

Soybean Management & The Land

A Best Management Practices Handbook For Growers



A Best Management Practices Handbook For Growers



Farming is a competitive business, and to stay competitive you have to maintain that necessary balance between productivity and protecting the natural resources that sustain your operation.

To help bring you the benefits of that balance, the American Soybean Association (ASA) presents the Best Management Practices Handbook. This publication offers you a unique workbook/resource book system that shows you how to take a close look at your operation, select the appropriate best management practices (BMPs), set practical and economical goals, and develop a comprehensive action plan.

Here's how the system works...

Your copy of the handbook includes both a workbook and a resource book. The workbook has three chapters. Chapter 1, *Farm Inventory and Assessment*, features worksheets that help you rate different situations and conditions on your farm. Each worksheet is color-coded to match a corresponding color-coded solution in the resource book. Here's an example of how the workbook and resource book work together.

The next chapter, *Developing and Defining Goals*, is a survey that you'll use to outline your long-term and short-term goals.

In the final chapter, *Examining Problems and Determining Priorities — Developing an Action Plan*, you'll use the worksheets that you completed in the previous chapters, plus the resource book's practice descriptions, to develop an action plan that states your goals and concerns, and how and when you will address them.

The resource book, *Developing Alternatives — Examining Best Management Practices*, identifies common BMPs used in soybean production. As you read the descriptions of each practice, you'll gather information about the practices, their relative costs and site suitability, as well as their benefits and shortcomings. The Resource Book also includes an *Insects, Weeds and Diseases Identification Guide* that features pictures and symptom descriptions to help you identify pests common to soybean production.

Resource Book

Featured: Petroleum Product Storage

Petroleum Containment: properly storing petroleum products, such as diesel fuel and gasoline, on the farm.

What You Will Learn:

- How to determine if you need containment.
- How to determine the size of the containment area.
- How to determine the type of containment system to use.
- How to determine the location of the containment system.
- How to determine the materials to use for the containment system.
- How to determine the construction of the containment system.
- How to determine the maintenance of the containment system.

What You Will Need:

- 1. A copy of the Best Management Practices Handbook.
- 2. A copy of the Petroleum Product Storage worksheet.
- 3. A copy of the Petroleum Product Storage resource book.

What You Will Do:

1. Determine if you need containment.
2. Determine the size of the containment area.
3. Determine the type of containment system to use.
4. Determine the location of the containment system.
5. Determine the materials to use for the containment system.
6. Determine the construction of the containment system.
7. Determine the maintenance of the containment system.

What You Will Get:

- 1. A completed worksheet.
- 2. A completed resource book.

Workbook

Petroleum Product Storage

Step	What to Do	How to Do It	When to Do It	How Often	Who	Cost	Notes
1	Determine if you need containment.	See the worksheet for more information.	At the time of the assessment.	Once.	Grower.	None.	
2	Determine the size of the containment area.	See the worksheet for more information.	At the time of the assessment.	Once.	Grower.	None.	
3	Determine the type of containment system to use.	See the worksheet for more information.	At the time of the assessment.	Once.	Grower.	None.	
4	Determine the location of the containment system.	See the worksheet for more information.	At the time of the assessment.	Once.	Grower.	None.	
5	Determine the materials to use for the containment system.	See the worksheet for more information.	At the time of the assessment.	Once.	Grower.	None.	
6	Determine the construction of the containment system.	See the worksheet for more information.	At the time of the assessment.	Once.	Grower.	None.	
7	Determine the maintenance of the containment system.	See the worksheet for more information.	At the time of the assessment.	Once.	Grower.	None.	



Dear Friends:

Environmental Profitability. Not two words you usually find linked together. But in today's business world, respect for the environment, sound management, and profitability must be linked. Global competition requires U.S. soybean farmers to be the most efficient producers in the world. At the same time, our environmental challenges are mounting—a growing call from rural and urban Americans for cleaner water, cleaner air, wildlife protection, and improved soil conservation. Finding profitable environmental solutions is our only course for balancing the competing demands of today's industry.

Finding profitable environmental solutions is what the American Soybean Association's *Soybean Management and the Land: A Best Management Practices Handbook for Growers* is all about. Working with farmers, government, private industry, scientists, and conservationists, ASA has put together a Handbook that can help you face tomorrow's environmental challenges. The self-assessment portion of the Handbook identifies potential problems before they become problems. The resource guide provides answers and examples of the most practical, economical, and environmentally sound ways to improve your environmental management. The entire workbook echoes Ben Franklin's principle "an ounce of prevention is worth a pound of cure."

The Best Management Practices Handbook is a collaborative partnership of the ASA and the USDA's Natural Resources Conservation Service. The program was developed through initial support from the Shared Solutions Program of the Philip Morris Family of Companies. The program became a reality through generous sponsorship from the Monsanto Company and reflects Monsanto's commitment to sustainable agricultural practices. ASA also wishes to acknowledge a grant from National Fish & Wildlife Foundation. With the investment from NFWF, we will begin our producer outreach and education program. As partners, it is time to take a proactive step toward documenting that farmers are good stewards of our natural resources.

The American Soybean Association is proud to provide this Best Management Practices Handbook to our Soybean Association Members. Our organization's mission is to improve soybean farmers' profitability. Our hope is that you will find this Handbook useful in implementing cost-effective environmental solutions for your farm. Care and respect for our land, air, and water have been a tradition in the U.S. soybean industry. Environmental profitability must be the new tradition that we build if we are to meet the food and environmental needs of our new global community.

Sincerely,

A handwritten signature in black ink, appearing to read "Stephen L. Censky", written over a horizontal line.

Stephen L. Censky
Chief Executive Officer

Resource Book

Farmstead



Cropland



Pastureland & Other Areas



The Resource Book within this handbook, *Developing Alternatives — Examining Best Management Practices* summarizes many conservation measures or best management practices used in soybean production. The best management practices featured in this handbook have been proven in research and tested through farmer implementation. While the practice list in this handbook is extensive, it is not complete. Use this chapter as a starting point to find best management practices that may best suit your needs. Keep in mind, however, that a practice that may work in Iowa may not work in South Carolina. The same holds true for adjacent farms.

To assist you in completing Chapter 3's *Action Plan*, each practice will be pictured, with a corresponding description of its purpose, relative costs, and farmer testimony telling its benefits and shortcomings. While designed to be informative and to show alternatives, the Resource Book cannot replace personalized in-depth assistance that you may receive from your local USDA Natural Resources Conservation Service (NRCS), Conservation District, or Cooperative Extension offices.

In addition to featuring practices, this Resource Book also includes an *Insects, Weeds and Diseases Identification Guide* that includes pictures and symptom descriptions to help you identify pests common to soybean production.



A large majority of farmers have always been, and will continue to be proactive in protecting their natural resources. From terraces that were installed in the 60s to new state-of-the-art agrichemical handling facilities, farmers are leading the way in providing an abundant food supply and a quality environment. After all, farmers have the most to lose if they don't protect the soil, water, plants, air, and animals that surround them. To farmers, these resources are not only a livelihood, but a way of life. No one wants a polluted stream running by their home, especially farmers who use it to water their livestock, irrigate their fields, and supply water to their families. Farmers, more than anyone else, see that protected natural resources translate into profits and overall well-being for themselves, their family, and the environment.

That is the reason ASA created this Handbook and that is the reason why so many have dedicated their time and efforts to make this a useful tool for managing natural resources. We would first like to thank all the farmers interviewed, who were so helpful in providing comments, reviewing text, or giving a tour of their farm. Secondly, this book would not have been possible without the help of so many experts from the Natural Resources Conservation Service (NRCS), Cooperative State Research Education and Extension Service (CSREES), universities, non-profit organizations, private consultants, and many others. Countless hours were spent by many editing the document, ensuring technical accuracy, and providing photographic images. We hope you enjoy this book as much as we have enjoyed writing it.

Sincerely,

Denise Coleman
Editor-in-Chief

Krysta Harden
ASA Environmental Specialist

Very Special Thanks To:

Roy Bardole, Rippey, IA
Lynn Betts, Communications Director, NRCS, IA
Tom Buman, Agren Inc., Carroll, IA
Steve Censky, CEO, American Soybean Association, MO
Dr. Gary Clark, Kansas State University, KS
Molly Cline, Director of Food Industry Relations, Monsanto Company, MO
Marc Curtis, Leland, MS
Dennis DeFrancesco, Soil Scientist, NRCS, SC
Mitch Flanagan, Resource Conservatonist, NRCS, NHQ
Gerald Gogan, Farmland Industries, Kansas City, MO
Doug Knox, National NRCS Farm*A*Syst/Home*A*Syst Coordinator, WI
Rebecca Lafferty, State Executive Director, South Dakota Soybean Association, SD
Gary Margheim, Special Assistant to the Chief, NRCS, NHQ
Ron Marlow, National Water Mgt. Engineer, NRCS, NHQ
Seth Naeve, Extension Soybean Agronomist, University of Minnesota, MN
Margaret Owens, State Executive Director, South Carolina Soybean Association, SC
Pearlie Reed, Chief, NRCS, NHQ
Dr. Harold Rudy, Program Division Manager, Ontario Environmental Farm Plan, Toronto, Ontario
Katherine Trent, Shared Solutions, Richmond, VA
Tom Verry, Missouri Soybean Association, MO

Special Thanks To:

James Lee Adams, Jr., Camilla, GA
Jeff Anliker, NRCS, MA
Mary Jo Armstrong, NRCS, NHQ
Dr. Lanny Ashlock, University of Arkansas, AR
Joe Bagdon, NRCS, MA
Dr. Wayne Bailey, University of Missouri, MO
Mark Berg, Tripp, SD
Tim Brackman, American Soybean Association, MO
Darrell Brown, NRCS, IN
Sharon Buck, Environmental Protection Agency, NHQ
Cara L. Clark, NRCS, IL
Karen Cummings, American Phytopathological Society, St. Paul, MN
Dr. George F. Czapan, University of Illinois, IL
Charles Davenport, Greenville, NC
Dr. Dan Devlin, Kansas State University, KS
John Dotson, Halls, TN
Brent L. Dykes, Georgia Soil and Water Conservation Commission, GA
Anson Eaglin, OC, USDA, DC
David Erickson, Altona, IL
Anthony Esser NRCS, NY
Richard Faught, Armenia, ND
Brad Fisher, NRCS, NHQ
Darrel W. Forkrud, Cenex/Land O'Lakes Agronomy Company, MN
Barry Frantz, NRCS, PA
John Greene, Agri-Growth, Hollandale, MN
Gary Gross, NRCS, NHQ

Gary Jackson, Corlees, WI
Fred Jacobs, NRCS, NHQ
Floyd D. Gaibler, Agricultural Retailers Association, NH
John Gordley, Gordley Associates, DC
Bob Gulsvig, North Dakota Soybean Association, ND
Doug Hartz, Stuttgart, AR
Tom Hebert, Capitolink, DC
Bryan Hieser, Minier, IL
Dr. Leon Higley, University of Nebraska, NE
William Hughey, NRCS, NHQ
Jim Jarman, University Extension Center, MO
Lee Jenkins, University of Missouri, MO
Jim Kalisch, University of Nebraska, NE
Roger Kanable, NRCS, NE
Dave Keith, University of Nebraska, NE
Barry Kintzer, NRCS, NHQ
Chad Kleppe, Iowa Soybean Association, IA
Mike Kucera, NRCS, NE
John Laggeman, Deere Harvester Works, IL
Charles Lander, NRCS, NHQ
Ron Lauster, NRCS, IN
Cherie Lawrence, American Soybean Association, MO
Doug Lindgren, Perry, IA
Dale R. Ludwig, Missouri Soybean Association, MO
John Lumpe, Ohio Soybean Association, OH
Denise McWilliams, North Dakota State University, ND
Theresa Miller, Illinois Soybean Program Operating Board, IL
Tim Miller, University of Nebraska, NE
Russ Mills, FAPRI, University of Missouri, MO
Sarah Minor, NRCS, MO
Rick Mongler, NRCS, MO
Dennis Morrice, Kansas Soybean Association, KS
Gary Nordstrom, NRCS, NHQ
Chris Novak, American Soybean Association, MO
Lonzell Offutt, NRCS, NHQ
Charlie Rewa, Paxtuxent Nelson Lab, MD
Rebecca Richardson, Illinois Soybean Program Operating Board, IL
Jim Sallstrom, Winthrop, MN
Dave Schertz, NRCS, NHQ
Beth Schuler, NRCS, NHQ
Donald L. Schuster, NRCS, MO
Ward Shaw, Chadbourn, NC
Dr Phillip E. Sloderbeck, Cooperative Extension Service, KS
Ben Smallwood, NRCS, NHQ
Mary Sobba, University Extension Service, MO
Barb Stewart, NRCS, IA
Neil Strong, Novartis, IL
Tom Van Arsdall, National Council of Farmer Cooperatives, NHQ
Bart Waller, Cloy, GA
Claudine Wargel, Consultant, IL
Mark Werth, Illinois Dept. of Agriculture, IL
Gene Whittaker, National Wetlands Conservation Alliance, DC
Gerry Whitty, Morgan & Meyers Inc. for Soybean Cyst Nematode Coalition, WI
Bruce Wight, National Agroforestry Center, NE
Bill Wiley, Lyndon, KS
Jesse Wilson, NRCS, FL
Mike Yost, Murdock, MN
Steve Young, Missouri Fish and Wildlife, MO
Mike Youngerberger, Minnesota Soybean Growers Association, MN

Farmstead	2
Well Protection	2
Pesticide and Fertilizer Loading Facility	4
Petroleum Containment	6
Hazardous Waste Containment	8
Cropland	
Nutrient Management	10
<i>Cropland Pest Management</i>	
Integrated Pest Management	12
Field Scouting	14
Recordkeeping	16
Variety Selection	18
<i>Decisions Related to Pesticide Application</i>	
Pesticide Selection and Rate	20
Sprayer Maintenance and Calibration	22
<i>Cropland Water Management and Land Use</i>	
Cropland Soil Quality	
Soil Sampling	24
Cropland Soils	
Underground Outlet	26
Chiseling and Subsoiling	28
Crop Rotation	30
Conservation Cover Crops	32
Contour Farming	34
Contour Buffer Strips	36
Subsurface Drainage	38
Terrace	40
Diversion	42
Contour Stripcropping	44
Irrigation Water Management	46
Furrow Irrigation	48
Sprinkle Irrigation	50
Subsurface Drip Irrigation	52
Conservation Tillage	54
No-till Planting	56
Strip Tillage	58
Ridge Tillage	60
Mulch Tillage	62
Pastureland and Other Areas	
Filter Strips	64
Windbreak/Shelterbelt Establishment	66
Riparian Forest Buffer	68
Wetland Enhancement or Construction	70
Grassed Waterway	72
Insects, Weeds and Diseases Identification Guide	
Insect Identification	74
Weed Identification	78
Disease Identification	82

Well Protection: *protecting the area surrounding a well.*



Photo courtesy of USDA-NRCS,

“**A**t one time, there were a large number of glass companies in this area. They came here because of the abundance of natural gas. When the natural gas supply diminished, the glass companies left and this area was left with a lot of abandoned gas wells,” says Jim Kline from east central Indiana. Jim, a resident of Hartford City, Indiana, farms approximately 5,000 acres of corn and soybeans. On several of his farms that he rents, there were abandoned gas and water wells. To protect the nearby water quality, Jim decommissioned these abandoned wells. He did this by cutting the pipes off below the ground surface so that his implements would not hit the casings; installing a basket on top of the casing; and then filling the basket with concrete. According to Jim, the entire job was relatively inexpensive and worth the investment:

“While the contractor was here on other projects, we capped and decommissioned these abandoned wells. Fifty dollars and an hour of work gave me peace of mind that chemicals, soil, and other debris would not enter the water supply.”

Aside from decommissioning abandoned wells, Jim has also protected his ground water supply by locating his pesticide and petroleum facilities away from his farmstead’s well. Jim remarks:

“Twenty years ago, the pesticide storage facility was next to the well house. To protect our farmstead well water, I relocated the pesticide storage facility 150 feet away from the well house and ensured that the concrete floor of the facility was poured in one piece. This allowed for easy cleanup of any spill and prevented any pesticide infiltration into the soil.”

Jim also is in the planning stage of constructing a petroleum containment facility. He has acquired plans for the petroleum containment facility from Purdue University. Currently, the facility is 100 feet away from the farmstead’s well, but in the future he plans to install dikes around the facility to prevent any vehicle or implement collisions that may cause leaks.



What It Does:

- Use common sense when locating a well and mixing farm chemicals and fertilizers, such as:
 - Maintaining at least 100 feet from the well and any water bodies when mixing chemicals and rinsing containers.
 - Keeping fill hoses out of any spray mix tank.
 - Using anti-backflow devices like check valves to prevent chemicals from entering the well.
 - Not storing chemicals in a well house.
 - Disposing of empty chemical containers according to labels and state regulations.
- Capping a well in order to prevent debris from entering active or abandoned wells and to eliminate the hazard of an open hole to people, animals, and farm machinery.
- Ensuring that the well casing and cap are tightly secured with no holes or cracks.
- Keeping the top of your well at least one foot above the ground.
- Sloping the ground away from your well for proper drainage.

Did You Know?

If you fear that your well may be contaminated, water testing is key. The statements below may assist you in protecting your water supply.

- Well water should be aesthetically pleasing, which means it should be free from objectionable odor, taste, or color.
- Many kinds of water testing treatments are available and some are relatively inexpensive. A complete bacterial and chemical water quality analysis shows the following:
 - possible contaminants, such as bacteria and ammonia from sewage,
 - chlorides from sea water intrusion, and arsenic and uranium from natural minerals,
 - an assortment of potential aesthetic problems such as hardness or staining,
 - a comparison to state and national drinking water standards, and
 - validation of the accuracy of the analysis.

• Most testing laboratories or services supply their own sample containers. Use the containers provided and carefully follow the instructions given for collecting, preserving and handling water samples.

- Samples should be taken from the cold water tap closest to the water storage tank after the system has been purged of the water in storage, so that the water is obtained directly from the well.
- It is important that care must be taken to minimize the amount of gas that will escape into the air during the sampling process.
- Laboratory analysis should be completed within 48 hours of the time the sample is drawn.

Compatible Practices:

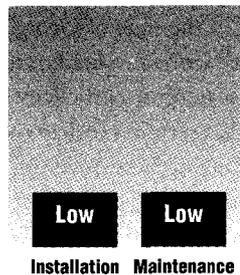
Well protection is compatible with:

- Integrated Pest Management
- Pesticide and Fertilizer Loading Facility
- Petroleum Containment Facility
- Hazardous Waste Containment

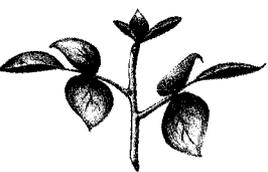
Maintenance:

- Repair the wellhead casing and vent screens as needed.
- Maintain filter strips around the well.
- Repair any cracks in concrete pads used for chemical mixing, loading, container washing, or petroleum containment so that hazardous chemicals and gas do not enter water supply.
- Keep snow, leaves, and other materials away from your well.

Relative Cost:



If all the earth's water fit in a gallon, available fresh water would equal just over a tablespoon. - *Farming for Clean Water in South Carolina*



Pesticide and Fertilizer Loading Facility: *storing, mixing, and loading sprayer tanks in a special location designed to protect farmer safety and water quality.*

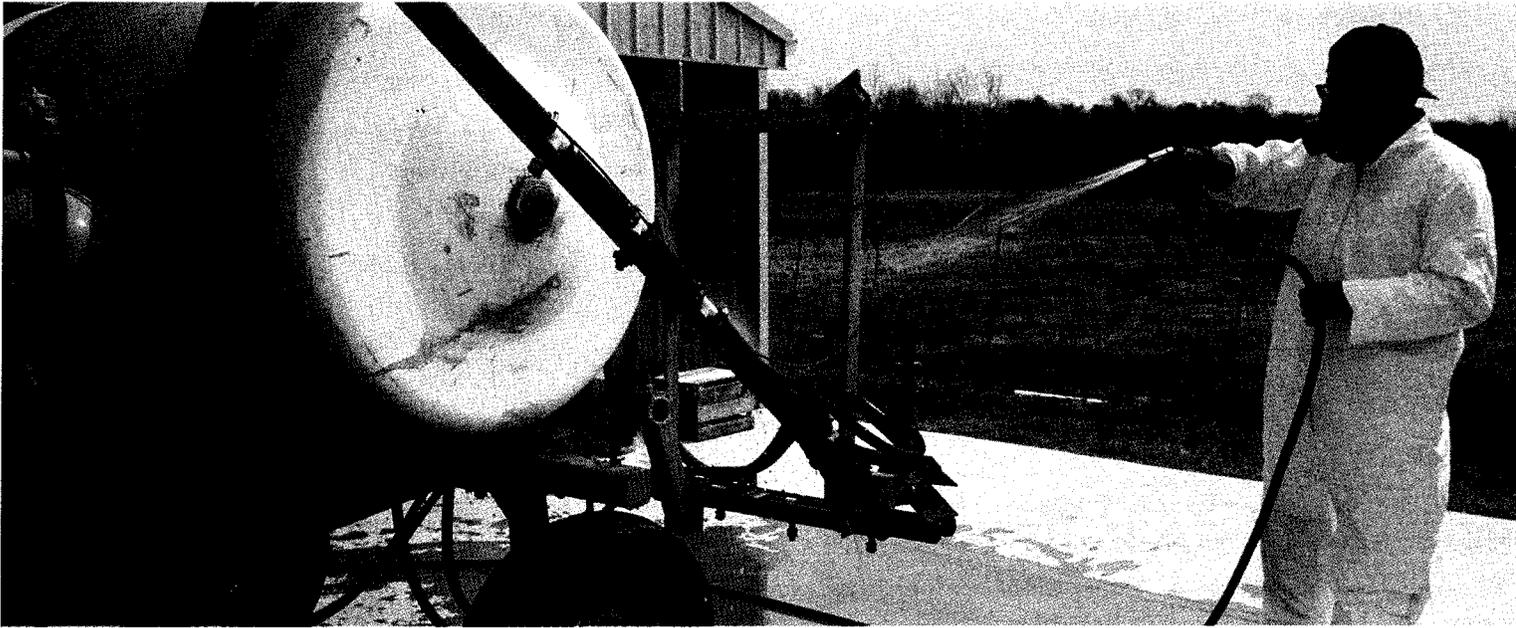


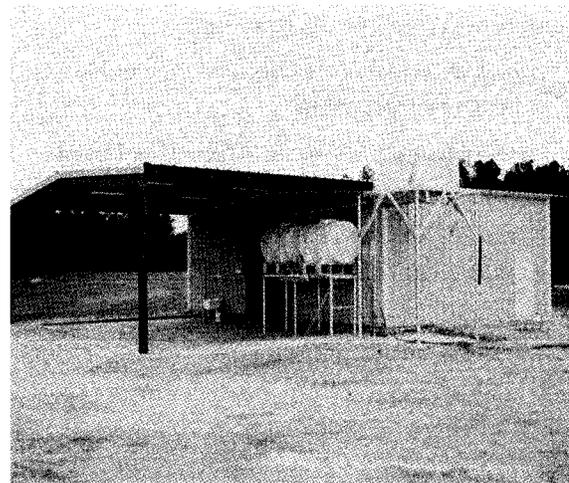
Photo courtesy of USDA

“It’s the prototype for the Southeast,” says Brent Dykes of the Georgia Soil and Water Conservation Commission. “Danny Hogan’s pesticide facility is the model for many of the pesticide facilities that will be constructed in the state of Georgia over the next few years.” Originally, Danny Hogan of Dexter, Georgia wanted a storage facility for his pesticides, but after seeing some orchard multi-purpose agri-chemical facilities in North Carolina, Danny decided to install a facility that served a variety of functions for a variety of crops. Danny raises a mixture of crops, ranging from soybeans and peanuts to cotton, corn and wheat. Designed to both safely store an assortment of chemicals and act as loading facility, the facility will not only contain a spill of 3,740 gallons, but will also fill his 1,100 gallon nurse tank in 15 minutes.

Measuring a total of 50 feet x 40 feet, the facility is divided in half, one side for mixing and one side for storage. The mixing facility accommodates Danny’s 60-foot sprayer booms. With 1,100 gallon water tank located 14 feet above the ground, Danny is able to supply water to his tanks by using a gravity flow system. “What used to take 50 minutes, now takes me 15 minutes,” says Danny. For pollution control, the curbing around the facility contains spills, while the sump traps all chemicals and water that flow from the slanted concrete floor. The sump contents are then transported to the rinsate tanks using a portable pump. To prevent groundwater contamination, an impermeable membrane was placed under the 5,000 psi concrete floor which spans the entire facility. Safety features, including safety signs, eyewash and shower stations, and fire extinguishers are located throughout the facility.

The total cost for the facility, excluding labor costs, was \$31,545, with \$20,000 of this amount covered by Georgia’s Conservation Commission Best Management Practices Demonstration Project. To reduce his out-of-pocket expenses, Danny and his workers constructed much of the facility themselves.

“Deciding to build a facility like this is not something that I would do without a lot of planning, advice, and knowledge. It’s expensive, but I’m ahead of the game. This facility will meet state regulations well into the 21st century.”



Danny Hogan’s pesticide facility located in Dexter, Georgia

What It Does:

- Protects water quality by containing spills.
- Reduces the chances of fish kills, animal poisoning, and groundwater contamination.
- Provides a safe place to store, mix and load chemicals.
- Speeds your operations during rush periods by quickly loading the proper chemicals, if properly designed.

Did You Know?

- Cleaning of containers or mixing of chemicals should occur at least 100 feet from wells, streams, lakes or ponds, wetlands, sinkholes, and field tile lines. Avoid locating facility in a flood plain.
- All incoming runoff should be diverted from the facility.
- An adequate pesticide and fertilizer loading facility should contain:
 - An emergency shower and eye wash area.
 - Your state's poison control center's number and an approved emergency spill plan. (If you do not have an approved emergency plan, contact your State Department of Agriculture or Cooperative Extension Office for more information.)
 - Material safety data sheets and pesticide labels.

Regional Differences:

Pesticide and fertilizer loading facilities work in all areas of the country, where these products are used. Contact your local conservation district or Extension agent for state-specific requirements.

Compatible Practices:

Pesticide and fertilizer loading facility works best with:

- Integrated Pest Management
- Well Protection
- Diversion
- Hazardous Waste Containment
- Nutrient Management
- Recordkeeping
- Sprayer Maintenance and Calibration
- Pesticide Selection and Rate

Maintenance:

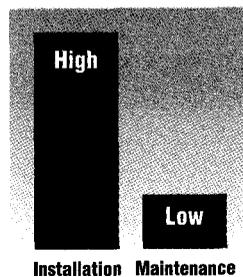
- Use the least amount of rinse water to wash down the mixing and loading pads. When handling rinse water, treat it with the same precautions as the undiluted product.
- Recycle rinse water whenever possible.
- Keep chemicals to a minimum over the winter.
- Lock up chemicals and fertilizers when they are not in use.
- Maintain and update your emergency response plan as needed.

For Your Safety:

Wear protective clothing as required by the pesticide label direction. When cleaning equipment and rinsing containers, you should wear:

- Long pants and sleeves,
- Chemical resistant shoes, apron, rubber gloves,
- Chemical resistant eye and face shields, and a
- Respirator.

Relative Cost:



Eight essential amino acids are found in soybeans that are necessary for human nutrition and that are not produced naturally in the body.

Petroleum Containment: *properly storing petroleum products, such as diesel fuel and gasoline, on the farm.*



Photo courtesy of USDA-NRCS, F

After talking to several individuals from various farm associations, Greg Leonard of Afton, Oklahoma decided to install a petroleum containment facility on his farm. "I wanted to be environmentally proactive," says Greg.

"Many individuals in Oklahoma predict that future Oklahoma State laws will require farmers to install an approved facility if they store over 1,000 gallons of petroleum. I wanted to be ahead of any future regulations."

Designed to accommodate 2,000 gallons of diesel fuel, Greg's facility consists of a concrete pad approximately 15 feet x 14 feet in size. Despite the fact that this facility is located over 300 yards from his well, Greg poured the pad, then the stem walls, and sealed the concrete using an impermeable concrete sealer in order to prevent possible soil and groundwater contamination. The walls of the facility are three feet in height to avoid any equipment collision with the tanks, while the exterior sides of the tanks are protected from damage by installing the pump on the top of the tank. Electrical cables buried underground in conduit further decrease the number of gaps and seams in the structure and decrease collision chances.

Greg claims there is little maintenance with the new facility, although he plans to continue to paint his steel tanks every five years to avoid any rust. As an extra measure, he has also installed white, crushed limestone around the perimeter of the facility to prevent grass encroachment.



Greg Leonard, shown with his two children Kody and Katie, constructs a petroleum containment facility to "stay ahead" of state regulations.

What It Does:

- Protects water quality by containing spills.
- Reduces the chances of fish kills, animal poisoning, and groundwater contamination.
- Provides a safe place to store diesel and gasoline.
- Speeds your operations during rush periods by quickly loading the proper chemicals, if properly designed.
- Avoids possible explosions by containing gasoline and diesel within secured, impermeable areas.

Did You Know?

- Fuel pumps should be located on concrete or asphalt surfaces.
- Automatic shutoff mechanisms reduce the chances of overflow and spillage.
- Petroleum containment should be at least 100 feet from stream and wetlands, and at least 50 feet from other buildings in the case of a fire or explosion.
- Roofing is a good practice no matter what the size of the facility.
- Fencing should be installed around the perimeter to avoid damage from vehicles.

Regional Differences:

Petroleum containment facilities can be used in all areas of the country.

