though Harvey had been there, they knew Harvey Metz, but I was recognized as the country that had helped them with the problem that they had, which was not enough food to eat. Those women came from those fields carrying in their hands as much of a sheaf of rice as they could carry, offering it as a gift. Their enthusiasm and their appreciation was so great! Here was a people who just three or four years prior to that had not had enough to eat; yet they were so pleased, and so happy with what was accomplished by some conservation work, they wanted to share that joy with this country.

I would also tell you that the folks that were appointed or elected to that first conservation district board were very proud of what they had accomplished. One lady, whose name was not mentioned by the Minister of Agriculture as he read the list of folks who were serving on that board became, what I found to be later, was very angry. It was difficult for me to know when those folks were talking whether they were pleased or angry. I just didn't know what was being said. I was pretty sure she was upset, and she was, because her name had not been mentioned. She was proud of the fact that she had a place on that board of supervisors.

She was probably more proud of the fact of her place there because the building of those dikes was accomplished by the women of the country, carrying the dirt in pans, dish pans, on their head and building dikes 500 to 1,000 feet long, three or four feet high with a comparable base. Two or three pans full would be a bunch, but they carried for weeks, 300 and 400 hundred at a time, continually dumping a pan of dirt and going to get another one. It's how the structures were built. Those structures were built at not a great cost to this country, not a great cost to the Aid for International Development Organization of USDA in Washington, D.C. because the person of Harvey Metz provided only the technical advice and assistance to help them get it done. When Harvey comes home from there, they have a program and a project that they can maintain. They don't particularly want our way of living. They did want another tractor, I would tell your that. The government had provided them with one tractor and a trailer. Now, ladies, the men did do some work in this project. The men loaded the dirt on this trailer from somewhere else and brought it to the site where the women were picking up, but the trailer had a dump on it. So they'd dumped the trailer, and go back after another load, while the women scooped it up and carried it to the dike. As I say, the local people were tickled to death with what had happened to them. They have to practice conservation to eat! We don't have to do that here, not yet. I would also tell you that not only were there laborers in the field, including the women, the men that built those dikes, those folks on that board of supervisors, but the chiefs of the tribes, as I visited with them, the five tribes were involved. It was protocol that I make those stops before I could leave there. In every case, following the ritual that you must go through before you start talking to the chief, those chiefs cried tears of gratitude about what had been accomplished, and about the fact that they had food for their people, which was their responsibility.

The peanut fields above the village, are on the contour now, but prior to this, the stream of water had gone through that village and cut gullies six and seven foot deep directly between the huts that they lived in. It was continuing to do that. It wiped out a road, if the road could be called a road. It was difficult to get across, but by establishing a waterway, putting in some control structures by hand with rocks and using contours, they had diverted that water around that village. That particular chief was unable to attend the dedication ceremony because he was ill, but when we stopped there, he wanted us to come to his hut. To give you some idea of the difficulty that Harvey Metz had, the young man that was trained at this university was the interpreter for myself when we visited with these folks. When we stopped to visit with this chief, he had not been to the ceremony. We sat down, when through the preliminaries, and suddenly everybody sat back in their wooden chair. I guess it was a chair, it was a place to sit anyhow, just sat back and said nothing. You know, I didn't know what had been said prior to that, and I looked at my interpreter, and I said, "What's going on?" He said that the chief didn't trust him to interpret to me what he might be saying. He had not been to the ceremony. He was afraid his own people might not relate what he was saying. That's the difficult part of the Harvey Metz's, provided again from USDA-Soil Conservation Service, who will someday leave and expect that program to continue at the rate that it is. I'm hopeful that it will. I think it will. Those young men that were trained here and are now back there are dedicated, but they have some tremendous obstacles to get around. The chief finally decided that he would talk and we did visit, and he was the one that showed me his surplus rice supply in the storage building. That was the first time he had ever had that along with peanuts and milo. The first time he had had a surplus, and he, too, cried tears of gratitude and said, "Please help us keep this program going. Please send us another Harvey Metz", obviously pleading his case. At the same time, another farmer, another resident of that village, had seen the tractor that the US Agency for International Development had provided to haul this dirt to build the dikes, and that farmer, of course, wanted a tractor. He didn't want to farm by hand anymore, but he isn't going to get the tractor. It's not the purpose of the program that's going on there now.

I would say just one other word as I talk about that, before I went there, I had seen many other programs of this government in years past assisting other countries to grow products, to grow food. As a farmer, I was sitting there with bins of corn, soybeans, and wheat, and I never could quite understand why it was necessary for us to be spending dollars to do those kinds of things. I now have a little better understanding of that. I started to change my mind some years ago on that as I grew a little older, but in particular, after this experience in West Africa. With the income that those folks have, there is no way in the world that they could ever buy one pound of corn, soybeans, or wheat from this country. They don't have the money to do it. What we're doing there at this time is humanitarian aid and it is getting to the people that need it. It's not going in a bag from here and somebody else ends up with it, and that happens. The people that need it are getting it! Someday, maybe 40, 50 years from now, because I think they're 50 years behind, in fact, we know they are, they just started their first district. Someday, they may have a product that they might sell on the international market as a result of the involvement of American agriculture. At that point, maybe, there will be some opportunity for sales to a country like Gambia in West Africa.

I've gone on longer than I had planned. You're lucky I didn't have my slides. In closing, I'd like to leave you with a final thought. Conservation of the land and water resources means treating it wisely in this country to sustain it's productivity both for ourselves and the generations that follow us. I think we must treat each acre according to its needs and use each acre within it's limits. That has long been our philosophy, and I think to do any less than that today will leave our children with the high price that they must pay for tomorrow. Thank you very much for allowing me to appear on your program.

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THE FOOD SECURITY ACT AND ITS POTENTIAL IMPACTS ON CROP AND COVER MANAGEMENT

Prepared Remarks of Ron Hendricks, Nebraska State Conservationist, USDA Soil Conservation Service

Let me take this opportunity to welcome you to Nebraska and to this conference.

I would also like to compliment the planners and organizers of this conference. It is very timely and very necessary today!

This is a tremendous opportunity to bring research, technology and users together.

The Food Security Act and its impact on tillage, crops and cover will and should have a dramatic and lasting impact.

The impact of the use of tillage, crops and cover (which I like to refer to as management practices) is showing and will show us several things:

1. There is considerable misunderstanding by all users.

2. There is a great deal of research needed for comparative and compounded impacts of these management practices individually and collectively.

3. If the Food Security Act is to succeed and our farmers to succeed, these types of management practices have got to succeed.

I would also add that the success of the combination of cropping systems, tillage and residue management have got to succeed because:

- They are cost-effective (produce benefits beyond their cost)

- They are and will point the future direction for Nebraska Ag. and U.S. Ag. and our future competitive advantage.

- They have got to be energy efficient (so soon we forget the oil crisis) (and US Ag. one of the highest users in the world per unit of production)

- They will reduce the dependence on "externalities" such as fertilizer, pesticides, energy and etc.

Nebraska has about 20,000,000 acres of cropland. From this there is about 10,000,000 acres of highly erodible fields. This is approximately 1/10 of the total national erosion control need.

Many Nebraska farmers have recently received letters notifying them that some of their fields have been determined to be highly erodible under provisions of the Food Security Act. They will now need to determine how to stay eligible for certain USDA programs.

I would now like for you to see a slide program that provides some suggestions on how to "stay eligible for USDA programs."

(SLIDE PROGRAM)

As we have just seen, there are several things the producer must consider as he/she determines whether to - or how to - comply with the Food Security Act.

Some farmers can continue to farm as they have in the past; their past treatment will comply with the "standards" for adequate erosion control based on the field office technical guide.

However, these farmers do need to do a couple of things to ensure they are in compliance:

- They need to record their plan - what they are doing and plan to do.
- They need to get the local district conservationist to certify that the plan meets the standards set forth in the FOTG and get the local NRD to sign-off signifying the plan meets the intent of the NRD.

Other farmers will need to go ahead with some adjustments they had planned to make anyway. They need to make sure their existing plan meets FSA requirements, sign the plan and get the SCS and NRD signatures, then go ahead and apply their plan according to their schedule.

Other farmers will need to make more substantive changes if they choose to stay eligible for the USDA benefits as mentioned earlier. What kinds of changes they make will have to be their decision.

Role of SCS:

The major role of SCS is to provide options based on two things:

1. Provide options that will have a direct impact on soil erosion.

2. Options that are economically feasible, cost-effective and are environmentally beneficial.

There are four basic areas that physically soil erosion:

- Length and steepness of slope.
- Amount of surface residue.
- Intensity or % of soil depleting crops.
- Tillage practices affecting residue, infiltration and runoff.

These options may be structural such as terraces, waterways, diversions and etc. to affect length of slope.

Non-structural may be combinations of tillage practices, no-till, strip cropping, contour farming, crop rotation adjustments, residue management to affect residue, infiltration, and soil erosiveness.

Or some combination of the above.

To give you an idea of the magnitude of combinations of options, a neighboring state began identifying them and there were over 7,000. Here in Nebraska it would be at least that high.

The impact of the FSA in Nebraska is an estimated reduction of 104,000,000 tons of soil loss. To give you an idea of the magnitude of this, if you loaded all that into railroad cars it would take over 1,350,000 cars or equal a train that would reach over halfway around the world. Incidently it would take over 40,000 engines to pull that train.

In closing:

Our goal in Nebraska is to have a conservation plan for every highly erodible acre - and - some level of conservation applied to each of those acres.

The level of the application of conservation is dependent on the existing availability and acceptability of technology and the economic resources and its impact to carry it out.

To continue to set the tone for the next two days, let me leave you with a couple of questions:

- How does no-till compare to ridge tillage?
- What does it do to disk that field three times rather than two?
- What impact does one month difference in spring tillage have?
- What are the comparative impacts of all the things we do on:
  - Soil fertility
  - Pest management
  - Energy requirements
  - Cost-effective productivity
  - State laws pertaining to erosion
  - Evolution of predictive modelling
  - Management options for cover and crop management
  - Research on erosion
  - Water erosion prediction
  - Tillage systems

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LB 474 AND ITS IMPACT ON TILLAGE AND CROP AND COVER MANAGEMENT IN NEBRASKA

Jim Cook, Legal Counsel, NNRC

How the Act Works

Nebraska's Erosion and Sediment Control Act (LB 474) was passed in 1986 and is very similar to legislation of the same type in Iowa and over twenty other states. Regulatory action to stop excessive erosion can only be triggered by off-site sediment damage, but the underlying objective of the Nebraska Act is long term productivity of the land.

Under the Act, complaints can be filed by those who have been damaged by sediment caused by excessive erosion. These include adjacent landowners, state or local agencies whose roads or other public facilities are damaged, and state or local agencies with responsibility for water quality maintenance. The NRDs may also authorize staff members or others to file complaints if damage is observed. It's unlikely that NRDs will often initiate complaints themselves, but the ability to do so can be helpful in promoting equity among landowners and operators in some situations.

When a complaint is filed, the NRD conducts an investigation. For the complaint to be found valid, the NRD must conclude that there is sediment damage and excessive erosion. Excessive erosion normally is defined as average annual erosion that exceeds the T value for the soil involved; in some cases erosion up to 2T can be allowed. Average annual soil losses are determined by use of the Universal Soil Loss Equation or the Wind Erosion Equation.

Some potential for conflict is emerging between state and federal erosion standards. Under the Food Security Act, alternative conservation systems which will sometimes allow soil losses in excess of 2T will be allowed. As a result, a landowner might have to apply more conservation to be in compliance with the state act (maximum allowable erosion at 2T) than to satisfy federal requirements. If such potential disparities continue to exist, care will need to be taken by NRD and SCS conservation planners to inform landowners and operators of the requirements of both programs.

After investigating a complaint a committee of NRD board members will decide whether to dismiss it or to make a finding of "probable violation". When a landowner receives notice of "probable violation", he or she is given the opportunity to work with the district and SCS to develop a conservation plan and a conservation agreement that will result in the excessive erosion being eliminated. Once a landowner has prepared such a plan and signed an agreement with a schedule for compliance, he or she is protected from LB 474 complaints as long as the schedule is maintained.

If the landowner does not agree that the state Act has been violated, the full NRD board can be asked to consider the complaint at either a regular meeting or at a formal public hearing. If the board then formally finds that there was a violation, it will issue an order requiring utilization of permanent or temporary conservation practices to eliminate the excessive erosion. Permanent practices, generally those that are considered capitol items such as terraces, waterways, dams, etc., cannot be required unless 90 percent public cost-share assistance is available. No cost-share is required for temporary (annual) practices such as conservation tillage, contour farming, and other management practices. Temporary practices can also be required as interim measures until cost-share funds become available for the permanent practices.

Experience to Date

The natural resource districts began receiving erosion and sediment complaints on July 1, 1987. By January 15, 1988, a statewide total of 18 complaints had been filed and an additional 30 to 40 inquiries had been received. Thus far, only two administrative orders have been issued, both of which require 90 percent cost-sharing for some permanent practices. Several complaints are still being investigated but it is expected that most will be resolved without the necessity of a formal order.

Given the short-term experience with implementation of LB 474, the number of conclusions that can be made drawn are few. It does appear that the "C" factor and the management practices that affect it will play a considerable role in negotiations between "violating" landowners and district representatives. For landowners that desire application of permanent conservation practices, they may be willing to negotiate conservation agreements providing for those practices at normal cost-share rates. Those that might prefer to hold out for the 90 percent cost-share assistance that is required to enforce a district order will be doing so at some risk. The risk is that the district will order other practices, such as seeding to grass or management practices as the most reasonable practices for the situation. While the landowner would still be able to apply permanent construction type practices after receiving such an order, he or she would not be eligible for 90 percent cost-share dollars and might not be able to obtain any cost-share funds within the time allowed for compliance by the order. Once an order is issued, application of practices must begin within six months and must be completed within one year.

As might be expected, LB 474 has already come under some attack. Senator Loran Schmit, Chairman of the Natural Resources Committee for the Nebraska Legislature has stated that he would prefer that the bill be repealed. He has indicated that he may attempt to do so yet this year by amendment to any one of several natural resources bills. I would not expect such an attempt to be successful, at least not without a public hearing, but the debate would be lively.

My personal opinion is that LB 474 will not result in a lot of administrative orders or litigation but will serve as another strong incentive for voluntary action to eliminate excessive soil erosion. It is never pleasant to use tools like LB 474, but they can play an important role and can have a very positive impact on desirable goals. The short-term experience with LB 474 thus far suggests that it, in combination with the conservation provisions of the 85 farm bill, will be viewed in that positive way by most who are affected by it.

EVOLUTION AND HISTORY OF EROSION PREDICTION EQUATIONS AND MODELING

Joe M. Bradford
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I. Introduction

A. There has been a rich history of the development of erosion prediction models involving such pioneers of soil erosion research as M. F. Miller, H. H. Bennett, L. D. Baver, H. L. Borst, F. L. Duley, J. O. Laws, H. E. Middleton, G. W. Musgrave, T. C. Peele, D. D. Smith, R. Woodburn, C. M. Woodruff, D. M. Whitt, W. H. Wischmeier, and A. W. Zingg; however, the evolution of erosion models has been deliberate with few new research advances.

B. Browning (1977) stated that "the decision by federal and state governments to carry out soil surveys on a systematic basis beginning in the late 1880's eventually had a profound influence on recognizing the need to quantify the factors that affect soil erosion."

Dr. Hugh Bennett, who under the second Roosevelt was to become head of the Soil Conservation Service, began to survey soils under the old Bureau of Soils in 1903, and for 25 years he tried without success to arouse interest in the destruction that he saw going on.

II. A Chronology of Major Events Related to Erosion Modeling in the USA

A. Before we take a close look at the early studies, let's scan some important events related to erosion modeling in the USA.

B. Chronology (taken from U.S. Department of Agriculture, Century of Service, 1963).

1796. December 7. President George Washington recommended the creation of a national board of agriculture.

1855. February 12. Michigan passed legislation providing for the establishment of the Michigan Agricultural College.

February 23. Pennsylvania passed legislation providing for the establishment of Pennsylvania Farmer's High School, later Pennsylvania State College, and now Penn State University.

1856. March 6. Maryland passed legislation to aid the establishment of Maryland Agricultural College.

1862. May 15. Law establishing the Department of Agriculture was signed by President Abraham Lincoln.

July 2. President Lincoln approved the Morrill Land-Grant College Act.

1875. First state agricultural experiment station established at Wesleyan University, Middletown, Connecticut.

1887. March 2. Hatch Experiment Station Act passed, providing Federal grants to states for agricultural experimentation. Each state was provided $15,000 a year.

