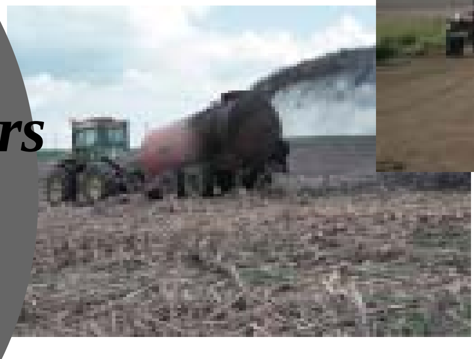
Iowa Manure Matters

Odor and Nutrient Management

EDC-129-23, Volume 7, Issue 1 Spring 2004



Implementing the phosphorus index for manure application

by Jeremy Klatt, Iowa Department of Natural Resources

The Iowa Department of Natural Resources (DNR) has proposed rules that would use the phosphorus (P) index to determine manure application rates in manure management plans for confinement feeding operations. Public hearings are scheduled for the week of March 22-26 at five different locations around the state. Once effective, the rules will be phased in over four years, starting with the original plans submitted to the DNR 60 days after the rule becomes effective.

Schedule for Public Hearings

Ainsworth, March 22, 2004 at 6 p.m., Marr Park Conservation Center, 2943 Highway 92

Des Moines, March 23, 2004, at 1:30 p.m., Fourth floor conference room, Wallace State Office Building, 502 E Ninth Street

Atlantic, March 24, 2004, at 6 p.m., Atlantic Public Library, 507 Poplar Street

Spencer, March 25, 2004, at 6 p.m., Spencer School Administrative Offices, 23 East Seventh Street

Elgin, March 26, 2004, at 6 p.m., Gilbertson Nature Center, 2258 A Avenue

The Iowa P index was developed by scientists from Iowa State University, the USDA-National Soil Tilth Laboratory, and the USDA-Natural Resources Conservation Service (NRCS). The index estimates the risk of P loss from a field, based on several factors including erosion, soil P tests, management practices, and the location of the field. Using the P index results in a site—vulnerability ranking, which categorizes the risk of P loss as *Very Low, Low, Medium, High,* or *Very High*.

Although an important component of the P index, the soil P test does not alone indicate the risk of P loss. A soil P test is used to make P recommendations, which are based on the probability of a yield response from a nutrient application. Because of the impact of other factors such as erosion, a high soil test does not indicate a high risk of P loss nor does a low soil test indicate that there is a low risk of P loss.

Proposed Application Rates. Based on the P index risk categories mentioned above, the DNR has proposed the following for application rates:

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Very Low or Low (0-2): Manure applications may continue to be based on nitrogen (N) crop usage rates.

Medium (2-5): Manure application shall be applied at P-based rates. Manure may be applied at N-based rates if soil conservation and manure management practices are planned so that the P-index rating is not increased above the *Medium* risk category.

High or Very High (>5): No manure shall be applied unless soil conservation or manure management practices are adopted which reduce the P index to the *Medium* risk category.

Application rates for the Low and Very Low risk categories. Although manure applications can be based on nitrogen (N) crop usage rates in the *Low* and *Very Low* risk categories, producers should consider the effect of manure application rates on the soil P content when planning manure applications. Continual application based on N can increase soil P, causing an increase in the P index over time. In most circumstances, applying N-based rates to the same fields every year rapidly builds the P in the soil.

Application rates for the Medium risk category. Many fields in the *Medium* risk category will have the option of N-based or P-based rates. For instance, when a field P-index ranking is just above the *Low* category, the N-based management would still be appropriate. However, for a field that is just below the *High* risk category, the P-based management may be needed to avoid increasing the P index to the *High* risk category.

Application rates for the High and Very High risk categories. While the proposed rule indicates no application of manure if a field is in the *High* or *Very High* risk categories, soil conservation practices can be used to reduce the P index to the *Medium* risk category. For example, increasing residue cover, adding filter strips, and installing grassed waterways will reduce erosion or sediment loss and will therefore reduce the P index.

The phased-in schedule allows most producers four years to file a manure management plan using the P index. This schedule allows producers to determine the P index for each field and, if necessary, it gives them time to adjust management practices to allow for continued manure application or to identify the additional acreage needed to comply with the rule.