Compatible Practices:

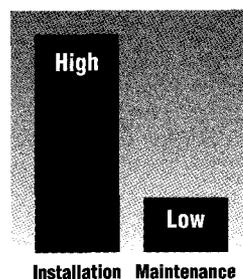
Petroleum containment works best with:

- Well Protection
- Hazardous Waste Containment
- Recordkeeping
- Filter Strips

Maintenance:

- Keep storage facility locked and materials out of children's reach.
- Identify the storage cabinet with a sign that indicates materials are hazardous.
- Check containers monthly for leaks and breaks.
- Paint or coat petroleum containers with asphalt to protect against rust.

Relative Cost:



Used oil from a single oil change can contaminate a million gallons of fresh water. - 60 Ways: Farmers Can Protect Surface Water

Hazardous Waste Containment: *properly storing pesticides and other hazardous waste materials on the farm.*



Photo courtesy of USDA-NRCS, PA

Darryl Corriher of Cleveland, North Carolina, stores his pesticides in one locked location that is separate from his petroleum storage area. This facility has a concrete and metal floor that allows for quick spill cleanup. In addition, he stores his chemicals on pallets to avoid moisture problems resulting from contact with the floor. Because Darryl buys all of his pesticides in bulk, he refills the appropriate containers with the same pesticides. To avoid keeping unnecessary chemicals, Darryl gives old containers and pesticides that exceed their effective date to the North Carolina Department of Agriculture's pesticide recycling program.



Darryl, shown with his wife Barbara and children Claire and Addison

What It Does:

Ensures pesticides and hazardous waste materials are stored safely on the farm by:

- Storing pesticides in their original container.
- Ensuring the product label is easy-to-read and legible.
- Maintaining an inventory of your products. This inventory should include: product name, active ingredients, date of purchase, and volume stored.
- Keeping pesticides and other hazardous materials in a secured but well-ventilated area that is protected from extreme temperatures.

Did You Know?

Below is a list of some typical hazardous waste products that may be located on your farm.

- Caulk and other types of adhesive,
- Cleaning solutions,
- Lead-based paint,
- Paint thinners,
- Antifreeze,
- Waste oil and grease,
- Lead batteries, and
- Pesticides, including their used cardboard and plastic containers.

To safely and properly store pesticides and other hazardous wastes, make sure you:

- Provide proper ventilation to ensure that chemicals are not absorbed by fertilizers.
- Store flammable liquids outside living areas and away from ignition sources, including pilot lights and electric motors.
- Store chemicals in a dry place since moisture can reduce the shelf life of both the chemical and its container.
- Avoid extreme temperatures. High temperatures can increase the volatility of some chemicals, particularly herbicides, while freezing can damage storage containers and also reduce a chemical's effectiveness.
- Read the label of all products to ensure safe storage.

Regional Differences:

Proper hazardous waste containment works in all areas of the country.

Compatible Practices:

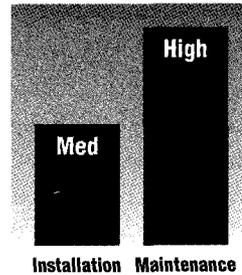
Hazardous waste containment works best with:

- Petroleum Containment
- Well Protection
- Recordkeeping
- Pesticide and Fertilizer Loading Facility

Maintenance:

- Maintain original labels and securely close lids. Cover with transparent tape if necessary to protect the label.
- Keep storage facility locked and all chemicals and other materials out of children's reach.
- Identify the storage cabinet with a sign that indicates materials are hazardous.
- Check containers frequently for leaks and breaks.

Relative Cost:



Five tablespoons of antifreeze can kill a 25 pound dog. - 60 Ways: Farmers Can Protect Surface Water



Nutrient Management: *applying the correct amount of fertilizer and manure to ensure the most efficient yields, while protecting water quality.*

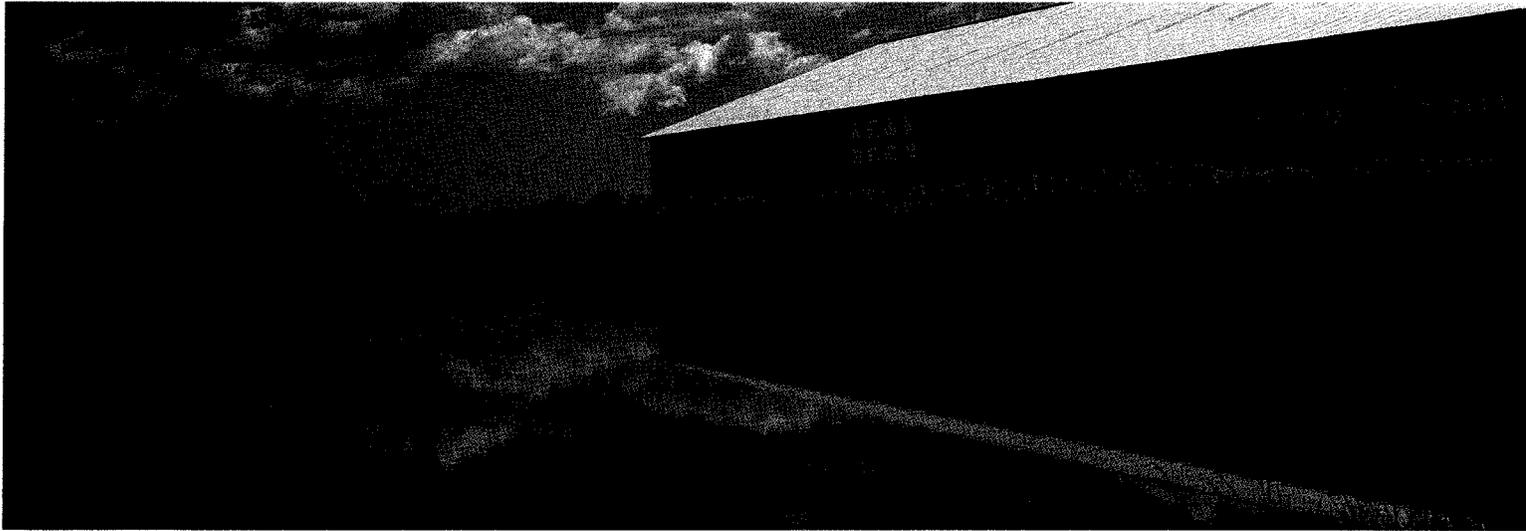


Photo courtesy of USDA-NRCS, IL

We have a manure situation that we need to manage. As a result, we have a nutrient management plan,” says John Gruber of New Holland, Ohio. In addition to farming 1,000 acres of corn, soybeans, and wheat, John raises approximately 500-600 feeder calves annually (450-750 lbs).

“For the most part, the feeder calves are allowed to graze. In the summer, I keep them in pastures, while in the winter, I release them into the crop fields to graze. By doing this, I avoid a manure accumulation on the farmstead.” Despite John’s efforts to avoid confining the cattle, at times these feeder calves and approximately 75-100 “fat or primarily confined” cattle are restricted to a feedlot. To handle this manure, John constructed a manure stack pad that has a 6-month storage capacity. This stack pad, combined with a filter strip, keeps manure runoff to a minimum.

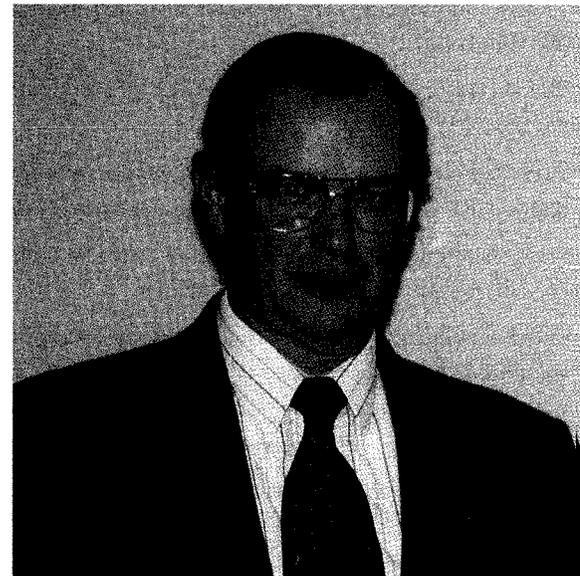
John avoids spreading his manure in the winter and primarily spreads it on his row crop fields that are not highly erodible. “We have some highly erodible land (HEL) ground, but we try to keep it in hay and pasture and avoid spreading manure on these fields. To dispose of manure in the summer, we spread it on wheat fields following harvest, prior to double cropping soybeans. After the corn harvest, we also incorporate manure with a chisel.”

To determine his nutrient needs, John conducts soil tests every other year. He also accounts for nitrogen carryover deposited by legumes.

“We try to rotate our crops wisely, in most situations, corn follows wheat or soybeans. By following soybeans, we cut our nitrogen commercial fertilizer needs by 20 percent for corn. When wheat follows soybeans on our farm, we normally give a 30 lb/acre credit for soybeans to account for soybean nitrogen fixation.”

His nutrient management plan is based on a phosphorus standard, rather than a nitrogen standard. For John, this has not posed a problem, “it will take us quite awhile before we exceed our phosphorus limits.”

As a whole, John encourages farmers to have a nutrient management plan. “I think that we need to get the point across that nutrient management is not a complicated process. If a farmer uses common sense and avoids overspreading on HEL ground, alongside streams, and in the winter, it’s easy. I know that some farmers may have their obstacles, but using common sense usually prevails.”



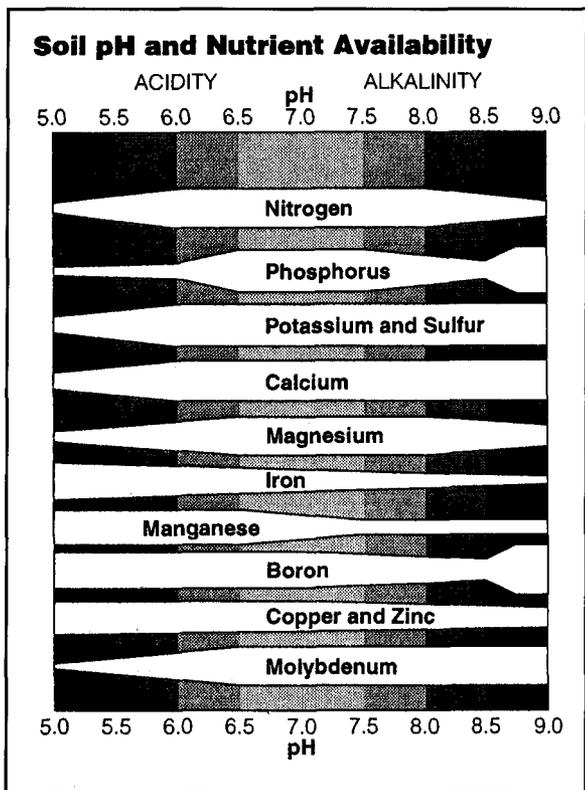
John Gruber attempts to manage most of his cattle’s manure by grazing his cattle when possible

What it Does.

- Provides the right amount of nutrients at the best time and location so they are used efficiently.

Did You Know?

- Soybeans best grow and develop when the soil pH is between 5.9 and 7.0. Soil pH influences nutrient availability. The following table demonstrates this:



Kansas Soybean Field Guide, 1996

- **Nitrogen** uptake by soybeans is important from emergence to the development of 2 nodes, about 2-4 weeks after emergence. In some cases or under some conditions, a range of 15-25 lbs/acre of nitrogen can be applied, especially in high residue conditions. Nitrogen is also necessary for pod formation and fill stages.
- Soybeans require some of each of the essential nutrients, particularly phosphorus and potassium.
- **Phosphorus and potassium** should be incorporated at planting time. Potassium deficiencies cause poor root development, weak stalks, uneven maturity, and shriveled seeds. Phosphorus-deficient soybeans will be slow to develop plant stalks and leaves and will also have irregular shaped pods.



Soybeans contain a higher amount of potassium in the grain than does wheat, corn, or grain sorghum and as a result, remove more potassium. - *K-State Research and Extension*

The following table shows the nutrient uptake during specific growth and development stages.

Sampling Stage	Days in Period	Nutrient Uptake Per Day (lbs.)		
		N	P205	K20
3-Tri-leaf	40	.75	.25	.68
6-Tri-leaf	11	1.45	.55	2.72
Full bloom	16	7.81	1.75	5.75
Pod dev. 15	9.13	2.27	9.60	—
Soft seed	21	11.43	2.76	2.43

How A Soybean Plant Develops
Special Reports No. 53, Iowa State University, 1994, Ames Iowa

Regional Differences:

Deficiencies in micronutrients are common in soybeans. The following table lists soil conditions where micronutrient deficiencies are most likely.

Nutrient	Likely Contributing Soil Conditions
Boron	High pH, drought, sandy, low organic matter
Calcium	Very low pH
Copper	High organic matter
Chlorine	None
Iron	High pH, wet, poorly aerated soil, cool temperature
Magnesium	Low pH, high potassium, sandy soils
Manganese	High pH and high organic matter
Molybdenum	Low pH, strongly weathered
Sulfur	Low organic matter, sandy soils, cold wet soil
Zinc	Exposed subsoil, high pH, very high phosphorus, cool wet soil

Johnson J. 1987. Soil fertility & crop nutrition. Ch. 7 p. 34-41. In Buerlain, J., D.L. Jeffers, & D. Eckert, Eds. The Soybean in Ohio, Extension Bulletin 741. Ohio State University

Compatible Practices:

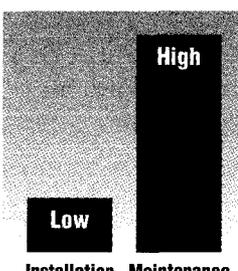
Nutrient Management works best with:

- Recordkeeping
- Soil Sampling

Maintenance:

Annually test soils and review yield goals.

Relative Cost:



Integrated Pest Management: *maintaining weeds, insects, and diseases below economically damaging levels using cultural, biological and chemical controls.*



W. W. Dierker 11

Integrated Pest Management consists of:

- **Field Scouting:** systematically checking crops and identifying insects, weeds, and/or diseases.
- **Recordkeeping:** keeping track of each field's yield history, soil tests, commercial fertilizer, manure and pesticide use, crop rotations, and equipment maintenance and costs.
- **Variety Selection:** choosing soybean varieties that complement a production area.
- **Pesticide Selection and Rate:** applying pesticides under the optimal environmental and climatic conditions, growth stage of soybeans, and/or weed size specified on the pesticide label.
- **Sprayer Maintenance and Calibration:** maintaining and calibrating sprayers to make sure you are applying the correct amount of pesticide over the desired area.

Field Scouting: *systematically checking crops and identifying insects, weeds, and/or diseases.*



Photo courtesy of USDA-NRCS, S

South Carolina soybean producer, Will Mims, is not the typical-minded young farmer. Will, who has been farming for ten years thinks with the knowledge of a farmer who has been farming for many years. He believes that every practice he performs on the farm will have long-term implications. “This farm has been in production since 1917. It is my responsibility to make sure that everything I do will allow me to farm this land for many more years,” says Will.

On his farm, Will has implemented several systems to help him achieve not only his production goals, but his environmental goals as well. These practices include no-till farming as much as possible and creating buffer strips around the edge of the fields. No-till is important to Will because it lowers the cost of production, takes less labor, and responds well to management. One aspect of management is an intensive program of scouting the fields for pests and weeds.

Will begins scouting ten-inch soybeans for pests on a weekly basis. He uses a drop cloth and sweep net and records the pests and their location in the field. If a pest is above the threshold as determined by Clemson University, he treats the field for that pest. He continues this process until maturity. “Scouting for pests has helped me to determine what pests are in my fields. In order to have success at this scouting game, you must be committed to scouting on a weekly basis,” comments Will. “Scouting has helped us to cut our costs and has increased our yields. Before we started with this program, we were not sure what was out in our fields.”

Will suggests that anyone beginning a scouting program should develop a chart and record the results of scouting in each field each time the scouting is performed. This will help the producer track the results in each field and could help in planning for the next year. In addition, Will suggests staying with the same routine each time. “I personally scout in the morning or the late afternoon because of the South Carolina heat,” says Will. Overall, scouting is a very important management practice to help Will in his efforts of no-till farming.



Will Mims scouts his fields weekly to cut costs and increase yields.

Recordkeeping: *keeping track of each field's yield history, soil tests, commercial fertilizer, manure and pesticide use, crop rotations, and equipment maintenance and costs.*

Lois Loff, from Dane, Wisconsin keeps records for her joint farming operation with her husband, Roger. For the past 15 years, Lois has recorded and documented all aspects of the farming operation, including financial and tax information, field scouting, tillage information and equipment purchase, maintenance, and repair. For Lois, it has proved extremely beneficial in planning for future years. "By documenting past experiences, we are able to make wise decisions for the future."

Lois uses both paper and electronic files to manage the farm records. Her recordkeeping ranges from computer accounting software with double-entry spreadsheets tracking financial and tax information to just using a spiral notebook that she keeps in the tractor to document field inputs. For herbicide, yield, and variety use, Lois tracks results on a field-by-field basis. For the past three years, Lois and Roger have used a global positioning system (GPS) on the combine. The GPS helps them manage weeds, grain moisture, and seed variety.

In addition to the GPS information that she gathers at harvest time, Lois also tracks a variety of information throughout the growing season on a field-by-field basis. Using a pencil and spiral notebook, Lois documents for each field, tillage type, fertilizer and chemicals applied, additional chemical additives used, seed variety use, and crop rotation. In addition to these elements, field scouting maps also allow her to see a history of weed problems and help her determine proper seed varieties and chemical use. "Keeping a spiral notebook with me is easy and efficient, I document the information when I'm in the fields. It's easy to carry with me, jot it down, and then it's done," says Lois.

Aside from tracking field information, Lois also finds tracking equipment to be very helpful and cost-effective. To track machinery purchases, Lois keeps a separate file on each piece of machinery, including vehicles. Within this file, she keeps purchase, maintenance, and repair information on each piece of equipment. This has proven to be extremely helpful when she replaces equipment. "Before replacing equipment, we are able to calculate our input costs." On average, Lois spends a great deal of time in January and December keeping records, and in the spring and fall she spends an hour per day tracking field information. By doing this, says Lois, "we are more aware of input costs and yield results. As a result, we make far better and more educated choices."

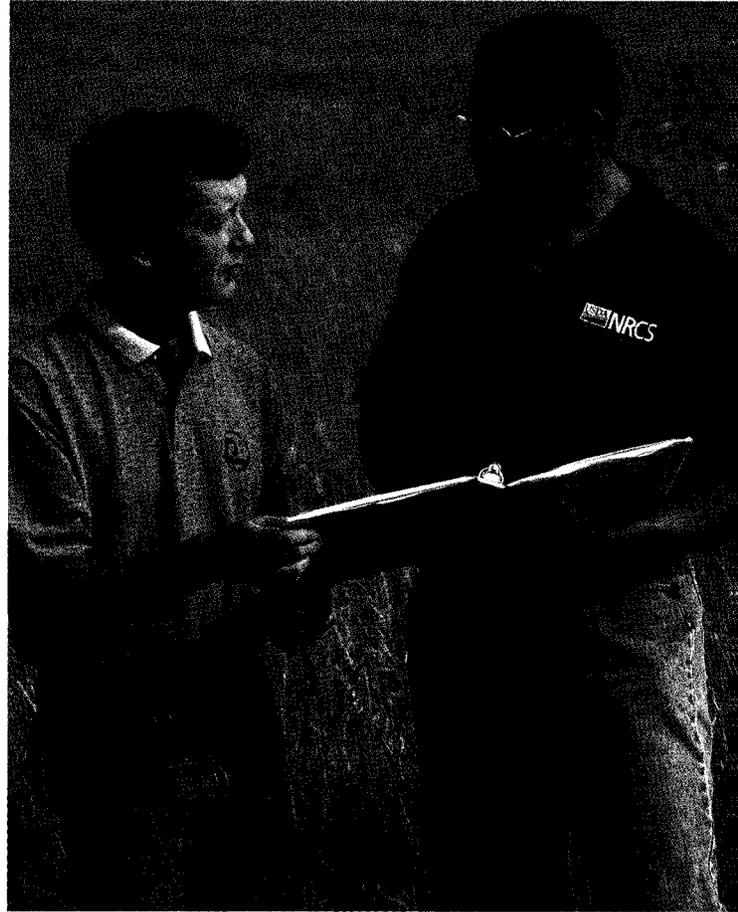
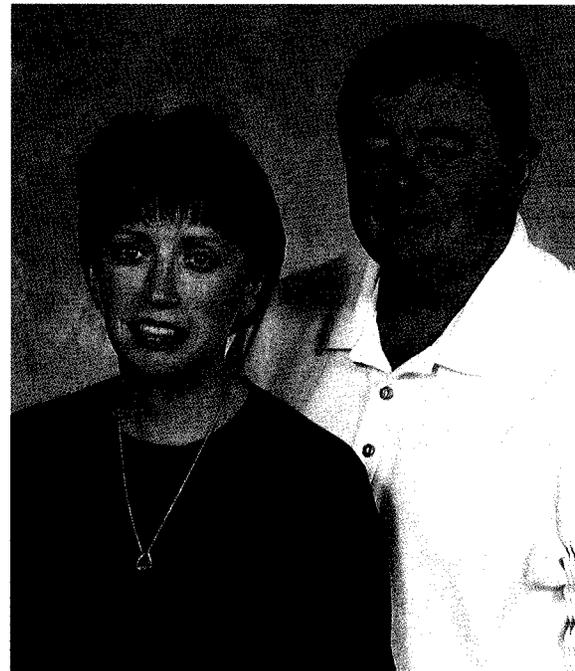


Photo courtesy of USD



Lois and Roger Loff insist sound recordkeeping is the key to successful farming

Variety Selection:

choosing soybean varieties that complement a production area.



Photo courtesy of USDA-NRCS, II

Situated in the northeast corner of Indiana, Jerry Perkins of Stroh, Indiana, farms row crops and also owns and operates a dairy operation. Jerry's typical crop rotation consists of the following: corn, soybeans, corn, soybeans, wheat/corn silage, alfalfa (4-5 years). Based on his latitude proximity and soil type, Jerry finds that soybean varieties, Late Group 2 or Early Group 3, work best on his farm.

Because Jerry's soils are quite light, they dry and warm up faster than what is normally expected in the northeastern Indiana climate. As a result, Jerry generally plants his Late Group 2 or Early Group 3 variety of soybeans between April 25-28, after the threat of frost subsides. Although Jerry grows soybeans on a variety of different soil types, he finds that these soybean varieties, coupled with no-till planting, crop rotation, and using a global positioning system, increase his yields and his bottom line. "While this isn't a perfect farm, I've been able to avoid some typical headaches, such as weed problems and low organic matter," says Jerry.

Unlike other farmers, Jerry has not had to choose a variety based on insect, disease, or weed control.

"I haven't been faced with having to choose Round-Up Ready or other pest resistant varieties, because our problems usually have not exceeded the economic threshold of cost-effectiveness. I have been able to avoid these problems because our soil is healthier due to no-till; the crop rotation does not allow weeds, insects, and diseases to 'lock-in'; and the use of a global positioning system allows me to target and adjust seed population and fertilizer based on soil type and conditions and herbicides based on weed conditions."



Jerry Perkins generally plants his Late Group or Early Group 3 variety of soybeans between April 25-28 after the threat of frost subsides:

Soybeans are available in many varieties. When selecting, consider varieties based on the following:

- Maturity,
- Lodging Resistance,
- Climate,
- Market Value,
- Yield Potential, and
- Disease Resistance.

Did You Know?

Selecting Based on Maturity Factors:

- Maturity of soybeans must be closely matched to the production environment and the cropping system.
- Soybeans are sensitive to day length or photoperiods. Soybean varieties are classified by photoperiods that extend approximately 100 to 150 miles north to south. There are ten maturity classes from 00 to 000-VIII. The lower the number the longer the planting season. Choose the variety most suited to your geographic region.
- As the maturity group number increases, the lengths of the vegetative and reproductive stages of development are extended.
- Generally, for every 3 days delay in planting, maturity is delayed by only 1 day.
- Utilizing a range of maturities can reduce the risks associated with weather and facilitates a timely harvest and efficient machinery use.
- Lower temperatures delay flowering.

Selecting Based on Lodging Resistance:

There are two basic types of classifications for soybeans:

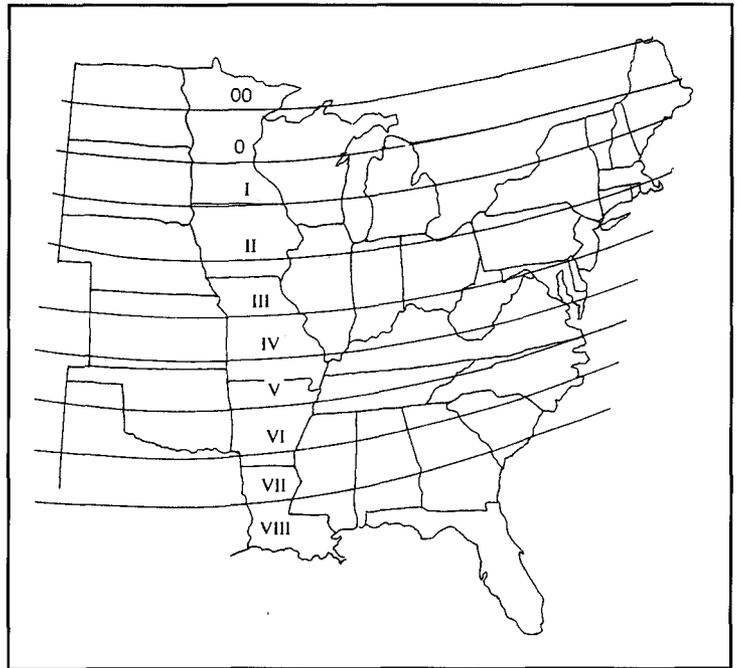
- **Indeterminate:** varieties continue to grow vegetatively several weeks after flowering. These varieties are found primarily in the North.
- **Determinate:** varieties complete most of their growth before flowering. Plants are usually short and compact. These varieties are found primarily in the South. In most cases, determinate plants are resistant to lodging and are recommended when planting in narrow rows and using high seeding rates.

Selecting Based on Disease Resistance:

No single soybean variety can provide complete protection against soybean diseases. However, choosing soybean varieties with resistant sources may assist in hindering these diseases. For information on how to avoid common diseases, consult the *Insects, Weeds and Diseases Identification Guide* located in this handbook.

Regional Differences:

Soybeans are sensitive to day length and photoperiods. Choose varieties that are suited to your area.



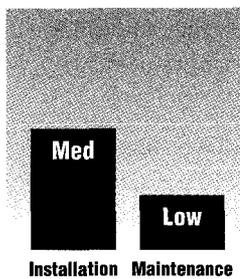
General bands of adaptability of soybean groups in the United States. (Smith, Crop Production: Evolution, History, and Technology, 1995)

Compatible Practices:

Variety selection works best with:

- Integrated Pest Management
- Conservation Tillage
- Nutrient Management
- Field Scouting

Relative Cost:



Lodging during the vegetative or reproductive growth will disrupt light production into the plant canopy and may reduce seed yield.

Pesticide Selection and Rate: *applying pesticides under the optimal environmental and climatic conditions, growth stage of soybeans, and/or weed size specified on the pesticide label.*

Coatsburg, Illinois, farmer David Niekamp has been meticulously reducing pesticide and herbicide rates for 15 years now. He tested the practice when he began farming and hasn't looked back. Today, he cuts pesticide rates by 30 to 50 percent, and herbicide rates from 30 to 40 percent. Farmers spraying pesticides rely on a variety of adjuvants, mostly petroleum-based, as carriers for the chemical. But David takes environmental consciousness one step further.

"We premix or encapsulate the chemical in Landoil, which is 93 percent food-grade soybean oil with seven percent emulsifier, then put it into water," David explains. "Landoil is our own product from soybeans we raise and it is biodegradable. It won't hang around like petroleum products."

David has learned that rate reduction requires extra management. Those who practice it should monitor weed heights closely, following manufacturer's instructions to determine the timing of applications, he says. Chemical-adjuvant mixing takes time and must be done in the proper order. "The oil goes in the inductor first," David says, "followed by the chemical. Only then is encapsulation achieved."

Encapsulation helps reduce application rates by giving products staying power, David explained. "Once sprayed, it only takes the product about 20 minutes to dry. As soon as it's dry on the leaf, the pesticide is rain-fast and will not wash off," David says. "Encapsulation also significantly reduces pesticide movement."

As a rule, David handles his own spraying. Most co-ops "don't want to bother with rate reduction," he said. "They're more comfortable with full-rate applications and the company guarantee they carry." On occasion, David has turned to a co-op for custom spraying, furnishing them with the Landoil and telling them, "I will not apply a pesticide or herbicide without it."

David, who swears by the results, said rate reduction saves money and protects natural resources. He saves from \$3 to \$10 per acre after paying for the oil, which costs from \$7 to \$9 per gallon depending on container size and freight. The exact economic benefit varies according to the protection product and the crop.

Though a reduction in input costs is clear, proof of improved yields is more elusive. Test plots demonstrate increased yield on average, if not on every plot individually, David says. But he is confident he achieves the most effective and efficient weed control possible. Weed escapes are an occasional reality, he says, but his side-by-side tests confirm similar weed escapes occur under full-rate applications.

Whatever the crop, product or potential savings, David always uses Landoil and reduces rates. It's always worth the effort, he said. The oil reduces drift and, David believes, leaching into groundwater. Plus, if spilled, encapsulation minimizes the applicator's direct contact with the chemical. Says David, "I use the product every time I spray. I just don't think we need to put all these chemicals in our ground."