1890. October 1. Congress authorized the establishment of the Weather Bureau in the Department of Agriculture.

1894. February 15. The Division of Agricultural Soils was established in the Weather Bureau.

1901. July 1. The Division of Soils was redesignated the Bureau of Soils.

1927. July 1. The Bureau of Soils was combined with the Bureau of Chemistry to form the Bureau of Chemistry and Soils.

1933. September 19. The Soil Erosion Service was created in the Department of Interior.

1935. March 25. The Soil Erosion Service was transferred to the Department of Agriculture.

April 27. The Soil Conservation Service was established as the successor of the Soil Erosion Service.

1938. October 16. The Bureau of Chemistry and Soils and the Bureau of Agricultural Engineering were abolished. Work transferred to Bureau of Agricultural Chemistry and Engineering and Bureau of Plant Industry.

1943. February 13. The Bureau of Plant Industry, Soil, and Agricultural Engineering was established.

1953. November 2. The Bureau of Plant Industry, Soils, and Agricultural Engineering was abolished and its functions transferred to the Agricultural Research Service.

The chronology of events is significant in that the Land-Grant Universities, State Agricultural Experiment Stations, USDA-ARS, and USDA-SCS play an important role in the development of erosion models.

III. Growth of Erosion Research and Erosion Modeling.

A. The first extensive scientific investigations of erosion were carried out by the German soil scientist Ewald Wollny from 1877-1895; however, his discoveries that related directly to runoff and erosion apparently went unrecognized by American scientists and engineers until L. D. Baver brought them into the limelight in 1938 (Baver, 1938).

Wollny studied:

1. the effect of vegetation and surface mulches on interception of rainfall and on the reduction of soil structure deterioration, and

2. the effect of soil type, slope, and vegetation on runoff and erosion.

B. The first American attempt to determine the quantity of runoff and erosion from a limited area of soil was carried out by the Forest Service in 1915 in Utah, closely followed by the experiments of M. F. Miller in Missouri in 1917.

C. The idea of soil erosion plots, as we know them today, was started in 1917 at the Missouri Agricultural Experiment Station by M. F. Miller and his associates. The objective of these studies was to determine the influence of different systems of cropping and cultural treatment on surface runoff and soil erosion.

D. Other similar experiments followed, using essentially the same method. These included: the Alabama Agricultural Experiment Station in 1920 using artificial rainfall to evaluate plant cover on different slopes; the Bureau of Public Roads at Raleigh, North Carolina, in 1924, comparing soil loss for three cropping systems on a Cecil fine sandy loam; and the Texas Agricultural Experiment Station at Spur, Texas, in 1926, comparing fall fallow and various crops on different degrees of slope.

E. Nation-wide interest in soil and water conservation developed rapidly and resulted in the passing by Congress of the Buchanan (Congressman James P. Buchanan of Texas) Amendment in 1929.

$160,000 was appropriated to establish ten federal-state Soil Erosion Experiment Stations. These ten stations were established in erosion problem areas representing wide differences in soil, climate, topography, and farming practices. The first established under this authorization was at Guthrie, OK on July 1, 1929.

Their locations were:

1. Pullman, Washington
2. Temple, Texas
3. Tyler, Texas
4. Guthrie, Oklahoma
5. Hays, Kansas
6. Bethany, Missouri
7. Clarinda, Iowa
8. LaCrosse, Wisconsin
9. Zanesville, Ohio
10. Statesville, North Carolina

IV. Major Events Forming the Direction on Prediction Equations

A. Duley and Hays. 1932. Effect of degree of slope on runoff and soil erosion. Dr. F. L. Duley was an early assistant to Professor M. F. Miller of the University of Missouri.

B. Baver. 1933. Soil factors affecting erosion.

First conceptual model:

$$E=fn(R,G,V,S)$$

E - erosion
R - rainfall factor (amount and intensity)
G - slope
V - amount and nature of vegetation
S - soil factor

$$S=D/(AP_p)$$

D - ease of dispersion
A - water absorption
P - permeability
p - particle size

C. In 1938, Neal from the University of Missouri studied the effect of the degree of slope and rainfall characteristics on runoff and erosion.

$$E=0.4S^{0.7}I^{2.2}T$$

where E = erosion loss in pounds, S = slope, I = rain intensity in inches per hour, and t = time in hours.

D. In 1940, Zingg (SCS, USDA, at Bethany, Missouri) expressed soil loss as a function of length and percent of slope.

$$E=aS^{1.4}L^{1.6}$$

where S = degree of slope, L = horizontal length of slope, and E = total soil loss.

Equation was derived from data taken at:

1. Bethany, MO (1931-1937) - Shelby loam
2. Clarinda, IA (1933-1935) - Marshall silt loam
3. LaCrosse, WI (1933-1935) - Clinton silt loam
4. Guthrie, OK (1931-1936) - Vernon fine sandy loam
5. Tyler, TX (1931-1936) - Kirwin fine sandy loam

E. In 1941, Dwight D. Smith (USDA-SCS, Columbia, Missouri) added crop and conservation practice factors.

In 1946, Hays showed that erosion at the LaCrosse, WI, station was correlated with the maximum amount of rainfall occurring within an 30-minute period.

In 1947, Browning, Parish, Glass added soil erodibility and management factors and developed the system for use throughout Iowa.

In 1947, Musgrave published a paper entitled "The quantitative evaluation of factors in water erosion - a first approximation." He reevaluated factors previously published and added a rainfall factor.

$$E=FS^{1.35}L^{0.36}P^{1.75}C$$

F - soil factor
S - degree of slope (%)
L - length of slope (ft)
P - amount of rainfall occurring within an 30-minute period
C - cropping factor

F. Research on factors affecting erosion was further expanded during the next 10 years in publications by:

1. Smith and Whitt (1947), who developed a prediction method for the Midwest claypan soils and later adapted it for the principal soils of Missouri.

2. Lloyd and Eley (1952), who developed a graphical solution to Musgrave's equation.

3. VanDoren and Bartelli (1956), who developed a similar system oriented toward Illinois conditions.

G. Possibly the most significant advance in erosion prediction was the establishment by USDA-ARS of the National Runoff and Soil Loss Data Center at Purdue University, West Lafayette, Indiana, in 1954, under the direction of Dwight D. Smith and Walter H. Wischmeier. The data center was given the responsibility of locating, assembling, and consolidating all available data on runoff and erosion from studies throughout the U.S. Some such data had laid in files for many years. More than 8,000 plot years of erosion plot data were assembled from 37 locations in 21 states.

Major improvements in soil loss prediction procedures resulted from this effort. The first was a rainfall erosion index, the product of the rainfall energy (E) and the maximum 30-minute intensity (I) of the storm (Wischmeier, 1959).

The second was a method of evaluating the cropping-management factor on the basis of local climate and crop cultural conditions (Wischmeier, 1960).

These developments were incorporated in the new equation (Wischmeier and Smith, 1960):

$$A=RKLSCP$$

Finally, in 1971, a soil erodibility nomograph was added (Wischmeier, Johnson, and Cross, 1971).

V. Summary

A. Summing the thoughts of L. B. Nelson (1958) in the SSSAP,

a. 1929 to 1942 - the golden years of erosion research

b. 1943 to 1954 - period of data collection, with few new ideas

c. 1954 to 1963 - period of consolidation, refinement, and evaluation of past advances.

B. Progress in developing accurate erosion prediction models has been slow, I believe, for four reasons:

1. Not enough fundamental work has been done in the past to insure a profitable applied program (see Nelson, 1958).

2. The increased use of rainfall simulators in field studies has promoted the concept of a constant erodibility factor, since field studies are normally conducted in the summer months on one soil condition.

3. The high cost and intensive labor requirements of a field soil erosion problem.

4. The complexity of the erosion process and the numerous factors affecting soil loss make it extremely difficult to create physically-based models. Therefore, most models rely heavily on multiple regression techniques.

C. People interested in reading more about the history of erosion research or erosion prediction models are urged to read the papers by Cook (1936), Bennett (1939), Nichols and Smith (1957), Nelson (1958), Smith and Wischmeier (1962), Johnson and Papendick (1968), Browning (1977), Meyer and Moldenhauer (1985), and Miller et al. (1985).

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USE OF CURRENT UNIVERSAL SOIL LOSS EQUATION

M. Scott Argabright
Conservation Agronomist
Midwest National Technical Center, SCS
(Outline of Material Presented)

A. Current uses of USLE

1. Conservation planning

   - Compare systems to a quality standard (T or other)
   - Compare systems to each other (relative values)

2. Inventories

   - Data collection
   - Interpretation of the data

3. Program eligibility and/or compliance

   - CRP
   - Conservation compliance
   - Sodbuster

4. Determination of HEL

   - $RKLS/T > 8$

5. Problems with using USLE for regulatory or eligibility purposes.

   - Desirable degree of accuracy and precision are difficult to achieve.

B. Limitations of current USLE

NOTE: "Limitation" means recognizing the scope of applicability of the equation, in order to use it wisely.

1. USLE uses lumped parameters rather than process relationships. Adaptability is limited.

2. It does not estimate <u>field</u> erosion.

3. It is not a watershed model.

   - Does not estimate erosion by concentrated flow.

   - Does not estimate location or quantity of sediment deposition.

4. Applies to a limited group of crops and tillage systems.

5. Irrigation-induced erosion.

6. Does not estimate single-storm events.

C. Pending changes -- USLE revision

1. Timetable: ARS background document, published by late summer, will provide the basis for SCS adaptation of the technology. SCS adoption will be carried out through a User's Guide Committee.

2. Rainfall factor R

    - Western US (differing storm type)
    - Thaw and snowmelt
    - Long flat slopes

3. Soil erodibility K

    - Time-variant K.
    - Erodibility relationships for rill and interrill erosion.

4. Topographic factor LS

    - Four sets of LS values
    - Irregular slopes

5. Cropping management factor

    - Subfactor relationships.

        - Soil loss ratios
        - Standard research plots
        - Subfactors: another level of detail
            - Canopy cover
            - Surface cover
            - Surface roughness
            - Surface consolidation
            - Incorporated biomass

    - Rock fragments.

6. Support practice factor P

    - Choices with present USLE: contoured or not contoured.

    - New guidelines will recognize differences due to:
        - ridge height
        - off-contour row direction
        - cropstage

D. Relationship of current and updated USLE to residue management, tillage, and crop rotations.

1. All are expressed in the C factor.

   - Residue management effects.

     - residue preservation
     - distribution and placement of residue

   - Tillage effects.
     - Residue placement
     - Surface roughness
     - Loose surface layer
     - Contour effects

   - Crop (plant) effects.
     - above-ground canopy
     - plant residue on the surface
     - below-ground root growth & biological activity

2. Subfactor method permits more descriptive analysis of variables and their interactions.

3. Proposed change in the "mulch factor" which expresses the effectiveness of surface residues.

E. Handling Changes in Technology

1. Changes must be expected and absorbed.

2. Changes are either:

   - Factual (new knowledge).
   - Perceptual (new understanding).

F. Misuses -- the people problems

1. Misusers are users.

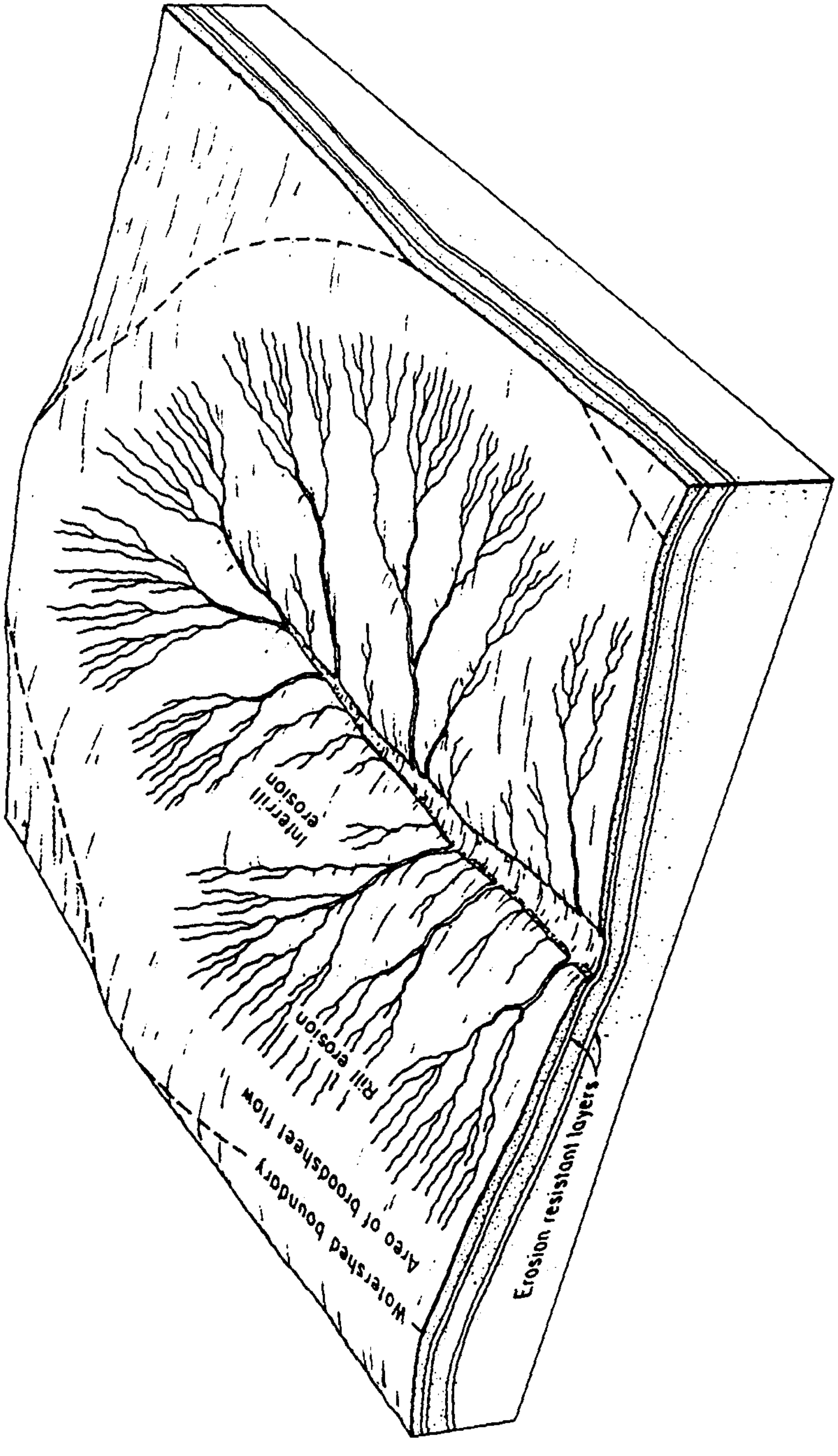
2. USLE as decision-maker instead of decision-guider.