Applying manure on a P-based rate. A P-based manure application rate replaces the P removed from the field by the harvested crop(s) or applies the amount of P recommended by soil test results. The proposed rule provides for application of up to four years of P in a single manure application. No additional P (manure or fertilizer) can be applied during the time covered by the application. Table 1 illustrates P-based rates for a corn and soybean rotation when using Iowa State University standard table values for manure and yield goals of 160 and 50 bushels per acre, respectively.

When applying a P-based rate, both the P removal and the recommendation for crop rotation, and the N needs of the crop receiving the manure should be considered. With yields of 160 and 50 bushels per acre for corn and soybeans, respectively, the two-year rotation removes approximately 100 pounds of P_2O_5

Table 1. P-based rates using ISU standard table values and a corn and soybean rotation.

Management System	N	P_2O_5	P-based application rate	P_2O_5 Applied	Available N Applied
	pounds/ 1000 gallons	*gallons /acre*	*lb/acre*	*pounds/acre*	
Grow/finish	50	42	2,400	100	118
Grow/finish (W/D)	58	40	2,500	100	128 *
Grow/finish (earthen)	32	22	4,500	100	127 *
Sow and Litter	25	20	5,000	100	123
Farrow-nursery	27	23	4,300	100	114
Nursery	35	20	4,200	84	130 *
Gestation	25	25	4,000	100	98
Farrow-finish	44	32	3,100	100	120*
	pounds/ton	*ton/acre*	*lb/acre*	*pounds/acre*	
Poultry (layer)	35	80	2.5	200	54 +
Poultry (broiler)	65	65	3.0	200	120 +
Turkey	40	40	5.0	200	124 +

*Assumed injection of liquid swine manure, and poultry manure incorporation within 24 hours. First year N availability of liquid swine manure considered 100 percent.

+ First year N availability of poultry manure of 65 percent per acre and the maximum N rate for the corn crop is 142 pounds of N per acre (assuming 1.2 pounds of N per bushel). The P-based liquid swine manure application rates in Table 1 range from 2,400 to 5,000 gallons per acre. In many cases, in addition to meeting the P needs of the two-year rotation, a P-based rate also provides most or all, of the N needed for the corn. By not applying manure to the soybean crop, the P-based manure application rates are similar to typical N-based application rates for a corn crop.

Due to the high concentration of P in poultry manure, it may be necessary to apply P-based rates of poultry manure on a three- or four-year crop schedule. Using the same yields, if poultry manure were used for two cycles of a corn and soybean rotation in a single application, 200 pounds of P_2O_5 per acre could be applied (100 pounds of P_2O_5 per acre per rotation cycle). Taking the first-year of N availability of poultry manure into consideration (65 percent), poultry manure application rates in Table 2 range from 2.5 to 5 tons per acre.

Although all manure management plans for confinement will eventually be based on the P index, the effect of the proposed rule on manure application rates will be highly site-specific. Fields that have received P in excess of crop removal for long periods of time and fields with relatively high erosion rates are more likely to have a higher P index and greater limitations on the amount of manure that can be applied. Conversely, fields with soil P levels near the optimum for crop production and fields that have relatively low erosion rates are more likely to have a lower P index and can probably continue to receive N-based manure applications. Therefore, while some operations may be substantially affected by the proposed rule for manure management, other operations will not.

The proposed rule and a fact sheet on the use of the P index in manure management plans are available at the Iowa DNR animal feeding operations Web site at http://www.state.ia.us/epd/wastewtr/feedlot/feedlt.htm

For more information about the P index, visit the Iowa NRCS Web site at http://www.ia.nrcs.usda.gov/

Non-basin technologies for open feedlots

by Gene Tinker and Deb Frundle, Iowa Department of Natural Resources

The Iowa Plan for Open Feedlots was designed to bring open feedlots into environmental compliance by the year 2006. Today, many open feedlots do not have adequate run-off control structures to properly protect Iowa waters. All open feedlots are required to have solid settling as a minimum control measure. Feedlots with more than 1,000 animal units, or lots with between 301 and 1,000 animal units with a stream running through the lot or a direct man-made conveyance to water, are required to have a National Pollution Discharge Elimination System (NPDES) permit. If an NPDES permit is needed, the feedlot is also required to have designed containment to receive the effluent or liquid wastewater, after the solids from the runoff have been settled.

Most systems use a runoff control basin (now called solid open feedlot effluent basin by Iowa law) to catch the effluent from solid settling, and hold the effluent until it is land applied. The size of the basin is dependent on the amount of feedlot runoff and on how often the basin is emptied.