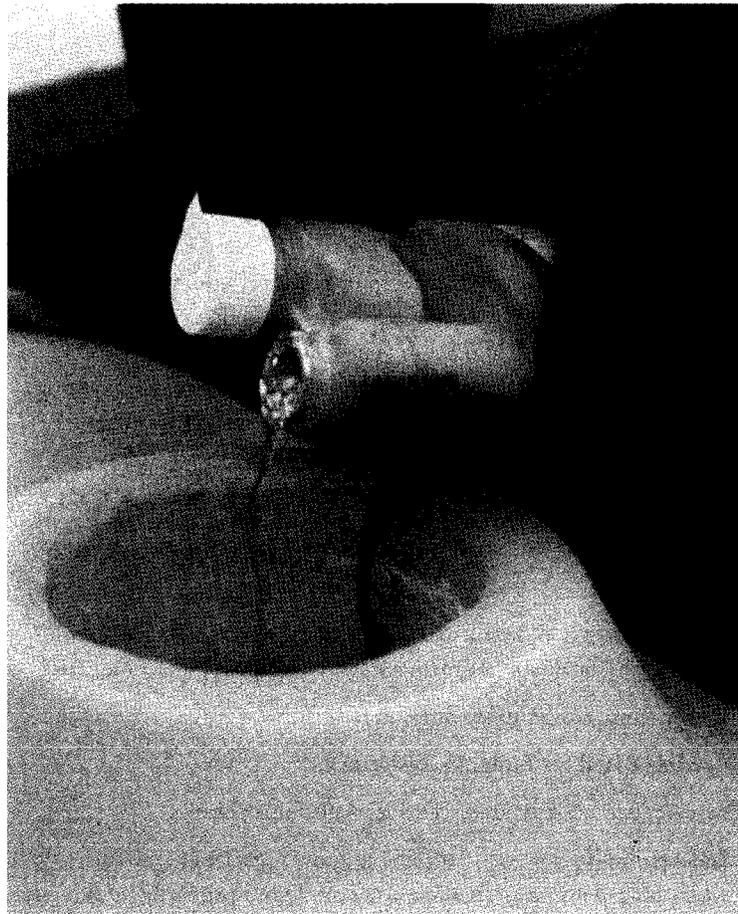
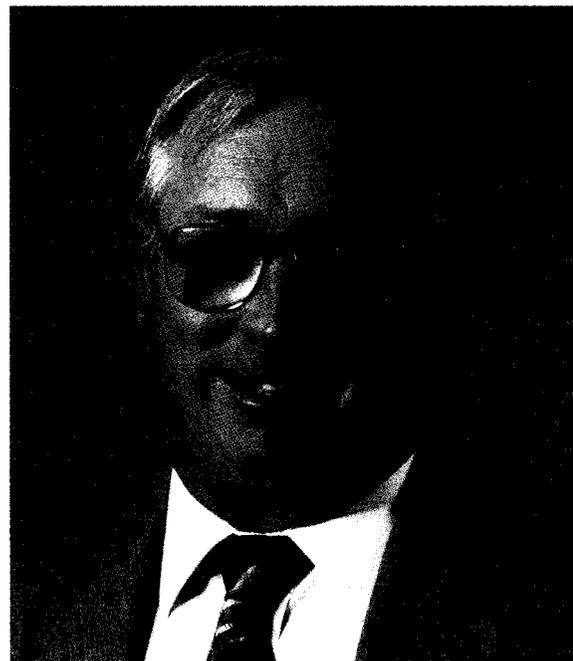


Photo courtesy of USDA-NRCS, S



Encapsulating herbicides and pesticides in Land Oil a soybean oil product allows David Niekamp to redu

Sprayer Maintenance and Calibration: *maintaining and calibrating sprayers to make sure you are applying the correct amount of pesticide over the desired area.*

Along with his three brothers and father, Chris Mann farms over 7,000 acres of row crops in central Indiana. Approximately 50 percent of this acreage is devoted to corn, while 40-45 percent of it is devoted to soybeans and 5-10 percent to wheat. Chris solely no-tills soybean and wheat, and no-till plants corn based on spring weather conditions. For Chris and his family, no-till has been a tremendous success. "By reducing labor and overall trips across the field, no-till allows us to farm more acreage. As a result, no-till makes us more profitable," says Chris.

In addition to reducing labor, machinery, and operating costs, Chris also finds that no-till reduces his dependency on chemicals. "No-till keeps weeds dormant. While we still have smaller seeded weeds, larger seed weeds are basically eliminated," says Chris. Chris uses herbicides to eliminate his weed problems, but his need for chemicals has been greatly reduced by using a number of cultural methods, such as planting denser canopies, plant and sprayer timing, using different seed varieties, monitoring fertility, and inoculating his soybean crop, to obtain maximum nitrogen fixation using the new USDA strains.

By using these methods, Chris believes that his soybean plants have a better chance of competing with weeds in a post-emergent system. As a result of these methods, Chris' need for post-emergent chemical weed control of grasses and broadleaves is cut by up to 50 percent (50 percent reduction for grasses, 25 percent reduction for broadleaves). This reduction saves him money.

Chris' reduction in chemicals also reduces spraying equipment operation and maintenance costs. To maintain his sprayer and ensure proper calibration, Chris changes his nozzles once a season. He also monitors his pressure gauges and checks the distribution pattern each time he enters the field. All in all, Chris believes proper maintenance and sound management make sense. "Farming is a business; research and proper maintenance are necessary to running a profitable operation."

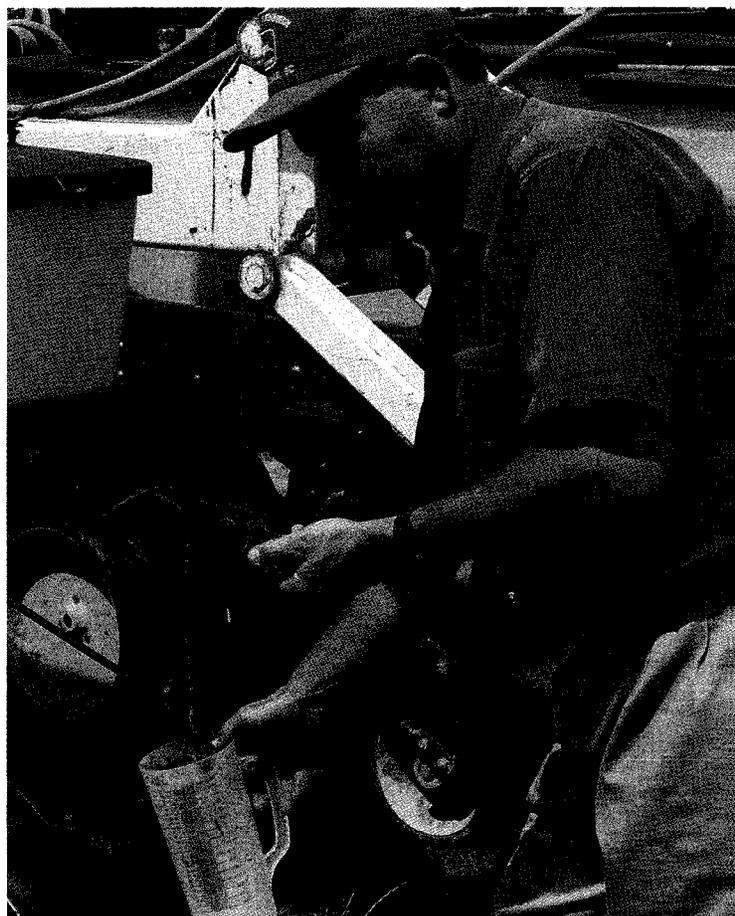
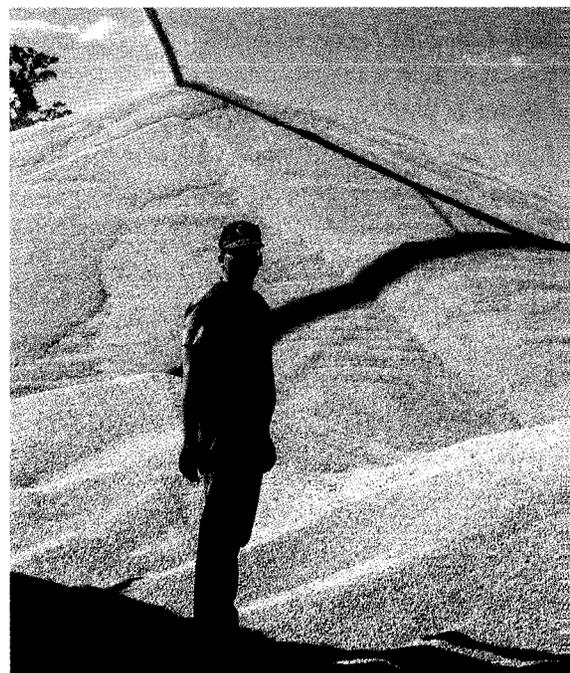


Photo courtesy of USDA-NRCS, S



Chris Mann's wise use of pesticides translate into big yields and increased profit

Soil Sampling: *gathering soils and analyzing them to check the soil pH and the amount of plant nutrients and diseases present in each field.*

Soil testing was invaluable, after the flood of 1993, to Terry Hilgedick of Hartsburg, Missouri.

"The flood of '93 dumped loads of sand on my river bottom fields. For several years after the flood, we soil tested every other year in order to fertilize our crops, especially corn and wheat. Prior to the flood, we usually tested every three years."

Terry tests his soils on a field-by-field basis, using the zig-zag method. Generally, he probes approximately 8" to determine what his field's nutrient needs are. Following the flood, Terry found that his fields were low in potassium. The top layer of sand had little nutrient value. "This lack of nutrients made a large difference in my corn and wheat yields," says Terry.

"It was too expensive to remove all of the sand, so I attempted to deep plow the sand into the soil. Even though I deep plowed, I still had problems raising crops on the fields affected by the flood. I could really notice a lack of growth, especially with corn and wheat. The top layer of sand was devoid of nutrients. Until the plant's roots reached the original soil, the plants really struggled. It took a number of years to get the soil back to what it was producing before 1993. The soil testing really helped us do this."

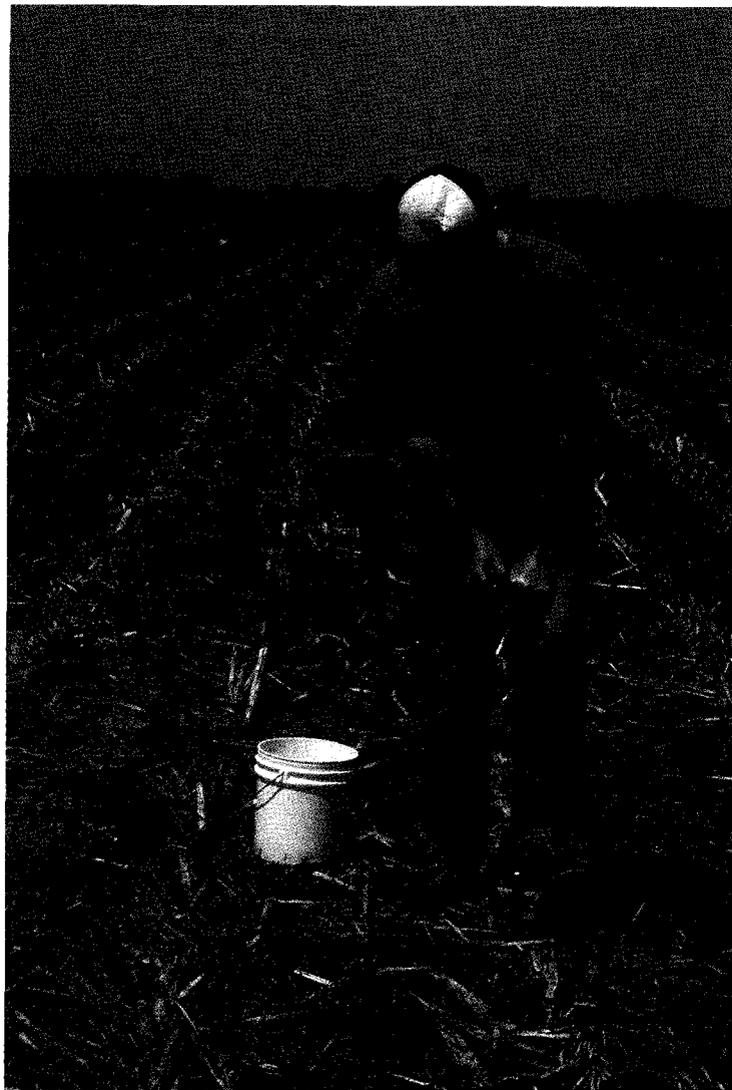


Photo courtesy of Soybean Cyst Nematode Coalitic



Terry Hilgedick found soil tests to be absolute: necessary after the Flood of '93.

What It Does:

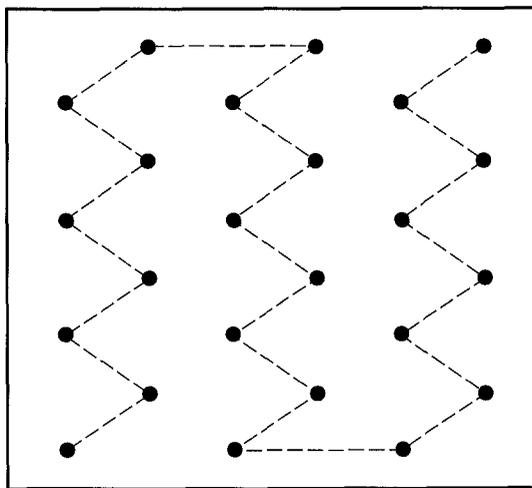
- Determines the proper amounts of lime and fertilizer for each field to be planted.
- May assist in detecting nematodes or other pests found within the soil.
- Provides information on drainage and compaction potential, herbicide application, and possibly variety selection and yield potential.
- Saves you money because you apply only the amount of nutrients that your crop needs.

Did You Know?

- If you suspect nematodes are present, place the soil sample in a plastic bag, not a paper soil test bag.
- Soil pH affects nutrient availability. The ideal soil pH for soybeans is from 5.9 to 7.0. Soil pH may change if you apply:
 - Ammonium fertilizers,
 - Liming materials, or
 - Irrigation water that contains fertilizer, sodium carbonate, or sulfur.
- To avoid last year's fertilizer rows, sample between rows. For nematodes, sample near the plant.
- Don't mix soils from contrasting areas.

Procedure for collecting samples:

1. Use a cylinder soil probe to collect samples.
2. Collect 10 to 20 soil cores in a zig-zag pattern across the entire area to be sampled.



Proper soil sampling uses a zig-zag pattern.

3. Collect soil cores from areas of similar soil texture and cropping history. If different crops or markedly different soil textures occur in the same field, sample them separately.
4. Collect to a depth of 6 to 8 inches. For no-till fields where there is little disturbance, three inches is sufficient.
5. Place the cores in a container bucket and mix thoroughly.
6. Place approximately 1 pint of mixed soil in a plastic bag and label the outside of the bag with an indelible marker.
7. Store the sample away from sunlight in a cool area until shipped to the laboratory.

Regional Differences:

Soil sampling works in all areas of the country. The following table identifies when to test.

If you are...	Then...
Planting a spring crop	Test the soils in the fall or winter.
Planting a fall crop	Test the soils in the summer.
Conducting a sample for soybean cyst nematodes	Test the soils at maturity or immediately after harvest.

Compatible Practices:

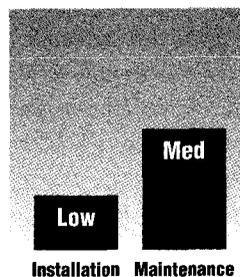
Soil sampling is compatible with:

- Nutrient Management
- Integrated Pest Management

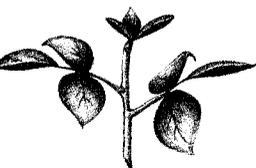
Maintenance:

- Maintain records from year to year.
- Use clean buckets and tools. Avoid any tools or buckets with pesticide residue.

Relative Cost:



If soybean cyst nematodes are present, crop rotation is the most powerful tool used to reduce the population.
 - *Missouri Soybean Field Guide*



Underground Outlet (for terrace system): *installing a pipe beneath the ground surface to dispose of excess water runoff.*

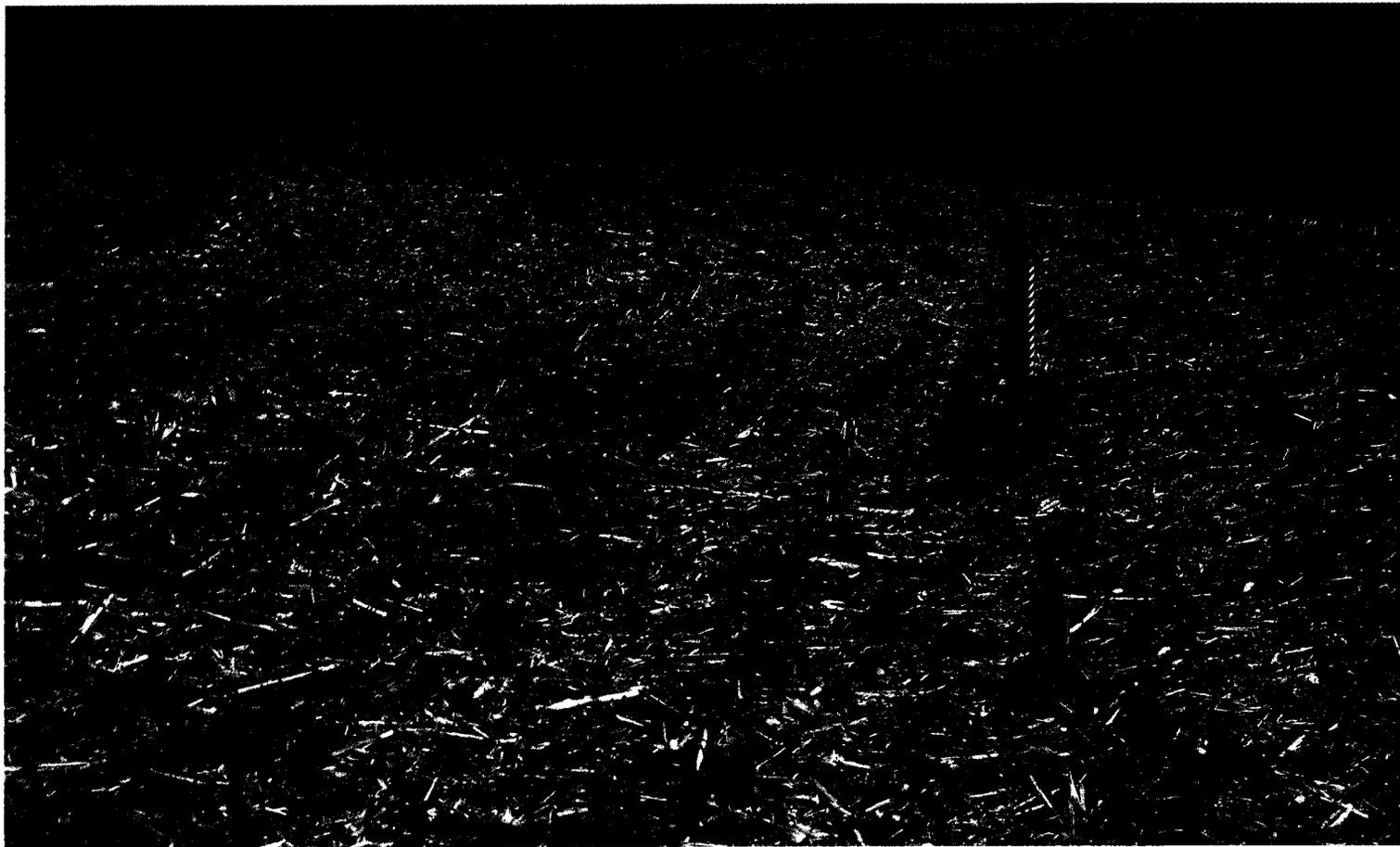


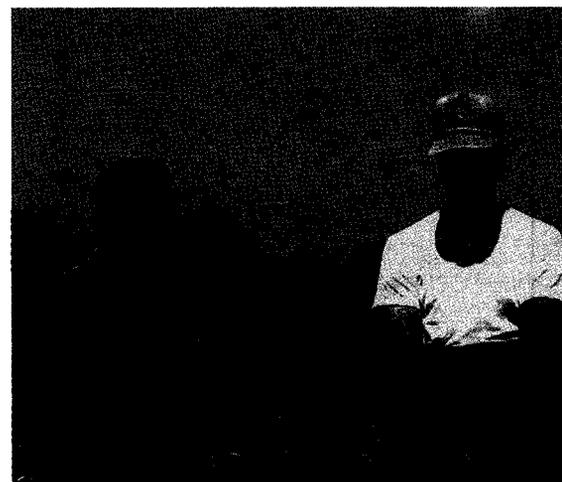
Photo courtesy of USDA-NRCS,

Before Dan Benne of Audrain County, Missouri, installed broad-based terraces and underground outlets, he could not get a tractor across his 160-acre field.

“The gullies were so deep, we had problems getting equipment across the field. We tried no-till planting, but it didn’t work well on these soils that went from very wet to very dry, within one or two days. As a result, we installed broad-based terraces, using underground outlets to control erosion. Originally, the 160-acre field contained several grassed waterways. While they worked at controlling erosion, you had to continually lift the equipment in order to avoid plowing up the waterways.”

Since installing the broad-based terraces and underground outlets, Dan has found that he can move his equipment across the field without a break in cultivating or harvesting. With this system, he has reduced the number of waterways to one large waterway and a number of underground outlets that handle all runoff from his terraced fields. The water control structures are easily spotted and easy to move around. “Since we’ve installed them, we’ve been able to hold back the water and the soil,” says Dan. “I’ve seen some big rains, and these terraces with the underground outlets have yet to overtop.”

When asked about maintenance and upkeep of this system, Dan says that the underground outlets, which temporarily pond the water and allow the sediments to settle, require little maintenance. “We clean the sediment basin around the structure, every three to four years. We also try to make sure that the cage remains over the risers and the tile outlet to ensure that muskrats or other animals don’t enter the system.”



Rick Mongler, NRCS technician, and Dan Benne, farmer, believe that Dan’s terraces and underground outlets nearly eliminate soil erosion on his farm.

What It Does:

- Improves water quality by trapping sediment, nutrients, and pesticides.
- Allows sunlight to decompose some of the pesticides by holding water runoff.
- Controls gully erosion on irregularly sloped fields by directing water to a controlled location with other conservation practices, such as terraces or waterways.
- Encourages water, nutrient, and pesticide infiltration.

Did You Know?

- Underground outlets control farm runoff from entering streams and waterways too quickly.
- Underground outlets are very similar to a waterway in that they prevent gully erosion.
- With underground outlets, sediment and the attached pollutant settle in the basin and water is slowly delivered to underground tile through surface intakes.

Regional Differences

Underground outlets work in all areas of the country.

Compatible Practices:

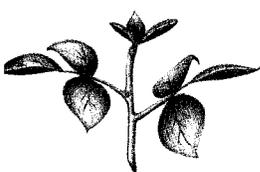
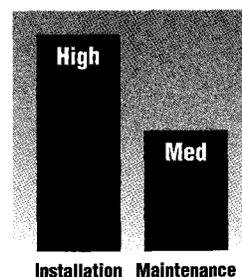
Underground outlets practices work best with:

- Terraces
- Diversions
- Contour Farming
- Contour Stripcropping
- Crop Rotations
- Conservation Tillage
- Grassed Waterways

Maintenance:

- To maintain effectiveness, removing sediment or raising the embankment is often required.
- Avoid building ridges around the basin of the underground outlets. Ridges will hinder proper drainage.
- Excavated material should be redistributed on the field.
- Vegetation within and surrounding the basin should be maintained.
- Remove any trash or debris from the basin.
- Check basin after large rainstorms or snow melts for any needed repairs.
- To avoid damaging with equipment, keep risers highly visible by using a brightly colored riser pipe and keeping it a distance from the surface.
- If tile blowouts occur, repair immediately.

Relative Cost:



Raindrops, striking the ground, can splash soil as high as 3 feet in the air and as far as 5 feet from where they hit the surface. - *60 Ways: Farmers Can Protect Surface Water*

Chiseling and Subsoiling: *loosening the soil without inverting and with a minimum of mixing with surface soil, to shatter restrictive layers below the soil surface.*



During the last week of February, John Oglesby is chiseling and subsoiling his fields. To prepare the ground for his new crop, John finds that subsoiling is necessary when farming on his Mississippi Delta soils. "By shattering the soil, I am removing the restrictive clay layers found below the normal plow depth. This hardpan shattering allows water and roots to penetrate the soil profile," says John.

John uses what he calls a "ripper hipper" to loosen the soil. Unlike a traditional plow, the ripper hipper penetrates the soil without inverting the soil profile layers. Little mixing of the soil occurs, yet the layer of compaction is shattered.



John Oglesby's "ripper hipper" breaks compacted soil layers.

What It Does:

- Improves water and root penetration and breaks compaction.
- Allows producers to plant into a stable seedbed.
- Destroys weeds.
- Increases the likelihood of planting seed into moist soil.
- Increases soil air.
- Decreases erosion by increasing water infiltration and reducing the amount of surface water runoff.
- Warms the soil at planting depth.
- Allows excess spring moisture to drain away from the planted area.
- Reduces excessive moisture in the crop's root zone.
- Increases yields by increasing the infiltration rate.

Did You Know?

- Chiseling and subsoiling can occur over the entire area or subsoiling may be done in specific field locations.
- Chiseling and subsoiling can be done in the spring or the fall. In some areas, subsoiling is done after a frost to reduce the impact of the compaction and to open a channel for water beneath the frost layer.
- Subsoiling can decrease your nutrient and pesticide runoff rate, while increasing your infiltration rate.
- Subsoiling may reduce gully erosion by preventing excessive runoff and accumulation of water at water discharge points in the field.

Regional Differences:

Subsoiling and chiseling works best in areas where the chances for surface runoff are minimal (land with <2 percent slope). It also works best where the soil clods and structure are not destroyed by heavy rains.

Compatible Practices:

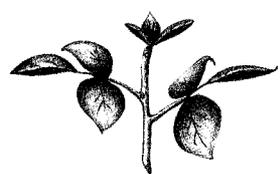
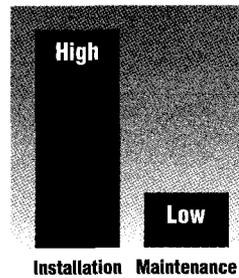
Chiseling and subsoiling is compatible with the following practices:

- Irrigation Water Management
- Crop Rotation
- Conservation Tillage
- Contour Farming
- Contour Stripcropping

Maintenance:

- Make it a habit to check equipment every growing season and examine shanks or disks on a regular basis during use.
- Monitor seedbed. Tillage may initially damage the crop, but in the long run, increased water infiltration will usually offset loss.

Relative Cost:



In subsoiling, using narrow points and spacing the standards farther apart will preserve more surface residue.

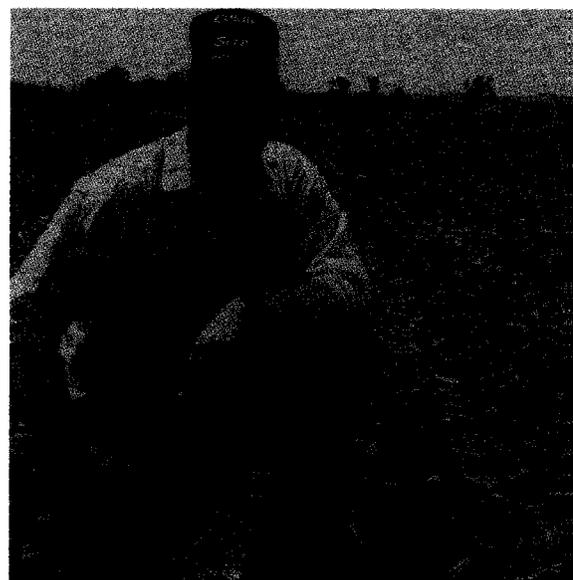
Crop Rotation: *alternating soybeans with another crop.*



Photo courtesy of USDA-NRCS, I

Vince Beck of Canton, South Dakota, is a believer in rotating his crops. Like many other farmers in his area, Vince annually rotates corn and Roundup-Ready soybeans. He has found that both crops work hand-in-hand with one another. The soybeans donate “free” nitrogen to the corn, which in turn, provides needed residue for the soybean crop. By adding nitrogen to the soil through soybeans, Vince has reduced his fertilizer costs. Conversely, the corn residue, remaining after disking, conserves soil moisture and reduces wind erosion.

Vince monitors his crops closely with global positioning yield monitors, so he can see the results of his work directly. By examining his yields and conducting soil tests, Vince can ascertain what his nutrient and pesticide needs are and the effects of residue directly. While the residue from his corn rotation presents some challenges, he notices overall that there is “less soil erosion and water runoff, and more organic matter in the soil.” “Over time,” Vince says, “my crop rotations and tillage practices have yielded a steadier and more balanced soil.”



Vince Beck rotates soybeans with corn

Conservation Cover Crops: *establishing and keeping cover on the ground until the main crop is planted.*

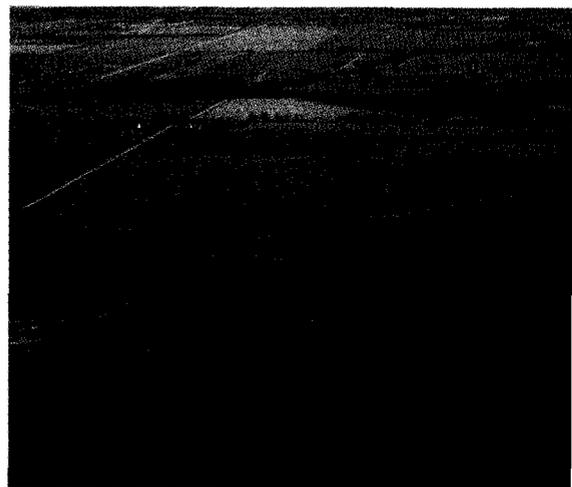


Photo courtesy of USDA-NRC

Kurt and Dave Hollenberg, two brothers from Mexico, Missouri, have been sowing red clover into their corn, soybean, and wheat rotation for a number of years. Dave Hollenberg states,

“While not everyone uses clover as conservation cover around here, planting red clover with a corn, soybean, and wheat rotation is probably our most beneficial practice that we use on the farm. The red clover adds needed organic matter to these clay soils.”