3. Resistance to applying new knowledge or understanding.

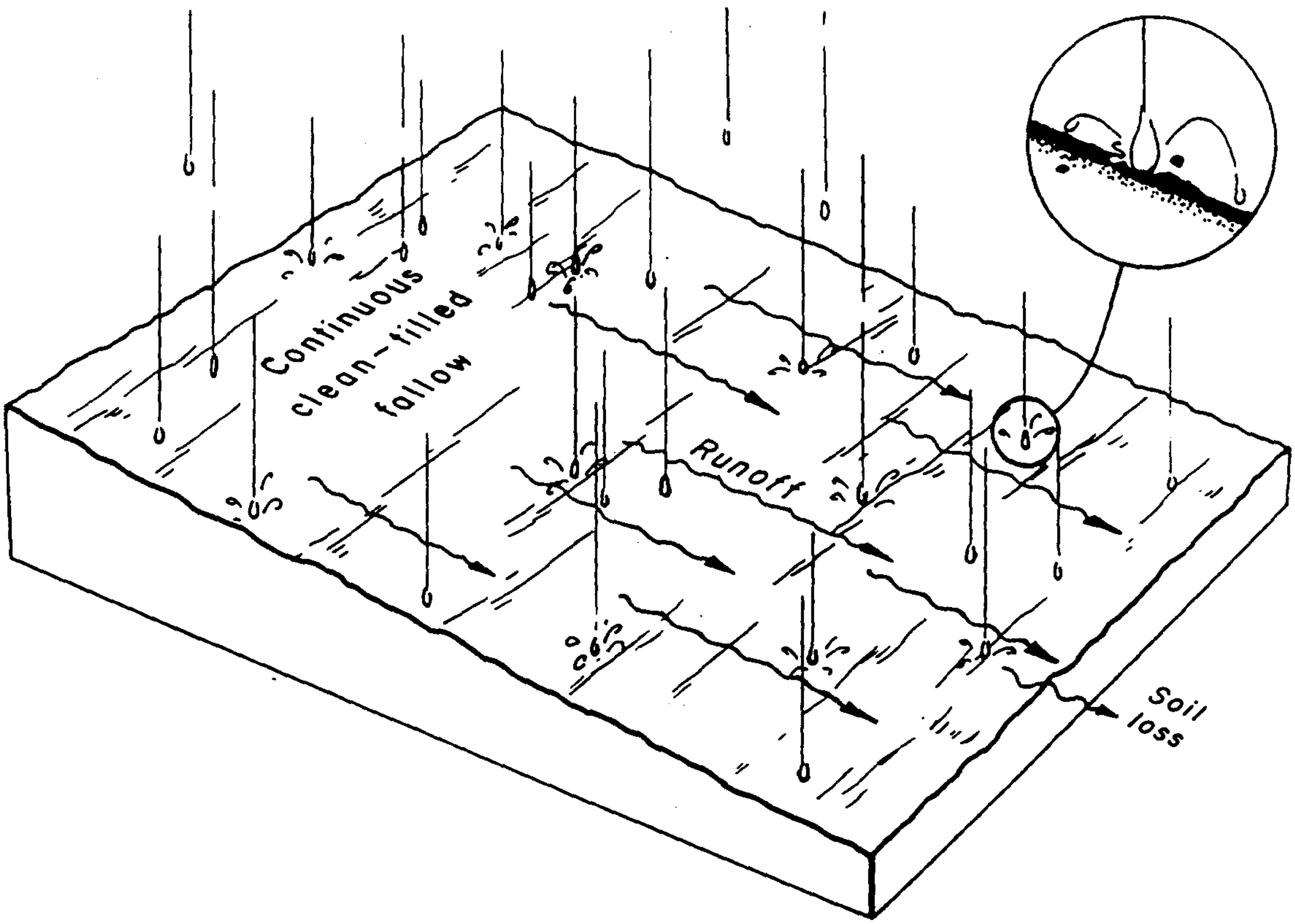
   - making things too hard
   - making things too easy (lowering standards)
   - it's the wrong time

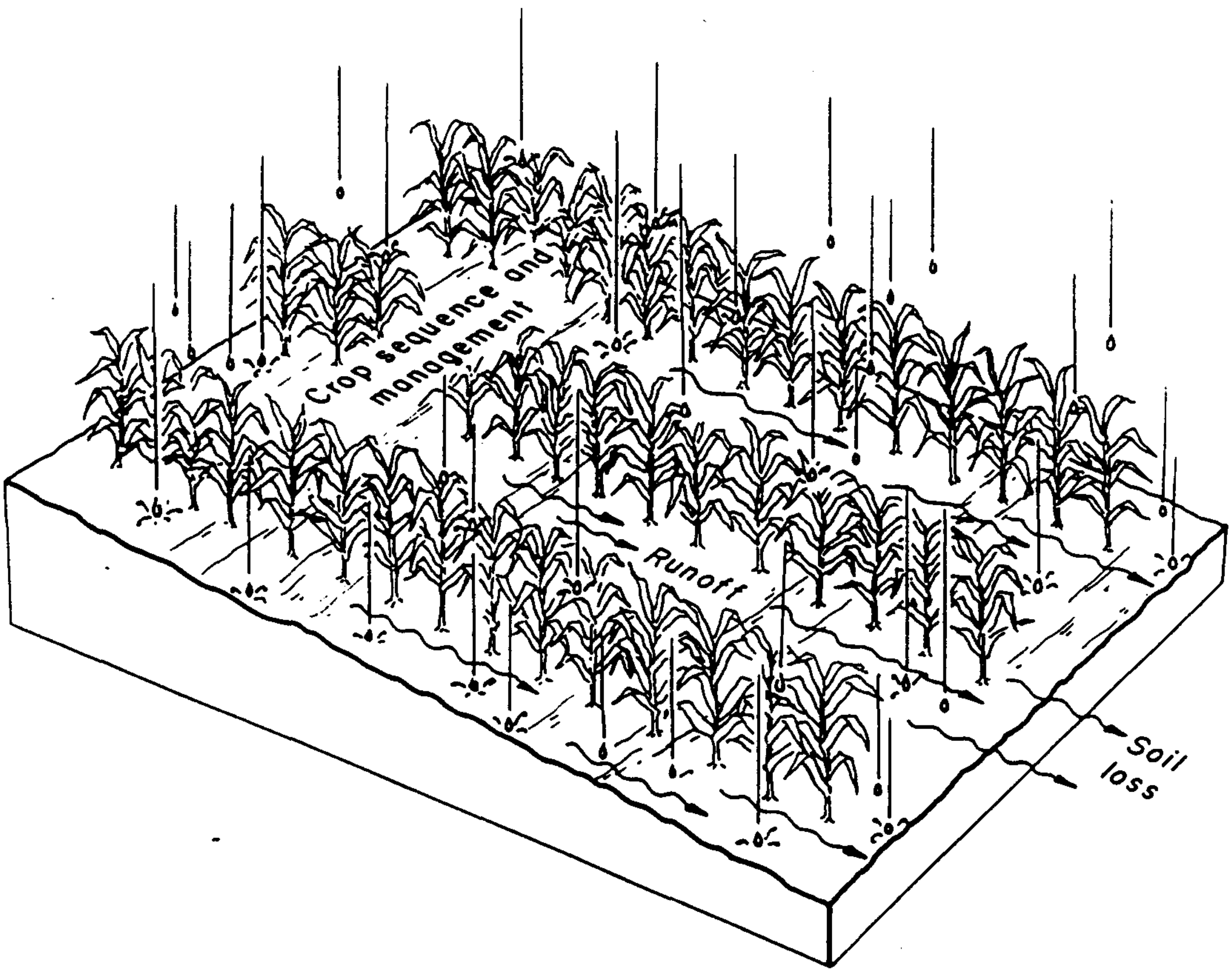
4. Unrealistic expectations:

5. Perception of USLE as a field model.

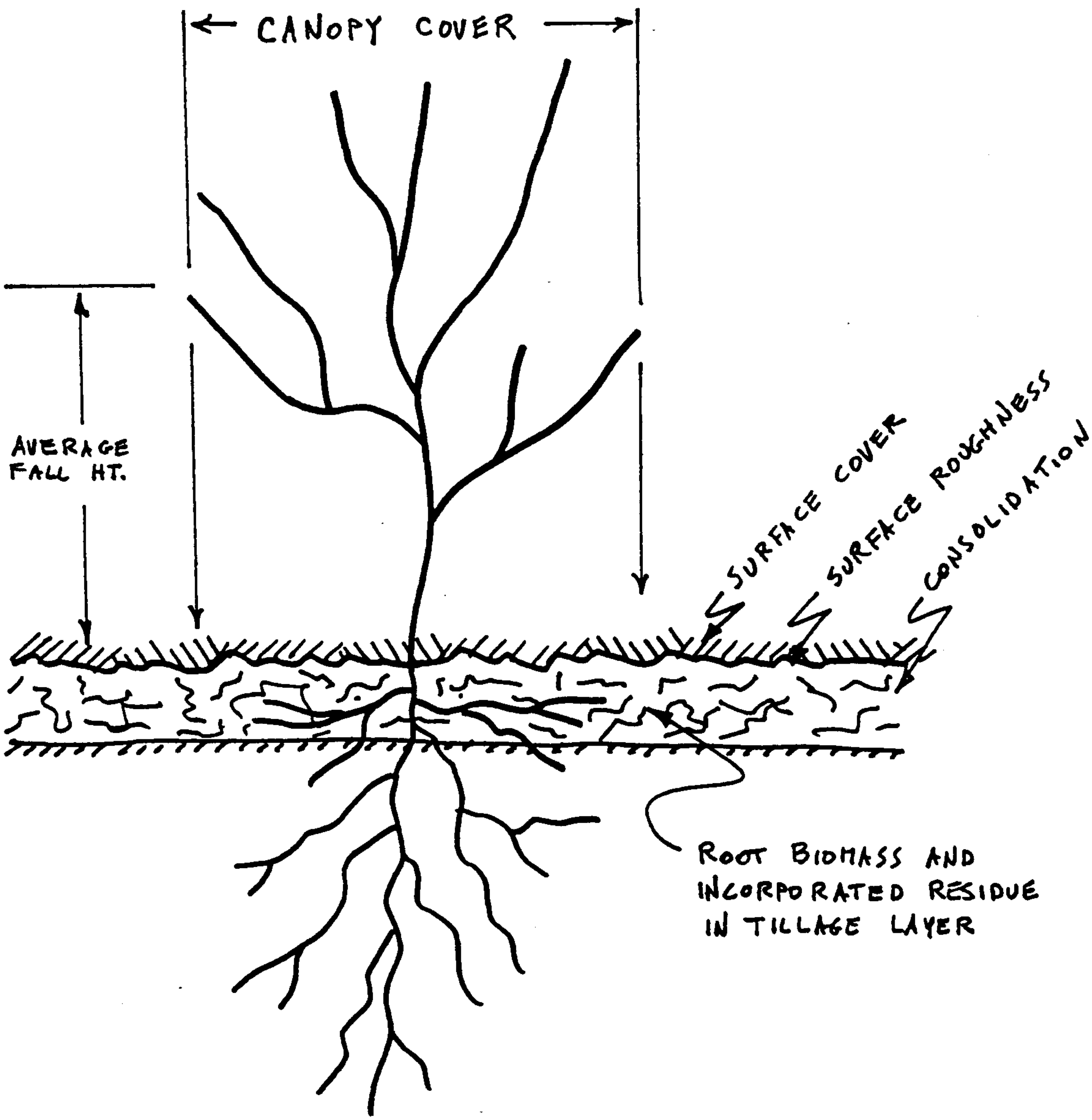


Watershed boundary
Area of broadsheet flow
Rill erosion
Interrill erosion
Erosion resistant layers


Continuous
clean-tilled
fallow
Runoff
Soil
loss


Crop sequence and management
Runoff
Soil loss

USING SUBFACTORS TO ESTIMATE THE COVER + MANAGEMENT FACTOR



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SENSITIVITY OF COMPUTER SOIL LOSS TO USLE FACTORS

George R. Foster
Agricultural Engineering Department
University of Minnesota

(Outline Material from Slides Used in Presentation)

UNIVERSAL SOIL LOSS EQUATION (USLE)

A=RKLSCP

A = Computer Soil Loss
R = Erosivity Factor
K = Soil Erodibility Factor
L = Slope Length Factor
S = Slope Steepness Factor
C = Cover-Management Factor
P = Supporting Practices Factor

USLE AS A TOOL

Identify High "Erodibility Potential"
Assess and Inventory Erosion Rates
Select Erosion Control Practice

USLE

DOES Compute Sheet and Rill Erosion
DOES NOT Compute Deposition
DOES NOT Compute Ephemeral Gully Erosion
DOES NOT Compute Sediment Yield

ORIGIN OF USLE

Runoff Plots - Natural & Simulated Rainfall
10,000 + Plot Years of Data
49 Locations Over ALL of Eastern US
Range of Soils
Range of Slope Lengths & Steepnesses
Range of Cover-Management Practices
Range of Supporting Practices

EROSIVITY FACTOR R

R Varies with Rain Storm and Intensity
Low of 50 to 175 Across Nebraska
45% Between May 15 and July 15

SOIL ERODIBILITY FACTOR K

Slope of Soil Loss vs. EI on Unit Plot
Range 0.03 to 0.70
Clay & Sand to Silt Loam
Many Values 0.22 to 0.40
Estimated with Nomograph-Some Soils Don't Fit

SLOPE LENGTH FACTOR L

Slope Length - Most Questioned
10% Change in Length - 5% Change in Soil Loss
Length Seldom Exceeds 300 ft
Range from about 0.5 to 4.0

IRREGULAR SLOPE

Applies to Nonuniform Slopes
BE CAREFUL!
Equal Protection
Deposition

SLOPE STEEPNESS FACTOR S

Range 0.1 to 20.0
10% Change in Steepness - 20% Change in Soil Loss
Current USLE Over Estimates for Steep Slopes

COVER-MANAGEMENT FACTOR C

Weighted Value for Soil Loss Ratio (SLR)

SLR - Ratio of Soil Loss from Practice at a Given Time to Soil Loss from Unit Plot

0.0 to 1.5 and greater

SOIL LOSS RATIO SLR

Function of:
- Canopy
- Ground Cover
- Within Soil Effects

CANOPY

Cover Above Soil
Intercepts Raindrops
Canopy Cover & Height

GROUND COVER

Single Most Important Cover-Management Effect

Effect Highly Variable in Data

50% Cover - 55% Reduction
50% Cover - 95% Reduction

WITHIN SOIL EFFECT

Surface Roughness
Effect of Roots & Residue on Erodibility
Effect of Consolidation on Erodibility
Effect of Tillage on Erodibility
Effect of Season on Erodibility

SUPPORTING PRACTICES FACTOR P

Represents Redirection of Runoff
Most Uncertain of USLE Factor
Contouring, Strip Cropping, Terracing

CONTOURING

Function of:
- Ridge Height
- Grade Along Furrow
- Storm Erosivity
- Cover & Roughness in Furrow

0.1 to 1.0

TERRACES

Function of:
- Grade Along Terrace Channel
- Sediment Characteristics

0.2 to 1.0 Graded Terraces

About 0.05 for Impoundment Terraces

STRIP CROPPING

Function of:
- Sediment production on "Bare" Strips
- Cover on "Covered" Strips

0.3 to 1.0

A USLE PERSPECTIVE

Data Highly Scattered and Varied

USLE Reflects Data Base as a Whole

Represents Understanding of Erosion within Framework of USLE Equation Structure

USLE REVISION AND UPDATE

Ken Renard, ARS, Tucson, AZ Project Leader
Cooperative Project to Review & Update USLE
Review & Analyses of Old & New Data
Erosion Theory
Out by End of Year

UNIT PLOT CONCEPT

Reference Condition
Arbitrary
Clean Tilled Fallow
9% Slope
72.6 ft Long

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MANAGEMENT OPTIONS FOR THE COVER AND CROP MANAGEMENT (C) FACTOR

Summarized from the Remarks of Dr. Alice Jones,
University of Nebraska, Department of Agronomy

Jones reported that for the "C" factor conservation technicians are examining the ratio of soil loss for the desired farming operation compared to those that would occur on a bare fallow unit plot developed in research data. She felt that overall cropping practices are some of the more important factors because farmers control them. This includes items such as tillage intensity and timing, residue management, and selection of crop rotation. She noted there have been estimates that 50% erosion control comes by maintaining 30% cover on the soil surface after planting.

She said that considerations used in quantifying "C" Factors include timing of tillage operation, the stages of crop growth, the development of canopy cover, and the sequence of rainfall events. The "C" Factor is usually developed as a sequence of cropping factors at six different times over the growing season. Erosion intensity is then related to distribution of rainfall and the specific soil loss ratio for each time component. The six time frames include a fallow condition between harvest and the first tillage operation, seedbed preparation and four stages which include the development of crop canopy from 10% to 75% cover and harvest.

Jones explained a slide showing the highest erosion intensity factor comes during the seedbed preparation period in Nebraska. Development of the "C" Factor involves combining the erosion intensity factor times the soil loss ratio over a period of time.

Jones then looked at what she said might be called a partial "C" Factor for each period. The highest partial "C" factor comes under the period of seedbed preparation and early cover development. Even though there is a high soil loss ratio during the fallow period, precipitation is quite low and so doesn't contribute much to the "C" factor. Jones noted that in terms of field operations the two periods having the highest level of "C" factor ratios are those from the time of spring tillage through 50% canopy cover. She felt that during that period there are many factors which influence the timing of the management inputs, including their other time commitments for livestock, acreage and equipment availability, and even climate.

She noted that there is a range of time in which eastern Nebraska cropping operations take place. Spring tillage frequently occurs sometime between mid-March and mid-May. Planting might typically occur from the first of April through the first of June. Fifty percent canopy cover can be reached anytime from late June through late July. Jones said that the range of time required for canopy to develop decreases as the season progresses, basically due to the increase of growing degree days. Thus there is a very great difference in the time of initiation of a practice to the final occurrence of the practice that is selected as part of the information that goes into development of the "C" factor.

Jones reported that diversity in development of crop staging criteria gives large variation to the "C" factor as one considers different geographic regions of the state. She explained that the data would show the variation in "C" factors by selecting different time frames for crop stage. There is a wide range of "C" factors for the early time period if planting is early. Tillage is the most important contributor to that variability. She said the variation in the partial "C" factor between early timing of operations and late timing of operations is quite significant when we examine those estimations for fall tillage operation as compared to no-till.

Jones summarized by noting several conclusions related to the general conservation planning program. The first conclusion is that more erosion control can be achieved with less tillage and subsequently more residue on the soil surface. A second point is that early spring tillage operations if followed by early planting, help promote erosion control because it allow plants to emerge earlier and develop earlier canopy cover to intercept rainfall during the May and June period. This is the period when Nebraska receives its most intense rainfall. A third conclusion is that with less tillage there is the least change in the "C" factor for various timings of spring tillage operations. A final conclusion is that "C" factor values are probably most reliable for no-till operations.