The U.S. Environmental Protection Agency (EPA) has revised the regulations for Concentrated Animal Feeding Operations (CAFO) to allow the use of alternative technologies to control the effluent from lots that need an NPDES permit. Therefore, non-basin, or alternative technologies are of great interest to producers as potentially cost-effective in total containment. Nonetheless, EPA has established relatively strict criteria for determining if a proposed alternative will be acceptable.

The Iowa Department of Natural Resources (DNR), Iowa State University (ISU), and the Iowa Cattlemen's Association have been working cooperatively to develop a system to identify open feedlots that may be candidates to use non-basin technology. To achieve this goal, the DNR must be able to verify if the designed systems adequately protect the waters in the state. Verification includes three major components: computer models, minimum criteria to help predict the success of non-basin systems on specific open feedlots, and monitoring to evaluate the effectiveness of the systems.

Iowa State University is developing computer models to compare the effectiveness of non-basin systems with a standard basin system. By using information on feedlot size, drainage area, distance from streams, and soil type and slope, the models can predict the effectiveness of an alternative design for an individual site.

Minimum criteria are being developed so that producers can work with professionals to determine if a non-basin system can provide adequate environmental protection for a specific feedlot. Open feedlot operators will be able to use these criteria to discuss possibilities with DNR environmental specialists and geologists, ISU staff or consulting engineers.

Infiltration basins and vegetative filter strips are the primary systems being considered. If properly designed and maintained, these systems will have a dense vegetative cover. Consequently, nutrients and pollutants will be reduced as the effluent is filtered through the soil, removed by evapotranspiration, attached to roots of vegetation, and taken up by plants. Other alternatives, such as composting, may be considered if an effective operational plan is developed.

Feedlots that receive approval to design, construct and operate a non-basin system must also agree to a multi-year monitoring plan. Monitoring will include sample collection of effluent, groundwater, and any potentially receiving stream to analyze nutrient treatment and pollutant dispersion through the system. These results will be compared with the model predictions and evaluated to ensure that no detrimental environmental impact has occurred. Non-basin systems that are not providing adequate environmental performance will be required to be replaced by a conventional system.

Open feedlot operators who would like to learn more about non-basin systems or discuss whether their feedlot could be considered for such a system should contact Deb Frundle (515) 242-6849 or Gene Tinker (515) 281-3103 at the Iowa DNR.

Managing corn and soybean residue with manure application

by Mark Licht and Mahdi Al-Kaisi, Department of Agronomy

Crop residue is important to soil and water quality and helps improve soil structure, infiltration and fertility. Also, crop residue reduces soil erosion and surface water runoff. Therefore, balancing residue cover on the soil surface and applying livestock manure are vital to improve soil productivity and environmental quality.

Complete residue cover can reduce soil erosion due to surface runoff significantly (up to 98 percent), compared to an unprotected soil surface. To meet conservation compliance requirements, a standard of at least 30 percent residue cover must remain on the soil surface after planting. In some cases, disc-covered manure application can reduce residue cover to below 20 percent, depending on how fragile the crop residue is. The type of manure application equipment used can significantly affect the amount of residue cover remaining on soil surface.

The results presented were obtained from a manure management study conducted in seven counties in Iowa. In the study, residue cover was estimated after the application of liquid manure at four different rates with three different types of manure applicators. The target application rates were 0, 2000, 3000, and 4000 gallons per acre. As the application rate increased, the applicator speed was reduced. The manure applicators used consisted of a disc-covering unit, a shovel incorporator, and a slot-injector manure applicator. The disc-covered applicator utilized discs to cover the manure that was applied directly on the soil surface (Figure 1). The shovel incorporator and the slot injector applicators placed the manure below the soil surface (Figures 2 and 3). In this study, the disc-covered manure applicator was used on corn stalks and all three applicators were used on soybean stubble.

The disc-covered applicator under soybean stubble reduced residue cover by an average of 61 percent more than under corn stalks (Figure 4). This significant difference in remaining residue cover can be attributed to the relatively higher amount of corn residue compared to soybean residue. The difference also can be attributed to the nature of each crop residues. Soybean residue is generally more fragile than corn residue; therefore, more soybean residue will be incorporated in the soil with disc covers than corn residue.

The type of application equipment also had a significant impact on the amount of residue remaining after manure application (Figure 5). Disc-covered manure application has shown to reduce soybean surface residue by 73 percent compared to residue reductions resulting from manure applications with the shovel incorporator and slot injector of 66 and 22 percent, respectively. Disc-covered applicators were more aggressive in overturning soil and residue to cover the

Figure 1. Disc-covered manure applicator.