After they harvest soybeans, Dave and Kurt plant wheat for grain. Clover is planted into the wheat. In the spring, the brothers rip the soil about 20-24 inches to incorporate the clover and break up the hard pan. The clover not only reduces erosion, but also adds needed organic matter and nutrients, such as nitrogen.



The Hollenberg Farm located near Mexico, Missouri

What It Does:

- Enhances wildlife habitat by providing food and shelter.
- Reduces soil erosion and nutrient and pesticide runoff.
- Assists in maintaining good soybean health by maintaining or increasing soil organic matter, water content, and nutrient balance.
- Reduces soil compaction and increases aeration when deep rooted crops are planted.
- Traps and cycles nitrogen that remains after the main crop is harvested.
- Reduces nitrogen leaching by gathering excess nutrients.
- Increases the food supply for soil microorganisms and organic matter in the soil.
- Stores moisture that is needed for the following crop.

Did You Know?

- Cover crops will reduce the amount of weeds in a field, which minimizes herbicide costs.
- Legume cover crops can lower fertilizer costs by adding nitrogen to the soil.
- Rye and millet are excellent cover crops for retaining nitrogen in the soil for later use.
- Cover crops not only reduce erosion but can also reduce pathogens entering surface waterways.
- Green manure in limited amounts can also act as a cover crop.
- Winter wheat double cropped with soybeans gives the benefit of a cover crop that you can harvest.
- For furrow irrigation or sprinkler irrigation, plant cover crops that cover the soil surface rapidly and produce enough residue to hinder erosion.

Regional Differences:

The following cover crops are used with soybeans in the following regions:

Location	Cover Crop Type
Midwest	Rye or Wheat
Northern Plains	Rye, Wheat or Kura Clover
South Central	Small Grains, Wheat, Rye or Clover
Southeast	Small Grains, Clovers, Rye or Wheat

Compatible Practices:

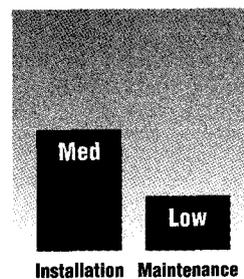
Conservation cover crops work best with:

- Conservation Tillage
- Contour Farming
- Nutrient Management
- Contour Stripcropping
- Filter Strips
- Contour Buffer Strips
- Grassed Waterways

Maintenance:

- Little maintenance is required.
- To invite wildlife to your farm, plant seed mixes, which provide food and shelter.

Relative Cost:



Incorporating light amounts of conservation cover into the soil can help (knee high or lower), while incorporating too much cover can be detrimental.

Contour Farming: *planting and cultivating crops across the slope.*



Photo courtesy of USDA-NRCS, I

Contour farming, shelterbelts, and riparian forest buffers are just a few of the best management practices that John Lieferman has used on his farm. A resident of Elkton, South Dakota, John has a variety of obstacles that he has encountered on his farm, including steep hillsides and eroding streambanks. To control erosion, John has used contour farming. By controlling the erosion on the hillsides, John has eliminated many of his streambank problems. John has found contouring to be an economical method of controlling soil erosion. In addition to contour farming, John has improved water quality and reduced erosion by fencing out his cattle and installing riparian buffers along the stream corridor. According to John, "all of these practices have been beneficial. The creek banks and water quality have improved and the condition, of our pastures continue to recover."



John and Sharon Lieferman pictured with son Matthew, use a variety of practices, such as contour farming and windbreaks, to implement a conservation system on their farm.

What It Does:

- Slows water flow, which reduces erosion by creating miniature dams across the slope.
- Increases water, nutrient, and pesticide infiltration.
- Reduces soil erosion and nutrient and pesticide runoff.

Did You Know?

- It's the easiest and least expensive way to protect your topsoil.
- Contouring may reduce soil loss by up to 50 percent over planting up and down the hill.
- Requires less fuel than planting and cultivating up and down the hill.
- Helps prevent gullies and sheet erosion.
- Contour farming works best on uniform slopes.
- In some soils, the development of saline seeps or other salinity problems may result due to increased infiltration.

Regional Differences:

Contour farming works in all areas of the country. It works best on areas with a uniform slope. Complex slopes may have many point rows, which can decrease the efficiency of field operations.

Compatible Practices:

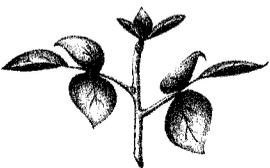
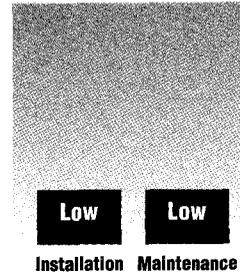
Contour farming works best with:

- Contour Buffer Strips
- Crop Rotation
- Diversions
- Filter Strips
- Grassed Waterways
- Irrigation Water Management
- Nutrient Management
- Integrated Pest Management
- Riparian Forest Buffer
- Terraces

Maintenance:

- Maintain a permanent key field guide, such as a contour buffer strip, to maintain the contour pattern.

Relative Cost:



Where grassed waterways are established, contour rows should enter the grass area nearly on the level, but with a slight grade downhill to direct the water to the waterway.

Contour Buffer Strips: *narrow strips of permanent plants established across the slope with alternating cropped strips.*

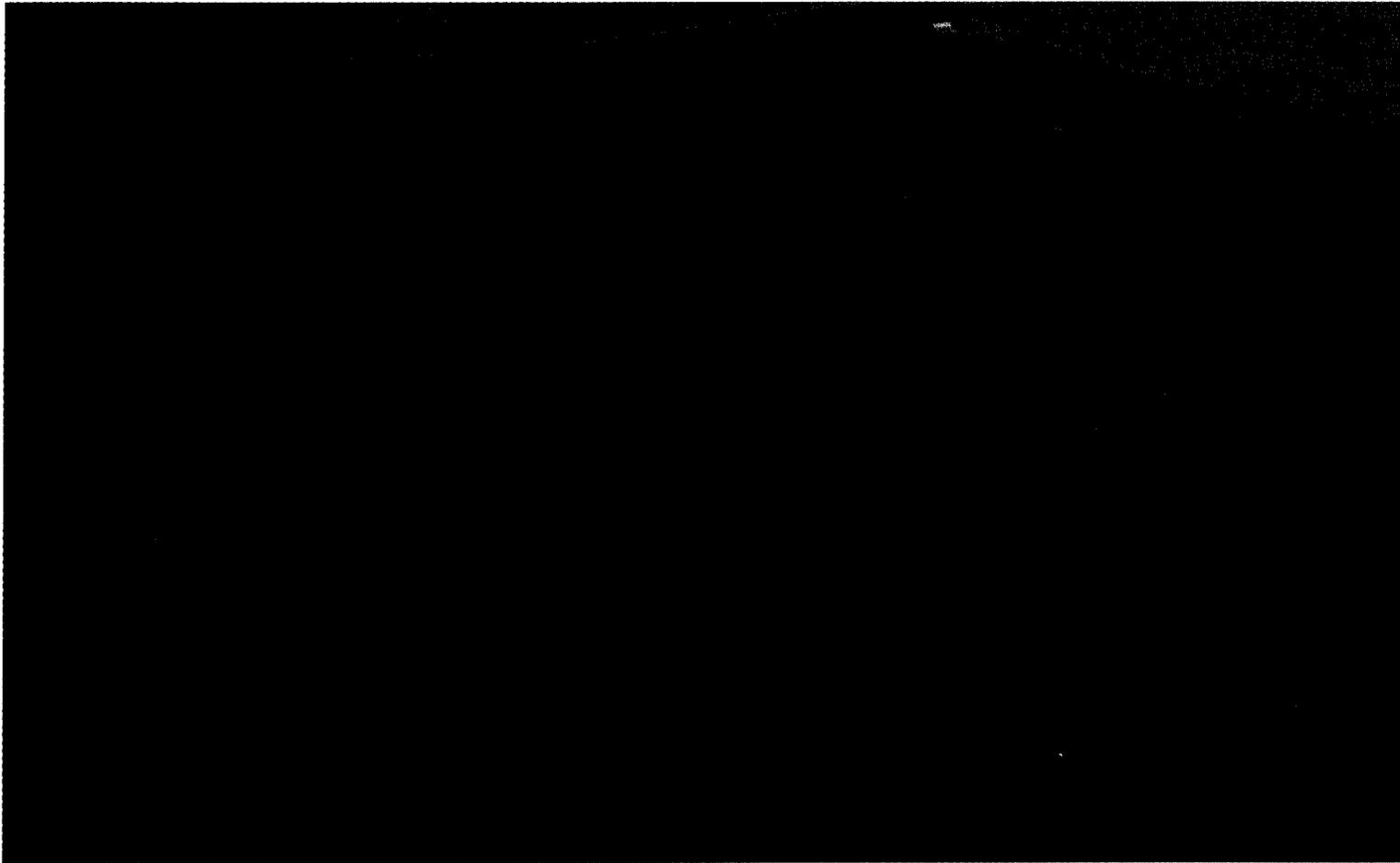


Photo courtesy of USDA-NRC

It has no name, but the stream bubbling through Farley Cole's Girard, Illinois, farm has an important end point. Nearby Otter Lake supplies 14,000 people with drinking water, and quality concerns have led area agencies to scrutinize its tributaries. Now more than ever, the farm's buffer strips, new dry dams and man-made wetland are highly prized water filtration systems.

Farley maintains buffer strips. Though he's farmed just 11 years, Farley's concept of an ideal buffer strip and its maintenance is refined. He mows regularly to reduce noxious weeds and tree sprouts. Once free of weeds, he opts to let the strips grow freely. The grassy retreats draw wildlife and upland game birds, and Farley delights in providing that habitat. To entice wildlife, he avoids fescue grass, often a buffer strip standby.

"We try and give it a diverse vegetation of alfalfa, clover, timothy and brome grass. The birds are better able to use it and it attracts a broader variety of insects for the birds to feed on," he says.

As a result, Farley said the quail population has more than doubled. Where high volumes of water tend to cross buffer strips, Farley turns to red-topped rye, which forms a uniform carpet and resists clumping under water flow. That means less water channeling into sod and, ultimately, minimal erosion.

Farley finds the buffer strips encourage absorption of water, an important yield factor, and minimize gullies. They also keep nutrients, herbicides and sediment on the farm where they do good, and out of the water supply, where they draw scrutiny. Says Farley, "as a land owner, you're not losing your soil and nutrients with buffer and filter strips. You're not sending them to the Lake or the Gulf of Mexico. Top-soil is your bread and



Buffer strips on Farley Cole's farm filter field runoff and entice upland game birds with a mixture of alfalfa, clover, timothy, and brome grass.

What it Does:

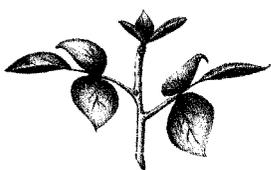
- Reduces soil erosion and nutrient and pesticide runoff.
- Enhances wildlife habitat by providing both food and shelter.
- Slows surface water flow, which reduces erosion by creating miniature dams across the slope.
- Increases water, nutrient, and pesticide infiltration.
- Allows for equipment travel and turns.
- Traps sediment.

Did You Know?

- Buffer strips established on the contour can reduce soil erosion anywhere between 20-75 percent.
- The recommended ratio of cultivated buffer strip width to crop is between 9:1 and 4:1.
- Native, warm season grass mixtures will benefit many species and beneficial insects.
- Mowing the strip every other year or third year will also increase your chances of seeing more wildlife.
- Some weedy growth in the strip is beneficial since it may be an insect source for young birds.
- Cultivated strip widths are determined by the following factors:
 - Slope,
 - Soil type,
 - Field conditions,
 - Climate, and
 - Erosion potential.

Maintenance:

- Conduct planting and cultivating parallel to the strip boundaries.
- Fertilize, according to soil tests, to maintain stand density and vigor.
- Establish newly created buffer strips before old buffer strips are tilled.
- To be most effective, buffer strips should have tall vegetation in the spring and early summer in order to protect young birds.
- Mow buffer strips to maintain appropriate vegetative density and height for trapping sediment.
- Spot seed if necessary.
- Redistribute sediment accumulations as needed to maintain uniform sheet flow across strip.
- Avoid applying insecticides on strips, unless necessary.



To be effective, each contour buffer strip must be at least 10 feet wide.
- 60 Ways: Farmers Can Protect Surface Water

Compatible Practices:

Contour Buffer Strips work best with:

- Conventional Tillage
- Crop Rotation
- Conservation Cover Crops

Regional Differences:

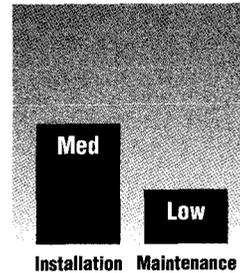
Many types of birds will use buffer strips as nesting grounds. Delay mowing until after birds have hatched and primary nesting season is over. The following schedule may be used when mowing contour buffer strips:

Location	Mowing Date
Midwest	July 15
Northern Plains	August 1
South Central	July 1
Southeast	July 1

2-CRP (Rev.3) Amend.6

NOTE: Mowing on the same date each year will reduce vegetative and wildlife diversity.

Relative Cost:



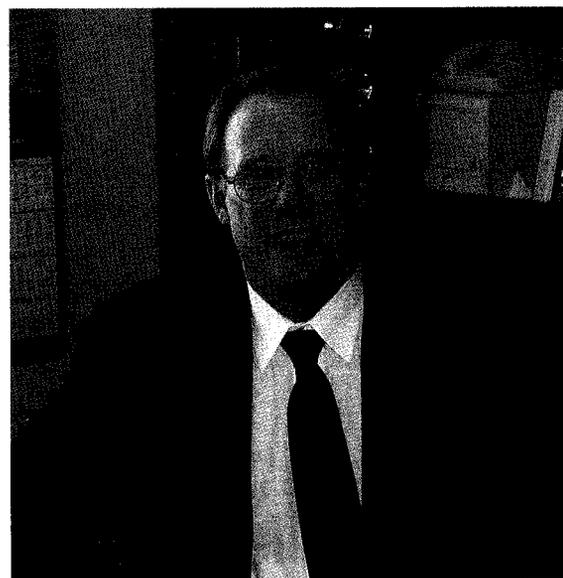
Subsurface Drainage:

controlling subsurfacewater through the use of tile drainage.



Photo courtesy of USDA-NRC

Bob Mehlhouse farms 1,000 acres in Renville County, Minnesota, that he has been farming since 1968. Besides using subsurface drainage he employs mulch tillage as a conservation practice on his farm. Subsurface drainage allows Bob to work in fields earlier and under better conditions. “The tile dries out the ground. I’m able to not only get on the fields earlier, but it also enables a more timely harvest. By draining the fields, compaction is minimized on the soils that I farm,” says Bob. Bob also finds that the tile prevents ponding of water over emerged crops after large spring and summer rains. Although Bob has incurred some cost in terms of installation and maintenance, he has seen yield increases from adding tile to his land. This is particularly true in low-lying areas.



Bob Mehlhouse finds that his yields have increased with subsurface drainage.

Benefits:

- Regulates the water table and promotes vegetative growth.
- Controls soil salinity.
- Improves water transportation.
- Allows for easier access to your field.
- Increases infiltration by increasing available moisture storage in the soil profile.
- Relieves artesian pressures and reduces surface runoff by increasing infiltration.
- Improves soil conditions for raising crops.
- Decreases erosion due to decreased runoff.
- Reduces delivery of sediment and attached pollutants to surface waters.
- Increases springtime soil temperatures permitting early season cropping.

Did You Know?

- In controlled drainage, subsurface water can be raised by blocking the drainage outlets and the water can be utilized for:
 - Wildlife habitat,
 - Subirrigation, and
 - Controlling nitrogen in the water supply by keeping more on-site for plant use.
- Depth, tile spacing, and the location of the drainage will be based on the following:
 - Soil type,
 - Topography,
 - Climate,
 - Ground water (amount and proximity to the surface),
 - Crop variety,
 - Outlet, and
 - Saline/alkaline conditions.

CAUTION:

Subsurface drainage should not be used to drain or alter wetlands. Consult your local Natural Resources Conservation Service (NRCS) office before installing drainage to ensure that no laws or USDA program requirements are being violated.



Tree roots, especially water loving trees like willow and cottonwood, may damage a drainage system and should be removed within 100 feet of the drain.

Regional Differences:

- Drainage works best in areas with a high water table.

Compatible Practices:

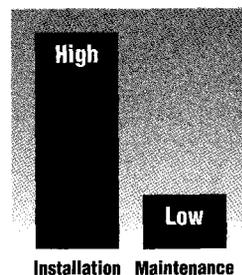
Subsurface drainage works best with:

- Terraces
- Diversions
- Conservation Tillage
- Grassed Waterways

Maintenance:

- Ensure that outlet is open to prevent water backup.
- Prevent small animals from entering the outlet by placing a rodent guard over the outlet.

Relative Cost:



Installation Maintenance

Terrace: *constructing a low earthen embankment across the slope that controls water and guides it safely off the field.*



Broad-based terrace: All slopes of the terrace are farmed

Farming in the Loess Hills of Iowa has its challenges. Warren Oliver of Missouri Valley, Iowa, can testify to it. “When I began farming thirty years ago, I rode the tractor from one ditch to another.” His farm was a victim of sheet, rill, and gully erosion. Over the years, Warren has installed terraces in several fields on his home farm. Warren uses a combination of terrace types to hinder soil erosion, including the broad-based, narrow-based, and grass-sloped terraces. While Warren utilizes no-till, he notes that:

“terraces are a necessary evil on the 25-26 percent slopes that I farm. Although they require more turning of machinery, I like how they hold the soil. There is very little erosion occurring. And if they are installed properly and maintained, they really work for the field and the farmer.”

When seeding new terraces, Warren plants brome grass in the fall. To establish a quick cover, wheat and rye followed by brome grass is an option. For wildlife cover, switchgrass is used. Where the terraces are less steep, they can be mowed. To control broad leaf weeds, he uses 2-4-D. Warren has had some rodent damage. However, for the most part, he has found that very little maintenance is required. “We cleaned out some terraces last year, but that was after they were in the ground for fifteen years.”



Grassed backslope terrace: The backslope of the terrace seeded to permanent vegetation, and is not farmed



Narrow-based terrace: Both the front and back slopes of the terrace are farmed

What It Does:

- Reduces soil erosion and nutrient and pesticide runoff.
- May enhance wildlife habitat by providing both food and shelter if grassed slopes are used.
- Assists in maintaining increased soybean yields because of increased infiltration and decreased erosion.
- Prevents gully erosion by diverting water in a controlled way.
- Slows water flow, which reduces erosion by creating dams across the slope.
- Increases water, nutrient, and pesticide infiltration.

Did You Know?

- Terraces control water runoff through:
 - **Storage** - collecting water and letting it infiltrate into the ground, and/or
 - **Grade** - channeling water off the field through a stable outlet
- Terraces should fit the contour of the land.
- Many types are available including:
 - Broad-based,
 - Grassed backslope, and
 - Narrow-based.
- Terraces can be installed with your own equipment with proper technical assistance in design and layout of the terrace.

Regional Differences:

- Terraces work best with uniform slope with clayey, silty, or loamy soils
- In order to protect your terrace, follow these procedures

If your terrace is...	Then...
broad-based and/or non-parallel	begin tillage at terrace ridge and proceed up and down slope parallel with terrace.
grassed backslope, narrow-based and parallel	begin on the front slope and work up hill parallel with terrace.

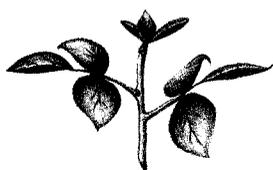
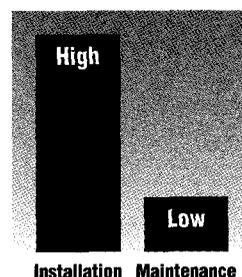
Maintenance:

- Never till or plant across a terrace.
- Never straddle a terrace ridge because it will flatten the structure.
- Maintain the same ridge height.
- Fertilize and seed according to recommendations.
- Avoid herbicide and tillage damage on grassed areas.

Compatible Practices:

Terraces work best with:

- Contour Farming
- Contour Stripcropping
- Filter Strips
- Underground Outlets
- Waterways
- Other Terraces or Diversions

Relative Cost:

Caution: Unless properly installed and maintained, terraces can cause gully erosion.

Diversions: *constructing an earthen embankment that controls water and guides it across the slope.*

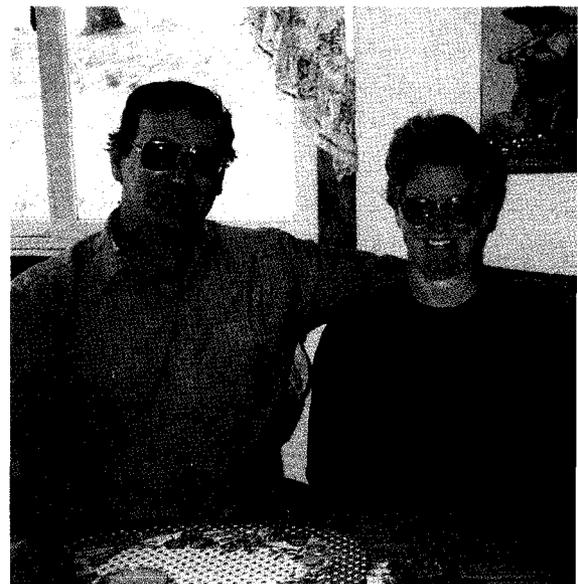


Photo courtesy of USEC

Our neighbor nearly lost his home on January 19, 1996, but he credits our diversion for saving it,” recount Mark and Sandy Wilmot of Union Dale, Pennsylvania. Located on the south knob of Elk Mountain, the Wilmot farm has over 37 acres draining into their diversion that protects their barn, house, and pond.

“I was amazed that the ditch never overflowed on that day in January,” says Sandy. The temperature rose to 68 degrees, it rained 3.5 inches, and we already had three feet of snow on the ground. You can just imagine the mess. If we didn’t have the diversion, we would have had several inches of water in the dairy barn and house. More importantly, our pond dam would have broke, and our neighbor’s house would have been history.”

Mark and Sandy installed the diversion, using cost-share from the Agricultural Conservation Program (ACP). Designed by the Natural Resources Conservation Service, the 1,410 foot-long diversion allows Mark and Sandy to not only divert and slow the water from the mountainside, but also allows them to move their equipment across it. Maintenance and upkeep consist of mowing the diversion twice a year, in July and August. “The maintenance isn’t too difficult, and the benefits in keeping the farmstead dry far outweigh the costs and time involved in mowing,” reports Mark.



Mark and Sandy Wilmot credit their diversion with

What It Does:

- Reduces soil erosion and nutrient and pesticide runoff.
- Can be used on cropland, pastureland, and forestland.
- May enhance wildlife habitat by providing both food and shelter.
- Assists in maintaining good soybean health because of increased infiltration.
- Prevents gully erosion by diverting water in a controlled way.
- Slows water flow, which reduces erosion by creating miniature dams across the slope.
- Reduces flooding.
- Increases water, nutrient, and pesticide infiltration.
- Allows for equipment travel.

Did You Know?

- Diversions and terraces are similar, but diversions are usually larger than terraces and are seeded to permanent vegetation in all cases.
- Diversions should fit the contour of the land.
- Strips should be installed in multiples of your farm equipment width for easy maneuvering.

Maintenance:

- Never till or plow across a diversion.
- Maintain the same ridge height and clean sediment from channel on a regular basis, if necessary.
- Mow when necessary. See Contour Buffer Strips for mowing instructions.
- Fertilize and seed according to recommendations.
- Watch for outlet washouts and repair when necessary.
- Keep out burrowing animals.

Compatible Practices:

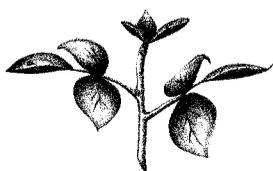
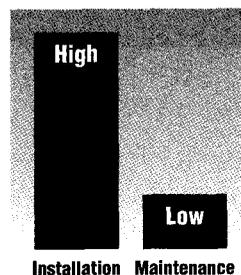
Diversions work best with:

- Contour Farming
- Contour Stripcropping
- Crop Rotation
- Conservation Tillage
- Filter Strips
- Grassed Waterways
- Other Terraces or Diversions

Regional Differences:

Location	Cover Crop Type
Midwest	Smooth Brome grass Common Lespedeza (wildlife friendly) Birdsfoot Trefoil (wildlife friendly)
Northern Plains	Intermediate Wheat Grass Smooth Brome grass Switchgrass, Big blue stem, Indiangrass
South Central	Bermuda Grass Switchgrass (wildlife friendly)
Southeast	Bermuda Grass Bahia Grass (wildlife friendly)

Relative Cost:



As early as 5,000 years ago, farmers in China grew soybeans.

Contour Stripcropping: *rotating contour strips of small grains, grass, or legumes with row crops.*



Photo courtesy of USDA-NRCC

When it comes to maximizing space and practicing efficient farming, Corwin Fee of Knoxville, Iowa, probably leads the pack. Raising both cattle and crops, Corwin finds that a combination of conservation buffer strips, stripcropping, waterways, and field borders allows him to not only save soil and grow crops, but also maximize his pastureland.

"I find this to be an efficient system. I cut the hay once a year in July, and then graze the areas in the fall. With Gallagher fencing (two-wire fencing) between fields, I can pasture my cattle in the crop fields once I harvest a crop. It's been five years since I've installed these buffer strips and stripcropping. I notice very little erosion on the farm," says Corwin.

To maximize grazing and hay production, Corwin plants these buffer areas with bromegrass, clover, and orchardgrass. By maximizing his pastureland with this approach and using a rotational pasture system on his non-cropland, Corwin only needs to feed hay to his animals from December through March. Corwin rotates his pasture every 3-5 days. His water sources are small dugout ponds that are shared between paddocks. "I like the ponds," says Corwin, "I keep the animals out of the streams as much as possible. Although I have one stream crossing on the farm, I prefer the dugout ponds. The ponds are easier to maintain than the streambanks, and the cattle have fewer injuries."



Corwin Fee's farm consists of a system of contour stripcropping, contour buffer strips, dugout ponds, field borders, and grassed waterways.

What It Does:

- Slows water flow, which reduces erosion by creating miniature dams across the slope.
- Traps sediment from row crop strips in closely sown strips, i.e. legumes, grasses, or small grains.
- Increases water, nutrient, and pesticide infiltration.
- Reduces soil erosion and nutrient and pesticide runoff.
- Increases soil quality by adding organic matter from grassed areas.
- Controls pests by breaking the cycle of weeds, diseases, and insects.
- Reduces pesticide and fertilizer crops by reducing the need for nutrient and pesticide applications.
- Provides wildlife habitat diversity.

Did You Know?

- Rotating strips with legumes provides a free nitrogen boost for next year's row crop.
- Strip width depends on your field slope and machinery width.
- Avoid herbicide drift on non-row crop areas by measuring strips to fit your spray boom.
- Contour stripcropping prevents gullies and sheet erosion.
- Development of saline seeps or other salinity problems may result due to increased infiltration.

Regional Differences:

Contour stripcropping works in all areas of the country. It works best on areas with a uniform slope. Complex slopes may have many point rows, which can decrease the efficiency of field operations.

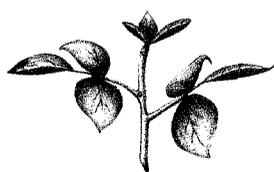
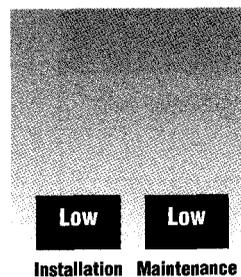
Compatible Practices:

Contour stripcropping works best with:

- Conservation Tillage
- Filter Strips
- Grassed Waterways
- Nutrient Management
- Integrated Pest Management
- Diversions
- Terraces

Maintenance:

- Maintain a permanent key field guide, such as a diversion, terrace, or contour buffer strip, to maintain the strip contour pattern.
- Smooth any ridges that may occur along the upslope side of grass strips that trap sediment.

Relative Cost:

Contour stripcropping can reduce soil loss as much as 75 percent depending on soil type and slope of the land. - NRCS, Nebraska

Irrigation Water Management:

knowing when to irrigate and how much water to apply.

Common irrigation methods which work for soybeans:

- **Furrows** - water is applied by gravity across the soil surface by flooding small channels or furrows. See Furrow Irrigation.
- **Center pivot, linear move** - water is applied by a continuously moving pipeline supported by mobile towers. See Sprinkle Irrigation.
- **Big guns** - water is applied by a single impact gun that periodically or continuously moves. See Sprinkle Irrigation.
- **Subsurface drip irrigation** - water is applied below the soil surface, at the root zone. See Subsurface Drip Irrigation.

There are several types of irrigation systems commonly used in soybean production. The table below identifies these methods.

This method of irrigation...	Works best with...
Furrows (graded)	<ul style="list-style-type: none"> • Low to moderate infiltration soils; • A variety of crops; • Low continuous flow rate; and • Is easily automated.
Center pivot, linear move, and big guns	<ul style="list-style-type: none"> • Various soils, primarily sandy and other high or variable infiltration soils; • A variety of crops; • Continuous water supply; and • Are adaptable for use on nearly all irrigable soils
Subsurface Drip Irrigation Systems	<ul style="list-style-type: none"> • Moderately permeable soils; and • Consistent water supply.