MANAGEMENT OPTIONS FOR THE SUPPORT PRACTICE "P" FACTOR
(Outline and Material from Presentation)

Roger Kanable, Conservation Agronomist
USDA - Soil Conservation Service
Lincoln, Nebraska

1. Contour farming "P" factors and limitations

2. Contour stripcropping "P" factors - systems and limitations

   A. For cropping sequences with 1/2 row crop or close-grown crop and 1/2 meadow

   B. For cropping sequences with 1/2 row crop, 1/4 close-grown crop and 1/4 meadow

   C. For alternate strips of row crop and small grain

3. Contour buffer stripcropping where permanent grass strips are narrower than the cultivated strips

Contouring

Contouring is effective in reducing water sheet and rill erosion based on the following limits:

Table 3 - P Values and Slope Length Limits for Contouring

Slope Group %	Residue Cover Less Than 50%	Residue Cover Greater Than 50%	P Value
	Maximum Slope Length Feet		
1-2	400	500	0.6
3-5	300	375	0.5
6-8	200	250	0.5
9-12	120	150	0.6
13-16	100	125	0.7
17-20	100	125	0.8
21-25	90	100	0.9

Land Slope Percent	P Values 1/ A	B	C	Strip Width 2/	Max. Slope Length 3/
1 to 2	0.30	0.45	0.60	130	800
3 to 5	.25	.38	.50	100	600
6 to 8	.25	.38	.50	100	400
9 to 12	.30	.45	.60	80	240
13 to 16	.35	.52	.70	80	160

1/ P Values -

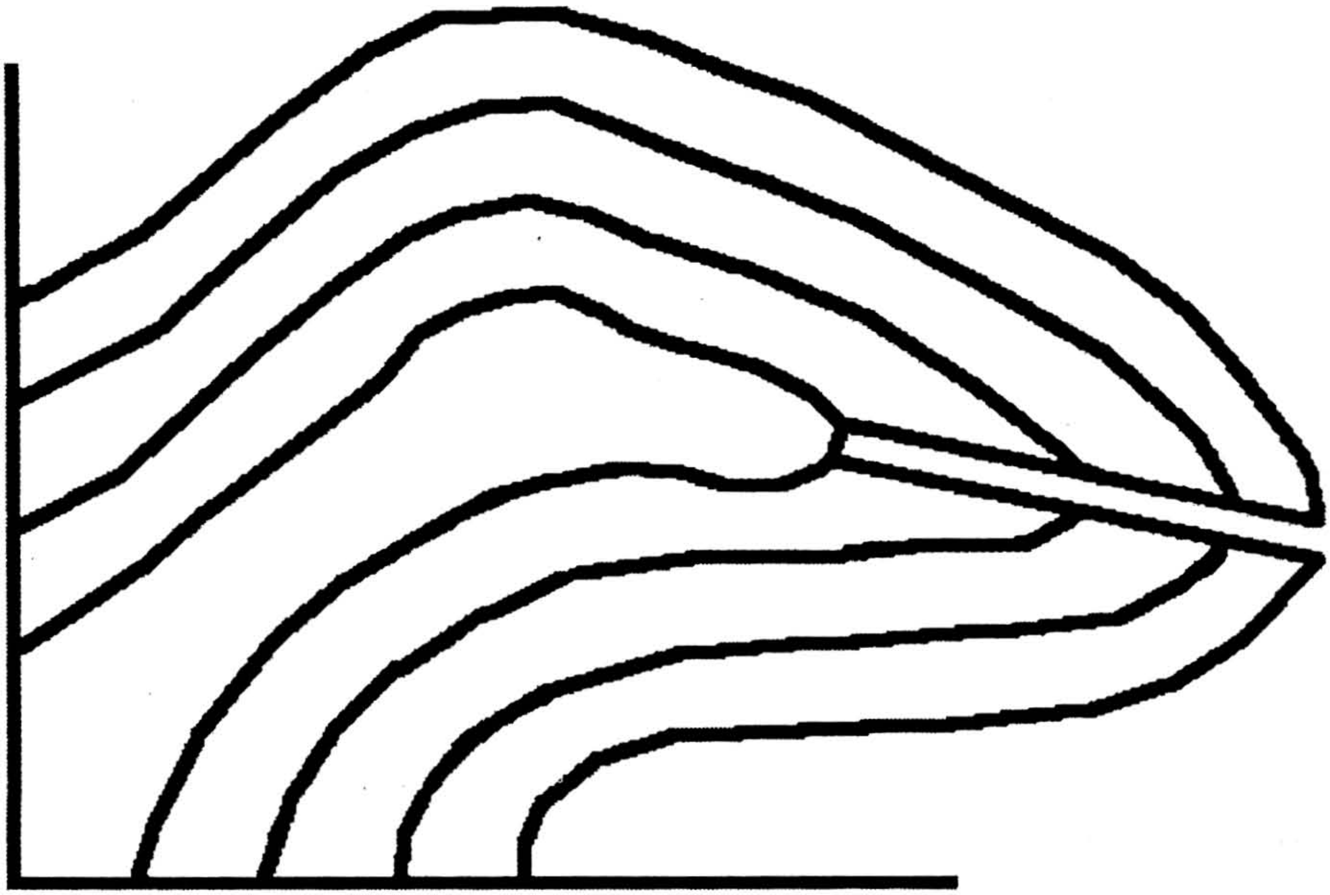
A - For rotations with 1/2 row crop or close-grown crops and 1/2 meadow.
B - For rotations with 1/2 row crop, 1/4 close-grown crop and 1/4 meadow.
C - For alternate strips of row crop and small grain.

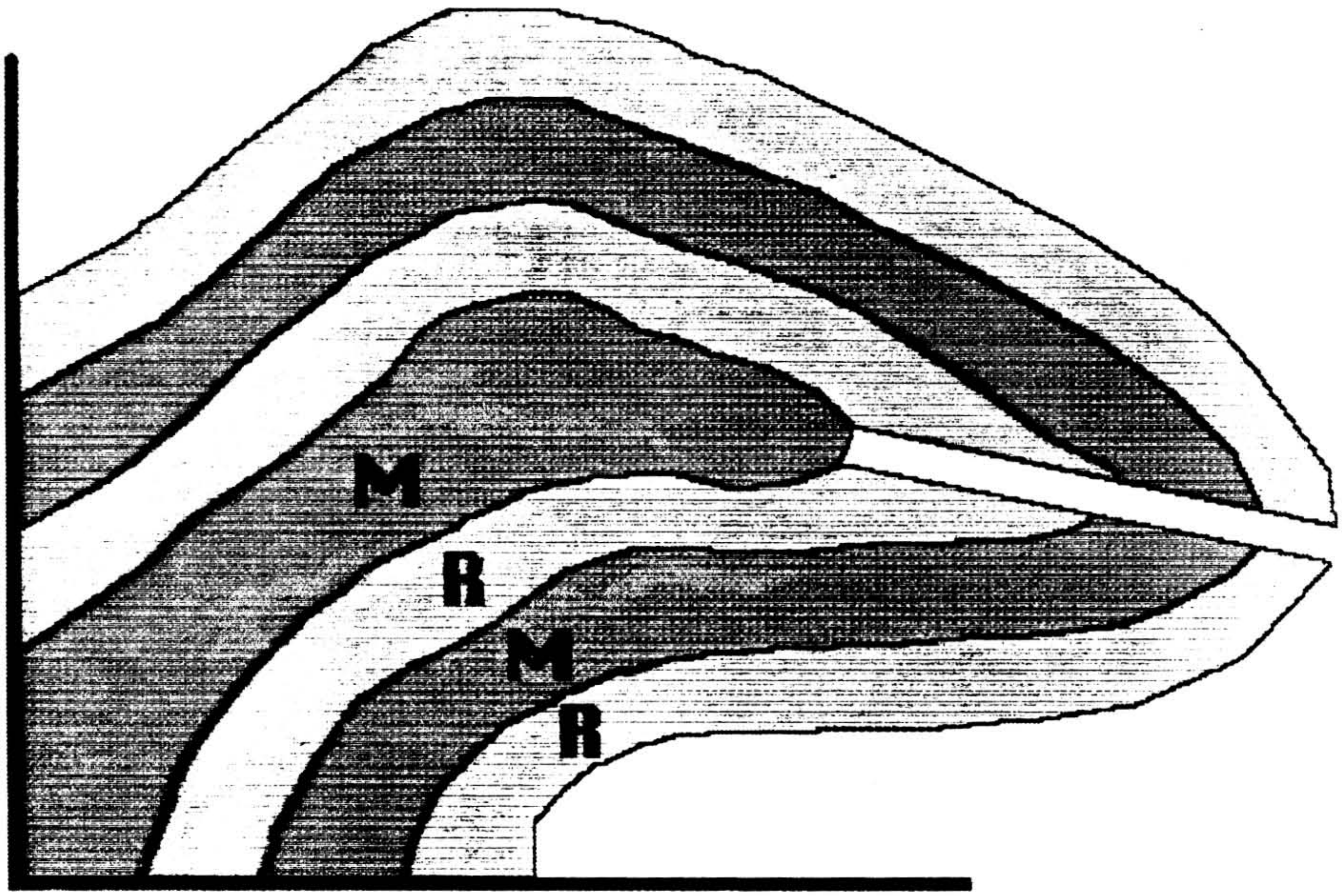
2/ Adjust strip width limit to accommodate width of farm equipment.

3/ Maximum length may be increased by 20 percent if residue cover after crop planting will regularly exceed 50 percent. When slope lengths exceed the limits shown on the table in a significant portion of the field, contour stripcropping should be used in combination with terraces to reduce slope length. Slope length limit is generally not a critical factor with contour stripcropping except on extremely long or steep slopes. The lengths given are judgement values based on field experience and are suggested as guides.

Where Permanent Grass Strips Are Narrower Than The Cultivated Strips, Use The Following "P" Factors:

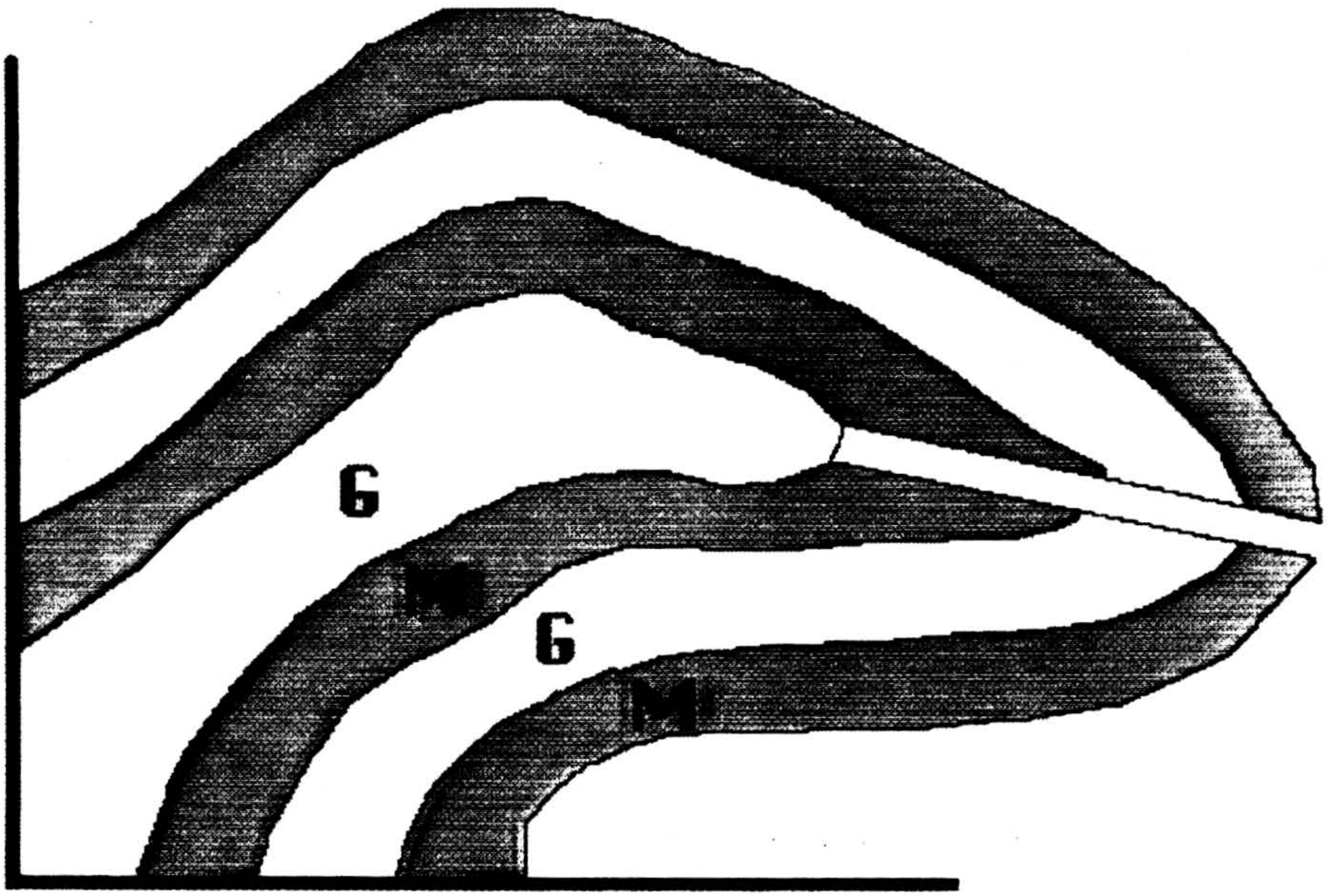
Land Slope Percent	Percent of Field in Grass 10%	20%	30%	40%	50%
1 to 2......	.55	.50	.40	.35	.30
3 to 5......	.45	.40	.35	.30	.25
5 to 8......	.45	.40	.35	.30	.25
9 to 12.....	.55	.50	.40	.35	.30
13 to 16....	.65	.55	.50	.40	.35
17 to 20....	.70	.65	.55	.50	.40
21 to 25....	.80	.70	.65	.55	.45