Figure 2. Shovel-incorporated manure applicator.

Figure 3. Slot-injected manure applicator.

applied manure. The shovel incorporator had more visible disturbance due to the shovel mixing of the applied manure with the soil. On the other hand, the slot injector was less disruptive to surface residue because it applies the manure below the soil surface.

The rate of manure application had a relatively smaller impact on corn and soybean surface residue cover. However, the rate of manure application can impact residue cover depending on the types of both the manure applicator and crop residue. Under corn residue, disc-covered application at a higher application rate and at a lower application speed significantly increased the amount of residue cover remaining after manure application than the low and optimal application rates (Figure 4). This result can be attributed mainly to the lower application speed, which causes less soil and residue disturbance. Similarly, soybean residue cover after disc-covered application resulted in a significantly lower residue cover for the low application rate compared to the high application rate (Figure 5). However, application rate did not cause a significant reduction in soybean surface residue due to the use of the shovel incorporator nor slot injector applicator because these methods are less disruptive than disc-covered applicators.

Effective manure application and residue management can be combined to improve both soil productivity and environmental quality. The slot injector applicator disturbed the minimum amount of soybean surface residue while applying manure at high rates. Under corn residue, the disc-covered manure applicator left more than 30 percent residue cover, therefore meeting conservation compliance requirements.

The effect of manure applicators on percent residue cover for corn and soybean residue is limited to the locations and environmental conditions at the time of manure application during the fall of 2003. The data presented in this article are preliminary and do not represent all soils and environmental conditions in Iowa.

The data reported are part of the 'Integrated Tillage and Manure Management Hub and Spokes Project, funded in part by the Integrated Farm and Livestock Management (IFLM) Demonstration Program and the Iowa Pork Producers Association.

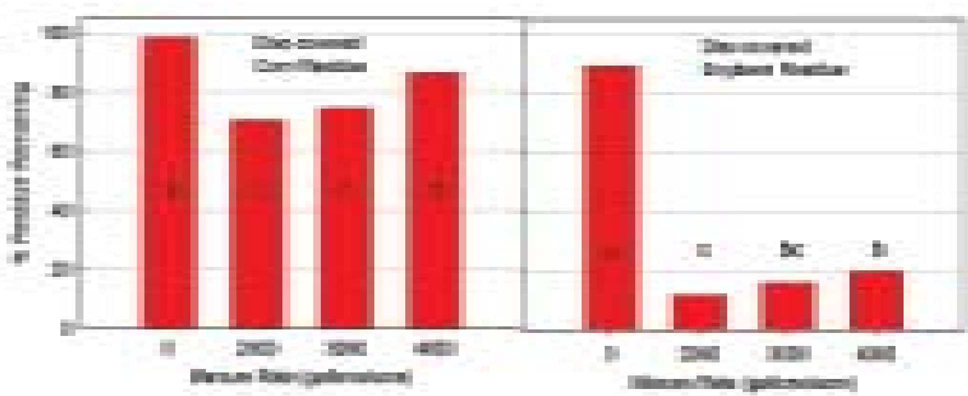

Figure 4. Corn and soybean residue cover after disc-covered application of liquid manure at four different rates.

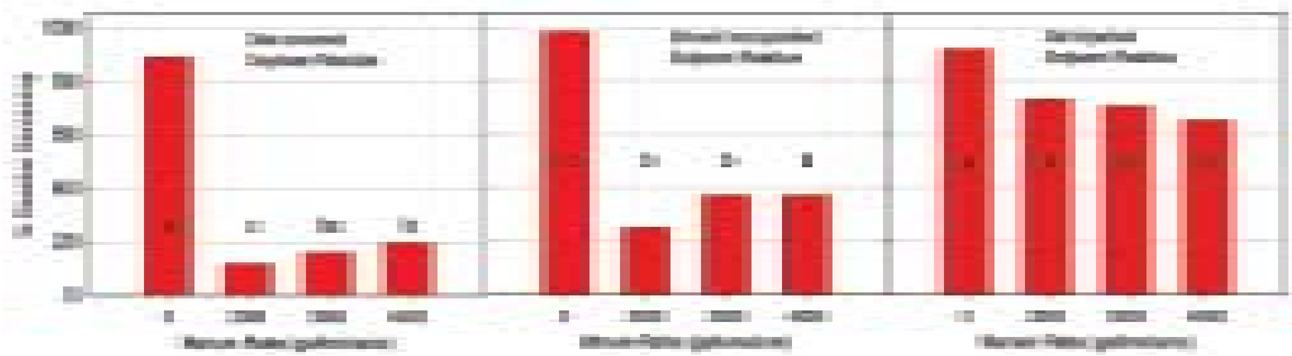

Figure 5. Soybean residue cover as affected by disc-covered, shovel injected, and slot injected manure application

