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Manure sampling, analysis, and applicator calibration

by John E. Sawyer and John Lundvall, Department of Agronomy

The goal of a project outlined in an article in the *Odor and Nutrient Management* newsletter, Fall 2002 issue, pages 4–6, is to demonstrate crop utilization of liquid swine manure nutrients—from understanding the nutrient rate of application to measuring crop response. In this article, we present results for the first step: understanding the rate of nutrient application. For each site in the demonstration project, this step entailed manure preapplication sampling and laboratory analysis, manure sampling during application with laboratory analysis, application equipment rate calibration, and nutrient application rate calculated from the calibration and at-application sample analysis. For the first 3 years of the project (2000–2002), we worked with 16 producer cooperators at 39 production/field sites located in 12 counties (representing 54

manure treatment applications). Specifics on the demonstration procedures are outlined in the Fall 2002 newsletter article.

Preapplication manure analyses compared with at-application analyses. For all sites, the manure source was from swine finishing facilities with storage in under-building pits or outside concrete tanks (two sites). Manure samples were collected 2



Agitating liquid swine manure in concrete pit.

This issue

Manure sampling, analysis, and applicator calibration

Certification workshops in 2003

Updates on certification program

to 3 weeks before planned application by either dipping manure off the surface or probing the storage profile. Forty of the 54 applications were based on total-nitrogen (N), with the remaining 14 based on total-phosphorus (P). Multiple samples (up to 11 samples per site) were collected during application to the demonstration sites (98 total manure samples for the 3 years). Manure was agitated during pump-out of the storage structures. Figure 1 shows a comparison between the preapplication sample analyses (total N, P_2O_5 , or K_2O per 1,000 gallons) and the average of the samples per site collected during application. Presamples were often analyzed only for total-N if the application was to be based on total-N. Figure 1 represents the ability of the presample to predict the manure nutrient concentration during application. Overall, the presample gave a good prediction of the total-N concentration expected during application. On average, the preapplication sample had 5.7 percent lower total-N than the at-application samples. Across all sites, the average ammonia-N in the liquid swine manure was 83 percent of the total-N. For P, the variation between pre- and at-application sampling was larger, but in some instances the presample was dipped off the manure surface, which is not expected to provide a good representation of P in an agitated pit. Because potassium (K) is contained in the soluble manure solution, the preapplication samples were close to the at-application samples.

Intended manure nutrient rate compared with calculated applied rate. Figure 2 shows the comparison of the intended manure total-N or total-P application rate and the calculated applied nutrient rate. The applied rate was calculated from the average analyses of the manure samples collected during application at each site and the application equipment calibration. For total-N, if one accepts ± 30 pounds N/acre as an acceptable ability to apply manure-N, then 18 percent of the applications (7 of 40 applications) were outside this range (all but one of these was with a vacuum-style applicator). In some instances, the calibration process indicated that greater than desired rates were going to be applied because of equipment limitations to reduce the flow rate and/or tractor speed limitations. These sites were kept in Figure 2, and an example is the two very



Collecting manure sample from tank wagon.

high application rates. The occurrence of applications well above intended rates happened with vacuum-style applicators, and especially when the manure nutrient concentration was high. For total-P, if one accepts ± 15 pounds P_2O_5 /acre as an acceptable ability to apply manure-P, then 29 percent of the applications (4 of 14 applications) were outside this range, mainly due to the presample P analysis being higher or lower than the at-application samples. However, a wider range in P application could be expected as some of the manure samples were dipped from the manure storage surface for total-N measurement rather than probed, which would be expected to not represent P as well.

When based on either total-N or total-P, 19 percent of applications were greater than 25 percent from the intended rate (10 of 54 applications). The majority of applications were within 15 percent of the intended rate. If you take out the two known high application rates from one site, then 13 percent of applications fall outside the ± 30 pound total-N/acre range. Seven of the 10 high application rates were made with vacuum-style equipment. Many of the applicators used in the project were equipped with a flow monitor and rate controller. These applicators calibrated well, and variation between intended and calculated rates generally were due to differences in the pre- and at-application manure analyses. Partly due to the preapplication sample analysis being lower than the at-application sample, the tendency was for the calculated applied rate to be larger than the intended rate.