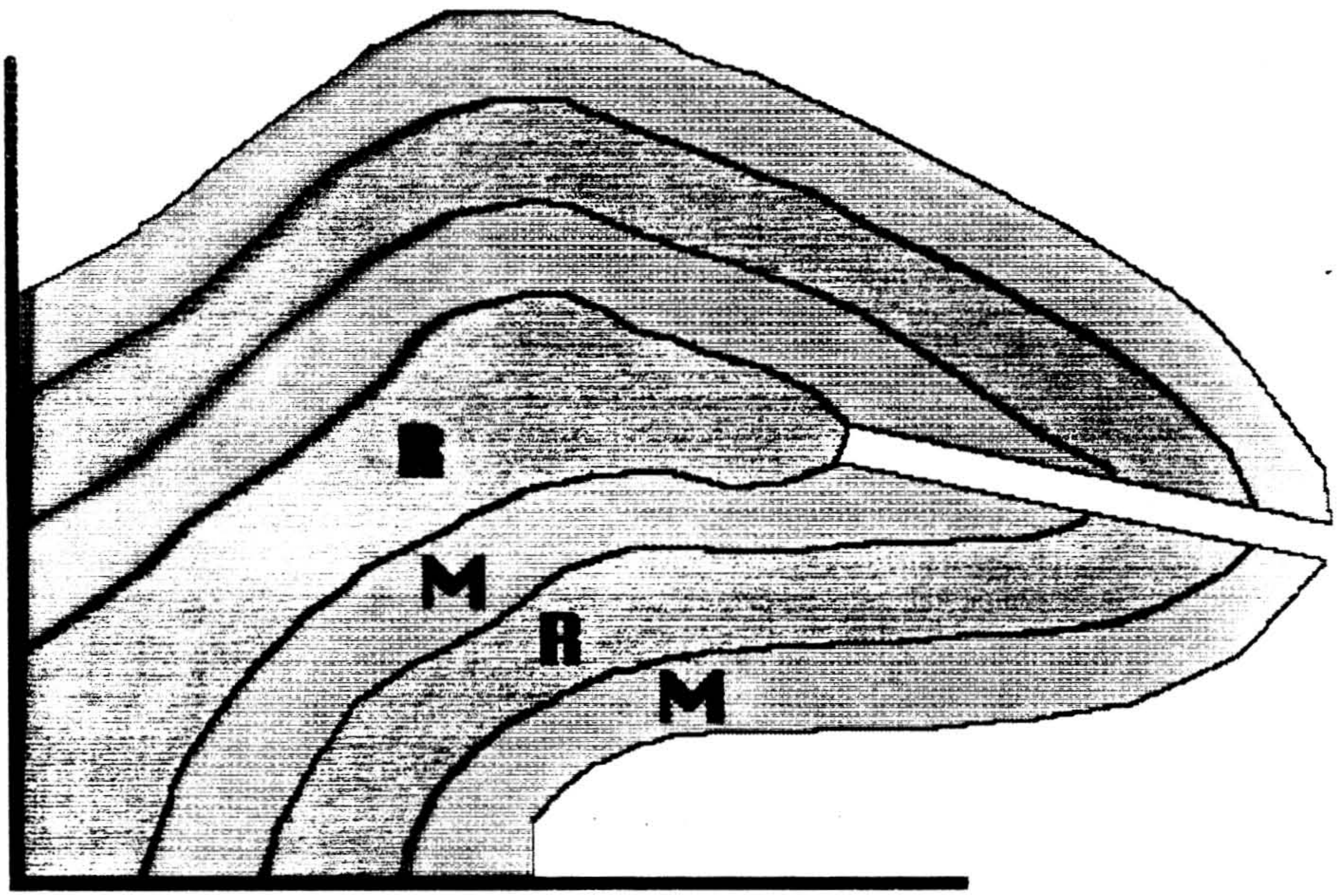
R - Row crop

M - Meadow



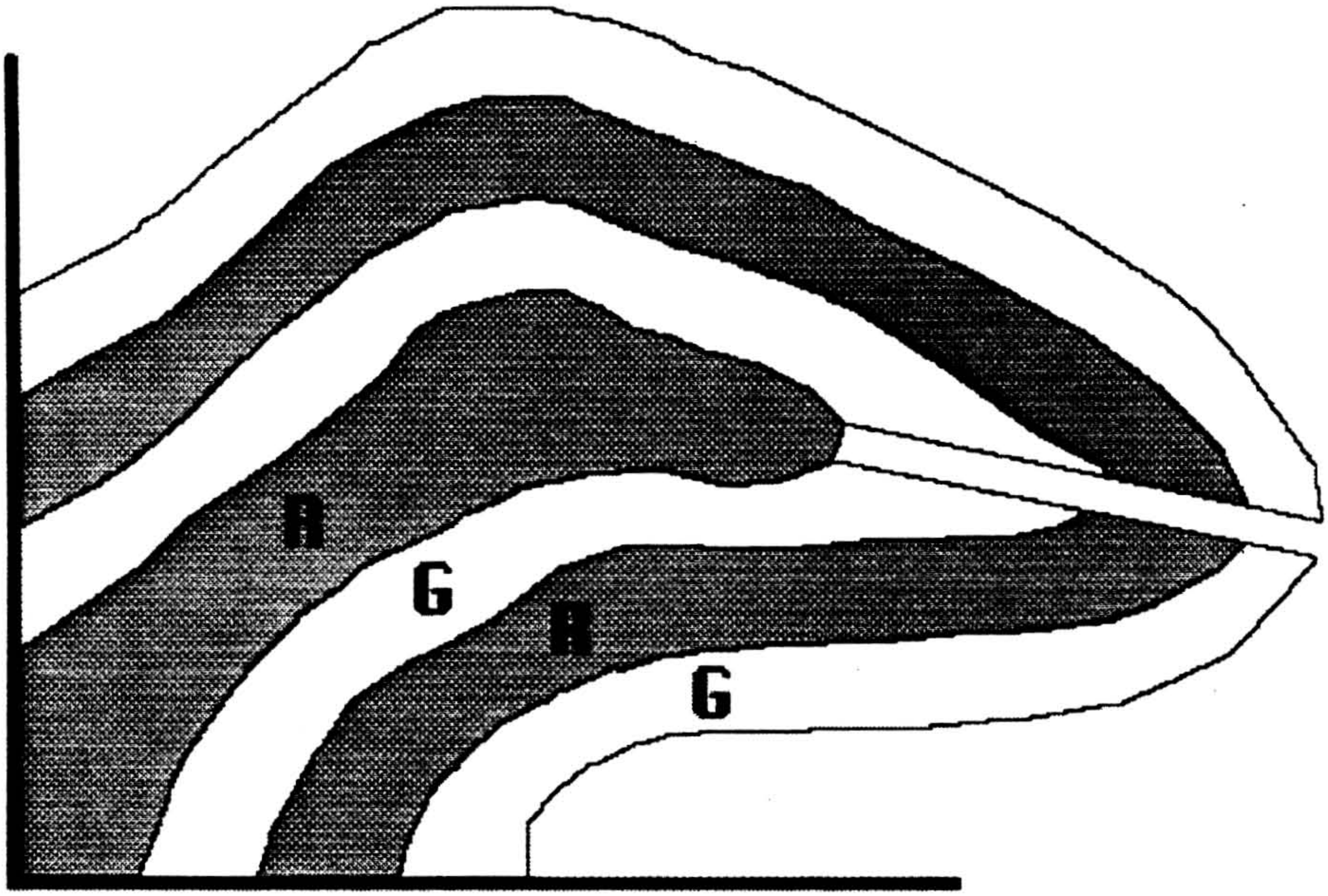
G - Small grain

M - Meadow



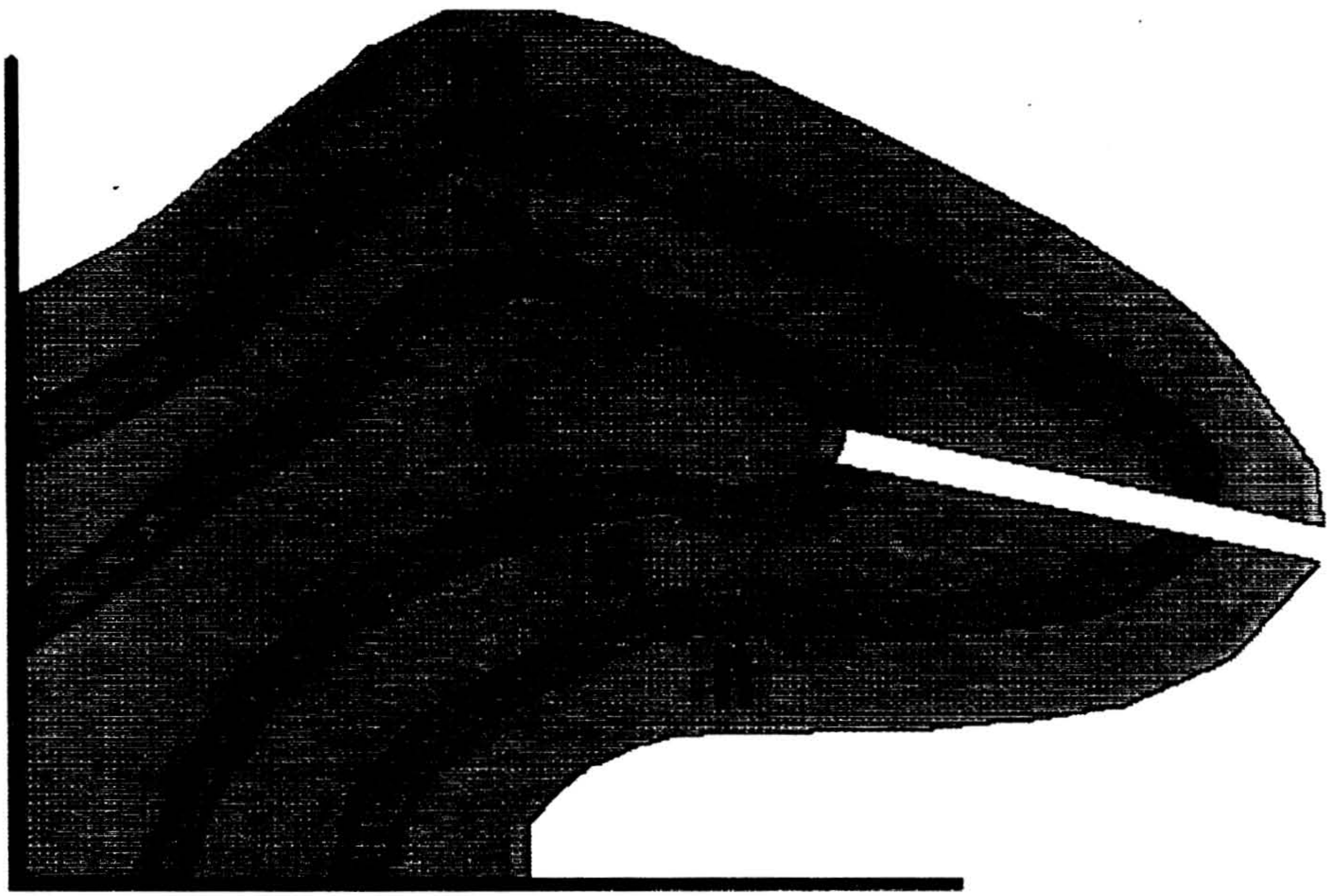
R - Row crop

M - Meadow



R - Row crop

G - Small grain



R - Row crop

M - Meadow

MANAGEMENT OPTIONS FOR THE K, L, AND V FACTORS OF THE WIND EROSION EQUATION

Paper by William G. Hance, State Resource Conservationist
SCS, Lincoln, Nebraska

As this symposium was being planned, it was recognized that there are many areas of Nebraska and the Plains area where wind erosion is a problem as much or more than water erosion. While the primary purpose of our workshop today and tomorrow is understanding our crop management options for sheet and rill erosion control, this fifteen minute time slot is dedicated to a quick look at management options for wind erosion control.

The wind erosion equation, E, is a function of I, K, C, L, and V. E, the wind erosion estimate, is average annual soil loss in tons per acre.

I, the soil erodibility factor, and C, the climate factor, are the basic resources being managed. Management options relate to K, L, and V.

K is the surface roughness or ridge roughness factor. It relates to tilled ridge patterns. In SCS we do not try to estimate effectiveness of random roughness such as that which would be afforded by rough plowed land. Ridge effect varies with differing height and width ratios and angle of erosive winds. See figure 1. Rod width is measured in the erosive wind direction.

L is the unsheltered distance along the wind erosion direction. Just as there may be a wide variety of USLE slope-length L distances within a field, there are often a wide range of wind erosion distances across the field. It is sometimes a little difficult to select the "right" representative L unsheltered distance. In general, the shorter the unsheltered distance, the better erosion control.

Windbreaks, vegetative barriers, stripcropping and stable filter strips are all potential management options to control erosion through reducing L.

V is the vegetative factor. Just as maintaining good ground cover is an important element in controlling sheet and rill erosion, "Keep the Land Covered" is the "Cardinal Rule" of wind erosion control. While percent ground cover is the primary consideration in water erosion control, the extent that vegetation can reduce surface wind velocity is more important for wind erosion control. Erect vegetation is much more effective at controlling wind erosion than flat residue -- even though the flat residue may cover a much higher percent of the surface. Small grain equivalence is the standard used in assessing how effective vegetation and residue may be for wind erosion control. See figures 2, 3, and 4.

In planning wind erosion control, planned treatment may address one or more of the K, L, and V. A stripcropping system may include windbreaks and narrow strips to reduce unsheltered distance L, ridges for maximum reduction of K, and maintaining erect vegetation and residue for maximum erosion control of V.

The primary rules of wind erosion are:

1. Keep the land covered
2. Reduce the field width
3. Ridge the land, and
4. Maintain stable clods

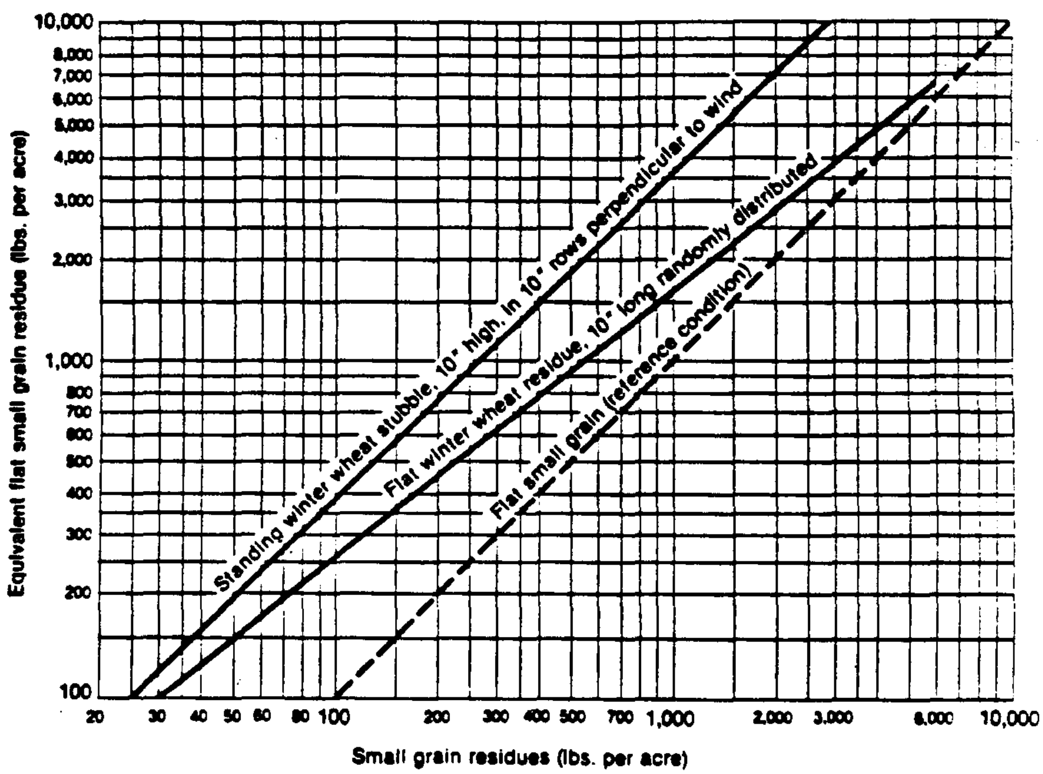
To estimate relative effectiveness of changes in K, L, and V, SCS uses computer tables that provide erosion estimates. Each table is for a specific soil (I factor), a specific climate (C factor), and a specific ridge roughness (K factor). Each row is for a specific field width L and each column for a specific V small grain equivalent. Figure 5 is a sample printout for a C of 50, a loamy sand I of 134, and a smooth field with a K of 1.0. A wide bare field erosion estimate is 67 tons per acre. The table shows how more vegetation and shorter unsheltered distances reduce erosion.

The Wind Erosion Equation, $E = f(IKCLV)$, is the best tool available for estimating wind erosion and effectiveness of erosion control management efforts.

Ridge Height - Inches	Furrow Spacing - Inches - Measured in Wind Erosion Direction																	
	4	6	8	10	12	14	16	18	20	24	28	32	36	40	44	48	54	60
1	.6	.7	.7	.8	.8	.8	.8	.9	.9	.9	.9	.9	.9	.9	1.0	1.0	1.0	1.0
2		.5	.5	.5	.6	.6	.6	.6	.6	.7	.7	.7	.8	.8	.8	.8	.8	.8
3			.5	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6	.6	.7	.7	.7
4					.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.6	.6	.6	.6
5							.6	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
6								.7	.6	.5	.5	.5	.5	.5	.5	.5	.5	.5
7									.8	.7	.6	.5	.5	.5	.5	.5	.5	.5
8										.8	.7	.7	.6	.6	.5	.5	.5	.5
9											.8	.8	.7	.7	.6	.6	.5	.5
10												.8	.8	.8	.7	.7	.6	.6
11													.8	.8	.8	.8	.7	.7
12													.8	.8	.8	.8	.8	.7

Figure 1. Soil Ridge Roughness - K Factor

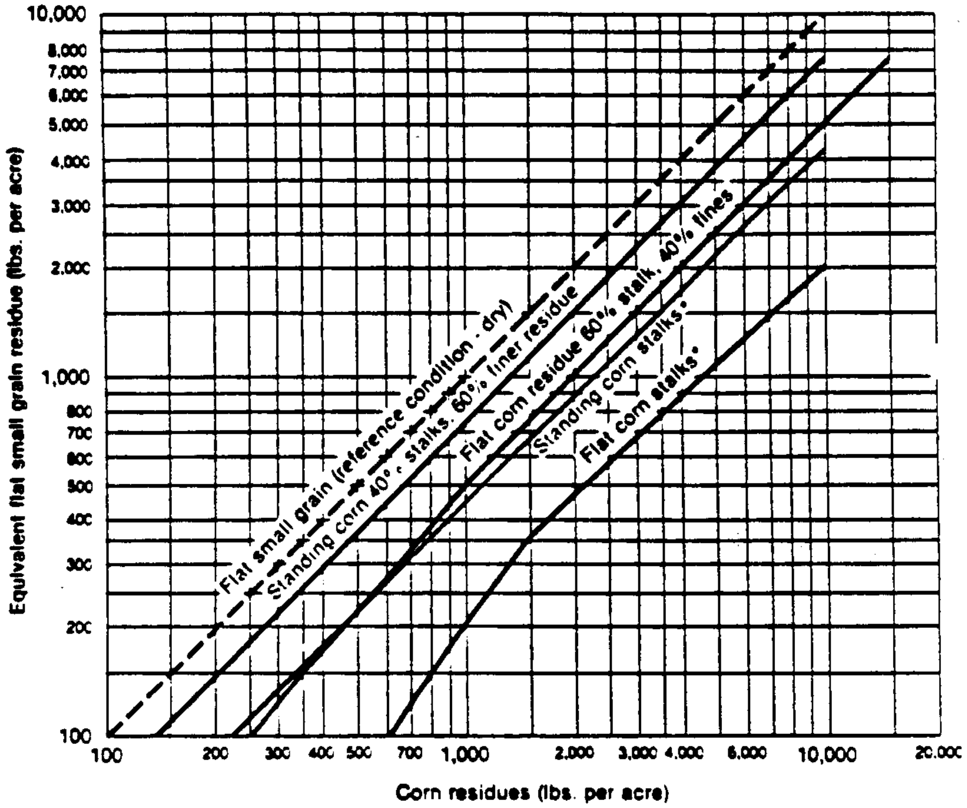
Flat Small Grain Equivalents of Small Grain Residues
(Use for wheat, barley, rye and oats)



Reference condition - dry small grain stalks 10" long, lying flat on the soil surface in 10" rows, rows perpendicular to wind direction, stalks oriented to wind direction
Source: Lyles and Allison—Trans. ASAE 1981, 24 (2) 405-408
Residues are washed, air dried, and placed as described for wind tunnel tests.