Concrete solutions for confinement feeding operations

by Sara Smith, the Iowa Department of Natural Resources

Iowa livestock and poultry confinement producers have something to look forward to "better concrete standards" meaning better-built manure storage. Effective March 24, 2004, new concrete pits and tanks that store liquid or dry manure must be constructed to meet the revised concrete standards proposed by the Department of Natural Resources (DNR). Although more stringent, the updated standards will require new design guidelines to ensure that the concrete tanks and pits will provide liquid tightness and more uniform design and construction standards.

The DNR upgraded its minimum concrete design standards for confinement feeding operations in response to a legislative mandate. However, the discovery of sub-standard concrete pits and tanks in the field emphasized the need for using the most up-to-date technical information. The DNR developed the standards in cooperation with the MidWest Plan Service (MWPS) and the Portland Cement Association (PCA). Additional input came from the Natural Resources Conservation Service (NRCS), stakeholder groups and private contractors. The standards were studied for about eight months.

Confinements that are included: The new concrete standards would apply to any of the following confinement feeding operations:

1. *New concrete tanks or pits that store liquid or semi-liquid manure*. The tank or pit can be located belowground or aboveground, be circular or non-circular, covered or uncovered. These new standards would be required for operations larger than a small animal feeding operation (SAFO= operation has an animal unit capacity (AUC) of 500 animal units or less). However, for all operations, even for a SAFO, if a concrete tank or pit has walls deeper or higher than 12 feet, the tank or pit must be specifically designed and signed by a professional engineer (PE) or a NRCS engineer, regardless of the size of operation.
2. *New concrete tanks that store manure exclusively in dry form*. The tank can be belowground or aboveground, covered or uncovered. Dry manure storage was specifically exempted from the older standards.
3. *New concrete tanks or pits constructed in areas that exhibit karst terrain or areas that drain into a known sinkhole*. In these cases, additional upgraded concrete standards must be followed, regardless of the size of the operation.

Designs developed with a PE or NRCS Engineer. Only operations that meet or exceed the "threshold requirements" require a PE or a NRCS engineer to do the design of the concrete tanks and pits. The threshold requirements have been established for operations that need a construction permit and for operations that after construction or expansion of their facility have an animal unit capacity (AUC) equivalent to, or exceeding 1,250 AU (swine farrowing and gestating operation), 2,750 AU (swine farrow-to-finish operation), 4,000 AU (cattle operation), and 3,000 AU for all others.

The PE or NRCS engineer must use the design considerations of the American Concrete Institute (ACI), the Portland Cement Association (PCA) or the MidWest Plan Service (MWPS).

There are advantages of engineered designs. Producers who voluntarily choose to have a PE or an NRCS engineer design and sign the concrete tank or pit will have a much shorter list of additional requirements to comply with, because of the design considerations being required.

Designs developed without an engineer. The older standards were based on minimums and often resulted in a typical but insufficient design and construction. The new design standards are more site specific. The design methods for walls are either the MWPS-36 for non-circular tanks, the MWPS TR-9 for circular tanks, or the 567 Iowa Administrative Code (IAC) Chapter 65 new Appendix D. This new Appendix D was specifically developed for a belowground tank with laterally braced walls such as a below-the-building concrete pit. Appendix D contains tables with wall design specifications based on tank depth, wall thickness, type of backfill material, and whether vehicles will be allowed within five feet of the walls.

Additional requirements also apply to concrete tanks designed without a PE or NRCS engineer. These additional requirements are greater if the concrete tank is for liquid and semi-liquid manure, or for a belowground or a partially belowground tank that stores dry manure. Fewer additional requirements apply for an aboveground concrete tank used to store manure exclusively in a dry form.

The new concrete standards address fundamental design considerations and construction aspects. Among these, are the sub-grade preparation, the installation of a drainage tile to artificially lower the groundwater table, and the concrete curing and consolidation or vibration.

