



Produced by:

IOWA STATE UNIVERSITY
University Extension



In cooperation with:

Written by:

Jeff Lorimor extension agricultural and biosystems engineer
Kris Kohl extension agricultural and biosystems field engineer
Randy Killorn extension agronomist
Bill Lotz extension crop field specialist
Paul Miller Natural Resource Conservation Service

Edited by:

Tracy Peterson
Elaine Edwards ISU Extension Communication Systems
Bonnie Harmon

Designed by:

Julie Mangels Juls Design, Ankeny, Iowa

A special thanks to:

North Carolina State University and the University of Illinois. Some of the materials in this manual were adopted from *Certification Training for Operators of Animal Waste Management Systems Manual*, published by North Carolina State University and *Certified Livestock Managers' Manual*, published by the University of Illinois. Reviewed by Ubbo Agena and field staff, Iowa Department of Natural Resources, and Gerald Miller and Jim Johnson, Iowa State University Extension.

...and justice for all
The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, and marital or family status. (Not all prohibited bases apply to all programs.) Many materials can be made available in alternative formats for ADA clients. To file a complaint of discrimination, write USDA, Office of Civil Rights, Room 326-W, Whitten Building, 14th and Independence Avenue, SW, Washington, DC 20250-9410 or call 202-720-5964.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Stanley R. Johnson, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.

December 1999
File: Environmental Quality 1-4
[E]



table of contents

INTRODUCTION

introduction page

Manure—an asset	1
Manure risks	1
Land application errors	2
Environmental and financial benefits	2

WATER QUALITY

water quality page

Water quality concepts	1
Conditions which impact water quality	1
• Immediate effects	
• Manure nutrients	
• Other manure components	
• Soil characteristics	
• Runoff	
Groundwater considerations	3
• Dependence on groundwater	
• The aquifer	
• Nitrate in drinking water	
Summary of key points	4

STORAGE

storage and handling page

System descriptions	1
• Formed tanks	
• Earthen manure storage	
• Lagoons	
Dry manure storage	2
Management requirements	3
Storage capacity calculations	4
• Rectangular pits	
• Round pits	
• Earthen basins	
Summary of key points	5

table of contents

NUTRIENT MANAGEMENT

nutrient management page

Managing manure nutrients for crop production

Determining nutrient content	1
Crop availability	2
• Nitrogen availability	
• Phosphorus availability	
• Potassium availability	
Nutrient requirements for crop production	3
• Method 1 for nitrogen	
• Method 2 for nitrogen	
Allocating manure to fields	4
Scheduling application	5
Summary of key points	5

LAND APPLICATION

land application page

Environmental safety	1
• Manure application guidelines	
Liquid manure application systems	2
• Injection systems	
• Broadcast systems	
• Irrigation systems	
Determining the proper rate	3
Soil-water relationships	5
• Estimating soil-water content	
• Scheduling irrigation	
• Understanding your system	
- Determining application rates for stationary big gun and rotary impact sprinklers	
- Determining application rates for traveling gun sprinklers	
Calibration	9
• Calibrating liquid tank spreaders	
- Volume method	
- Weight method	
- More about liquid spreaders	
• Calibrating solid and semisolid manure spreaders	
- Volume method	
- Sampled weight method	
- More about solid and semisolid manure spreaders	
• Reliability and quality of calibration results	
• Calibrating irrigation systems	

table of contents

Environmental issues	12
• Applying manure on frozen or snow-covered ground	
• Controlling soil erosion	
• Irrigation systems and neighbors	
• Prevent releases when handling pipes	
Example of actual releases	15
Summary of key points	17

EMERGENCIES AND SAFETY

emergencies and safety page

Emergency action plans and safety

Emergency action plans	1
Personal safety	4
• Manure gases	
- Hydrogen sulfide	
- Methane	
• First aid for victims of manure gas asphyxiation	
• Effect of air quality on human health	
Summary of key points	7