Figure 2

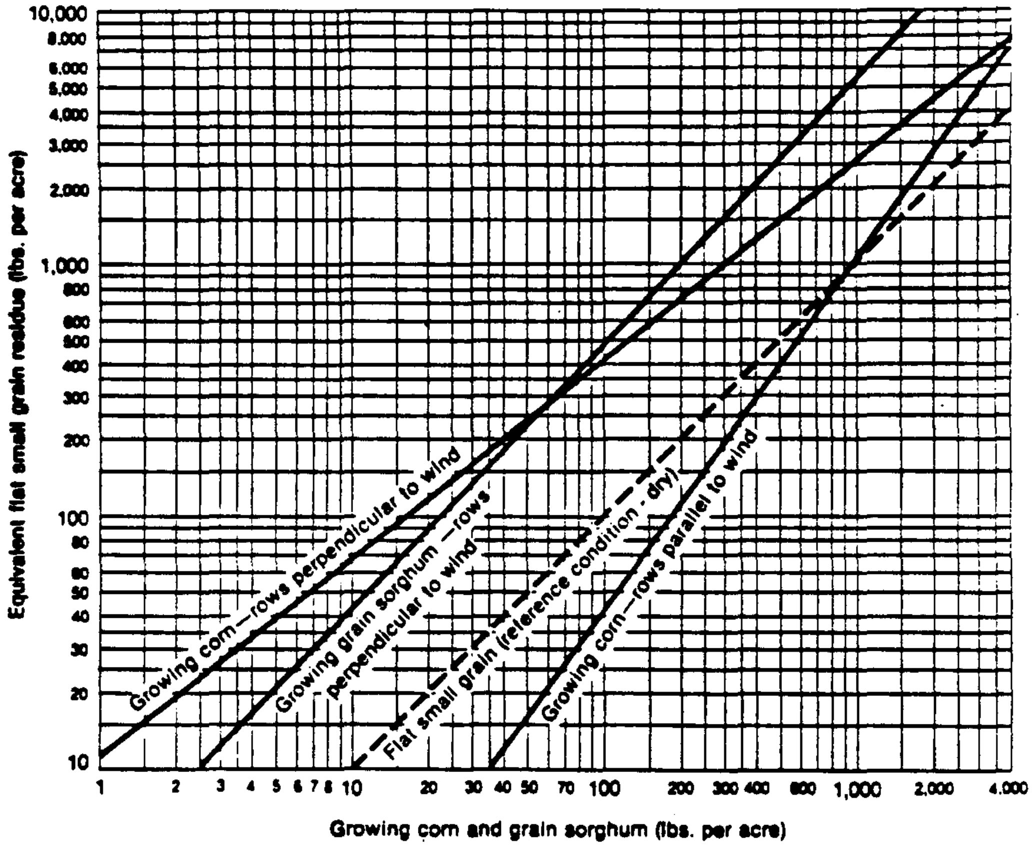
Flat Small Grain Equivalents of Corn Residues



Source* Lyles and Allison. Trans. ASAE 1981, 24(2) 405-408 (Flat to 2,000 lbs standing to 3,500 lbs Extended by SCS)

Figure 3

Flat Small Grain Equivalents of Growing Corn and Grain Sorghum



Source: Armbrust & Lyles, 1984 - unpublished

Figure 4

(E)= SOIL LOSS FROM WIND EROSION IN TONS PER ACRE PER YEAR — JANUARY, 1981

SURFACE - K = 1.0 — C = 50, I = 134

(V)== - FLAT SMALL GRAIN RESIDUE IN POUNDS PER ACRE

(L) UNSHELTERED DISTANCE IN FEET	0 (Bare)	250	500	750	1000	1250	1500	1750	2000	2250	2500	2750	3000
10000	67.0	58.1	45.9	34.0	21.1	10.9	5.4	2.6	1.6	0.5			
8000	67.0	58.1	45.9	34.0	21.1	10.9	5.4	2.6	1.6	0.5			
6000	67.0	58.1	45.9	34.0	21.1	10.9	5.4	-.6	1.6	0.5			
4000	67.0	58.1	45.9	34.0	21.1	10.9	5.4	2.6	1.6	0.5			
3000	67.0	58.1	45.9	34.0	21.1	10.9	5.4	2.6	1.6	0.5			
2000	67.0	58.1	45.9	34.0	21.1	10.9	5.4	2.6	1.6	0.5			
1000	63.1	54.6	42.9	31.5	19.3	9.8	4.8	2.3	1.3				
800	62.0	53.6	42.1	30.8	18.9	9.5	4.6	2.2	1.3				
600	58.2	50.1	39.2	28.5	17.3	8.6	4.1	1.5	1.1				
400	54.2	46.6	36.2	26.1	15.6	7.6	3.5	1.6	0.9				
300	51.2	43.9	33.9	24.3	14.4	6.9	3.1	1.4	0.8				
200	45.3	38.7	29.6	20.9	12.1	5.6	2.5	1.1	0.5				
150	40.2	34.1	25.8	17.9	10.2	4.5	1.9	0.8	0.4				
100	35.9	30.4	22.8	15.6	8.7	3.7	1.6	0.5					
80	32.8	27.6	20.6	13.9	7.7	3.2	1.3	0.4					
60	27.8	23.3	17.1	11.3	6.1	2.4	0.9						
50	24.6	20.5	14.9	9.7	5.1	2.0	0.7						
40	22.4	18.6	13.4	8.7	4.5	1.7	0.6						
30	18.6	15.3	10.9	6.9	3.5	1.2							
20	13.8	11.3	7.8	4.7	2.3	0.7							
10	8.0	6.4	4.2	2.4	1.0								

Figure 5

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SOME EXTENSION AND RESEARCH PROGRAMS RELATED TO EROSION IN NEBRASKA

Summary by Elbert Dickey, University of
Nebraska-Lincoln, Department of Agricultural Engineering

Several research and extension programs in Nebraska are evaluating tillage, residue and erosion relationships. One reason for the emphasis on tillage and erosion is because of the continuing loss of soil from Nebraska cropland.

Research shows that a 20 to 30 percent residue cover will generally reduce erosion about 50 percent. However, research has not fully addressed the question of "What combination of tillage tools or tillage implements will leave 30 percent residue cover in different types of residue? As a result, Nebraska has undertaken a research project to examine the effects of ten different tillage and planting systems on corn and soybean residue. Residue cover is being measured before and after each tillage operation. For corn residue, the effect of stalk shredding and the impacts of both fall and spring anhydrous application are also being studied. Additionally, soybean residue cover resulting from different row spacings and varieties is being studied.

Results show that chisel plowing reduces soybean residue cover by an average of 67 percent, disking reduces it by about 68 percent, and field cultivation reduces it by about 58 percent. These are the three dominant tillage tools used in Nebraska. Ridge till removes about half of the residue. Only no-till consistently leaves more than a 30 percent residue cover, which is the minimum cover accepted for conservation tillage.

A computer imagery technique is being developed to determine residue cover from photographic slides. There is a close correlation between the computer imagery technique and the conventionally used photographic grid technique. One application of computer imagery would be the documentation of residue cover to help farmers comply with conservation requirements of the 1985 Food Security Act.

Research is being conducted on some relatively new tillage techniques to reduce runoff and erosion. These include: layby subsoiling which enhances surface storage; basin tillage which creates a small dam every three to five feet between rows; and reservoir tillage which uses a subsoiler shank and a paddle wheel arrangement to implant a small storage reservoir. All these techniques are used after the crop is up and growing. Another technique being evaluated uses a subsoiling or deep chiseling operation immediately in front of planting. These techniques are being evaluated under low pressure center pivot systems and in dryland conditions using rainfall simulation. Additional work focuses on comparing runoff and erosion from these tillage techniques used up and down hill and on the contour in both clean-till and no-till environments.

Related to tillage and erosion studies is research on erosion impacts on productivity. Yield is being measured relative to landscape position and erosion phase of the soil.

The Agricultural Energy, Soil and Water Conservation Project is a targeted educational program having three components: conservation tillage, irrigation water management and ecofallow. Conservation tillage target areas are in eastern Nebraska and ecofallow is centered in western Nebraska. A second targeted educational project is the Logan Creek Special Study, also in eastern Nebraska. Both projects have specific goals which include increasing the use of conservation tillage by at least 20 percent. The Logan Creek Special Study also includes the use of structural practices to help reduce soil loss.

These educational programs include field days and planting demonstrations which allow farmers to gain "hands on" experience in calibrating and adjusting equipment. Conservation tillage demonstration plots and tours of the plots have helped farmers realize these methods can work in their neighborhood. On some fields, no-till is used on half of the field and a conventional system is used on the other half. In 68 percent of these thirty-one side by side tillage comparisons, no-till was at least $5 per acre less expensive than conventional tillage because of reduced fuel, labor and equipment costs. In most of the comparisons, yields were about the same.

Local guidance committees which include farmers and agribusiness representatives have been developed within the targeted programs to tailor the educational programs to meet specific clientele needs. Use is also made of Extension Assistants to provide direct assistance to farmers.

Within the targeted programs, extensive use of mail and field surveys have been made. These surveys allow Extension personnel to develop educational programs to address farmer perceptions. Surveys before and after the projects allow Extension personnel to document program impacts. In a mail survey of 2,000 farmers across Nebraska, 56 percent of the respondents replied that they were using conservation tillage. A field survey which included residue measurements and a listing of tillage operations showed that relatively few farmers were using conservation tillage when using the 30 percent cover criterion. Even with a 20 percent cover criterion, only 18 percent of the farmers were classified as using conservation tillage.

THE USDA-WATER EROSION PREDICTION PROJECT (WEPP)
--a project to develop improved erosion prediction technology for use by action agencies

By John Gilley, Research Agricultural Engineer, USDA-ARS, Lincoln, Nebraska
& George R. Foster, Head, Agricultural Engineering Department,
University of Minnesota-St. Paul

(Outline Material from Slides Used in Presentation)

MAJOR COOPERATING AGENCIES

USDA-Agricultural Research Service
-Soil Conservation Service
-Forest Service
USDI-Bureau of Land Management

WEPP PRODUCT

Prediction Technology for:
Sheet-Rill Erosion
Ephemeral Gully Erosion
Sediment Yield from Field Sized Areas
Sediment Characteristics

WEPP - a USLE REPLACEMENT

Target Users

All USLE Users, Especially
Field Office Personnel

WHY REPLACE the USLE?

USLE -- Mature Technology:
No Major Improvements through USLE
USLE -- Restrictive Equation Structure:
Can not Represent Important Processes
USLE -- Empirical:
Difficult to Apply to Unmeasured Conditions

WHY NOW?

Recognized Need
Advancements in Hydrologic and Erosion Sciences
Personal Computers and Data Bases
Experience with Models like CREAMS

FEATURES OF WEPP

Team Effort
Scientist/User Involvement
Multi-Agency Involvement
Project Management Tools
User Requirements
Technology Appropriate for User
A National Program

APPLICATIONS

Conservation Planning
Project Planning
Inventory and Assessment

MAJOR FEATURES

Based on Fundamental Hydrologic and Erosion Processes
Easily Used
Computer Implemented
Extensively Uses Data Bases

TECHNICAL STRENGTHS OF WEPP

Fundamental Processes
Measurable Properties
Research Determined Parameter Values
Field Representation

LAND USES

Field Sized Areas

- Cropland
- Pastureland
- Rangeland
- Disturbed Forestland

WEPP DELIVERY

August 1989
Usable Product
(Better than USLE)
Computer Program
Documentation

BEYOND 1989

Intensive Testing (1989-1992)
Research/Development (1989-?)
Revised Model/Program (1992)
Wide Spread Implementation
(1992-life cycle of model)

IMPLEMENTATION

Development of Production Program
Model/Program Maintenance
Development of Data Bases
Training

ARS INVOLVEMENT IN WEPP

National Research Leadership
Identification of User Needs
Experimental/Analytical Research
Computer Program
Model Implementation

SCS INVOLVEMENT IN WEPP

Team Participant
Identification of User Needs
Soil Characterization
Site Selection
Model Implementation

IMPROVED EROSION PREDICTION

In West
On Rangelands
On Disturbed Forest Land
For Conservation Tillage
In a Single Package
- Deposition on a Landscape Profile
- Nonuniform Slopes
- Ephemeral Gully Erosion
- Sediment Yield from Field-Sized Areas

TILLAGE SYSTEMS AND COVER MANAGEMENT

Prepared Remarks of Arnold King, Head, Ecological Sciences,
SNTC, USDA Soil Conservation Service, Fort Worth, Texas

The Food Security Act has, of course, had a tremendous impact on the nation's soil conservation program.

I believe most farmers view conservation compliance provisions of the Act as a mandate that they can live with. It will require scientific planning, and their level of understanding the relationships between erosion, crop residue, and management practices must be increased. I suppose this is the major purpose for this symposium.

Major variables that can be influenced by management decisions include crop canopy, residue mulch, incorporated residue, tillage, and residual effects of different crop types.

Each of these effects can be treated as a subfactor in arriving at a cover-management factor "C" in USLE. The same effects apply to wind erosion prediction, but the current procedure does not address the relationships as directly as does the USLE. Hopefully, some progress will be made to help alleviate this limitation in predicting wind erosion. Wind erosion data is extremely difficult to validate under field conditions, so I sincerely sympathize with our wind erosion scientist.

Our current data base concerning crop and management effects on erosion is extensive, but additional research is needed to fine tune some of the relationships. For instance, decay rates in the southern states are significantly different from those in cooler climates. Nature's way of offsetting this situation is to produce rapid cover of weeds, and I'm not sure that we are addressing this concept in our USLE "C" factors.

Another concept that needs research is the very evident change in soil erodibility under conservation tillage systems. The soil surface accumulates residue in various stages of decomposition, and it also begins to accumulate lignin, fats and waxes in noticeable quantities after a few successive years of conservation tillage.

This phenomenon is particularly evident under a no-tillage system. So, in addition to ground cover and canopy, I believe the soil becomes measurably less erodible after only a few crops are grown under conservation tillage. This is not based on theory; it can be easily seen, and it can be felt.

However, one problem, or limitation, of this benefit is that one heavy duty tillage operation essentially destroys this good surface condition that may take several years to restore.

We need a stronger data base concerning the effects of conservation tillage on water quality. The effects on surface water are fairly conclusive and in almost all cases the effects are positive. However, groundwater quality is a relatively new issue for nonpoint source types of pollution. How much filtration is provided by the soil as a natural water purifying agent? What are the natural nitrate levels in groundwater and how much pollution can be attributed to poor fertility management? Does residue management for erosion control have adverse effects on groundwater quality? We may soon be thinking of cover crops as a method of pumping out excess moisture and nitrogen rather than simply providing soil protection. These and other challenges face the farmers, SCS, and researchers during the next decade and we need to work closely together to achieve mutually acceptable land treatment alternatives.

PANEL ON TILLAGE PRACTICES, CROP ROTATION AND COVER MANAGEMENT - KANSAS

Summarized from the Remarks of George E. Ham, Head, Agronomy Department,
Kansas State University, Manhattan, Kansas

Dr. Ham presented a summary of recent research in Kansas pertaining to tillage systems, crop rotations, and residue management. He said that most of the material he would discuss could be found in "Conservation Tillage Research 1985", a publication available at the back of the room. He noted that other relevant Kansas publications were also available at that location. He then presented slides characterizing pertinent Kansas data.

Ham noted that average precipitation in western Kansas is about 16 inches a year and that a corner of the southeast part of the state receives about 40 inches. He stated that precipitation has some impact on the results in terms of moisture conservation and the impact of crop yields in some of the practices.

He reported that the "R" factor, the rainfall erosion index, varies from 100 to over 250 in Kansas as compared to 50 to 175 in Nebraska. This makes it difficult to control sheet and rill erosion and stay within "T" in parts of the state.