Furthermore, the new standards will no longer allow wire mesh as floor reinforcement in concrete tanks or pits that are 4 feet deep or deeper. DNR inspectors found out that during construction the floor wire was stepped on or improperly placed, resulting in inadequate reinforcement and increased cracking.

Table 1 summarizes the major changes introduced with the new minimum concrete

Table 1. Changes in concrete standards

Requirement	Older Standards	New Standards
Walls:		
- Thickness, for tank height (H) •10 feet	8"	Variable [1, 2, 3]
- Thickness, for tanks H<10 ft	6"	Variable [1, 2, 3]
- Minimum reinforcement	#4 rebar @ 18" on center	Variable [1, 2, 3]
Additional requirements:		
1. Subgrade preparation	None	Yes [1, 3]
2. Specify drain tile location	None	Yes [1, 2, 3]
3. Minimum compressive strength,)	4,000 & 3,000	4,000 & 3,000
in pounds per square inch (psi	as batched and delivered	as placed [1, 3]
4. Cement & aggregates	None	Yes [1, 3]
5. Consolidation or vibration	None	Yes [1, 3]
6. Minimum steel grade	40	40 [1, 3]
7. Rebar cover	None	Yes [1, 2, 3]
8. Floors:		
- Thickness, irregardless of H	5"	5" with tolerances [3]
- Reinforcement for tanks H •4 ft	#4 @18" or 6 x 6- W1.4xW1.4 wire meshor steel equivalent	#4 @ 18" [3]
- Reinforcement for tanks H<4 ft	None	6 x 6- W1.4xW1.4 [3]
9. Footing dimensions	None	Yes [1, 2, 3]
10. Tie bars or dowels	None	Yes [2, 3]
11. Rigid forms for concrete	No change	No change [1, 2, 3]
12. Concrete curing	None	Yes [1, 3]
13. Waterstops	None	Yes [2, 3]
14. Backfilling of walls	None	Yes [1, 2, 3]
15. PE design required for tanks with H>12 feet	None	Yes [1, 3]

[1] Does not apply if a PE or a NRCS engineer designs and signs the concrete tank or pit for liquid and semi-liquid manure.

[2] Does not apply for an aboveground concrete tank for the storage of manure exclusively in a dry form and that is designed without a PE or a NRCS engineer.

[3] Does not apply if a PE or a NRCS engineer designs and signs the concrete tank for the storage of manure exclusively in a dry form.

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standards for a concrete tank that will store liquid, semi-liquid and dry manure, above or below ground.

New concrete standards for Karst and Sinkhole Areas. Finally, the new concrete standards contain more stringent requirements if the proposed concrete tank or pit will be located in an area that exhibits karst terrain or that drains into a known sinkhole. These requirements apply to all confinement feeding operations, regardless of their size. In these environmentally sensitive locations, the DNR recommends that producers construct aboveground tanks. However, if construction of a belowground or partially belowground tank must take place, the DNR will require a minimum vertical separation to the limestone, dolomite or soluble rock of at least five feet. Otherwise, the design must be prepared and sealed by a PE who will need to certify on the structural stability of the tank. Groundwater monitoring requirements will be required on these sites.

Although it is not always required, producers who are planning on constructing or expanding an operation should consult with a professional engineer or a NRCS engineer. If this is not possible, pertinent technical literature should be obtained. For additional information on these issues and the new concrete standards, please contact a DNR engineer at (515) 281-8941 or your nearest DNR field office. Complete copies of the concrete rules are available on the DNR Web site at www.IowaDNR.com under “Animal Feeding Operations.”

Iowa Manure Matters: Odor and Nutrient Management is published by Iowa State University Extension, with funding support from the USDA Natural Resources Conservation Service through Cooperative AgreementÊ No. 74-6114-10-04. To subscribe or change the address of a current subscription, write to Angela Rieck-Hinz, 2104 Agronomy Hall, Iowa State University, Ames, Iowa, 50011-1010 or call 515-294-9590, fax 515-294-9985 or email: amrieck@iastate.edu. Please indicate you are inquiring about the *Odor and Nutrient Management* Newsletter. The newsletter’s coordinators are Jeff Lorimor, extension engineer, Department of Agricultural and Biosystems Engineering; Angela Rieck-Hinz, extension program specialist, Department of Agronomy; and Wendy Powers, environmental extension specialist, Department of Animal Science; the editor is Marisa Corzanego, the subscription manager is Rachel Klein, the production designer is Beth Kroeschell, and the Web page designer is Liisa Jarvinen.

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.