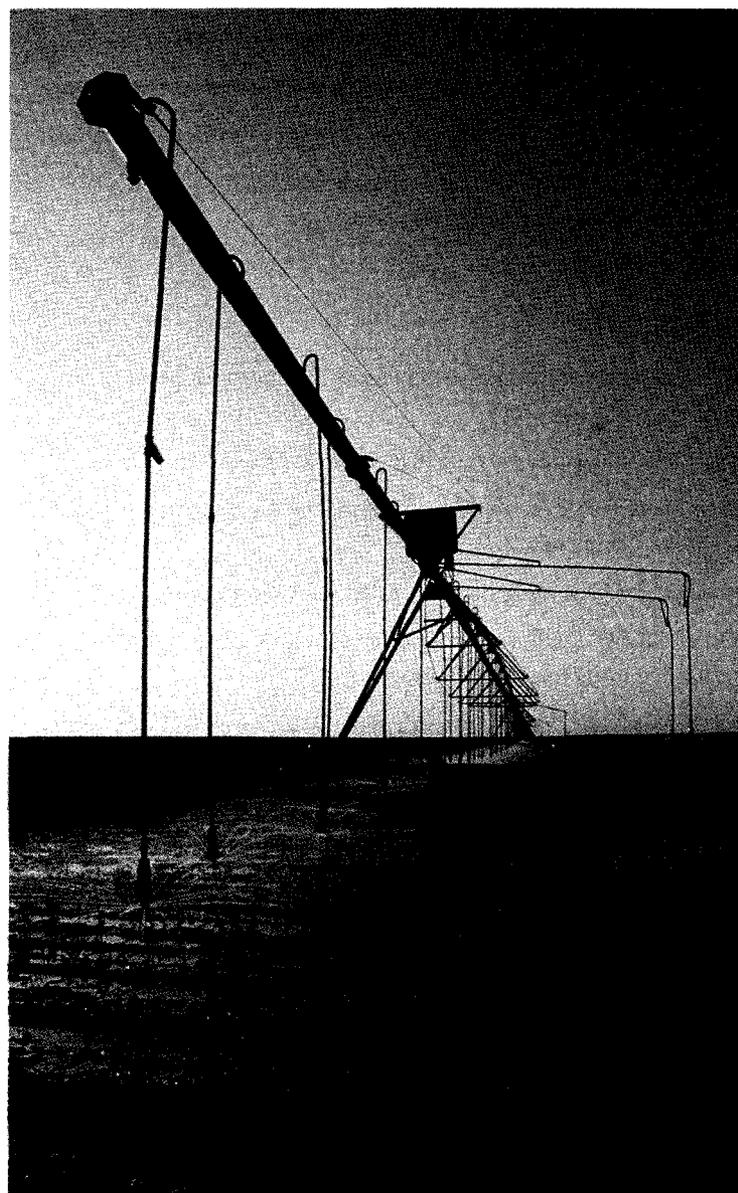


Photo courtesy of USD

What Are My Irrigation Needs?

- Typical peak water use for soybeans is .32 inches per day.
- The simplest way to determine basic irrigation water needs is as follows: $QT=DA$, where:

Q = Flow rate (ft³/s)

T = Time (hr)

D = Depth (in)

A = Area (acres)

For example, a flow rate of 1 cubic foot per second for 1 hour = 1 inch depth over 1 acre (448.8 gallons per minute). This simple equation, modified by an overall irrigation efficiency, can be used to calculate daily water supply needs by plants, number of acres irrigable from a source, and/or the time required to apply a given depth of water from an irrigation well or diversion.

What It Does:

- Determines the rate, amount, and timing of irrigation water in a planned and efficient manner.
- In examining irrigation management, you need to look at the following:
 - Soil type(s) and fertility,
 - Stage of plant growth,
 - Local climate,
 - Topography,
 - Water source quality and quantity, and
 - Crop characteristics.

Did You Know?

- Using plant appearance as the moisture deficit symptom can be misleading. When a plant appears dry, it may already be under moisture stress conditions, or the dry appearance may also indicate a lack of nutrients, essential elements, or disease.

To estimate dry conditions:

- Feel the soil, and/or
 - Use a soil probe, and
 - Utilize an irrigation scheduling method.
- Soybean roots are very dense in the top 6 inches of soil, but the plant's tap root normally extends 2-3 feet below the surface.

How often should you check the soil?

Soil Texture	Deep Rooted	Shallow Rooted
Coarse	3-4 days	2 days
Medium	5-6 day	2-4 days
Fine	8-10 days	5-6 days
Check soils more often in hotter weather		

- Roots will not grow in a dry soil; soil moisture outside the actual root development area is always needed.
- More water is needed for soybeans when:
 - The days become longer and warmer;
 - Soybeans are flowering and fruiting (after fruiting, the demand for water may decrease); and
 - The plant matures and becomes larger. See diagram.

Should I install or upgrade my irrigation system?

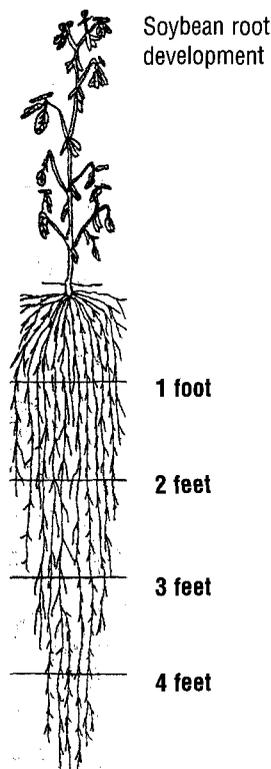
When determining the benefits and costs of installing or updating an irrigation system, the following scenarios should be considered:

- Improved water management with the existing irrigation system;
- Improved precipitation storage in the soil resulting from improved soil condition, better crop residue use, number and type of tillage operations, contour farming, water table control, etc; and
- Economic value of improved yield versus cost of installing an irrigation system.

When considering a change, remember to compare an equivalent level of management. For example, often a poorly managed surface irrigation system is compared to a properly managed sprinkler system. This type of comparison is ineffective; determine your management style and assume the equivalent in a new irrigation water management system.

Maintenance:

- Evaluate soil and plant needs to determine nutrient and pesticide needs.
- Conduct soil tests to monitor the buildup of available nutrients.
- Calibrate soil moisture meters regularly.
- Incorporate fertilizers to prevent their runoff.



Never assume a plant root zone. Always observe root development in the soil.



Furrow Irrigation: *channels are cut in the soil, and a portion of the ground is covered with water.*



Photo courtesy of USDA



In the spring, Marc drains the field by raising the flashboard riser.

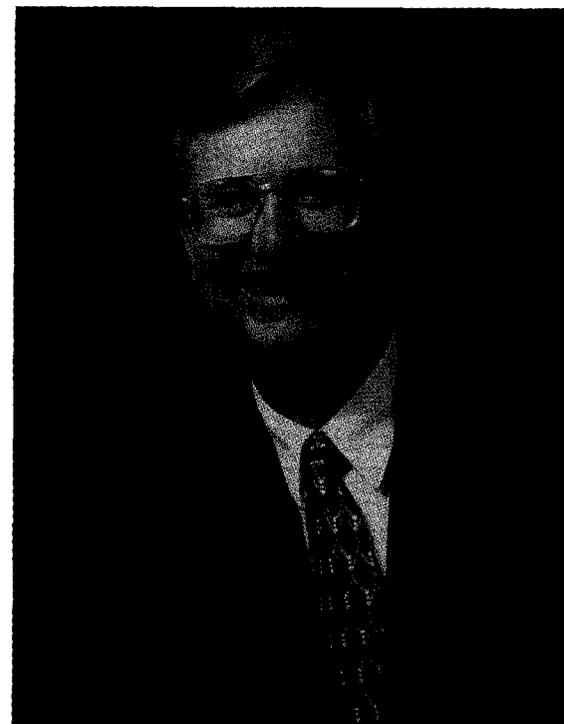


Precision land forming allows for installation of more effective drainage systems, particularly for graded furrow irrigation systems.

Farming in the Mississippi Delta, Marc Curtis of Leland, Mississippi, adopts a corn, soybean and rice rotation. In this type of rotation, proper irrigation management is extremely important. In a majority of the 2,500 acres that he farms, Marc relies on surface irrigation to water his fields.

“Here in the Delta, we typically rely on fields with raised borders on all sides with an irrigation riser at the top and a flashboard riser at the low end of the field. These fields are usually precision landformed with straight levees.”

Using precision landforming in combination with a flashboard riser allows Marc to properly irrigate the low spots of the field, while also allowing them to drain. In the winter, Marc floods the field by raising the dam of the flashboard riser. Flooding the field not only controls weeds, but also provides feeding ground and habitat for waterfowl. “We see a lot of different types of migratory birds here in the Delta; they eat



Marc Curtis uses a variety of practices to operate his furrow irrigation system.

What It Does:

- Furrow systems use gravity to distribute large streams of water.
- Water enters the soil by vertical and lateral infiltration.
- There are several types of furrow systems commonly used in soybean production. The advantages and disadvantages of each are listed in the chart below.

Did You Know?

- Furrows can be straight or contoured with the land.
- Laser controlled land leveling is best for grade uniformity.
- Tailwater runoff recovery is nearly always required by graded furrow irrigation to provide uniform and adequate irrigation in the lower part of the field.
- To get adequate water infiltration in the lower portions of the field, the upper end is usually overwatered, resulting in deep percolation losses.
- Salts may concentrate in ridges and beds, thus prohibiting seed germination.
- Water with a high amount of sediment can be used.

Compatible Practices:

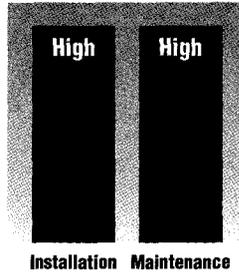
Furrow irrigation works best with:

- Crop Rotation
- Conservation Tillage
- Filter Strips
- Nutrient Management
- Integrated Pest Management
- Chiseling or Subsoiling (eliminates compaction)

Maintenance:

Annually haul and redistribute any eroded soil that may accumulate in low areas.

Relative Cost:



Furrow System	Advantages	Disadvantages
Level-furrows on a flat or nearly flat grade	<ul style="list-style-type: none"> • High uniformity can be attained. • Net irrigation application can be adjusted. • No runoff. • Water with large sediment amounts can be used. • Easily automated. • Easiest to manage of all systems. 	<ul style="list-style-type: none"> • Except on perfectly flat fields, extensive preparation is required for installation. • Surface drainage is essential. • Short set times require frequent changes. • Higher possibility of salt leaching on ridges than other systems.
Graded-furrows that are evenly spaced but allow water to flow downslope	<ul style="list-style-type: none"> • The number of furrows irrigated at one time can be adjusted to match available water delivery. • Water with large sediment amounts can be used. • Low initial cost, if no extensive land leveling. 	<ul style="list-style-type: none"> • Extensive land grading may be required. • Labor requirements are high because irrigation streams may not flow uniformly. • Higher possibility of salt concentration on ridges than other systems.
Graded with blocked ends-furrows that are blocked at ends to encourage ponding	<ul style="list-style-type: none"> • Reduces or eliminates runoff. • Application uniformity can be increased by allowing ponding in lower parts of the field. 	<ul style="list-style-type: none"> • Limited to field slopes where ponded areas are between a fourth and a third of the field length. • Furrows must have large cross section to encourage ponding. • An increase in labor is required to watch and adjust flows.
Graded using surge technique-furrow system using a plug which travels slowly through a pipe to distribute water through gates	<ul style="list-style-type: none"> • Reduces labor. • Easy to adjust the speed of the plug. • Improves uniformity. • Reduces runoff and deep percolation. • Accounts for variable grades. 	<ul style="list-style-type: none"> • Extensive land grading may be required. • Screening to remove trash from gates is lost. • Some water is lost at the start when the plug has moved far enough to allow water to discharge from all outlets.
Graded using tailwater recovery-furrow system which returns runoff water to the head of the field to reuse in irrigation	<ul style="list-style-type: none"> • Off-site runoff is decreased, thereby decreasing potential pollution. • Wastewater is available for reuse. • Irrigation application uniformity is increased. • Pesticides and nutrients contained in runoff are reapplied. 	<ul style="list-style-type: none"> • Cropland is taken out of production for reservoir pond. • Ponded water containing nutrients and pesticides may create a potential hazard for wildlife.



Flooding fields at various depths will create a diversity of wildlife habitats. For instance, shorebirds prefer wet mud and water up to four inches in depth, while wading birds like water up to 12 inches deep.

Sprinkle Irrigation:

using a system of nozzles to apply water to crops.

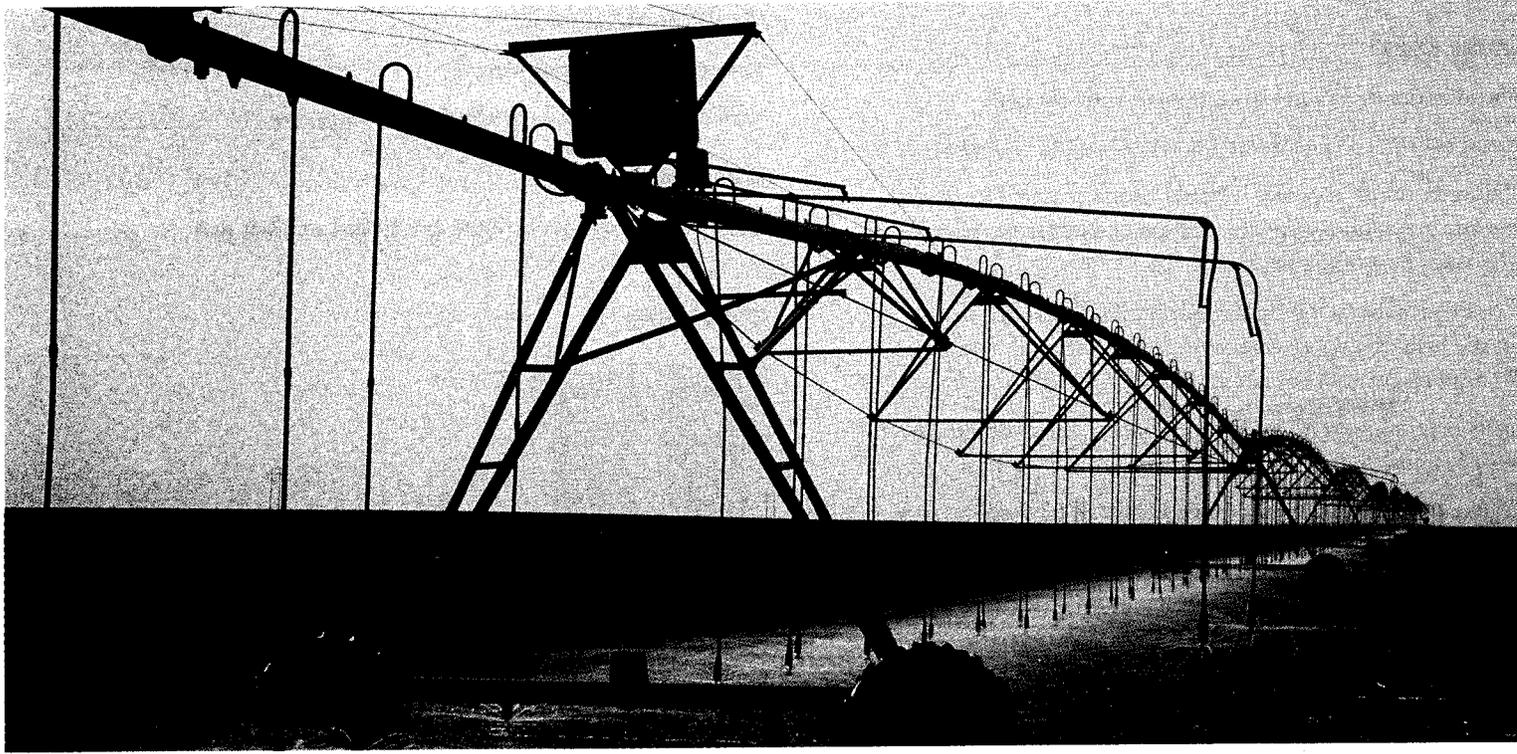


Photo courtesy of USIA

Along the Missouri River, John Williamson of McBain, Missouri, irrigates his crops using a center pivot irrigation system. Extending 1,800 feet in length, the center pivot waters approximately 250 acres. In a normal year, John adds 3 to 5 inches of extra water to irrigate his crops. This extra water boosts his yields, reports John.

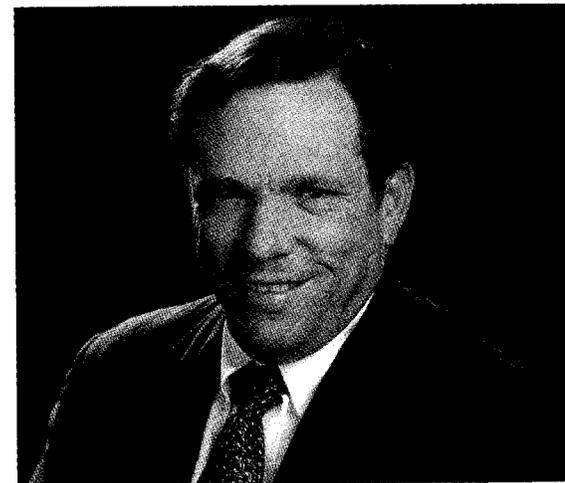
"If I irrigate corn, I see a 30 to 40 bushel increase per acre. With soybeans, it is harder to see a change. Soybeans are an indeterminate crop. Unlike corn, they can live through rough and dry weather, because they use a lot less water."

On average, it takes about three days to add an inch of water. In a dry year, John estimates that it costs approximately \$3 to \$4 per acre, per year, to irrigate his crops. John finds that most of his costs to irrigate are not centered around pumping water, but rather maintenance of the system. John recounts,

"This is an older system. I installed it in 1972. As it ages, I notice that I am spending more in system maintenance. Most of the cost centers around down time. There are 28 wheels, 14 tires, and 42 gearboxes to service. It takes time to check these when it is not running properly. Despite this, the system really pays for itself, especially in dry years."



This irrigation field reservoir stores water for a field or group of fields.



For nearly 30 years, John Williamson has

- A variety of sprinkler models are used to irrigate. Systems are classified by how their laterals operate. Three primary types of systems are:
 - Fixed,
 - Periodic move, and
 - Continuous, self move.
- Pressure for sprinkler systems is generally provided by gas and electric motors or diesel engines; where elevation drop is sufficient, sprinklers can be operated using gravity to provide the necessary pressure.
- Sprinkler systems can have a 50-95 percent efficiency based on the type of system used, cultural practices, and management.
- Well-managed sprinklers that apply water uniformly, deter ponding, and minimize surface water movement and deep percolation.

Did You Know:

There are several types of sprinkler systems commonly used in soybean production. The advantages and disadvantages of each are listed in the chart below.

Compatibility:

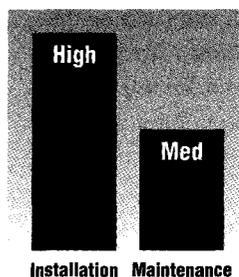
Sprinkle Irrigation works best with

- Crop Rotation
- Conservation Tillage
- Filter Strips
- Nutrient Management
- Integrated Pest Management

Maintenance:

- Maintain nozzles.
- Maintain proper operating pressures.
- Use a check valve and anti-siphon device to prevent pesticide and nutrient contamination.

Relative Cost:



Sprinkler System	Advantages	Disadvantages
Center pivot-a sprinkler system which has a continuously moving horizontal rotating lateral supported by towers and anchored at a fixed point	<ul style="list-style-type: none"> • Operating labor is reduced. • Main supply lines are minimized. • High application uniformity is possible. • Because a small amount of water can be applied, it is simple to manage water applications. • Light frequent applications can be made. • Chemical applications can be made through the system. • Reduces erosion. • Can operate as part of a circle system. 	<ul style="list-style-type: none"> • Water evaporation losses increased. • Often short of meeting peak daily crop water use, cannot keep up in extended periods of hot and dry weather. • Low pressure at the lateral end, thus higher pumping costs. • Maintenance cost is higher than with standard pivot systems. • Field corners are missed. • Some fertilizers or pesticides may be transported through wind drift. • Large, initial investment.
Big guns-large periodically moving guns are operated and moved as a large single impact	<ul style="list-style-type: none"> • Reaches missed corners of center pivot fields. 	<ul style="list-style-type: none"> • Sensitive crops may be damaged. • Some fertilizers or pesticides may be transported through wind drift.



Rainfall distribution and amount during soybean pod filling determines final yield. Using two plant dates may be good insurance against inadequate moisture.

Subsurface Drip Irrigation: *using a system of underground drip tubes to apply water to crops.*

“Irrigation for soybeans can increase dryland yields by 20 percent to 100 percent, or add 10 to 25 bushels per acre depending on the year and weather. However, soybean plants and root systems do not respond well to very wet or saturated soil conditions,” concedes Dr. Gary Clark of Kansas State University. Because subsurface drip irrigation (SDI) can be used to control and apply water more precisely than other conventional irrigation methods, Dr. Clark and other Kansas State Research and Extension colleagues are investigating the effect of SDI on soybean yield.

There are several benefits to using SDI. SDI applies water directly to the root zone, while leaving non-irrigated zones between the plants very dry. These dry conditions can minimize weed growth and decrease the need for herbicides between rows in certain climatic areas. According to Dr. Clark, “subsurface drip irrigation is gaining in popularity for use on small or odd-shaped fields that are not practical or economical for center pivot irrigation.” Primarily, these SDI systems are used to irrigate corn in Kansas, but there is growing interest to use SDI on soybeans, which are often rotated with corn. However, the water management criteria used for corn may not be appropriate for soybean and little information exists on drip irrigation management for soybeans.

As a result of this interest, Dr. Clark initiated research to compare the yield response of soybeans to shallow versus deep placement of drip irrigation tubes for SDI. Drip irrigation tubes were installed at depths of both 12 (shallow) and 18 (deep) inches. Soybean seeds were planted in standard rows of 30 inches and were also drilled in 10 inch rows. Outside rows between plots were several feet away from the drip irrigation lines and were considered non-irrigated. The 1999 study results are listed below:

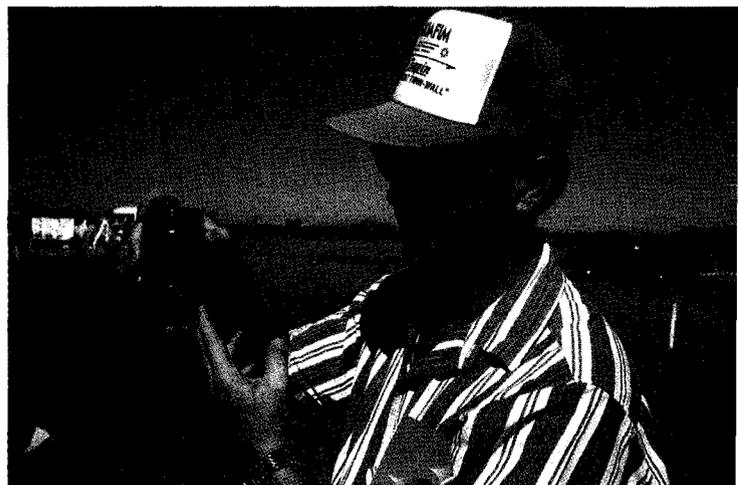
Drip Tube Depth	Standard 30" (15") rows		Drilled 10" rows	
	12"	18"	12 "	18"
Irrigated Rows	34.9	42.5	39.1	38.7
Non-Irrigated Rows	25.5	24.1	27.6	26.3

1999 Soybean Yield (bu/ac) from a subsurface drip irrigation study at Kansas State University.

In summary, soybean yield was increased by 56 percent for the irrigated rows that were closer to the buried drip laterals than the non-irrigated rows. Depth of tubing placement appeared to have an effect on soybean yield in the standard (30-inch) row plots. While these results are from one year of research and other climatic years and geographic locations will have different results, the trends in this research are promising for continued SDI research on soybeans.



Dugout view and wetting pattern of a buried drip irrigation lateral line (18 inches deep). Photo courtesy of Kansas State University.



Gary Clark examining a poor quality water sample for SDI

What it Does:

- Is the most efficient of all methods of irrigation when properly managed.
- Uses less water when properly managed.
- Applies water directly to the plant's root zone and reduces crop stress.
- Lowers water usage and pumping costs.
- Minimizes evaporation.
- Is effective in irrigating odd-shaped fields, such as center pivot corners.
- Prevents soil and nutrient erosion from irrigation runoff.
- Controls deep percolation because water amounts are applied in small doses.
- Allows for improved field traffic due to drier soil surface conditions.

Did You Know?

- Subsurface drip irrigation can be used with most water sources. However, all water sources must be filtered and most will need some periodic chemical treatment to prevent clogging of the drip emitters.
- Drip irrigation benefits come from consistent soil moisture in the root zone. This means "low volume, frequent irrigation and 'spoon feeding' of the root zone."
- Subsurface irrigation may reduce water usage by at least 25 percent.
- Nitrogen and other fertilizers can be fed into the system to fertilize plants directly at the root zone.
- Farmers may save money by modifying a ripper, mounting the tape above the toolbar, and installing the drip line, themselves.
- Because subsurface irrigation is relatively new, little is known about its lifespan. However, many commercial systems have been in use for over 10 years.
- Proper maintenance is required to insure long-term health and operation of the system.

Companion Practices:

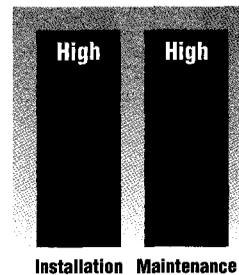
Subsurface drip irrigation works best with:

- Crop Rotation
- Conservation Tillage
- Nutrient Management
- Integrated Pest Management

Maintenance:

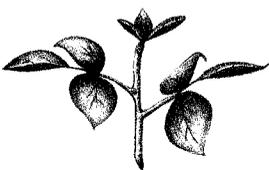
- Do not cut corners on filters. The proper level of filtration is necessary to ensure the system's long-term viability.
- Screen and sand media filters should be checked during or after each operating period.
- Measure soil moisture to determine if irrigation schedules need to be adjusted.
- Prevention of clogging often starts before this system is installed. Chemical and biological analysis of the irrigation water is needed to determine filtration system type, proper placement and use of flow meters, and proper placement and use of pressure gauges.
- Flush driplines occasionally to remove debris from emitters and buildup in the lines.

Relative Cost:



Note:

- Installed cost per acre is approximately \$200 higher in most areas than full scale (125 acre) center pivot irrigation systems.
- While center pivot irrigation systems have a cost advantage over subsurface irrigation systems where full size center pivots can be utilized, subsurface drip irrigation may prove to be economical and efficient for small and irregularly-shaped fields, or when water supplies are limited.



Irrigation accounts for the largest use of ground water in the U.S. — 49 billion gallons. Texas leads the nation in the number of irrigation wells with 122,000.

Conservation Tillage: *planting in the previous crop's residue*



Photo courtesy of USDA-NRCS

There are several types of conservation tillage. They include:

- No-Till Planting
- Strip Tillage
- Ridge Tillage
- Mulch Tillage

The following table gives you an estimate of the range of residue levels after one tillage pass.

Levels may vary due to speed and depth of tillage and moisture content of the soil and residue.

Machine or Operation	Percent Residue Left	
	Corn/Small Grain	Soybean
After harvest	75-95	65-90
Over winter weathering	80-95	70-80
Moldboard plow	0-10	0-5
Paraplow/Paratill	80-90	75-85
V ripper/subsoiler	70-90	60-70
Chisel plow with:		
Sweeps	70-85	50-60
Straight chisel points	60-80	40-60
Twisted points	40-60	20-30
Coulter chisel plows with:		
Sweeps	60-80	40-50
Straight chisel points	50-60	30-40
Twisted points	30-50	20-30
Disk chisel plows:		
Sweeps	50-70	30-50
Straight chisel points	50-60	30-40
Twisted points	30-50	20-30
Disks:		
Offset primary cutting	30-60	20-40
Offset heavy plowing	25-50	10-25
Tandem disk (primary cutting)	30-60	20-40
Tandem disk after harvest, before other tillage (light)	70-80	40-50
Field cultivators as primary tillage operations:		
Duckfoot points	35-65	30-55
Sweeps or shovels 6-12"	35-75	50-70
Sweeps 12-20"	60-80	55-75
Field cultivators as secondary tillage operations:		
Duckfoot points	60-70	35-50
Sweeps or shovels 6-12"	70-80	60-75
Sweeps 12-20"	80-90	65-80
Finishing tools:		
Soil finisher (disk, shank, leveler)	50-70	30-50
Seedbed conditioner (spring tooth and rolling basket)	70-90	50-70
Culti-packer	60-80	50-70
Harrow, spike tooth	70-90	60-80
Drills:		
Hoe Openers	50-80	40-60
Disk Openers	80-100	60-80
No-till coulters	75-80	60-80
Planters:		
Runner planters	85-95	80-90
Double disk opener planters	85-95	75-85
Sweeps or double row cleaning disks	60-80	50-60
Ridge-till planter	40-60	20-40
No-till planter with:		
Smooth coulter	85-95	75-90
Ripple coulter	75-90	70-85
Fluted coulter	65-85	55-80
2 or 3 fluted coulter	60-80	50-75
Anhydrous applicator	75-85	45-70

Benefits:

- Plants crops in the previous crop's residue.
- Reduces erosion by leaving pieces of residue to intercept raindrops, thus decreasing erosion.
- Improves soil tilth by adding organic matter.
- Saves you time and money because you make fewer trips across the field, lowering fuel and labor costs, and causing less wear and tear on the machinery.
- Reduces compaction by eliminating unnecessary trips across the field.
- Allows crops to withstand drier conditions, because the surface residue reduces evaporation, increases infiltration, and lowers the soil temperature.
- Protects water quality by decreasing erosion.
- Provides food and cover for wildlife.