Ham next compared the climatic factor for wind erosion in Nebraska and Kansas. In Nebraska this ranges from .01 to 59 while in Kansas this ranges from 120 to something less than 70. Southwest Kansas has some sandy soils, has the greatest "C" factor and is also relatively windy. He remarked that he had read some information identifying Garden City as the windiest city in the U.S.

He then compared the estimated average annual erosion loss on Kansas cropland in tons per acre. He said that wind erosion varied from very high in southwest Kansas to negligible in eastern Kansas. In contrast sheet and rill erosion ranges from 1.3 and 1.4 tons per acre per year in western Kansas to as high as 19.5 in some of the bluffs along the Missouri River in the eastern part of the state. He noted that some of those areas have been allowed relief by allowing conservation plans to exceed "T" on some soils as far as the conservation compliance provision of the Farm Bill is concerned.

Ham then showed a series of slides designed to illustrate how conservation tillage practices impact on crop yield. He said the point of the slide on corn tillage studies was that they are doing very well with no-till situations compared to conventional corn tillage.

A slide on soybean tillage studies showed that results varied, largely relating to internal drainage of the soils. Grain sorghum tillage studies also tended to show that there is a reduction in yield in the two soils that are not well drained. Otherwise he felt the data show that conservation tillage can compete reasonably well.

Ham identified proper placement of fertilizer as one of the factors which can help make a tillage system successful. Methods that broadcast fertilizer were less effective in tests and methods which incorporate fertilizer in the soil were more effective.

In the wheat tillage study long term averages with a wheat fallow rotation resulted in yields of no-till and reduced-till equal to or greater than those of conventional. In western Kansas going from conventional to no-till especially showed some advantage. Moisture savings were a benefit in these locations. It was often found that a wheat-sorghum-fallow rotation performs best for yields. Some economic studies done at Tribune and Hayes have found the reduced-till wheat-sorghum-fallow rotation as the best rotation in terms of the inputs and income received. Wheat and sorghum both benefited in this rotation.

Ham showed a slide illustrating wheat-corn-fallow rotations at a Colby branch station. Yields were generally better with conservation tillage than conventional. However, he noted there was a problem in 1985 due to compaction from working the soil when it was too wet. Ham also presented some data on irrigated sorghum yields and explained the effects of residue management on yields.

Ham's final slide dealt with ridge-till research studies. He said that one problem with ridge-till is that it doesn't do well on lower organic matter soils because the ridge will not stay built. There is also a problem with point rows when terraces are not parallel. An additional problem is that it's not easy to utilize when dealing with small grains.

Advantages to ridge-till include that it has better end row drainage and earlier spring warmup and planting can be done earlier. It can help eliminate preplant tillage costs and herbicide costs are reduced compared to no till and other minimum tillage systems. Ridge-till is well suited to banding the residual herbicides. He also said that weak management risks are reduced in ridge till because of planting in a weed-free, residue-free seed bed and use of two cultivations. Soil erosion is reduced because the soil is protected at all times.

PANEL ON TILLAGE PRACTICES, CROP ROTATION, AND COVER MANAGEMENT ACTIVITIES - IOWA

From Dick Thompson, Farmer, Boone, Iowa

PROBLEMS OF RAIN INFILTRATION

Why doesn't the rain go into the ground anymore? There is compaction of soils because of too much tillage at the wrong times of the year, spring and fall. As a result, the rain does not go into much of the soil in Iowa anymore but runs away taking valuable soil nutrients and pesticides into the streams and lakes. This is why the 1985 Farm Bill will require farmers to change tillage practices and crop rotation by 1995 in order to receive government support payments.

In our years of experience with ridge-tillage, we find we have percolation, or downward movement of water into the soil, because of the loose soil structure containing air spaces and earthworm burrows. This good soil structure and earthworm burrows are possible because of no tillage at the time the earthworms are near the surface to propagate. Fall tillage is especially hard on earthworm populations. Cultivation in the summer when they are at lower levels, does not seem to be as detrimental.

No-till will also increase water percolation into the soil but has problems in other areas. No-till is not well adapted to the northern half of the midwest because of the wetter colder soils which cause yield reductions. Heavy applications of several herbicides are required with no-till resulting in serious groundwater pollution problems. In Iowa, 100 of the 800 public wells are contaminated with atrazine. For these reasons soil and water conservation should promote ridge-till when the whole picture of agriculture is considered.

The positive attributes of ridge-till are as follows.

1. Residues are left on the soil surface, resulting in excellent erosion control and less ponding in the low areas.
2. Eliminates spring and fall tillage which increases the earthworm numbers.
3. Improved water percolation by controlled traffic and earthworm activity, therefore there is less compaction.
4. Requires less or even no herbicides.
5. Lowers production costs by less labor, fuel and equipment.
6. Equal or higher yields with lower costs means more profit.
7. Earlier planting with dryer and warmer ridges.
8. Less stress with fewer field operations.
9. Saves moisture.
10. Moves toxic residues away from the planting row.
11. Cereal grain rotations work in the ridge system.
12. Fall cover crops can be incorporated with planter w/o burndown herbicide.
13. Ridge-till planter can incorporate manure while planting the crop.
14. Harvest of crops possible under wetter fall conditions.
15. Ridges have less wind erosion, the snow and residues stay in the field.

During the past twenty years some of the University people have argued whether ridge-till yields are two bushels plus or minus the control yields, while the major issues that were just listed remain in the background. Hopefully, with the soil loss equation as related to ridge-till, the time will be spent on the major issues and not entirely on the fractions and the decimal points in the arithmetic of the equation.

The "C" and the "K" factors need to be changed for ridge-till. Run-off data from ridge-till was not available when the soil loss equation was formulated. Data collected during the first years of converting to ridge-till does not show the full potential of water percolation and change in soil structure. Also early ridge-tillers actually listed their crops, removing all the ridge and planting in a furrow. The trapped water in the row became a production and erosion problem. Nebraska data indicates that infiltration doubles by the fourth season of ridge-till. Ohio data shows that tile drains start working again in the third year after changing to ridge-till. Purdue data indicates compaction is almost gone by the fifth year under ridge-till on the Eppley farm at Wabash, Indiana. Farmers observation of several years of ridge-till is that the erosion is much less than predicted by the Universal Soil Loss Equation. Improved soil structure and reduced compaction by controlled traffic and the increase in earthworms help the rain go into the soil. With the reduction of tillage, the aggregate structure improves allowing more air in the soil and facter downward water travel.

The determination for the "C" factor (residue cover) is made at only one time period, just following the planting process. At this time with ridge-till some of the residue has been pushed aside to allow a more desirable planting environment for the row crops. The clean planting strip, allows faster drying and temperature warm up for the newly planted seeds, which will give faster emergence and higher stand count. Complete ground cover with residue is the best for erosion control but is not in the best interest of the newly planted seed. Residues keep the row area wet and cold with leaching of toxins from residue in the row area. Cleaning off the top of the ridge removes the toxic or allelopathic chemicals in the residues that would affect the new seeds and young plants. This clearing off process moves weeds and weed seeds into the wheel track away from the planted row which reduces or eliminates the need for herbicides. These pushed together or partly covered residues appear less on the surface and the percent reading would be less, showing a less desirable for ridge-till in controlling erosion. The residues and the loose soil serve as a sponge during the rainfall and some of the residue appears again on the surface as some of the soil moves down into the residue pack.

The percentage of residue cover is very important in the erosion process because of the protection offered from the blast of the raindrops. The residue acts as a cushion when the raindrop hits a piece of residue, absorbing the energy and reducing the chances of moving the soil particles into suspension in the water and moving off the field in the water flow. The water flow runs off the site uncontrolled because of the relatively flat or uniformly sloping soil surface. Residues are important, but corn stalks spread on a cement parking lot will not make the water go into the cement. Ridge-tillage with controlled traffic, more air space in the soil, higher earthworm populations, less compaction can begin to change this parking lot into a field that will start accepting rainfall into the soil with less moving off the field. The flow characteristics of the ridge-till field are not the same as an unridged field.

The water flow is controlled by the ridges which reduced gully erosion. Residue and cloddiness in the valleys between the ridges slows runoff and permits more infiltration. The controlled traffic also lessens the compaction of the entire field.

We would like to quote from a letter from William A. Hayes, former Regional Agronomist, S.C.S. "Research shows a direct relationship between the percent residue cover and the amount of soil erosion with all conservation tillage systems except ridge-till. With ridge-till, the amount of erosion that occurs is directly related to the amount of residue placed only on the furrow bottoms (valley between the ridges). Refer to the paper, "Runoff and Soil Loss as Influenced by Tillage and Residue Cover." Therefore, the USLE does not apply to the ridge-till system. A new equation was developed for the ridge-till system, "estimating soil loss on ridged fields." When comparing the USLE to the "new equation for ridged fields," use the ridge till up and down the slope in a rainfall area where "R" is 150, soil factor "K" of .32, 150' slope, 12 percent slope, "C" of .09 (continuous corn 125+ BU.) and "P" of 1.0. Soil loss A = 9.5 T/A/YR. with the USLE and 2.11 T/A/YR. with the new equation. The lower soil loss, 2.11 T/A/YR., appears to be much more realistic and appears to be in agreement with the experiences of many farmers and others familiar with ridge-till. In the new equation for ridged fields, the grade of the furrow bottom becomes percent of slope. For comparison, let us assume the same factors in the previous problem except we won't go up and down the 12 percent slope, but go across the slope with a 4 percent grade in one problem and an 8 percent slope in another.

4 Percent Grade A = 0.62 T/A/YR.
8 Percent Grade A = 1.68 T/A/YR.

It is essential that this "new equation for use on ridged fields" be made available to SWCS technicians as soon as possible (spring and summer 1988) to permit accurate farm planning for the 1985 farm program. Farmer experience and research have proven the USLE is inadequate and erroneous in evaluation of ridge-till on severely eroded land. A responsible scientist from the Washington Technical Service Centers and the former ARS man responsible for the USLE have recommended that the new equation be adopted and used in place of the USLE in water erosion evaluations of ridge-till fields."

A farmer in northern Iowa needs to buy a new planter and cultivator. The SWCS states the farmer should no-till continuous corn to meet the five ton soil loss per acre per year. The problem on the remaining less erodible land would be that no-till would lower yields 20-30 bushels per acre on these wet cold soils and would require herbicides for weed control. The farmer can't afford two kinds of equipment nor can he spend the time changing the equipment from one field to another. A change is needed in the soil loss equation for ridge-till so the farmer can use the ridge-till equipment on both the hills and the flat land. If the ridge-till across the slope with a fall cover crop does not meet the 5 ton soil loss per acre per year, then the field should be in permanent grass.

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PANEL ON TILLAGE PRACTICES, CROP ROTATION AND COVER MANAGEMENT ACTIVITIES - MISSOURI

Summarized from the Remarks of Curtis Walker,
SCS Area Resource Conservationist, St. Joseph, Missouri

Walker reported that three counties in northwest Missouri had a relatively unique situation in that the tobacco industry has an $8 million impact on the economy. Tobacco directly affects between 500 and 1,200 in that area producers in regard to their conservation compliance activities for the Food Security Act. The "C" Factor for a continuous tobacco rotation is relatively high compared to continuous soybeans. Walker said that when a soybean-tobacco rotation is used "C" factors are lowered. He stated that many "C" factors are based not upon the crop, such as tobacco itself, but compared to another crop. Tobacco is most nearly equated with corn in regard to soil loss tables. However, data is lacking to specifically back the practice.

Walker said that no-till or strip-till for tobacco is not a common practice. However, there are cases where they are trying to add residue to the tobacco situation by the use of cover crops.

Another item of interest in Missouri is the "buffer" strip. This is not true contour strip cropping but occurs where permanent grass strips are narrower than the cultivated strips and row crop strips. Walker noted that Arnold King had earlier mentioned the wide flexibility or adaptability of buffer strip crop systems as an option to the Food Security Act plans. He said that in the four corners area of Iowa, Missouri, Kansas, and Nebraska generally it's not considered an option on some of the steeper slopes, but that it does have a place. Walker noted that the possibility that strips could fit in as an alternative to terraces on steep ground and provide an alternative to vast lengths of mechanical work. The landowner may change land uses if he wants without the encumberances of terraces in the field. He said the strips can be installed under the Conservation Reserve Program. He reported that grass seed production from buffer strips is a possibility (on land not in the CRP) and that strips represent an opportunity to develop or diversify wildlife habitat.

Missouri is using group planning with farm operators with highly erodible land to address planning requirements of the FSA. Primary systems such as strip cropping, contouring or terraces are compared to a list of rotations common to the county to provide as many alternatives as possible. Walker made a number of handouts available, including a handout on native grass contour buffer strips.

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NON-POINT POLLUTION CONTROL

Prepared Remarks of Larry B. Ferguson
Chief, Water Compliance Branch
U.S. Environmental Protection Agency Region VII

I appreciate the opportunity to discuss with everyone here the mutual problem of NPS Pollution and its control. The conference here is timely, as we probably can do more to control NPS (sediment particularly) with the management practices represented by the "C" factor than anything else. I'll first talk about the Water Quality Act of 1987, with the focusing point to be Non-Point Source Pollution Control. However, I must reiterate - this program (Water Quality Act of 1987) has a major focus on water quality as opposed to only soil erosion. We recognize soil erosion control has some water quality effects but water quality improvement is the main goal. This has some subtle and not so subtle effects, we will have to target dollars and resources and may be looking at flat lands and floodplains as well as slopes to find their total contribution of pollutants that cause the deterioration of Water Quality in surface water bodies and groundwater.

In the past there have been a number of programs and efforts to address NPS -- including 208, Clean Lakes, ACP, RCWP, and others. There have also been state dollars and efforts but none of those are quite as far reaching and comprehensive as called for in the --

WATER QUALITY ACT OF 1987

(SLIDE #1)

This act was actually passed three times. The last time it was passed by Congress over the President's veto on February 4, 1987.

° Section 319[1)]

This section deals with the management of NPS of pollution. There are two major activities under this section that we have to deal with by the [2)]deadline of August 4, 1988, the Assessment Report and the Management Plan. I'll go through each of these after I first say a little about the [3)]funding. $400 million over 4 years was authorized by this legislation for implementation. Appropriations are $0. There are, however, funds from other sources to carry out the development of the Assessment Report and Management Plan by the State's Water Quality Agency.

(SLIDE #2)

The Assessment Report has four requirements. They are:

1) Extent and effect
2) Cause
3) Process to ID BMP's
4) Listing of State Programs

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1) Bullet No. from slide

Under Extent and Effect we are to cover what waters are being impaired and how are they being impaired. What uses are being effected, are they in - Streams - Lakes - Groundwater - or Wetlands.

For Cause - we look at what category of NPS is causing the problem. Agriculture or urban runoff, is it mining or forestry or construction activities.

#3 is a process to ID BMP's. This should include intergovernmental coordination and public participation. This may be an area where a state should look at something other than just individual practices - possibly a collection of them, or as SCS calls it a RMS, Resource Management System. This certainly reflects on this workshop and the broad range of things that can be done within the thousands of alternatives covered by the management options of the "C" Factor.

And finally a listing of State programs. This is any program that is available or used in the specific state that can be utilized to address NPS causes of pollution - not just sediment pollution. It includes Local, State, and Federal programs to be used to implement the State NPS Management program.

(SLIDE #3)

The keys of State assessment are - it should have a 1) watershed orientation to defining problems. (This is not to be confused with the SCS PL-566 Watershed projects, however, the watershed boundaries could be the same.) 2) This assessment should also be based on available data, recognizing the timing of activities within the Act. It also asks that where insufficient data exists for a reliable assessment, that a strategy and timetable be developed for those watersheds to complete the assessments.

3) General Priorization - this is a general listing concerning NPS and the magnitude of problems that are to be addressed in the Management program. We envision a high - medium - low type of ranking that addresses the concerns of Water Quality Standards.

(SLIDE #4)

The State NPS Management Program. It is 1) due August 1, 1988 to EPA. It should reflect the 2) Watershed orientation from the Assessment Report and it covers the 3) proposed activities over the next four years. Along with this there must be a public notice and availability for reviews prior to submittal to EPA. We want strong public participation in the development of Management Programs; Conservation and Natural Resource Districts should have a major role in this. We expect some level of detail from the State Water Quality agency, but public input is essential for site specific watershed problems, information on critical areas, BMP's or RMS's to address them, and delivery mechanisms for the controls after the State identifies a critical watershed.

(SLIDE #5)

In State NPS Management Plan - there are six major components, or seven if you include the public participation aspects. They are:

- BMPs 1)
- NPS Control Programs 2)
- Implementation Schedule 3)
- Funding Sources 4)
- Certification of Legal Authority 5)
- Analysis of Federal Program Consistency 6)

I'll go through and explain each of these.