APPLICATOR RULES

applicator rules page

Manure applicator certification	1
Manure management plans	1
Records	5
Manure application separation distances and restrictions	5
Adjacency and building separation distances	6
• Separation distances	
• Right-of-way separation distance	
• Water course separation distances	
Confinement animal feeding operation construction permits	7
Summary of key points	8

table of contents

RECORD KEEPING

record keeping page

Nitrogen records	1
Land application records	1
Field sketches	2
Sample records	2

OTHER RESOURCES

other resources page

Iowa State University Extension field specialists/agricultural engineers	1
Iowa State University Extension field specialists/crops	1
Natural Resources Conservation Service	3
• NRCS state office	
• NRCS area offices	
Iowa Department of Natural Resources	3
^a IDNR Environmental Protection Division field offices	
Manure and soil testing laboratories	4
• Soil and manure analysis	
• Soil and biosolids analysis	
• Manure analysis	
• Soil testing	

table of contents

TABLES AND FIGURES		<i>page</i>
Uncontrolled discharges (<i>figure 1</i>)	.....	<i>introduction 3</i>
Number of uncontrolled releases each year caused by land application errors (<i>table 1</i>)	.....	<i>introduction 3</i>
The hydrologic cycle (<i>figure 1</i>)	.....	<i>water quality 5</i>
Potential sources of nonpoint source pollution (<i>figure 2</i>)	.....	<i>water quality 5</i>
Rectangular pit capacity gallons — 6 feet of liquid (<i>table 1</i>)	.....	<i>storage and handling 6</i>
Rectangular pit capacity gallons — 8 feet of liquid (<i>table 2</i>)	.....	<i>storage and handling 6</i>
Rectangular pit capacity gallons — 10 feet of liquid (<i>table 3</i>)	.....	<i>storage and handling 7</i>
Round pit capacity gallons — various depths (<i>table 4</i>)	.....	<i>storage and handling 7</i>
Earthen basins capacity gallons — pumpout depth = 6 feet (<i>table 5</i>)	.....	<i>storage and handling 8</i>
Earthen basins capacity gallons — pumpout depth = 8 feet (<i>table 6</i>)	.....	<i>storage and handling 8</i>
Earthen basins capacity gallons — pumpout depth = 10 feet (<i>table 7</i>)	.....	<i>storage and handling 9</i>
Earthen basins capacity gallons — pumpout depth = 12 feet (<i>table 8</i>)	.....	<i>storage and handling 9</i>
Corn N Requirements (<i>figure 1</i>)	.....	<i>nutrient management 6</i>
Plant available nutrients excreted by livestock in Iowa in 1990 (<i>table 1</i>)	.....	<i>nutrient management 6</i>
Nutrients in animal manure (<i>table 2</i>)	.....	<i>nutrient management 7</i>
Nutrients excreted by animals (<i>table 3</i>)	.....	<i>nutrient management 8</i>
Correction factors to account for nitrogen volatilization losses during land application of animal manure (<i>table 4</i>)	.....	<i>nutrient management 9</i>
Nutrient removal for Iowa crops (<i>table 5</i>)	.....	<i>nutrient management 9</i>
Nitrogen fertilizer recommendations for manured soils and corn after alfalfa (<i>table 6</i>)	.....	<i>nutrient management 10</i>
Priority ranking of fields for animal manure application based on soil test for phosphorus and potassium and the crop to be grown (<i>table 7</i>)	.....	<i>nutrient management 10</i>

table of contents

TABLES AND FIGURES CONT.

page

Ideal parameters of manure injection design (figure 1)	land application 18
Chisel point-type injector (figure 2)	land application 18
Sweep-type injector (figure 3)	land application 19
Sweep-type injector with coulter and closing disks (figure 4)	land application 19
Residue measurements at ISU manure application field days has shown that up to 89 percent of the residue can be retained by the Sukup and Yetter no-till injector and the Farmstar no-till injector. (figure 5)	land application 20
Many of the sweeps retained 60 percent residue coverage. (figure 6)	land application 21
Covering disks perform well in residue. Residue coverage depends on how deep they are run. (figure 7)	land application 21
Behavior of soil at selected soil-water depletion amounts (table 1)	land application 22
Typical infiltration rate curve (figure 8)	land application 22
General flow rates and coverage diameter for Big Gun™ stationary sprinklers (table 2)	land application 23
Typical layout of a traveling gun irrigation system (figure 9)	land application 23
Manure spreader calibration (table 3)	land application 24
Liquid manure application rates (table 4)	land application 25
Field office locations of Environmental Protection Division (chart 1)	emergency and safety 3
Characteristics and effects of gasses produced in livestock buildings and manure storage structures (table 1)	emergency and safety 8
Health symptoms of Iowa swine facility workers (table 2)	emergency and safety 8
Facility weight capacity for swine (table 1)	applicator rules 10
Facility weight capacity for bovine (table 2)	applicator rules 10
Facility weight capacity for poultry (table 3)	applicator rules 10
Crop nitrogen usage rate factor (table 4)	applicator rules 11

table of contents

TABLES AND FIGURES CONT.