Did You Know?

- The time to start managing the crop is at harvest.
- A low residue-producing crop should follow a high residue-producing crop.
- Wait until spring for tillage operations to keep residue on the surface for winter and spring snow melt.
- The amount of crop residue is highly variable, depending on the yield, tillage equipment, row width, alignment of disk blades, residue type, etc.
- Slower tillage speeds and shallower tillage increase residue. Adding sweeps or adjusting equipment can increase residue.

As it relates to soybeans:

- To get even soybean residue coverage, install a spreader on the combine that distributes residues evenly. Clumped residue areas keep the soils cold and delay you from entering the fields.
- Soybean residues decompose rapidly. As a result, avoid chopping and disturbing them after harvest.

Regional Differences:

Conservation tillage results vary across the country. Some things that may work in some areas of the country may not work in others. Use these write-ups as a guide and test these types of tillage practices in your own farming operation to see what works best.



When it comes to storage and transportation, soybeans should be moved and stored very carefully since they are more susceptible to cracks and breakage than most grains.

Compatible Practices:

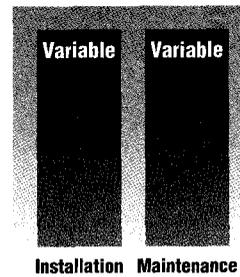
Conservation tillage works best with:

- Crop Rotation
- Conservation Cover Crops
- Integrated Pest Management
- Soil Sampling
- Nutrient Management
- Filter Strips

Maintenance:

- Monitor your tillage pass to determine how much residue is left on the field. Equipment may need to be weighted to cut through heavy residues.
- Test your soils regularly to determine nutrient needs.
- Conduct field scouting on a regular basis to detect weeds and pests.

Relative Cost:



Note:

- May require purchase of high residue planting equipment.
- Increased management may be required.

No-till Planting: *growing crops in narrow slots of previously undisturbed crop residue.*



Photo courtesy of USDA-NRCS, II

“**S**tick with it and be patient,” is Jack Stamp’s advice when talking about no-till. Jack, who farms 2,500 acres near Persia, Iowa has been experimenting with no-till planting since 1989. Today, Jack no-till plants all his corn and soybeans. For corn, Jack uses row-cleaners with 3/4-inch wavy coulters ahead of the planter unit, while he plants beans in rows 10 inches apart using a no-till drill. When asked why he no-tills, Jack replies,

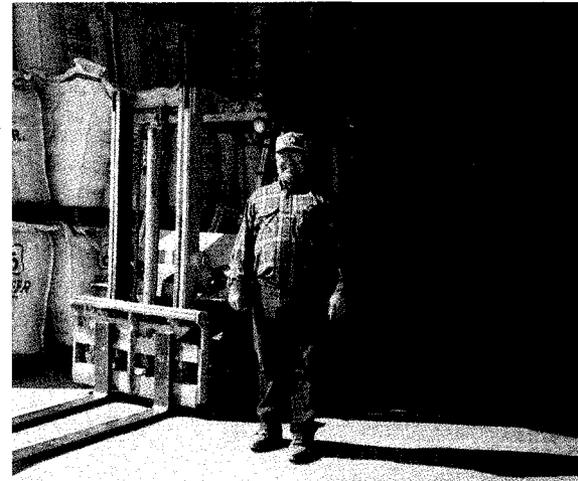
“I find no-till much more cost-effective. You save fuel, time, and labor in making fewer trips across the field, and the chemical costs have remained about the same. Actually one person can do now what it once took three people to accomplish. In fact, with no-till we burn only 3 gallons of fuel per acre, that includes tractor, delivery, and truck costs.”

Originally, Jack experienced some setbacks with no-till as it related to weed control and early application. As Jack explains:

“It takes time for the no-till system to become effective and a primary problem is with weed control, but in the past few years, the herbicides have improved, and broad leafs with extended no-till have been virtually eliminated. With conventional tillage, I was basically replanting the weeds. I have had to do ‘rescue treatments’ on certain fields, which can be costly, but with regular weed scouting, a lot of these problems can be eliminated.”

Jack recommends to those who try no-till to start with a small parcel of land and to “prepare the ground for no-till by eliminating the compaction layers before you start no-tilling.” Jack applies anhydrous in the fall, but notes that farmers should, “stay off the ground in the fall unless absolutely necessary. One of the biggest problems in no-till is to stay off the fields, especially when it is wet. With so few trips across the field, if properly maintained and prepared, compaction can be eradicated.”

Jack also recommends that residue be distributed evenly from the combine by installing a straw chopper and chaff spreader. Clumped pockets of residue can result in late planting, which in the long-run affect yield. With a chopper and chaff spreader on the combine, residue is distributed evenly resulting in warmer soils in the spring and throughout the growing season.



Jack Stamp eliminates considerable labor costs by using no-till planting.

What It Does:

- Reduces soil erosion.
- Assists in maintaining soybean yield by maintaining or increasing soil organic matter, water content, and nutrient balance.
- Increases drought and freezing tolerance.
- Enhances wildlife habitat by providing both food and shelter.
- Reduces weed germination.
- Minimizes release of carbon from soils, thus reducing the greenhouse effect.
- Reduces trips across the field and resulting compaction problems.

Did You Know?

- The higher the residue, the greater the benefits.
- After heavy rains, no-till allows you to enter fields sooner than conventional till methods.
- Conservation Districts may lease no-till drills.
- If you're new to no-till, start slowly to learn the system.
- Cultivation may be needed for emergency weed control; however, cultivation should be limited to spot treatment.
- The benefits of no-till may take several years to develop.
- The higher the stubble, the less likely you are to incur wind and drought damages.
- For additional wildlife benefit, leave rows of unharvested crops standing at intervals across the field.
- No-till works best if you prepare yourself ahead of time, by soil testing, examining the soil structure, and eliminating compaction.

Regional Differences:

No-till works in all areas of the country. Depending on soil type, you may achieve the following results:

If the soil is...	Then...
Clayey	No-till may make the soil more crumbly.
Sandy	No-till may allow the soil to hold more water.

Compatible Practices:

No-till planting works best with:

- Crop Rotation
- Conservation Cover Crops
- Integrated Pest Management
- Field Scouting
- Nutrient Management

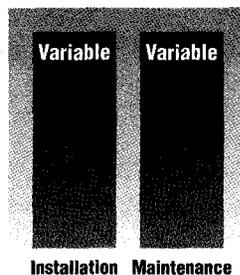
Maintenance:

- Weed control is accomplished primarily by herbicides and crop rotation.
- Test your soil regularly to determine nutrient needs and use a starter fertilizer if necessary.
- Scout for insect pests and apply insecticides when natural predators are not present.
- Spread the residue evenly. Do not allow it to accumulate in one area.
- Do not burn residue.

CAUTION:

Growers can partially compensate for cooler soil temperatures in a no-till system by planting more shallow. However, shallow planting exposes the seedlings to higher concentrations of soil-applied herbicides and may also result in lodging. Growers should check the label of the herbicide product for recommended planting depth to minimize seedling injury.

Relative Cost:



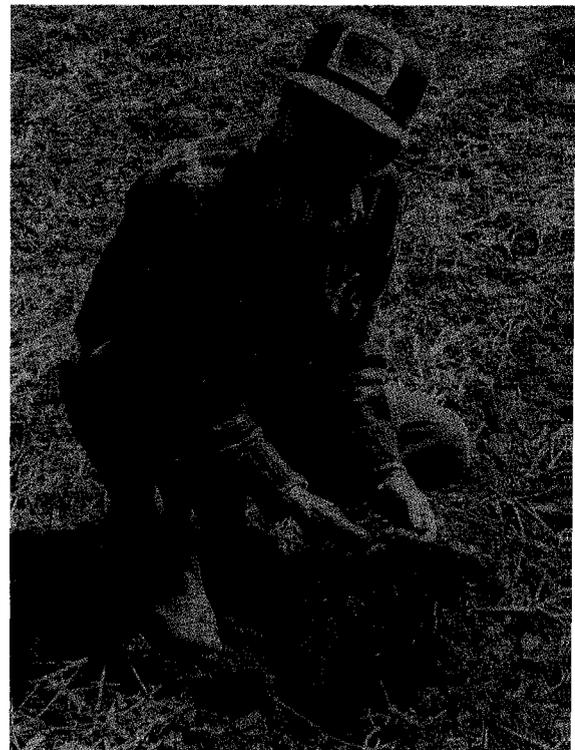
To be successful in no-till, use a chaff spreader on the combine for fragile soybean residue. Without it, the soils will remain too cool in areas with heavy residue.

Strip Tillage: *growing crops in narrow residue-free strips that are no more than 1/3 of the row width and leaving the remaining soil untilled.*



“**C**orn likes tillage,” reports Roy Bardole of Rippey, Iowa. A long-time no-till farmer, Roy is experimenting with strip tillage to see if his corn yields increase. For seven years, Roy has had success with no-till drilling his soybeans. However, with no-till corn, he has had more ups and downs.

“The cold, moist soils in Iowa sometimes limit us from getting higher yields in corn than we might expect,” Roy explains. In test plots ranging from 90 to 360 feet wide and 1,210 feet in length, Roy, with the help of Monsanto’s Center for Excellence, is attempting to ascertain the benefits of strip tillage. According to data collected on Roy’s strip tilled corn acreage, the average soil temperature was 2.7 degrees higher in the strip tillage system than the no-till system throughout May. Furthermore, over 10 times the number of earthworms were found on Roy’s strip till acreage than on his conventional till corn plots. All in all, the studies indicated that strip tillage aerated the soil and increased crop residue by tilling narrow strips that are no more than one-third of the row width. By leaving two-thirds of the row in no-till, Roy was able to increase organic matter, reduce compaction and erosion, and save time and labor.



Roy Bardole examines the soil's moisture content

Ridge Tillage: *growing crops on preformed ridges alternated with furrows protected by crop residue.*

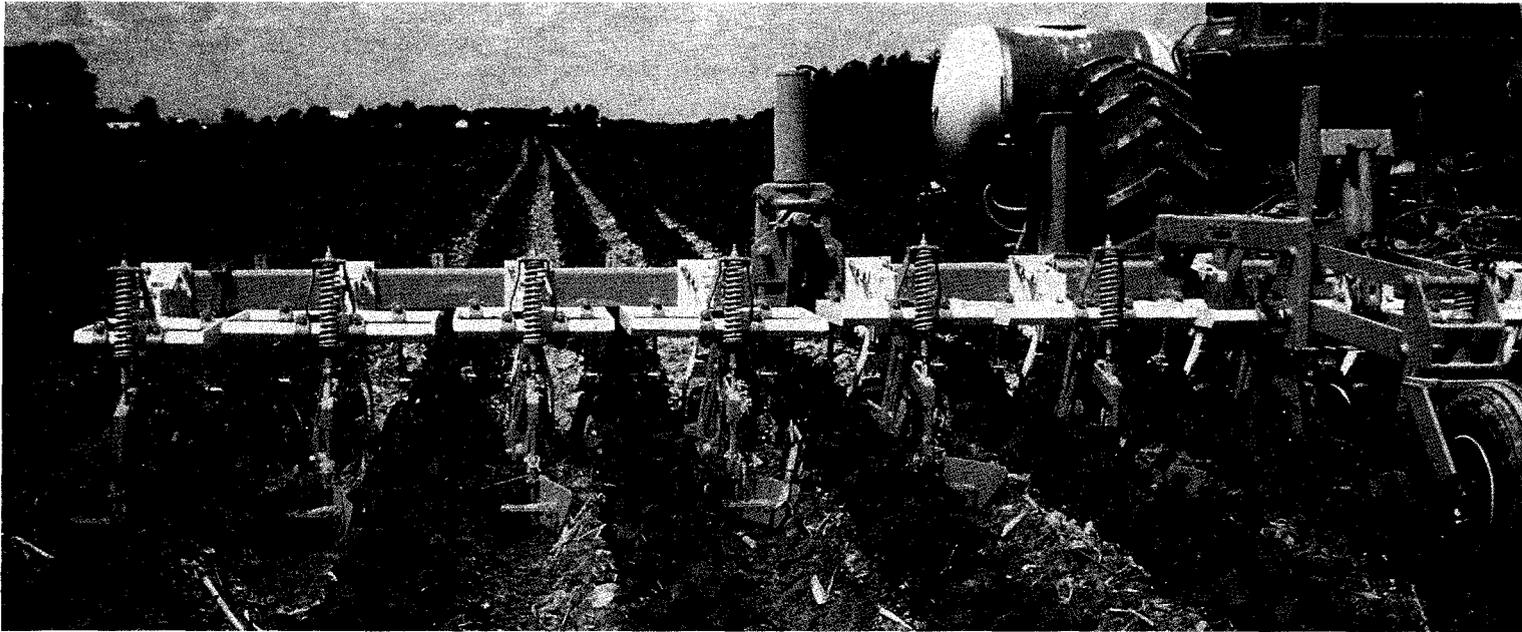


Photo courtesy of USDA-NRCS, IT

Farming a rotation of corn and soybeans, Howard Parr of Rossville, Kansas, finds a significant soybean yield increase when he uses sprinkle irrigation in combination with ridge tillage. Along the Kansas River Valley, some of Howard's irrigated fields yield up to 80 bushels per acre. When asked what is his secret of success, Howard replies, "Here in the valley, it averages 22 inches of rain per year. You can't waste water, instead you have to do your homework and look at water availability." Howard uses ridge tillage to dam and conserve water. "With sprinkle irrigation, you want to save water and utilize as much as possible," says Howard.

Like Howard, Tom Walerak ridge tills. Because his soils are often cool and wet, Tom finds that ridge till works best. With ridge tillage, he consistently sees an increase of soil organic matter of one or more percentage points in the past seven to ten years. Tom's primary reason for utilizing this practice is erosion control. Some of his land has 2 to 4 percent slopes. He feels that he has drastically cut the amount of wind and water erosion from his farm with ridge tillage. Tom also uses fewer pounds of pesticides by banding these products over the row. By doing this, Tom has cut his chemical usage by one-half. In addition, Tom uses a box banding system for P, K, and $ZnSO_4$. To Tom, "without proper fertilizer application, ridge tillage will not work."

Aside from erosion, for Tom, the second most important reason for using this production practice is cost savings. He can greatly reduce machinery and fuel costs by reducing the number of trips across his fields. This cost savings helps his bottom line.



Howard Parr, pictured with his son Ky, uses ridge tillage to conserve water



Tom Walerak finds that ridge tillage

What It Does:

- Reduces soil erosion from wind and water.
- Maintains or improves soil organic matter.
- Conserves soil moisture.
- Allows water, nutrients, and pesticides to infiltrate the soils, thus reducing surface runoff.
- Provides weed-free bed by moving weed seeds from the planting zone to the interrow area.
- Manages snow to increase moisture available to plants.
- Modifies cool, wet soil conditions.
- Provides food and cover for wildlife.

Did You Know?

- Proper ridge till maintains residues and ridge height throughout harvest and winter season.
- For best results, distribute residue evenly across the field.
- Prior to planting, ridge height should be at least 6 inches.
- After planting, the top ridge should be at least 3 inches higher than the furrow between the ridges.
- To manage snow, where stubble does not exceed 6 inches, orient ridges 45° from perpendicular to the prevailing wind direction.
- When used continuously, ridge till will accumulate and add organic matter to the soil.
- Wildlife habitat is enhanced by leaving rows of unharvested crop standing at intervals across the field.

Regional Differences:

Ridge till works in all areas of the country.

Compatible Practices:

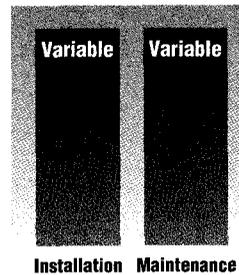
Ridge till works best with:

- Crop Rotation
- Conservation Cover Crops
- Field Scouting
- Integrated Pest Management
- Nutrient Management
- Contour Farming
- Irrigation Water Management

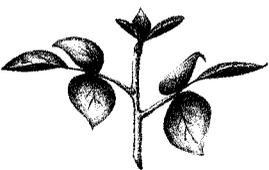
Maintenance:

- After planting, keep residues within the furrows until the ridges are rebuilt.
- Rebuild ridges to their original height and shape during the last row cultivation.
- Maintain cultivation and planting equipment, such as ridging attachments, row cleaning, devices, and guidance systems.
- Avoid disturbing more than one third of the row width with fertilizer placement.
- Keep stubble on field for wildlife and wind erosion protection.

Relative Cost:



Set your yield goal 5 to 10 percent above your average yield, based on soil type, county average yields, and yields on neighboring farms.

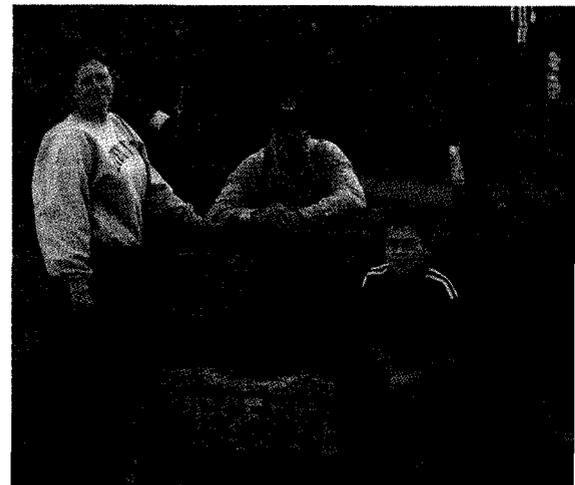


Mulch Tillage: *growing crops where the entire field is tilled before planting, but some residue is maintained.*



Photo courtesy of USDA-NRCS,

In Battle Creek, Nebraska, John Schroeder raises corn, soybeans, and cattle. To plant his crops, John uses mulch tillage. “Mulch tillage allows me to get on my fields quicker. These bottom land soils are too cold in the spring to use anything else,” says John. John finds that the 25-30 percent soybean residue and 35-40 percent corn residue that is left on the field after harvest controls erosion and feeds his cattle. “In the fall, I let the cattle graze in the crop fields. While being able to pasture my cattle on different fields is good, the real benefits are fuel reduction and reduced time in the fields,” John states. By using mulch till, John eliminates approximately three to four trips across the field that he would normally experience using conventional till. “With conventional tillage, I would chisel, disk, field cultivate, and then plant. But with mulch till, I may only till once to smooth rough areas and then plant. All in all, this saves me time and money.”



John Schroeder, shown with wife, Becky and son, Jackson uses mulch tillage when farming his bottomland soil

What It Does:

- Reduces soil erosion from wind and water, compared to conventional tillage.
- Maintains or improves soil organic matter.
- Conserves soil moisture.
- Allows water, nutrients, and pesticides to infiltrate the soils, thus reducing surface runoff.
- Manages snow to increase moisture available to plants.
- Modifies cool, wet soil conditions.
- Provides food and cover for wildlife.
- Reduces trips across the field and resulting compaction problems.

Did You Know?

- Mulch till normally refers to tillage using non-inversion implements, i.e. chisels or disks.
- For best results, distribute residue evenly across the field.
- Stubble should be a minimum of 6 inches to retain snow.
- To maintain as much residue as possible, limit fall tillage to undercutting tools, such as:
 - blades,
 - sweeps,
 - rippers, or
 - subsoilers.
- Wildlife habitat is enhanced by leaving rows of unharvested crop standing at intervals across the field.

Regional Differences:

Mulch tillage works in all areas of the country.

Compatible Practices:

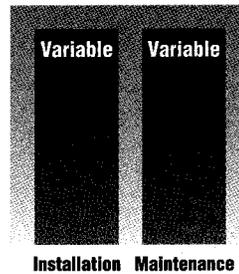
Mulch till works best with:

- Crop Rotation
- Conservation Cover Crops
- Field Scouting
- Integrated Pest Management
- Nutrient Management
- Contour Farming
- Irrigation Water Management

Maintenance:

- Avoid baling or grazing since the benefits of residue will be reduced.
- Where low residue crops are planted rotate with high residue crops and use cover crops where appropriate.

Relative Cost:



Slower tillage speeds and shallow tillage depth leave more residue on the surface.

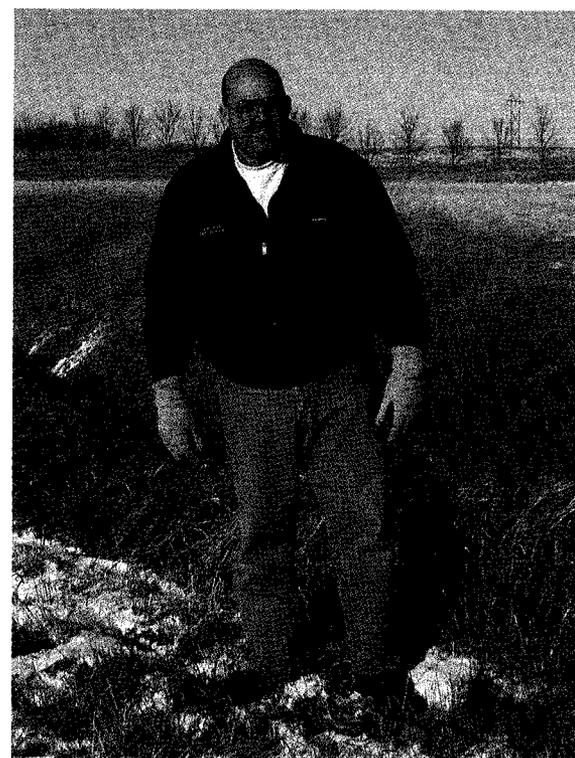
Filter Strips: *using grass or other vegetation to reduce soil, manure, fertilizer, pesticides, and other pollutants from entering waterways.*



Photo courtesy of USDA-NRC

Bob Fox established filter strips along a drainage ditch running through his Franklin, Minnesota, farm in 1998. He seeded the 5.4 acres of filter strips to native grasses, including big bluestem, indiangrass, and switchgrass. These strips range from 33 to 350 feet wide. Although this functional prairie area is still in its establishment phase, Bob has noted more wildlife on this part of his farm, particularly birds.

Although his actions are supported by the federal government's Conservation Reserve Program (CRP), Bob initially decided to place this piece of land into a continuous CRP program for environmental reasons. He was interested in reducing sediment that flows into the environmentally fragile Minnesota River. Although he has not directly noted differences in the sediment content of surface drainage from his field, he knows that the filter strip does make a difference.



Bob Fox's filter strip serves as both filter and habitat for wildlife.

What It Does:

- Enhances wildlife habitat by providing both food and shelter for:
 - Song birds
 - Small mammals
 - Waterfowl
 - Upland game birds
- Traps sediment and attached nutrients and pesticides before the contaminants enter waterbodies.
- Slows surface water runoff and allows infiltration of surface water.
- Reduces wind erosion.
- Enhances farm beauty and diversity.
- Acts as a turnrow for farm machinery.
- Provides forage for on-farm use or cash crop.

Did You Know?

- Plant density is most important when establishing a filter strip.
- Forested filter strips work better than grass strips if you are trying to trap nutrients in a “nutrient sink”.
- Grass filter strips work better at removing sediment.
- For best results, establish the filter strip on the contour of the land.
- Filter strips are most effective adjacent to streams, lakes, wetlands, or ponds.
- Strips should be wider on steeper slopes, factors such as soil types and vegetation should be considered when deciding on width.
- Filter strips, combined with other conservation practices, can be used to treat animal waste runoff and waste water.
- Filter strips should be at least 20-30 feet in width, with forested filter strips being at least 35 feet in width.
- To reduce sediment and particulate contamination, plant spacing should not exceed four inches.

Regional Differences:

Filter strips work in all areas of the country.

Compatible Practices:

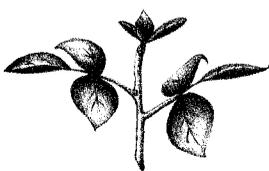
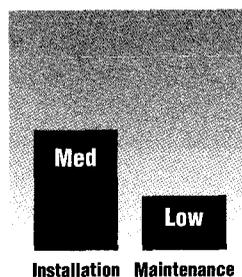
Filter strips work best with:

- Contour Stripcropping
- Conservation Tillage
- Wetland Enhancement or Creation
- Crop Rotation
- Nutrient Management
- Integrated Pest Management

Maintenance:

- Prevent erosion where water filters into streams.
- Avoid herbicide drift.
- Mow and remove vegetation periodically to maintain effectiveness of filter area.
- For wildlife benefits, the mowing schedule should be similar to the schedule listed under Contour Buffer Strips. To filter nutrients and sediment, mow earlier.
- Control grazing if livestock have access to filter strip.
- Control weeds.
- Lime and fertilize to soil test recommendations.
- Maintain strips for diffuse overland flow of water so that channelization of water does not occur.

Relative Cost:



Filter strips can be used as equipment turn areas, if care is taken to minimize disturbance to soil and vegetation.

Windbreak/Shelterbelt Establishment: *planting single or multiple rows of trees or shrubs.*

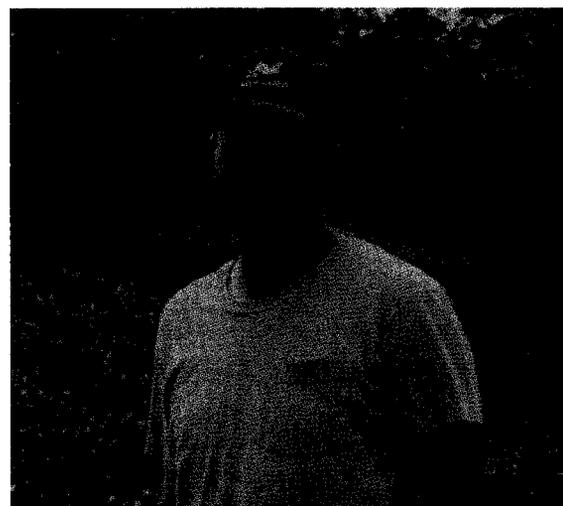


Photo courtesy of USDA-NRCS,

In Goodwin, South Dakota, winds are an inevitable part of life, as Gary Jaeger can testify. To reduce wind erosion and snowdrifts, Gary has installed several shelterbelts or windbreaks. Consisting of a row of single pine, cottonwood, and other deciduous trees, his shelterbelts have provided a number of benefits to his farm. Gary recalls, “in 1976 during the drought, the shelterbelts kept us from going under. During the winter, they held a lot of snow, which provided a water reserve in the spring and shade in the summer. As a result, our crops did the best in these areas.”

Preventing snowdrifts and maintaining moisture are not the only benefits that windbreaks provide. In his 23 years of farming, Gary has also noticed that there is less soil erosion near the trees than in other portions of the fields. He states:

“The trees really hold the soil back. While we have noticed more wildlife and wildlife damage in the area, benefits like reduced soil erosion, and moisture retention far outweigh the costs. I feel the trees are a real benefit to my farming operation and would replace them if they were damaged.”



Gary Jaegar's trees do more than hinder wind erosion

What it Does:

- Reduces wind erosion.
- Protects growing crops from damage by wind-borne soil particles.
- Manages snow to increase moisture for plants.
- Provides food and cover for wildlife and wood byproducts.
- Enhances farm beauty and diversity.
- Improves irrigation efficiency.

Did You Know?

- Windbreaks consist of single or multiple rows, perpendicular to the prevailing wind direction.
- Differs from vegetative wind barriers in that it consists of trees and shrubs, more than grasses.
- The distance sheltered by the windbreak should be 10 times the design height at maturity.
- A variety of species lessens the chance of drought, disease, or insect damage.

The Vegetative Wind Barrier is a type of windbreak. It:

- Differs from windbreaks in that it consists of grasses rather than trees and shrubs.
- Should be maintained at a minimum height of 1.5 feet to control wind erosion.
- Should be at least 2 feet wide and contain some evergreens, if enhancing wildlife habitat.

Note: spacing between barriers should not exceed 10 times the expected height of the barrier.

Compatible Practices:

Windbreaks and shelterbelts work best with:

- Conservation Tillage
- Irrigation Water Management
- Stripcropping
- Conservation Cover Crops
- Contour Farming
- Filter Strips

Maintenance:

- Replace dead trees or shrubs, as needed.
- Eliminate any exotic or invasive species.
- Control vegetation that may compete.
- Provide water if necessary.
- Thin barrier to maintain function.
- Apply nutrients, if needed, to speed initial growth and maintain plantings.
- Control weeds.
- Permanent vegetative barriers should not be mowed or pruned unless height exceeds the wildlife objectives.

If renovating or restoring windbreaks is needed:

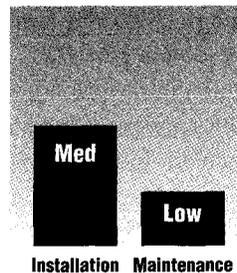
- Prune or thin unwanted limbs and plantings.
- Remove debris to prevent insect or disease infestation, and possible fires.
- Create brush piles with pruning debris to provide wildlife cover.

Regional Differences:

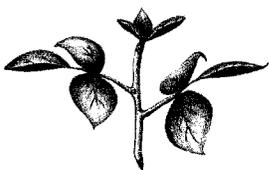
Permanent vegetative wind barriers should be used on 10 percent slopes. The following schedule indicates when windbreaks or shelterbelts should be planted.

Location	Planting Time
Midwest	March - June 1
Northern Plains	Mid-April - May 31
South Central	February - mid-May
Southeast	December, January, February

Relative Cost:



To screen for noise, the windbreak should be as wide as it is tall.