(SLIDE #6)

- Best Management Practices (BMPs)

This could be considered as a next level of specific detail after the State Management Plan. There should be a 1) general identification in Assessment Report of the BMP's or measures (RMS's) for the states to be used to reduce pollutant loadings by category (agriculture, urban, mining, runoff) and sub category (like row crop, pasture, forestry) or a particular nonpoint source identified and designated in the assessment. A State Management Plan could go so far as to target a specific MBP in a specific watershed. These practices can then be 2) refined in watershed plans and should take into account the 3) groundwater impacts of the various practices.

(SLIDE #7)

- NPS Control Programs

States must identify the regulatory and non-regulatory programs to assist in development and implementation of BMP's including: enforcement, technical assistance and financial assistance. However, they should also have 1) Watershed Specific Programs 2) targeted for implementation/ demonstration projects that 3) Develop farm-level NPS control plans. These would be similar to the plans developed for CRP on highly erodible land except that the NPS plans would also take into account agriculture chemical, pesticies and fertilizer management. We would like to see 100% coverage for critical areas - due to the short time frame (August 1988) we will be looking for a process to be identified to get these plans developed and ongoing. This is the who does what and when part of the NPS Program. Hopefully, though my present understanding of it is incomplete, these type of farm plans would be developed as Resources Management Systems that SCS has in its Field Office Technical Guide as opposed to the erosion control plans as is done in CRP planning. While it is difficult at best to measure short terms changes in Water Quality, 4) Monitoring and Evaluation Programs need to be incorporated into every watershed program so that changes in Water Quality can be documented. For some waterbodies (watersheds) or stream segments, measurements of biological productivity or indicator species may need to use computer modeling as a surrogate for monitoring data or to evaluate alternatives plans. 5) Funding and technical assistance. Funding, though authorized, is not appropriated. More on that a little later. Identification of lead and cooperating agencies should be done in the program development. Their responsibilities should be clearly identified and agreed to.

The NPS control programs should focus on small watersheds and groundwater areas. Examples of this are: a small lake watershed, a shallow aquifer area with nitrate problems or a high quality, high value, trout stream. The reason for this is one of timing. Our time frame to report to Congress is four years from August 4 of this year. We need to show results and successes. Therefore, we have to target those areas where we can show improvement. A general ranking scheme of High - Medium - Low will get things started, but we need to sort out those areas and projects that have a high implementability or high value/high impact areas where we ge the greatest bang for the buck.

(SLIDE #8)

Then there are NPS control program concerns that are not as focused, these are 1) General Programs that might cover a region of a state, a river basin or aquifer area or even the whole state with general concerns. They are 2) education and 3) training. If its really a problem or concern we will have to let the public know to get their response and approval (support) to pursue a Management program.

4) Technology Transfer will also play a part. In dealing with Water quality, we will be dealing with things more complex than just dirty water. What level of technology does it take to address the problem? This is especially true if we work with computer modelings for pesticides and nutrients. We'll have to utilize all sources of information, universities, USDA agencies, EPA and other governmental sources and private industry to be successful in this effort. It will require coordination and cooperation and everyone needs to be involved right on up to the landowner/operator. Since that is where the work is done, programs don't apply practices and management - people do.

(SLIDE #9)

Next this program should have an implementation schedule. It should have a 1) four-year layout of activities with the 2) identification of annual milestones to gauge the effectiveness of the program and allow for mid-course adjustments and corrections. Examples of these milestones include: anticipated improvements in water quality, water use or achievement or water quality standards; number and types of BMPs - Plans implemented or state programs established or NPS laws passed. The 4) projections of what a State plans to do is a milestone in the largest sense, this should not be just what the State Environmental agency plans to do, but should include other agencies as well. It should cover the proposed actions of all agencies (state and federal) that are involved.

(SLIDE #10)

- Funding Plan

1) Identify sources other than Section 319 (h) & (i) to carryout the State's NPS Management Plan in each of the 2) four fiscal years. We know there is a great deal of uncertainty in this area, but we ought to show expected 319 funds and any 3) matching non-federal funds as well.

319(h) is basic funding to carry out state management programs - this can include Groundwater concern - 400 m dollars are authorized, 70 m in '88, 100 m each in '88 and '90, 130 m for '91 - we can use 205(j) and 319(h) for implementation but need a 40% non-federal match and a minimum level of effort funding rate.

319(i) funds are specifically designated for groundwater concerns, not to exceed 7.5 m dollars/yr. If available, they can be used as a 50/50 match.

(SLIDE #11)

Certification of Legal Authority

This is a certification of adequacy of State laws. 1) An Attorney General statement that the laws of the state (or states) provide adequate authority to carry out the program. If not, a 2) listing of additional authority necessary and a 3) schedule to attain it expeditiously enough to allow implementation within the four-year management program.

(SLIDE #12)

The last of the six elements of the State NPS Management Program is Federal consistency. We expect the State to list and 1) review Federal assistance programs or Federal development projects for their consistency with it's Management program. This will provide the State with an important tool to assure that proposed Federal assistance and development projects are implemented in a manner that the State deems consistant with it's NPS Management Program.

(SLIDE #13)

Let's review a few things that I referred to earlier. Nonpoint Source, what it is? It's 1) not regulated under point source controls. It comes from 2) diffuse sources not from a point source like the end of a pipe and it is the 3) result of runoff percolation from the way we all manage our activities on the land. That is what you have been talking about here the last two days. NPS pollution is the footprint of all of our activities on the land, stamped on our Water Resources by the strength of millions of separate, private and public decisions. It is our society's problem and society's insitutions are going to have to work towards NPS solutions. I can't help but feel that understanding what the "C" factors means is for agriculture, one part of that solutions.

(SLIDE 14)

Priority setting and Targeting the job is one way to start. The job is too big to do in four years and we could never have that many dollars. This is what Congress has directed us to do.

(SLIDE 15)

Watershed Priorities - The 1) focus should be on small watersheds and groundwater areas from a Statewide perspective. We look for a 2) general ranking scheme coordinated on a watershed basis with the eye on the long term needs of the state. 3) High Value/High Impacts areas are key to showing success in the short timeframe. Additionally, program approaches should address non-agricultural NPS sources, construction erosin, urban stormwater runoff, developing areas, forestry and others.

(SLIDE 16)

In targeting there are four factors we will use. They are 1) most valuable water by use, watersheds where NPS cause the 2) worst environmental threat, public health risk or potential threat. Watersheds where NPS controls offer the 3) greatest benefits from control from 4) implementability, those watersheds where capable and cooperative groups and agencies are willing to proceed with NPS implementation.

To sum up Section 319 let me say that we have 2 ambitious congressional deadlines - 8/88 the Management Plan is due and then we have 4 years to control and show success. The content of the management plan is ambitious, there are lots of levels of details to cover. If it's to be worthwhile we need adequate input from all sources. We need to continue to build a dialog between Agriculture - conservation and environmental groups, we have to know where each other is going.

WATER QUALITY ACT 1987

- Section 319
- Deadline - August 4, 1987
  - Assessment Report
  - Management Plan
- Funding

ASSESSMENT REPORT

Four Requirements

- Extent and effect
- Cause
- Process to ID BMP's
- Listing of State Programs

KEYS OF STATE ASSESSMENT

- Watershed orientation
- Based on available data
- General Prioritization

STATE NPS MANAGEMENT PROGRAM

- Due August 1, 1988 to EPA
- Watershed Orientation from Assessment Report
- Proposed Activities over next 4 years

STATE NPS MGMT PLAN CONTENTS

- BMPs
- NPS Control Programs
- Implementation Schedule
- Funding Sources
- Certification of Legal Authority
- Analysis of Federal Program Consistency

BEST MANAGEMENT PRACTICES (BMPs)

- General ID in Assessment Report
- Refine in Watershed Plans
- Identify Source Category and GW Impacts

NPS CONTROL PROGRAMS

- Watershed Specific Programs
- Targeted for Implementation/Demonstration
- Develop Farm-Level NPS Control Plans
- Monitoring/Evaluation Programs
- Funding/Technical Assistance Sources

NPS CONTROL PROGRAMS

- General Programs
- Education
- Training
- Technology Transfer

IMPLEMENTATION SCHEDULE

- Four-year Layout of Activities
- Identification of Annual Milestones
- Projection of what State plans to do

FUNDING PLAN

- Identify Sources other than Sect. 319
- Four-year Schedule
- Matching Sources

CERTIFICATION OF LEGAL AUTHORITY

- Attorney General Statement
- Listing of Any Additional Authority Needed
- Schedule to Obtain Authority

FEDERAL CONSISTENCY

- State Reviews Federal Assistance Programs
- Comment on NPS Program Impacts
- Federal Agencies have to Consider Comments

NONPOINT SOURCE

- Not Regulated Under Point Source Controls
- Diffuse Sources
- Result of Runoff or Percolation

PRIORITY

TARGETING

WATERSHED PRIORITIES

- Focus on Small Watersheds and GW Areas
- General Ranking Scheme
- High Value/High Impact Areas

TARGETING

- Most Valuable Water uses
- Worst environmental threat
- Greatest benefits from control
- Implementability

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TILLAGE AND CROP AND COVER MANAGEMENT UNDER THE FOOD SECURITY ACT

Summarized from the remarks of Paul Smith, Resource Conservationist,
SCS Nebraska State Office (Group Facilitator)

Smith reported that the group had considered sixteen major concerns and problems with tillage and crop and cover management under the Food Security Act. These included:

(1) There is a concern over the cost of machinery needed in order to change management practices.

(2) A more careful analysis is needed of what land should be planted. Many farmers are continuing to plant marginal land. The Conservation Reserve Program needs to be considered as an alternative.

(3) There is a concern over use of the "C" factor tables. The figures used in the Tech guides are average annual figures, but the figure that should be used can change with the time of the year.

(4) There is a question on definitions used in "C" factor charts and how they should be used.

(5) There are concerns about how plans calling for residue or rotation would be enforced. Smith said that farmers would need to state whether they are in compliance when they sign their ASCS forms. ASCS would later conduct a 15% spot check.

(6) Concern was expressed about maintenance of practices. It was noted that wording on maintenance was being added to Food Security Act conservation plans and that lack of maintenance could constitute a violation in a spot check.

(7) There is concern that the plans be dynamic and subject to change. Technological changes and changes in formulas could result in additional work for conservation personnel.

(8) A major concern is what an individual should do if his whole farm is highly erodible. There was concern over whether such individuals could afford to comply, especially with structural measures. It was noted that alternative conservation systems could allow a higher "T" level on a county by county basis. It was also stated that crop residues are the most economical treatment if they will do the job.

(9) There is concern that not everyone can take advantage of the Conservation Reserve Program because of the value of their land. Another problem is that five counties have reached their limit on Conservation Reserve Program signups.

(10) It was mentioned that there may need to be changes to give ridge till more credit in the formulation of the "C" factor.

(11) Concern was expressed that the farmer and SCS may not agree on the percent of cover there is on the field. This was seen as a communication problem. The technician would need to survey the field with the farmer and tape in hand.

(12) There are concerns about the uniformity of "R" factors across county lines. It was mentioned that the training and appeal processes may help mitigate this problem.

(13) Residue requirements for compliance could result in a harsh penalty for the farmer. If a farmer is required to have 60% residue and has only 50% he could lose his program benefits. However, five year rotations could help to overcome problems if limits are exceeded in only one year.

(14) There are some concerns about whether more highly erodible land would be converted to crops when the Conservation Reserve Program ended after ten years. It was pointed out that a new call would need to be made on that land and that if it is highly erodible the landowner would still have to comply unless the law changes.

(15) One participant questioned whether any credit should be given in "C" factors for "deep ripping." It was pointed out that it is a high energy cost practice that is probably not economically feasible. Research has not yet proved that it significantly changes the penetration of water.

(16) A final concern is how the Food Security Act requirements for tillage or cropping requirements might conflict with the ACR annual program. The answer is that whichever is most restrictive in cover requirements would need to be followed.

"THE WHYS AND WHEREFORES OF THE UNIVERSAL SOIL LOSS EQUATION -- HOW MUCH FLEXIBILITY SHOULD THE CONSERVATION TECHNICIAN HAVE?"

Summarized from the Remarks of Ernie Hintz, Agronomist, SCS,
Midwest National Technical Center (Group Facilitator)

Hintz reported that the group decided it was necessary to utilize definitions in determining the USLE. However, anytime the aid of a definition is needed some accuracy or credibility is lost.

The group came to the conclusion that it had very little opportunity to vary the "R" value or erosivity value of water erosion. Hintz said that the "K" value, or the erodibility, is the other side of the erosion process. There is opportunity to make variation in the "K" value, but in the midwest most of those values are given. This is not the case in the northwest or some of the western parts of the country. But he noted that here the "R" and "K" values are fairly well set and as a result there was not a great deal of good discussion of them.

However, he felt that dealing with the "L" and "S" factors was a completely different story. He said there have always been problems in dealing with the "L". He suggested the audience remember that the model predicts erosion off a slope, not off a field. This is where judgement and variations originate in most cases. He said that a major question is what slope length and what percent slope are we going to let represent that field.

He noted that another problem has been determining the point where concentrated flow begins because that is a point where slope length ends and thus can help determine length of slope. He said the group came to the conclusion that in many cases there is a tendency more to overestimate slope lengths than to underestimate.

Hintz noted that slope length has much less effect on the end result than slope steepness and that the equation has been simplified to assume there is no variation in slope. He said those utilizing the system should realize that where there is a convex slope erosion is being underestimated and where there is a concave slope it is being overestimated. He stated that there is considerable flexibility in using the "L" and "S" factors and that we need to understand what happens when we use that flexibility.

Hintz noted that there had been previous mention of factors which showed there is leeway and flexibility in working with "C" factors. He said that in addition to management and cover we need to examine the amount of erosivity that occurs during those periods of time when we are looking at how erodible conditions are in the field. He noted that SCS policy makers have been satisfied to use an average when looking at statewide conditions.

Hintz noted that he had an opportunity to calculate "C" values. He said that after meeting with the Extension Service, SCS and the Agricultural Research Service they had agreed upon the dates they were going to use and looked at some of the values statewide. They examined when corn was planted in the state over a 5-year period, then used that to select the date for corn planting in the state. They had many producers planting corn two weeks earlier and many producers planting corn two weeks later. Hintz said that meant they had a month period during which planting can vary, but they had agreed to accept that level of accuracy. He felt that in a site specific case they had the opportunity to use the USLE more specifically but that in very few cases had they selected to do so. He said they had probably had more opportunities to vary in using the USLE than they had manpower to utilize.

Hintz reported that up to this time there had been quite a chance to be flexible in use of the "P" factor; perhaps sometimes to the point of misuse. He summarized that the discussion showed little opportunity to manipulate the "R" and "K" values, but more opportunity to be flexible with the rest of the values. This greater level of flexibility applies especially to the "P" value and relatively less to the "C" value.

"CURRENT RESEARCH AND ITS POTENTIAL IMPACT ON THE UNIVERSAL SOIL LOSS EQUATION"

Summarized from the remarks of Lloyd Mielke, Soil Scientist, Agricultural Research Service (Group Facilitator)

Mielke reported that his group almost immediately decided there wasn't any research need in the USLE arena. They then began other discussions on research.

He stated that August of 1989 is to be the introduction of the Water Erosion Prediction Project (WEPP) generation of the erosion prediction effort. The discussion indicated that in the following years there will probably be a considerable amount of readjustment of WEPP and the equations being tested. He said one comment was made that the test of worth will probably come through the court system. Another point was that other professionals such as geologists, civil engineers, and various levels of resource management specialists need to be included and informed how the tool will be used. It was also mentioned that an educational program for WEPP would need to be coordinated among all the agencies.

Mielke reported that three research needs that were identified. It was mentioned that tilth needs to be related to measurable parameters. A second need concerned information on the impact of erosion on the farm field and spatial variability and what that may mean in terms of yield performance relative to landscape position. A third item mentioned was that standardized procedures for sampling and standardized procedural methods to carry out research are needed so that data from different resource areas can be compared.

A further item of discussion was the prospect of decreased future federal funding. Cooperative efforts and competitive grants were seen as potential sources of future funding. Mielke said that the discussion brought out that erosion probably isn't one of the high items on the current list of funding priorities. It was mentioned that sometimes opponents say, "Well, you've been working on it, and working on it and working on it. After 50 years if you haven't gotten it solved, maybe there is something wrong." Mielke stated that the current competition for funds is with water quality concerns.

Mielke reported that a better data base is needed. He said that it may be more difficult to manage a data base and keep it in good repair than it is to build one. He noted that the National Soil Survey Data Base was developed over the last 30 years, mainly to support the soil survey program. He stated that it generally takes a great deal of time to clean it up and get it in the form you need it if you are using it for different projects. However, a concerted effort is now being made to make the base more usable and that may be a factor in the soils portion of WEPP after it is implemented. Mielke said that his notes stress the need for consistency and that WEPP might provide a guideline to help create that consistency.

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