page

Required separation distance (for spring irrigation) from actual wetted perimeter to residence, commercial enterprise, religious institution, educational institution, or public use area (table 5)	applicator rules 11
Minimum distance requirements which allows two sites to be considered as separate operations (table 6)	applicator rules 11
Separation distance requirements for structures for non-bovine operations (table 7)	applicator rules 12
Separation distance requirements for structures for bovine operations (table 8) .	applicator rules 13
Minimum thresholds for construction permits (table 9)	applicator rules 14
Indemnity fees charged to producers who file manure management plans after 1/1/99 (table 10)	applicator rules 14
Application data (worksheet)	record keeping 3
Weather data (worksheet)	record keeping 4
Field sketches (worksheet)	record keeping 5
Testing results (worksheet)	record keeping 6
Manure inventory (worksheet)	record keeping 7
Field application inventory (worksheet)	record keeping 8



*I*owa's manure law requires manure applicators to become certified by March 1, 1999. The 1998 Iowa Legislature included the certification provisions as part of House File 2494. As Livestock facilities become larger, there may be increasing pressure to apply manure faster, under poorer weather conditions, and at higher rates than are environmentally friendly. Manure applicator certification is designed to help you use manure as an asset and avoid water quality problems due to improper application. Reported releases and discharges to the state's rivers, stream, and lakes have increased since 1992.

MANURE—AN ASSET

Manure has been applied to agricultural land for many years. People discovered long ago that manure makes crops grow better and produce more. Long-term research on manure application (dating back more than 100 years) clearly shows that manure applications at the right rates are good for the soil. Manure increases organic matter, helps develop better soil structure, increases cation exchange capacity, promotes better drainage, increases the number of microorganisms, and generally improves the “tilth” of the soil. Soils with a long-term history of being manured have been shown to be superior to soils that were not manured, or were fertilized with commercial fertilizers.

Manure nutrients from liquid swine pits may be worth \$20 per 1,000 gallons or more. By replacing commercial fertilizer with manure, producers can save up to \$40 to \$60 per acre.

In recent years we have become increasingly aware that manure also can have negative effects on the environment. Uncontrolled releases of liquid manure from pits or lagoons can cause immediate fish kills and loss of other aquatic life. And long-term, over-application of manure can cause buildups of nutrients in the soil, particularly phosphorus, that can ultimately cause surface water quality problems.

The key to maintaining manure as an asset and a valuable resource is careful handling and applying at proper rates. That’s what manure applicator certification is about—helping you, as a manure manager, do a better job so the manure you manage remains an asset, rather than becoming

a liability.

MANURE RISKS

IDNR records show approximately 86 uncontrolled discharges to surface waters were reported between February 1992 and May 1998. That’s an average of 14 per year, and the trend is increasing (see Figure 1 on introduction page 3).

This may reflect a greater number of uncontrolled releases and discharges or it may simply reflect greater public scrutiny or reporting. During those six years, 32 fish kills occurred. Not all releases resulted in pollution of state waters, but all were significant enough to require IDNR investigation and follow-up. Of course, unreported discharges are not shown. The reported discharges occurred from the following types of facilities: earthen storage structures, 42; formed pits, 20; open feedlots, 24.

Sixteen discharges were due to poor construction, such as failing to remove existing field tiles, leaking or plugged lines or valves, or leaving organic matter in earthen berms during construction. Twenty-six releases were caused by poor management or lack of attention, such as leaking waterers or ruptured water lines that caused pits to fill and overtop, running out of storage capacity in pits or lagoons, or even intentional dumping. Overtopping of earthen basins, formed pits, and lagoons all occurred, as did discharges from open feedlots due to precipitation events.