Riparian Forest Buffer:

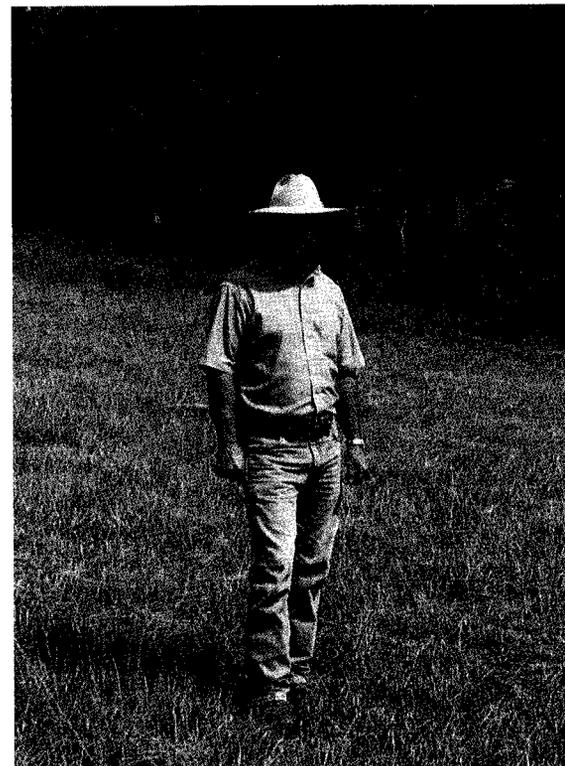
planting trees or shrubs adjacent to waterbodies.



Photo courtesy of USDA-NRC

“In the 1960’s, it was a clear view from the road to river,” says Ronnie Russell of Urbanna, Virginia. Since Ronnie has been operating a 2,000-acre farm along the Rappahannock River, he has allowed natural vegetation to grow back. Thirty years later, there are native pine and locust lining the perimeter of the peninsula between Weeks Creek and the Rappahannock River. As a result, a variety of wildlife inhabit the land, including eagles, osprey, turkey, raccoons, and rabbits. In fact, as we were driving along the access road, conducting this interview, a white tail deer crossed in front of us. Off the peninsula’s shores, Ronnie has caught rockfish, bluefish, croakers, and oysters. An avid fisherman, Ronnie sees the value in turning the riparian border to trees. “Trees provide needed shade for the aquatic life,” says Ronnie.

In addition to the riparian forest buffer, grasses occupy another 400-yard border around his fields that lie adjacent to the Weeks Creek and the Rappahannock River. This grassland, totaling 100 acres, has been enrolled in the Conservation Reserve Program (CRP). “CRP was really the answer here next to the creek and the river,” states Ronnie. “Most of the land is highly erodible and too difficult to farm. We enrolled it in CRP, because the rental rate was reasonable. It also acts as a filter strip to any runoff from the field and provides great cover for wildlife. If all goes well, we may re-enroll it in the next sign-up.”



Ronnie Russell's riparian buffer strip provides

What it Does:

- Creates shade to lower water temperatures and improves aquatic habitat.
- Provides food and cover to both aquatic species and upland wildlife.
- Provides in-stream aquatic habitat ingredients, such as large branches, leaves, etc.
- Reduces flow of nutrients into groundwater.
- Reduces sediment, nutrient, and pesticide surface runoff from neighboring fields.
- Enhances farm beauty and diversity.
- Increases streambank stability and reduces streambank erosion.
- Allows infiltration of surface water.
- Reduces flooding damage by slowing out-of-bank flood flows.
- May provide timber, woodfiber, and other forestry byproducts, if properly managed.

Did You Know?

- Strips should be between 30 and 300 feet wide, depending on the size of the stream and cropping conditions.
- Smoother streambanks allow for more vegetation.
- A riparian buffer consists of three zones:
 - Zone 1 - area closest to the waterbody, which consists of native vegetation that protects the shoreline. Vegetation is not harvested.
 - Zone 2 - along Zone 1, which consists of timber and grasses that trap sediments, pesticides and nutrients. Vegetation may be harvested.
 - Zone 3 - between Zone 2 and crop field, which consists of grasses.

- Because riparian buffers are usually located next to waterbodies, many of these areas have year-round moisture that allows woody species to establish quickly.

Compatible Practices:

Riparian forest buffers work best with:

- Conservation Tillage
- Diversions
- Terraces
- Crop Rotations
- Enhanced or Constructed Wetlands

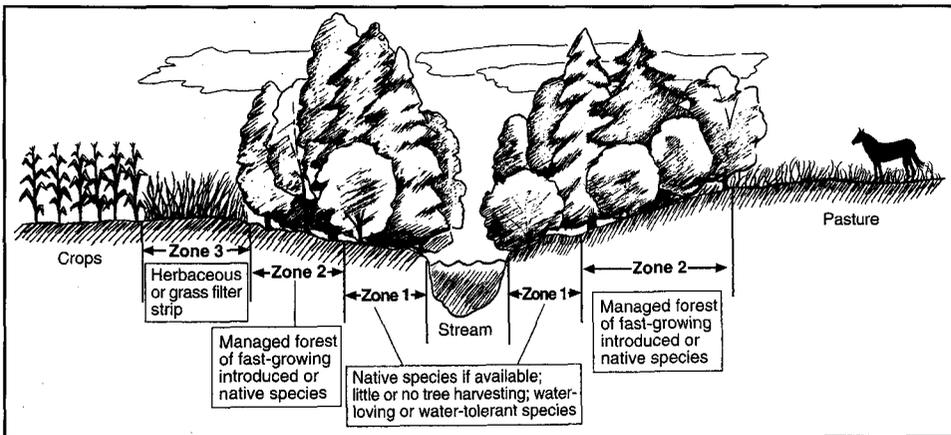
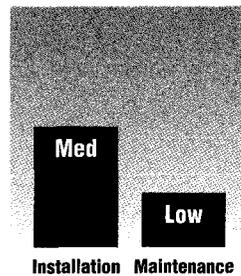
Regional Differences:

Riparian forest buffers work in all areas of the country.

Maintenance:

- Keep fences repaired to restrict grazing.
- Control erosion upslope to protect riparian buffers.
- Where trees and rodents are a problem, protect newly established trees with tree shelters. Prevent small birds from becoming entrapped in shelters by using netting over the shelters.

Relative Cost:



Drawing courtesy of USDA-NRCS

An acre 16 feet wide and 1/2 mile long results in less than one acre taken from crop production. - *Farming for Clean Water in South Carolina*



Wetland Enhancement or Construction: *rehabilitating existing degraded wetlands, or building new wetlands.*



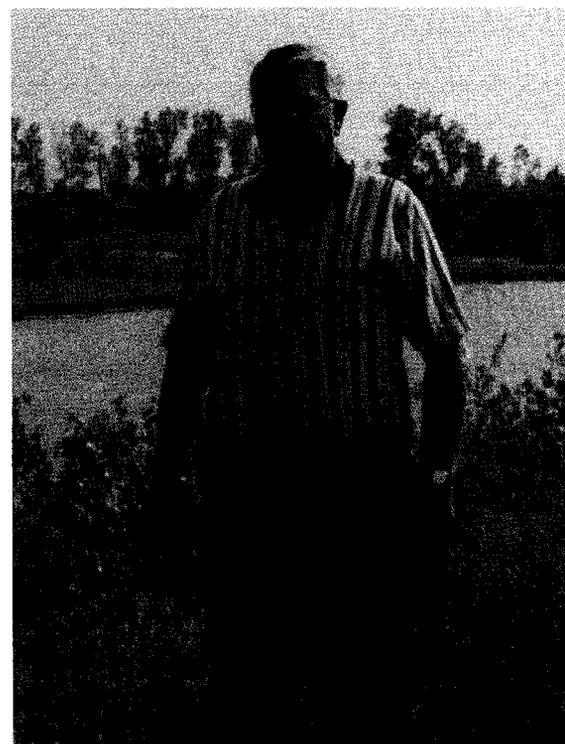
Photo courtesy of USDA-NRCS, II

Both a farmer and hunter, Ron Gibson of Norborne, Missouri, has been adding and enhancing wetlands on his farms since 1993. Following the flood of 1993, Ron took advantage of several programs offered by the government to install wetlands on his flood-destroyed fields. The Wetlands Reserve Program (WRP) and the Conservation Reserve Program (CRP) allowed Ron to receive payments for the land that was no longer cost-effective to farm. Since enrolling in the programs, Ron has built two wetlands and enhanced two more. Ron relies primarily on natural vegetation, like foxtail and smart weed, to stabilize the wetland and create wildlife cover.

In Ron's case, the natural grasses and cover attract all kinds of wildlife, including deer and waterfowl.

"I am an avid duck hunter. Since installing and enhancing these wetlands, I have noticed an increase in all types of wildlife, from turkey and songbirds to rabbits and quail. I have also noticed an increase in the duck population and species. Last fall, I had over 3,000-4,000 birds on one 57-acre wetland. There were a variety of species, including: mallards, teals, pintails, wigdens, and wood ducks. In addition, I had a large number of Canadian, snow, and blue geese."

Currently, Ron uses his wetlands for personal hunting and to reduce runoff entering the nearby Missouri River. However, in the future, he concedes that he may think about fee hunting in his wetlands. Right now, Ron admits that his wetlands provide a variety of benefits.



Ron Gibson's wetland is home to thousands of birds during hunting season.

What it Does:

- Improves aquatic habitat.
- Provides food and cover to both aquatic species and wildlife.
- Traps sediment, nutrient, and pesticide runoff from neighboring fields.
- Provides for wood byproducts.
- Increases streambank stability and reduces streambank erosion.
- Reduces flooding damage by reducing overland flow.
- Recharges groundwater supplies.
- Enhances farm beauty and diversity.
- May serve to remove excess nutrients from farm runoff.
- Provides temporary water storage.
- May maintain summer stream flow.

Did You Know?

- Permits may be needed before wetland enhancement and construction begins.
- Most wetland enhancement involves constructing small earthen structures and may involve plugging subsurface tile drains.
- Dikes and levees should meet NRCS or US Army Corps of Engineer standards.
- All of America's waterfowl depend on wetlands for breeding, nesting and feeding.
- More than 5,000 plant species, 190 amphibian species, and one third of all birds are supported by wetlands.
- Invasive or non-native species should be avoided.

Compatible Practices:

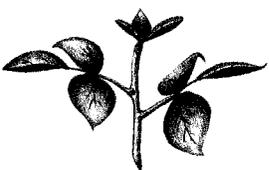
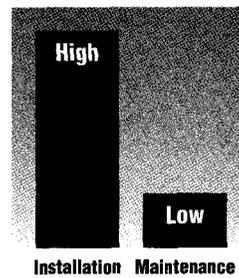
Wetland enhancement or construction works best with:

- Diversions
- Riparian Forest Buffer (if appropriate)
- Filter Strips

Maintenance:

- In most cases, wetlands should be left alone, except to control exotic or invasive species.
- If enhancing wetlands, replanting some species may be necessary.
- Burrowing animals, i.e. muskrats, should be monitored to ensure dikes are not damaged.
- Intake pipes and outlets may need to be monitored and cleaned periodically.
- Fence out grazing animals.

Relative Cost:



Constructed wetlands can be used to denitrify nitrogen-laden drainage water before entering streams.

Pastureland and Other Areas

Grassed Waterway: *constructing a channel that is shaped or graded to allow for stable and uniform water runoff.*

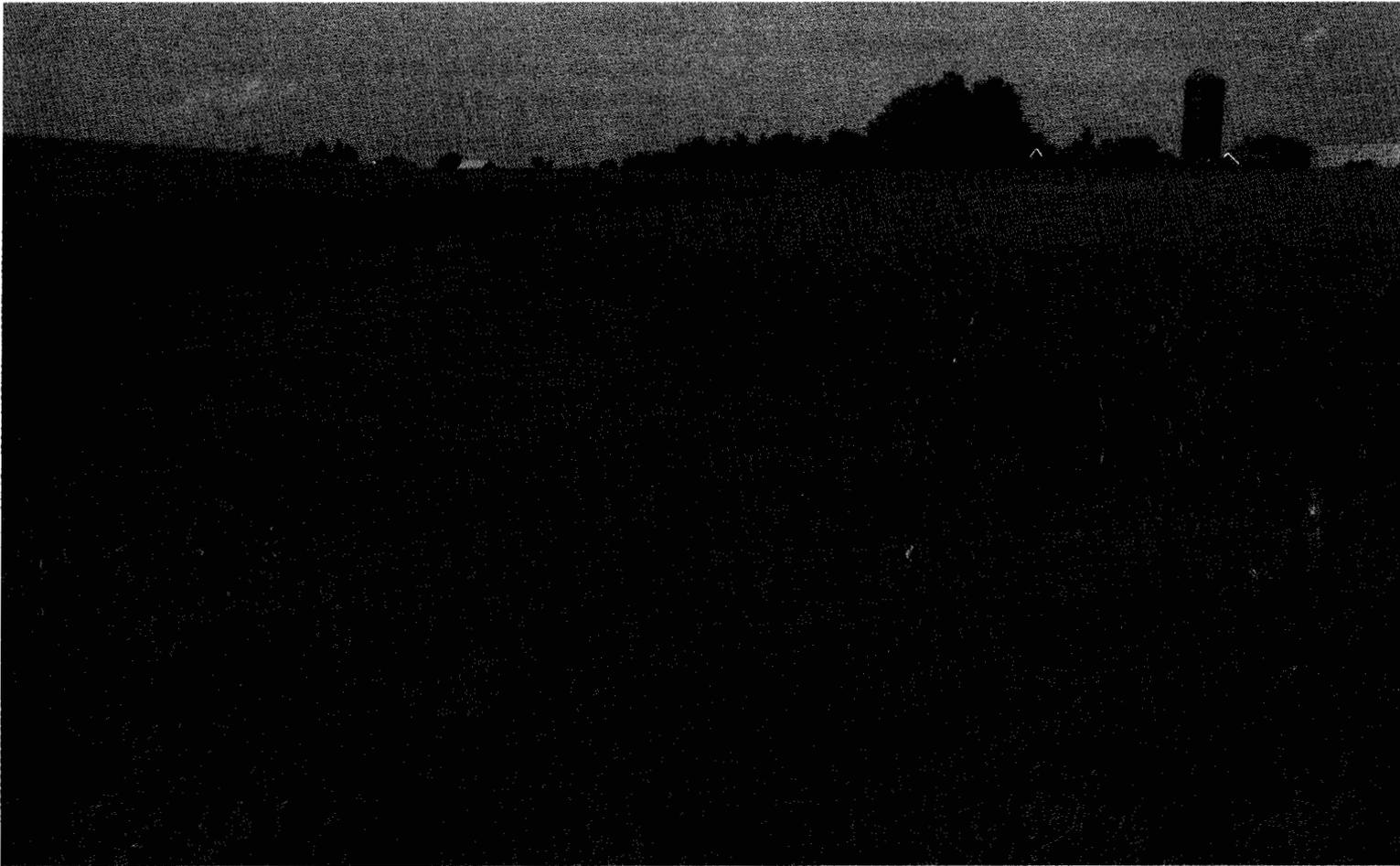
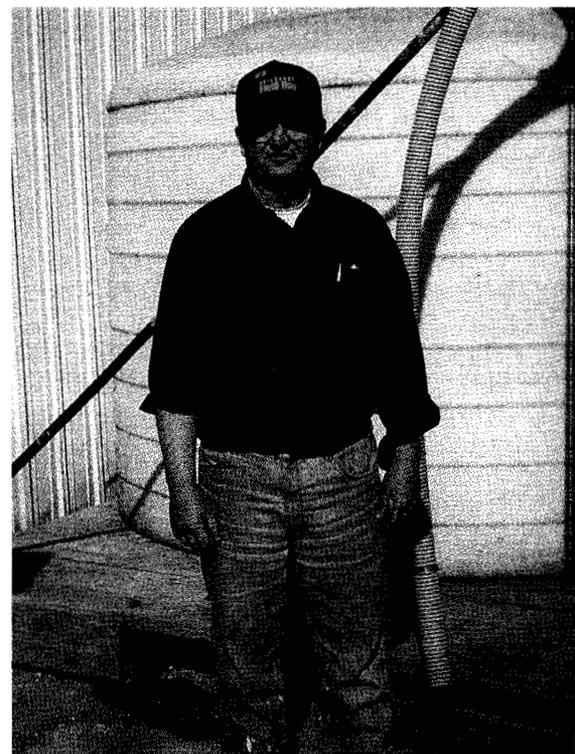


Photo courtesy of USDA-NRCC

Gordon Wassenaar of Prairie City, Iowa, has been using grassed waterways on his farm for a number of years. In combination with no-till planting, grassed waterways have virtually eliminated soil erosion on his farm. To seed his waterways, Gordon uses a combination sun/shade mixture, consisting of fescue, rye grass, and Kentucky bluegrass. Gordon seeds this mixture in the spring or late summer, when competition from annual weeds will be minimal. For maximum erosion control, a figure-8 planting method should be used. In most cases, “the rye grass germinates quickly, followed by the fescues, with the Kentucky blue grass requiring the most time,” Gordon says.

Gordon mows his waterways twice per year if weather and time permit. To avoid the nesting season, Gordon waits until early July to mow and, if possible, mows again in September.



Gordon Wassenaar uses a mixture of fescue, rye, and Kentucky bluegrass to seed his waterways.

What It Does:

- Reduces erosion by slowing water runoff in natural drainageways.
- Discourages gully erosion.
- Reduces pesticide, nutrient, and water runoff by acting as a grassed filter.
- Provides cover for small birds and animals.
- Slows and spreads water before it enters a vegetative filter strip.
- Traps sediment.
- Acts as an outlet for diversions and terraces.

Did You Know?

- Temporary cover, mulching, irrigating, or netting may be required after waterway construction until vegetation is established.
- Grassed waterways can have stone- channeled centers depending on the grade.
- When establishing vegetation, planting across the waterway or in a figure-8 pattern is usually recommended to reduce erosion.

Regional Differences

- Grassed waterways work in all areas of the country where natural drainageways exist.
- Plant sod-forming native species, which have stiff, upright stems that can act as filter.

Compatible Practices:

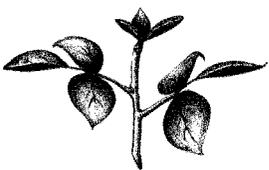
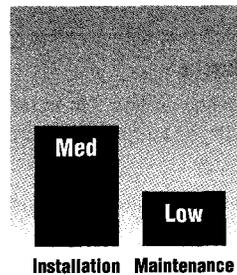
Grassed waterways work best with:

- Terraces
- Diversions
- Filter Strips
- Underground Outlets

Maintenance:

- Lift plows and other machinery out of the ground when crossing the waterway.
- Prevent herbicide drift.
- Do not use the waterway as a roadway.
- Mow periodically but wait until nesting season is over (see Contour Buffer Strips).
- Lime and fertilize as needed based on soil recommendations.
- Maintain the width of the waterway.
- Avoid planting end rows along the waterway, to prevent gullies from forming along its edge.
- Keep tillage and row direction perpendicular to the grassed waterway.
- Ensure a stable outlet.
- If necessary, grade or reshape the edge of the waterway to insure water flows into the channel.

Relative Cost:



During the Civil War, soldiers used soybeans as “coffee berries” to brew “coffee” when real coffee was scarce.

Insects, Weeds & Diseases

Soybean Insect Identification

Insect	Description	Environment	Prevention and Control Including Economic Threshold
<p data-bbox="54 459 73 555">© J. Kalisch</p>  <p data-bbox="92 729 236 762">Army Cutworm</p>	<p data-bbox="507 480 657 513">Army Cutworm</p> <ul data-bbox="507 518 935 613" style="list-style-type: none"> • Tan-colored larvae to 1¼" with dark stripes, feed at night • Feeds on leaves 		<ul data-bbox="1273 480 1375 513" style="list-style-type: none"> • Chemical
<p data-bbox="54 795 73 890">© J. Jarman</p>  <p data-bbox="92 1065 261 1098">Bean Leaf Beetle</p>	<p data-bbox="507 816 683 849">Bean Leaf Beetle</p> <ul data-bbox="507 853 935 1006" style="list-style-type: none"> • Usually a yellow or light tan to reddish brown beetle; ¼" long; 4-6 rectangular spots on back • Feeds on leaves, round holes signal infestation 	<ul data-bbox="963 816 1254 965" style="list-style-type: none"> • Defoliation is only important early in the season • Beetle may feed on blossoms or pods late in the season 	<ul data-bbox="1273 816 1541 924" style="list-style-type: none"> • Treat if severe cotyledon destruction, or seven or more beetles per soybean row foot
<p data-bbox="54 1131 73 1226">© J. Jarman</p>  <p data-bbox="92 1400 245 1433">Black Cutworm</p>	<p data-bbox="507 1152 667 1185">Black Cutworm</p> <ul data-bbox="507 1189 935 1280" style="list-style-type: none"> • Blackish larvae • Feeds below ground, cutting plants from roots at soil level 		<ul data-bbox="1273 1152 1375 1185" style="list-style-type: none"> • Chemical
<p data-bbox="54 1466 73 1583">© W.W. Dierker</p>  <p data-bbox="92 1736 236 1769">Blister Beetle</p>	<p data-bbox="507 1487 651 1520">Blister Beetle</p> <ul data-bbox="507 1524 935 1612" style="list-style-type: none"> • Soft-shelled beetle with an elongated shape, 1-1¼" long; gray, black or yellow-brown in color; may be striped 	<ul data-bbox="963 1487 1190 1570" style="list-style-type: none"> • Found on plants and occasionally feeds on flowers 	<ul data-bbox="1273 1487 1481 1520" style="list-style-type: none"> • Spot treatment only
<p data-bbox="54 1802 73 1918">© Lee Jenkins</p>  <p data-bbox="92 1810 236 1844">Cabbage Looper</p>	<p data-bbox="507 1823 689 1856">Cabbage Loopers</p> <ul data-bbox="507 1860 935 1951" style="list-style-type: none"> • Light green with white strip on each side; moves in a looping fashion • Feeds on leaves, leaves appear ragged 	<ul data-bbox="963 1823 1222 1943" style="list-style-type: none"> • Found during pod filling stage • Larvae feed through pod wall to damage beans. 	<ul data-bbox="1273 1823 1567 2005" style="list-style-type: none"> • Large worms difficult to control • Treat when an average of 30 worms are found per 30 feet of row • Treat when less than ¼" long

Insect**Description****Environment****Prevention and Control Including Economic Threshold****Corn Earworm (a.k.a. Soybean Podworm)**

- Caterpillars growing to 1 $\frac{3}{4}$ "; yellow-green, pink, brown or black body with a yellowish-brown head
- Feeds on leaves, leaves appear ragged

- Found primarily from July through September
- Most noticeable in weedy fields

- After pods appear, treat when an average of two large earworms ($\frac{1}{2}$ " or more)/row foot are present
- If flowering, treat if there are 5 worms per row foot

Fall Armyworm

- Caterpillar that is dark brown with variable markings, head is white with an inverted Y on the front but not always well defined
- Feeds on leaves

- Found during seedling growth

- Fall armyworm is rarely a problem on soybeans
Velvetbean caterpillar is more probable, which is easier to treat

Garden Fleahoppers

- Shiny and black; $\frac{1}{16}$ " long; antennae and legs are longer than the body
- Females have long or short wings
- Nymphs are green
- Feeds on leaves, causing pale spots, which turn brown and curl along edge

Grasshoppers

- Various colors and sizes (up to 2 $\frac{1}{2}$ " in length); light green body with narrow white stripes on sides
- Feed on foliage and green pods
- Foliage looks ragged with irregular holes

- Occurs from May-October, especially during drought
- Damage greatest at field edges near weedy or grassy areas

Green Cloverworm

- Caterpillar has a light green body and head with faint white stripes; 1" or longer; three pair of legs along the middle of the body
- Larvae wiggle violently when disturbed
- Feeds on leaves which appear ragged

- Found during pod and seed formation

- Treatment is not necessary if some larvae are beginning to die from a fungal disease, turning white or velvety green
- Treat if 9 to 16+ larvae per row foot

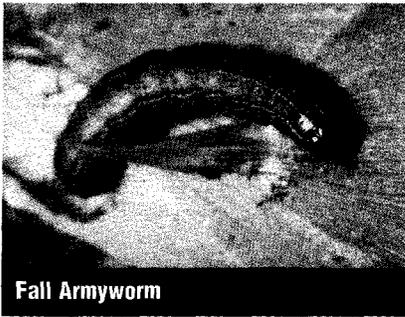
Imported Longhorn Beetle

- Small weevil, $\frac{1}{8}$ " long; broad snout and wide neck, mottled gray in color
- Feeds on leaves and smaller veins, giving a ragged appearance

© D. Keith

**Corn Earworm**

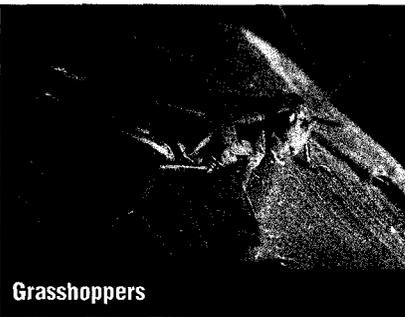
© J. Jarman

**Fall Armyworm**

© J. Kalisch

**Garden Fleahoppers**

© J. Jarman

**Grasshoppers**

© USDA

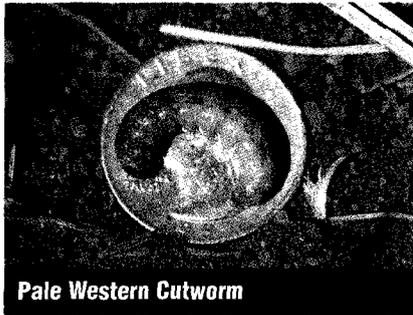
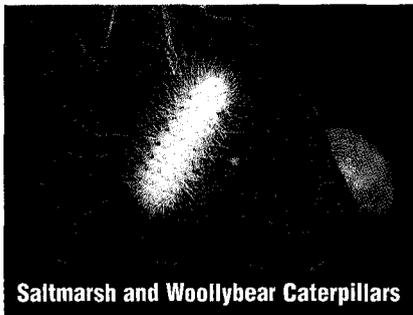
**Green Cloverworm**

© I. Miller

**Imported Longhorn Beetle**

Insects, Weeds & Diseases

Soybean Insect Identification

Insect	Description	Environment	Prevention and Control Including Economic Threshold
<p data-bbox="61 464 84 562">© J. Kalisch</p>  <p data-bbox="99 737 318 768">Mexican Bean Beetle</p>	<p data-bbox="521 485 740 516">Mexican Bean Beetle</p> <ul data-bbox="521 520 959 684" style="list-style-type: none"> • Adults are oval, $\frac{5}{16}$" long, dark yellow, 16 small black spots on back • Larvae are bright yellow and covered with spines • Feeds on leaves, skeletonizing them 	<ul data-bbox="980 485 1208 516" style="list-style-type: none"> • Rarely occur in States 	
<p data-bbox="61 800 84 898">© Sloderback</p>  <p data-bbox="99 1073 334 1104">Pale Western Cutworm</p>	<p data-bbox="521 821 756 852">Pale Western Cutworm</p> <ul data-bbox="521 856 959 957" style="list-style-type: none"> • White larvae $1\frac{1}{4}$" in length, with brown head • Feeds <i>below ground on roots and emerging tillers</i> 	<ul data-bbox="980 821 1224 852" style="list-style-type: none"> • Found in western states 	<ul data-bbox="1292 821 1398 852" style="list-style-type: none"> • Chemical
<p data-bbox="61 1136 84 1234">© D. Keith</p>  <p data-bbox="99 1409 488 1440">Saltmarsh and Woollybear Caterpillars</p>	<p data-bbox="521 1157 911 1188">Saltmarsh and Woollybear Caterpillars</p> <ul data-bbox="521 1192 959 1325" style="list-style-type: none"> • Very hairy caterpillars, may be white or multi-colored; 2" long • Feed on upper leaves primarily, smaller larvae may feed on undersides of leaves 	<ul data-bbox="980 1157 1268 1220" style="list-style-type: none"> • Occur during the seed-filling stages of plant growth 	
<p data-bbox="61 1472 84 1570">© J. Kalisch</p>  <p data-bbox="99 1745 277 1776">Seedcorn Maggot</p>	<p data-bbox="521 1493 699 1524">Seedcorn Maggot</p> <ul data-bbox="521 1528 959 1696" style="list-style-type: none"> • Less than $\frac{1}{4}$" long; legless and cylinder-shaped; dirty white to creamy yellow in color • Adults are gray and resemble houseflies • Burrow into seeds before emergence 	<ul data-bbox="980 1493 1260 1619" style="list-style-type: none"> • Occur in cool, wet weather during sprouting stage • May kill the seed before it emerges 	<ul data-bbox="1292 1493 1565 1682" style="list-style-type: none"> • Avoid spring applications of liquid manure • Treat if stand loss is severe; replanting may be advisable with a seed treated with protectant
<p data-bbox="61 1808 84 1885">© USDA</p> 	<p data-bbox="521 1829 683 1860">Soybean Looper</p> <ul data-bbox="521 1864 959 2060" style="list-style-type: none"> • Light green with white strip on each side; moves in looping fashion; has black legs; fatter at tail-end; has two pair of legs in the middle of the body • Often confused with green cloverworm • Feeds on leaves 	<ul data-bbox="980 1829 1260 2018" style="list-style-type: none"> • Found usually in the middle of a lush canopy • Prefers plants that are not drought-stressed • Causes problems usually in August and September 	<ul data-bbox="1292 1829 1565 1913" style="list-style-type: none"> • Treat if 6-8 large ($\frac{1}{2}$") loopers are found per row foot

Insect

Description

Environment

Prevention and Control Including Economic Threshold



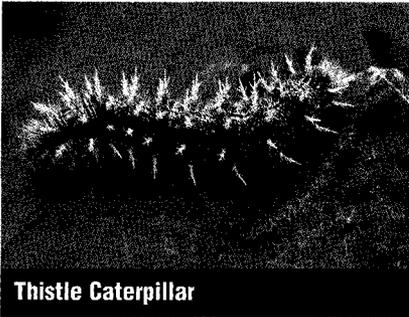
Stinkbugs

Stinkbugs

- Shield-shaped body; $\frac{3}{8}$ - $\frac{3}{4}$ " long; adults are green or yellow-gray to brown; nymphs are light green with orange-yellow and black markings; mouths form into a slender beak
- Feed on pods and developing seeds

- Found during flowering and pod formation

- Spot treatment or border treatment may be necessary
- Treat when an average of 10 plant-feeding bugs per 30 feet of row are found



Thistle Caterpillar

Thistle Caterpillar

- Hairy caterpillar that is covered with spines, 2" long at maturity.
- Feeds on leaves-skeletonizing them, leaves may be webbed together
- Injury most severe at border rows

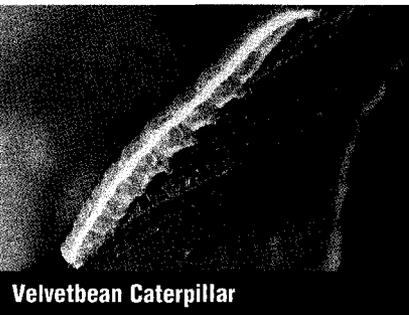


Three-cornered Alfalfa Hopper

Three-cornered Alfalfa Hopper

- Wedge-shaped, green insect about $\frac{1}{4}$ ", has a humped back
- Feeds on young stems after plants are 10" tall, confined to petiole

- Found on late-growing alfalfa



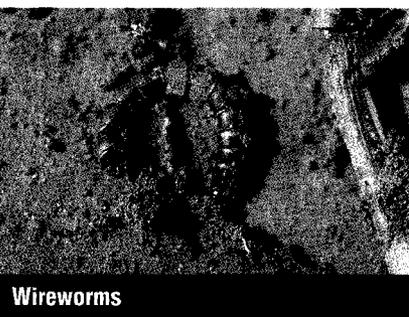
Velvetbean Caterpillar

Velvetbean Caterpillar

- Light green to black body with a yellowish-orange head; has a forked tail; and wiggles when disturbed
- Feeds on leaves

- Found during flowering and pod formation

- Treat if 4-6 pests are found per row foot. Treat when defoliation will exceed 1% after midbloom, 30% before midbloom



Wireworms

Wireworms

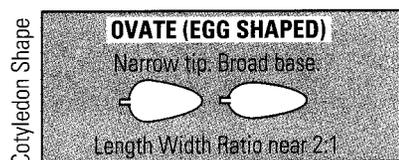
- Cream to brown in color; slender larvae 1-1 $\frac{1}{4}$ " long; body is shiny and hardy
- Feeds on seeds and roots



Yellow-striped Armyworm

Yellow-striped Armyworm

- Reddish brown to black velvety worm with bright yellow stripes running lengthwise along each side, may be $\frac{1}{2}$ " long
- Feeds on leaves of young plants



First true leaves alternate?

Often purple underneath.

Leaves sparsely hairy or smooth

Leaves & cotyledons very hairy



EASTERN BLACK NIGHTSHADE

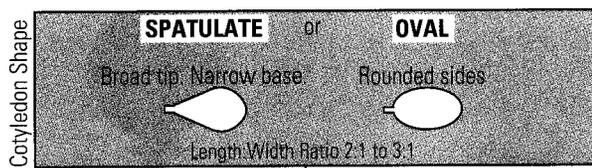


HAIRY NIGHTSHADE

Other weeds with Ovate cotyledons:
First true leaves

Alternate:
Ground Cherry
Horseweed
White Cockle

Opposite:
Chickweed



First true leaves opposite? (Later leaves may alternate)

YES

NO

First true leaves lobed?

YES

Small cotyledons



COMMON RAGWEED

NO

Large cotyledons



GIANT RAGWEED

Rough leaf surface. Later leaves alternate with three prominent veins.



ANNUAL SUNFLOWER

• First true leaves alternate
• Large cotyledons
• True leaves star shaped (wild cucumber) or pentagon shaped (bur cucumber)



WILD CUCUMBER BUR CUCUMBER

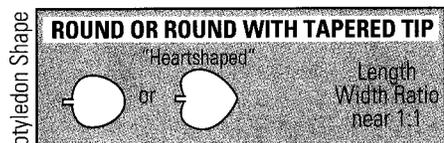
Other weeds with Spatulate or Oval cotyledons:

First true leaves **alternate:**
Blue Mustard
Tansy Mustard
Prickly Lettuce
Hemp Sesbania

Canada Thistle
Musk thistle
Shepherdspurse

First true leaves **opposite:**
Jerusalem Artichoke*
Marijuana*
Spurge, Annual
Devilsclaw*

* Later leaves alternate



First true leaves alternate?

YES

YES

Cotyledons velvety

VELVETLEAF

Heart-shaped true leaves with short hairs.

NO

YES



VENICE MALLOW

NO

Third and subsequent leaves deeply lobed?



PRICKLY SIDA

Other weeds with Round cotyledons:

First true leaves alternate:
Common Mallow
Corn Gromwell
Sicklepod
Yellow Rocket

First true leaves opposite:
Henbit
Marshelder
Copperleaf
F. Pennycress (later alternate)



First true leaves alternate.
Large cotyledons with prominent veins

TALL MORNINGGLORY

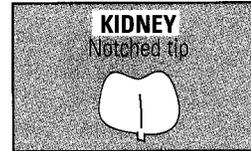


IVY LEAF MORNINGGLORY



PITTED MORNINGGLORY

Other weeds with Butterfly cotyledons:
Most Morningglory species



First true leaves alternate..

True leaves hairy with uneven margins

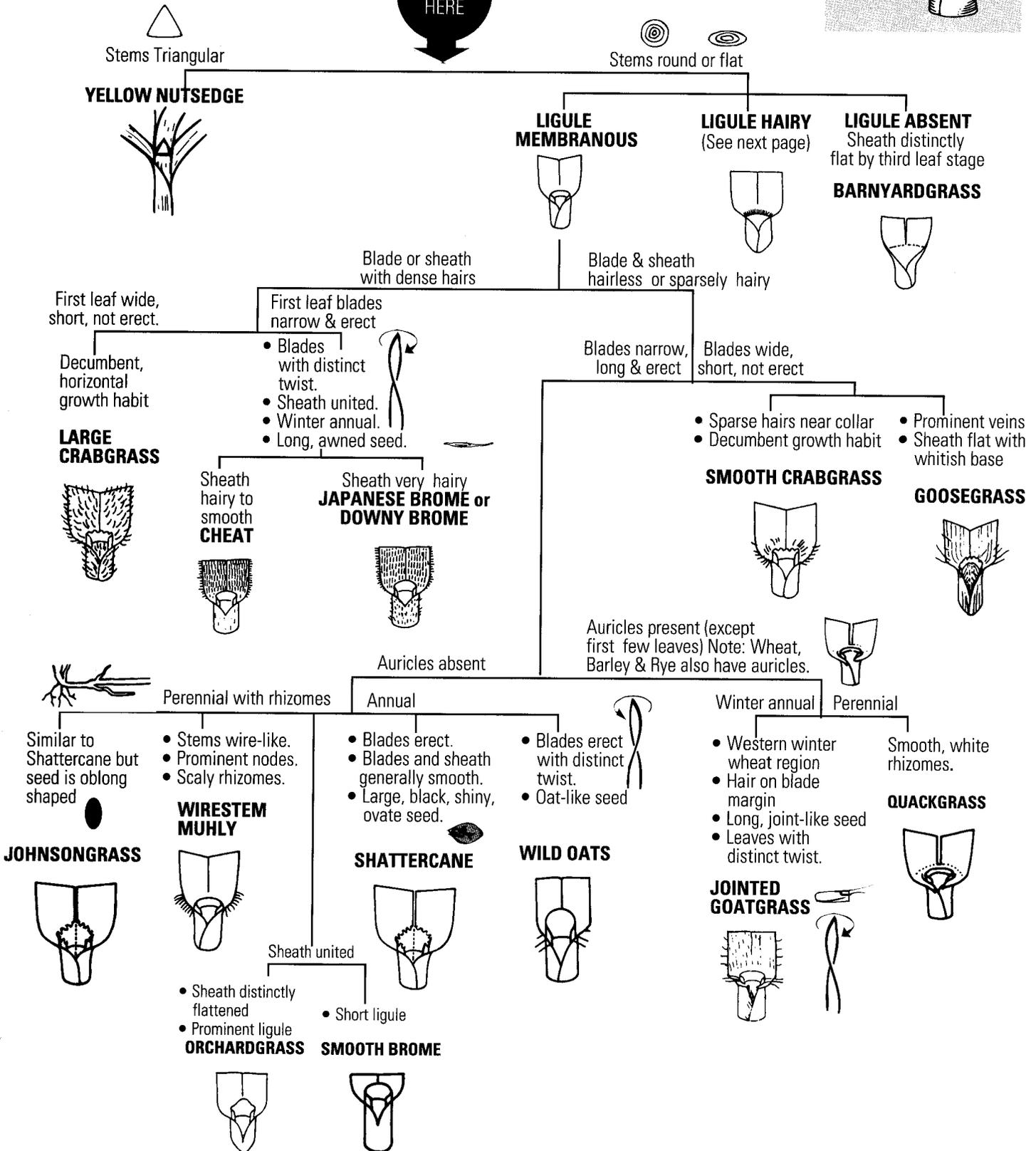
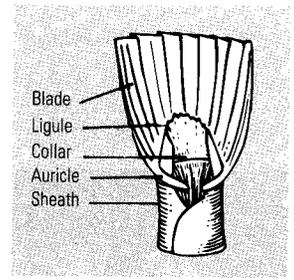
WILD MUSTARD

Arrowhead shaped leaves. Perennial with vine-like growth habit

FIELD BINDWEED

Other weeds with Kidney cotyledons:
Hedge Bindweed
Wild Radish

Farmland Industries, Inc.'s. Grass Weed Seedling Identification Key



LIGULE HAIRY



Blade with hair | Blade with little or no hair (also see Woolly Cupgrass)

Blade hairy upper surface only

Blade hairy on both surfaces or blade margins

Sheath margin hairy

Sheath margin without hair. Sheath occasionally with hair

Blade with short hair (fuzz) on upper surface

Blade with long hair on upper surface near base by third leaf stage

Sheath nearly round Small oblong seed

Sheath flattened Large spiny seed

- Underside of blade smooth or sparsely hairy
- Sheath margins hairy

- Sheath flat, without hair, often with reddish base

GIANT FOXTAIL



YELLOW FOXTAIL



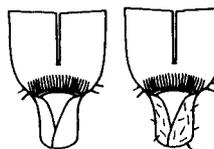
Small ovate seed

GREEN FOXTAIL



- Seedling occasionally with hair on sheath or blade, but later smooth and shiny
- Prominent, white midrib on older plants

FALL PANICUM



- Occasional sparse hair on collar margins
- Sheath smooth, often with reddish base

FIELD SANDBUR



Blade with distinct hair throughout or on margins only.

Blade & sheath hair very short, dense & difficult to see.

Random hairs on FIRST leaf and sheath

Prominent sheath hairs at 90° angle to stem

- Blades and sheaths later smooth & shiny
- Prominent, white midrib on larger plants

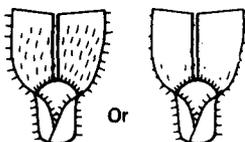
FALL PANICUM



- Blades hairy to nearly smooth

WITCHGRASS
(small seed)

or
WILD PROSO MILLET
(large seed)



- First blade horizontal, wide with blunt tip.
- One blade margin often crimped
- Very large seed



WOOLLY CUPGRASS



COURTESY OF THE UNIVERSITY OF CALIFORNIA, BERKELEY

Insects, Weeds & Diseases

Soybean Diseases

Disease

Description

Environment

Prevention & Control

© APS 1999



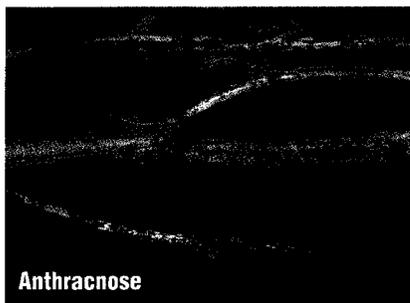
Alternaria Leaf Spot

Alternaria Leaf Spot

- ¼" brown spots with concentric rings grow together to form large dead areas
- Some defoliation may occur

- Moist weather in seed fill stage
- No control is needed

© APS 1999



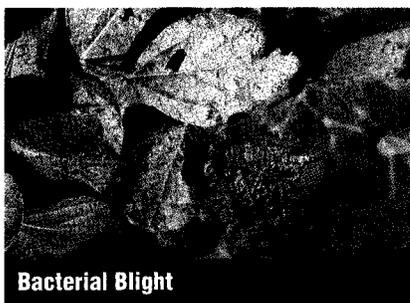
Anthracnose

Anthracnose

- Dark blotches cover stem

- Favors warm, wet weather and occurs at plant maturity
- Plant disease-free seed
- Plow under infected residue
- Use seed protectant fungicide
- Rotate crops
- Control wind and water erosion

© Agri-Growth, Inc.



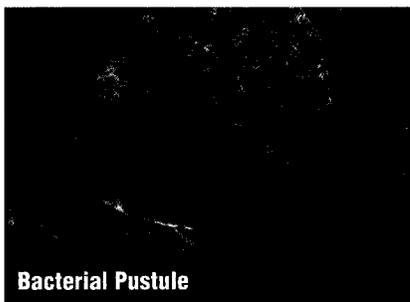
Bacterial Blight

Bacterial Blight

- Small, angular, water soaked, yellow and brown spots appear on leaves. When dry, the centers turn reddish brown to black and are surrounded by a green or yellow halo.
- Areas of leaves may disintegrate, giving leaves a ragged appearance

- Occurs in windy, cool, and wet weather
- Is spread during cultivation while the foliage is wet
- Plant disease-free seed
- Rotate crops
- Avoid cultivating when leaves are wet
- Use fungicide seed treatment

© Agri-Growth, Inc.



Bacterial Pustule

Bacterial Pustule

- Small, pale green spots with brown centers appear on leaf surface
- A small blister can be found in the center of the spot on the lower leaf surface

- Occurs in wet weather, from the flowering to early pod formation stage
- Control wind and water erosion
- Avoid cultivation when foliage is wet
- Plant resistant varieties and use disease-free seed
- Rotate crops

© APS 1999



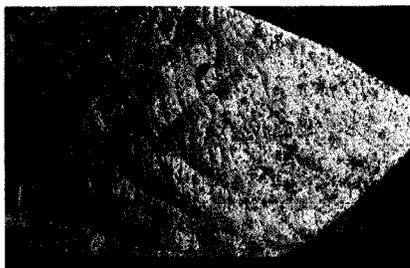
Bacterial Tan Spot

Bacterial Tan Spot

- Large, dead patches start from the outside of the leaf and work inward

- Spread during storm weather
- Occurs during pod formation and seed fill stages
- Control wind and water erosion
- Plant resistant varieties

© Agri-Growth, Inc.



Brown Spot

- Small, red-brown angular spots occurring first on lower leaves
- Severely infected leaves turn brown and drop off
- The lower portion of diseased plants may be bare of leaves before maturity
- Plants may be almost completely defoliated

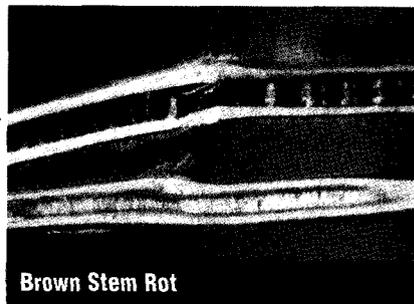
- Can occur during wet weather at seedling stage, but most severe damage is during latter seed fill stage
- Rotate crops
- Plant disease-free seed
- Use foliate fungicides
- Apply fungicide seed treatment

Disease

Description

Environment

Prevention & Control



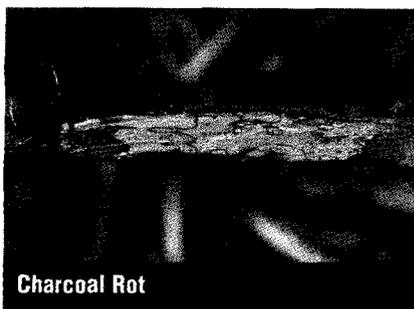
Brown Stem Rot

Brown Stem Rot

- Brown discoloration appears inside stem
- Leaves turn brown between veins and may drop

- Most severe at cooler temperatures, but also occurs during warm, dry weather

- Rotate crops
- Plant resistant varieties
- Fields should not be planted with soybeans for at least two years after an infection



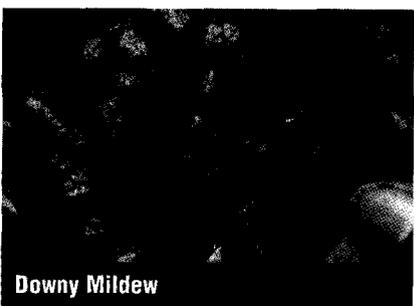
Charcoal Rot

Charcoal Rot

- Leaves turn yellow and wilt but remain attached
- A lesion appears on the lower stem
- When outside coating is removed, the stem appears to be grayish in color with black streaks in the woody part

- Occurs in hot and dry weather or stress conditions at the seed fill stage

- Plant resistant varieties
- Rotate crops



Downy Mildew

Downy Mildew

- Upper leaves have yellow-green spots that turn brown
- Purplish or gray growths found on the underside of lower leaves
- Defoliation may occur
- Seeds may have a white coating

- Appears during cool, moist conditions after the canopy closes at the seed fill stage

- Plant resistant varieties
- Rotate crops



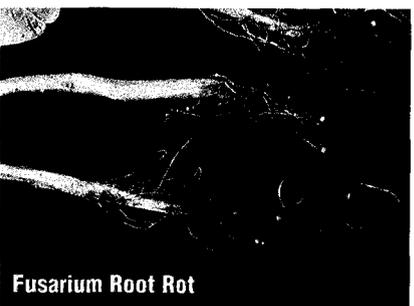
Frogeye

Frogeye

- Small reddish spots enlarge in diameter and form a brown nearly white center with a brown trim
- Spots join to form larger dead areas
- Infected leaves may fall
- Lesions on stems are long and reddish with a black border and over time, the entire lesion blackens

- Occurs in warm, moist weather, during the flowering and early pod formation stages

- Plant resistant varieties and disease-free seed
- Rotate crops
- Fields should not be planted with soybeans for at least 2 years after an infection



Fusarium Root Rot

Fusarium Root Rot

- Seedlings and young plants may wilt and die
- Roots of older plants rot with brown lesions

- Appears during the seedling stage under cool, moist conditions

- Ridge soil around base
- Avoid compaction
- Maintain adequate P and K levels



Powdery Mildew

- Upper leaf surface develops a white, powdery appearance, eventually covering entire leaf surface

- Occurs in a dry summer with cooler than normal temperatures at seed fill

- Plant resistant varieties
- Avoid wind erosion
- Use foliar fungicides

Insects, Weeds & Diseases

Soybean Diseases

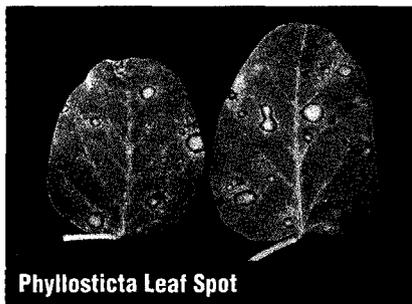
Disease

Description

Environment

Prevention & Control

© APS 1999



Phyllosticta Leaf Spot

Phyllosticta Leaf Spot

- V-shaped lesions become grayish tan with a dark border
- Numerous black specks found in older lesions
- Small lesions occur on stems and circular stems occur on pods
- Not considered a serious disease

- Likes wet weather and begins to occur during late flowering and early pod formation

- Control wind erosion
- Rotate crops
- Plant disease-free seed
- Plow under infected residue

© Agri-Growth, Inc.



Phytophthora Seedling Blight and Root Rot

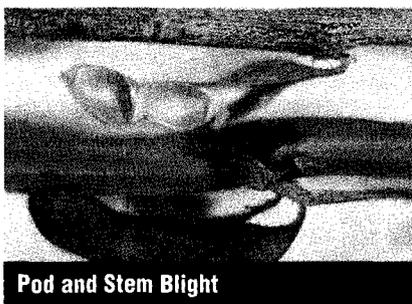
Phytophthora Seedling Blight and Root Rot

- Clusters of plants run turn gray-green, wilt, and turn yellow but remain intact
- Chocolate brown discoloration of the lower stem
- Plants will be stunted
- Differs from stem canker, in that it causes root rot

- Occurs during pod forming stage under warm and moist soil conditions (above 77° F)
- Severe losses occur in wet season

- Plant resistant or tolerant varieties
- Rotate crops
- Use fungicide seed treatments
- Provide proper drainage

© APS 1999



Pod and Stem Blight

Pod and Stem Blight

- Dots in a line appear on damaged or mature stems and are scattered on pods
- Seeds may be small
- Seeds may have mold growing over them

- Occurs during warm, wet weather at maturity stage when harvest is delayed

- Harvest seed soon after maturity
- Plow under infected residue
- Use fungicide seed treatments
- Rotate crops

© USDA



Purple Seed Stain

Purple Seed Stain

- Pale to dark purple discoloration of the seed coat
- Infected leaves may be uniformly purple with small irregular spots
- Infection occurs at flowering or soon after

- Appears during warm and humid weather at flowering stage or soon after

- Apply foliar fungicides
- Use seed protectant
- Avoid soil and wind erosion
- Plant varieties that are moderately resistant

© APS 1999



Pythium Rot, Seed Decay, and Damping Off

Pythium Rot, Seed Decay, and Damping off

- A soft, water rot
- Seeds turn brown and are often overgrown with white mycelium

- Occurs during pre- and post-emergence, prevalent under cool, moist conditions

- Apply fungicides
- Use seed treatments

© Agri-Growth, Inc.



Rhizoctonia Root and Stem Decay, Damping off

- Reddish brown lesions occur on lower stem
- Plants wilt and die
- Seedling leaves appear gray-green then turn brown

- Occurs when soils are wet and cool followed by warm temperatures in seedling stage

- Ridge soil around base of plants during cultivation
- Maintain adequate P and K levels

Disease

Description

Environment

Prevention & Control

Root Knot Nematode

Root Knot Nematode

- Symptoms become evident during pod filling stage
- Plants are stunted and wilt during hot weather
- Roots have galls
- Galls may appear within 2-3 weeks of planting

- Occurs in sandy soils during warm weather
- Found primarily in the south central and southeastern U.S.

- Control wind and water erosion
- Rotate crops
- Use resistant varieties
- Apply nematicides

Sclerotinia Stem Rot

Sclerotinia Stem Rot

- White, cotton-like growth on lower stem
- Dark, hard masses of fungus are on the stem

- Occurs in wet conditions during flowering and early pod formation stage

- Avoid rotation with beans and sunflowers
- Promote drying the canopy

Southern or Sclerotium Blight

Southern or Sclerotium Blight

- White, cottony, fan-like fungus grows over stem surface near the ground
- Mustard-like seeds appear on the surface of the fungus

- Occurs in warm, dry soils, during seedling stage or the latter seed fill stages

- Plant tolerant varieties
- Rotate crops

Soybean Cyst Nematode (SCN)

Soybean Cyst Nematode (SCN)

- SCN can exist for years without any noticeable signs
- Typical symptoms include: uneven plant height in the field, static yields over several years, and/or delay in canopy closure

- Occurs primarily in southern states, but it is moving northward

- Collect periodic samples
- Ensure good K nutrition and pH between 6.0 and 6.5
- Clean tillage when moving from field to field
- Rotate resistant soybean varieties
- Rotate soybeans with non-host crops

Soybean Mosaic

Soybean Mosaic

- Leaves are crinkled and mottled with light and dark green patches
- Leaves may become leathery, coarse, and brittle near maturity
- Seeds may be discolored and flattened

- Temperature dependent and most obvious at 65° F
- Occurs in an environment that favors aphids (carriers)

- Plant disease-free seed
- Remove infected plants
- Practice good weed control, particularly against broad leaf weeds

Stem Canker

Stem Canker

- A brown sunken lesion will develop on leaf scar after a secondary stem has fallen. This usually appears on one side of the lower stem near the soil line.
- A reddish brown sunken lesion girdles the stem and the upper plant dies

- Favors warm, wet and windy weather during seed fill

- Control wind erosion
- Plant disease-free seed and resistant varieties
- Use fungicide seed treatment
- Rotate crops

Insects, Weeds & Diseases

Soybean Diseases

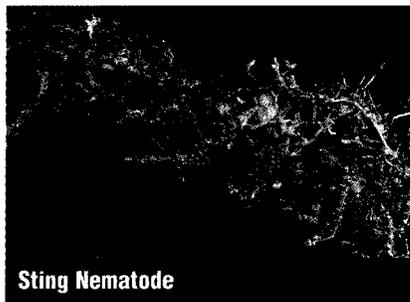
Disease

Description

Environment

Prevention & Control

© USDA



Sting Nematode

Sting Nematode

- Plants are stunted and yellow
- Root proliferation occurs above dark lesions
- Roots are stubby and discolored and will eventually rot

- Occurs usually in sandy soils
- Is noticeable at early pod formation

- Control water and wind erosion
- Rotate crops
- Apply nematicides
- Plow under infected residue
- Clean equipment between fields

© Agri-Growth, Inc.



Sudden Death Syndrome

Sudden Death Syndrome

- Leaves develop interveinal yellow blotches that turn brown
- Defoliation occurs but with secondary stems remaining attached
- Stem and roots turn gray-brown
- Pods drop

- Appears in mid-to-late season under cool, wet conditions
- Is associated with soybean cyst nematodes
- Irrigated crops are more susceptible

- Maintain nutrient requirements
- Plant resistant varieties

© APS 1999



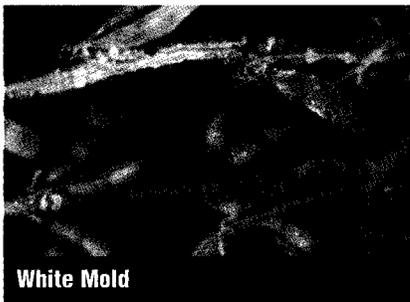
Target Spot

Target Spot

- Reddish brown lesions that are surrounded by a yellow halo

- Occurs in humid weather during pod formation and seed fill

- Rotate crops
- Control water and wind erosion
- Plant resistant varieties
- Use fungicide seed treatment



White Mold

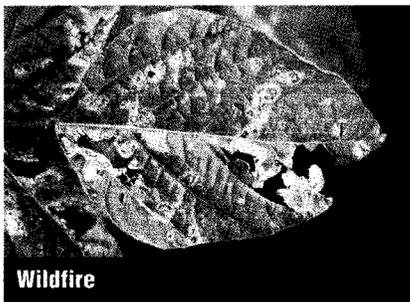
White Mold

- White, fluffy mold on the outside of infected plant stems
- Plants wilt, drop leaves, and turn white or pale tan
- Fungus on stem will produce black sclerotia

- Occurs mid to late season
- More prevalent in narrow rows

- Plant disease-free seed
- Clean equipment between fields
- Control weeds, particularly broad leaves
- Rotate crops, avoid beans and sunflowers
- Avoid spreading manure on fields

© APS 1999



Wildfire

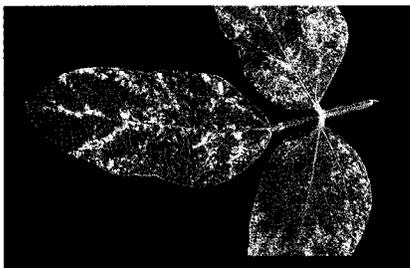
Wildfire

- Light brown spots surrounded by a large, yellow halo form
- Spots enlarge during wet weather and consume leaf
- Usually accompanies bacteria pistules

- Spreads under windy and wet weather during the flowering and early pod formation stages

- Plant resistant varieties
- Rotate crops
- Use disease-free seed
- Do not cultivate when foliage is wet

© APS 1999



Yellow Mosaic

- Dead spots develop in yellow areas as leaf matures

- Any environment that favors aphids during pod formation and seed fill

- Plant disease-free seed and resistant varieties
- Remove infected plants
- Control weeds

Monsanto is proud to work in partnership with farmers to promote sustainable agriculture. Plant biotechnology contributes to sustainable agriculture by increasing food production without harming or depleting the Earth's limited natural resources. Biotech crops contribute to sustainability by enabling techniques that can improve soil and water quality, and by optimizing yields and using arable land more efficiently. At Monsanto, we are committed to providing the tools you need to profitably grow crops with less impact on the environment.

New developments in biotechnology allow us to identify and transfer the specific gene that creates a desired trait in a plant, and offer a more precise way to produce plants with certain beneficial characteristics, such as greater nutrition. Biotechnology also may one day produce plants that make us less dependent on non-renewable resources such as oil and natural gas, providing new sources of energy or ways to reduce pollution.

Benefits such as these help make agriculture more sustainable by promoting practices that are environmentally sound, socially responsible and economically viable. By practicing sustainable agriculture today, we can maintain the quality of life for future generations.

MONSANTO

Food • Health • Hope™



Sponsorship provided by

MONSANTO

*Food • Health • Hope*TM



TM



SHARED
SOLUTIONSSM

The Philip Morris Family of Companies



Philip Morris
U.S.A.