introduction

LAND APPLICATION ERRORS

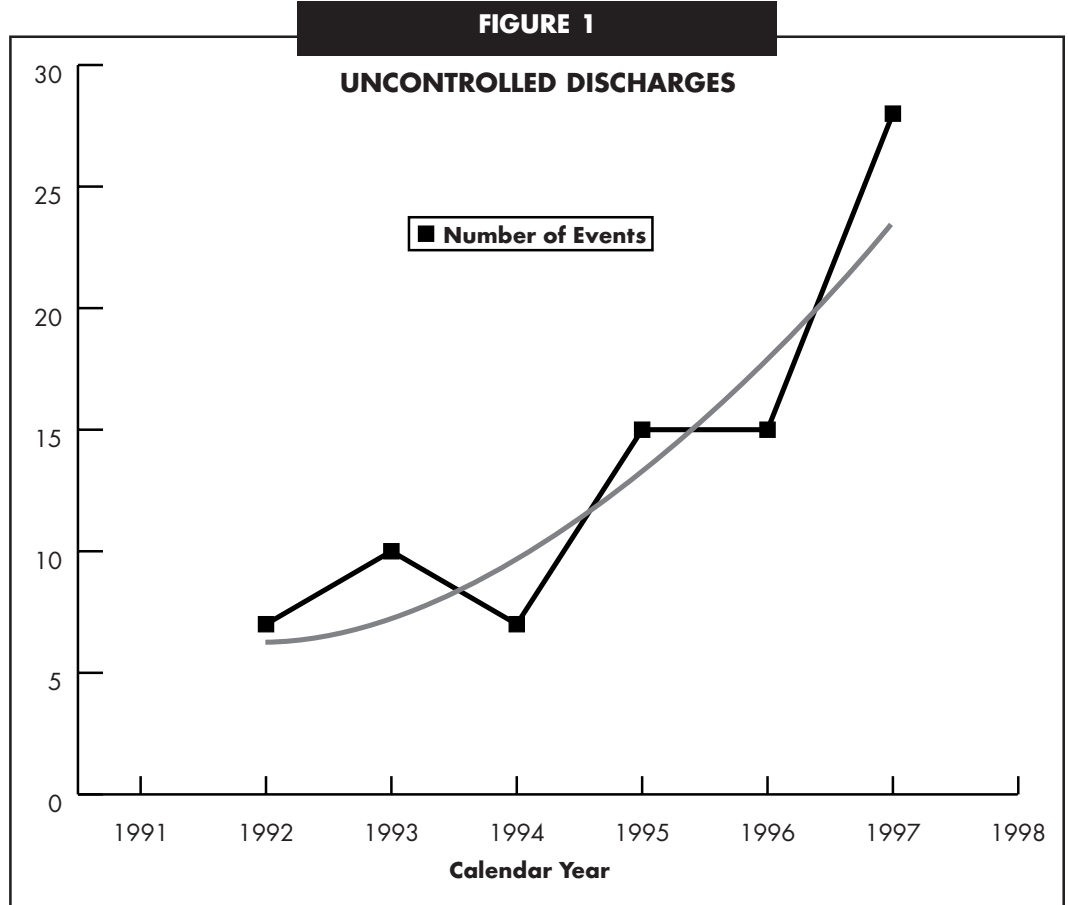
Land application errors caused 30 releases, more than either construction or management errors. Releases during land application resulted from applying manure to frozen soils, irrigation line separations during pumping, pumps being left on too long, simply applying more manure than the soil could hold, and precipitation immediately after manure application. While the number of releases during land application is not high on a statewide basis, the records confirm these releases often reach streams or rivers, causing fish kills and other environmental damage. The number of releases during land application each year also has been rising (*See Table 1 on introduction page 3.*)

ENVIRONMENTAL AND FINANCIAL BENEFITS

Manure can be managed to minimize environmental impacts while optimizing economic benefits for all parties. Longtime research clearly shows that properly applying manure to land is beneficial to the soil and water in both the short and long term.

The following material is presented to help you become legally certified to apply manure in Iowa and help you understand how to manage manure correctly so that it is an asset, rather than a liability.

introduction



IDNR-recorded uncontrolled manure and lagoon effluent releases.

TABLE 1

**NUMBER OF UNCONTROLLED
RELEASES EACH YEAR CAUSED
BY LAND APPLICATION ERRORS**

YEAR	NUMBER OF RELEASES
1992	2
1993	5
1994	1
1995	5
1996	5
1997	12