Variability in nutrient analyses for samples collected during application. Figure 3 shows the comparison of individual manure sample N, P, and K analyses and the site average analyses. Because the project worked

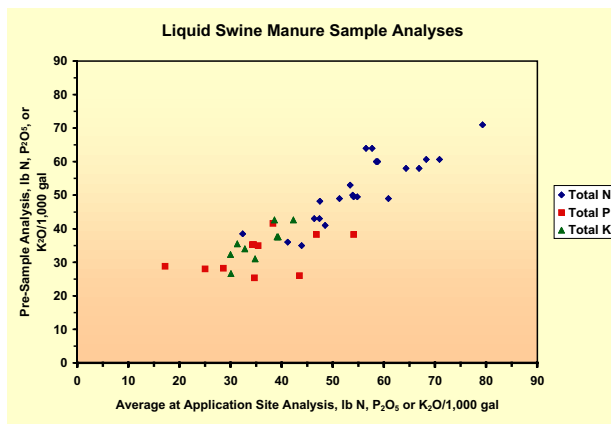


Figure 1. Comparison of pre- and at-application manure nutrient analyses.

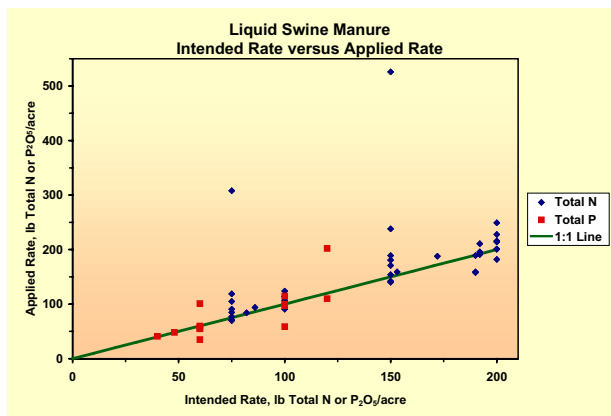


Figure 2. Comparison of intended and calculated as-applied manure nutrient application rates.

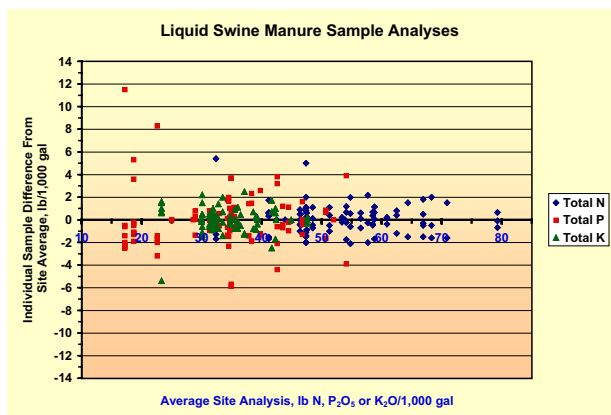


Figure 3. Variability in average manure nutrient analyses between demonstration sites and within multiple samples collected during application.

with producers from a wide area of Iowa and with different swine production practices, one would expect a wide range in total N, P, and K content, as is seen with the distribution in average site analyses. For total-N, the lowest site had 32 pounds and the highest site had 79 pounds total-N/1,000 gallons. For total-P, the lowest site was 17 and the highest 54 pounds P_2O_5 /1,000 gallons. For total-K, the lowest site was 23 and the highest 48 pounds K_2O /1,000 gallons. These differences in site averages highlight the importance of sampling and laboratory analysis rather than using book values. Only if a book value happens to coincide with the actual analysis would the book value be helpful for determining application rates.

Figure 3 also shows the variation within the multiple samples collected during each application. For N and K_2O , the ranges are very narrow, with most samples falling within ± 2 pound/1,000 gallons (94 of 98 samples within this range for N and K). For P the variation was wider (22 of 98 samples greater than ± 2 pounds P_2O_5 /1,000 gallons), indicating the tie between P and variation in solids content as a storage structure is emptied.

Summary. The project is documenting the importance of sampling liquid swine manure for determining nutrient concentrations. In conjunction with application equipment calibration, manure preapplication analyses are helpful for achieving desired nutrient application rates. The entire application process requires effort, but can be successful if careful attention is paid to sampling, calibration, and rate monitoring and control. In addition, over time a manure analysis history from the pre- and at-application samples can be developed that will aid future applications and reduce the reliance on preapplication samples.

The ISU Swine Manure Nutrient Utilization Project, part of the Integrated Farm/Livestock Management (IFLM) Demonstration Program, receives funding from the Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation, USDA Natural Resources Conservation Service, and the Leopold Center for Sustainable Agriculture.

This is the second in a series of newsletter articles highlighting the ISU Swine Manure Nutrient Utilization Project. The final article will appear in the March 2003 ONM newsletter and will highlight crop yield response to manure nutrient application.



Certification workshops in 2003

by Angela Rieck-Hinz, Department of Agronomy

The 2003 commercial manure applicator satellite downlink is scheduled for **Tuesday January 7, 2003, from 9 a.m. to 12:30 p.m.** This satellite downlink will provide the required 3 hours of annual training needed by all commercial manure applicators and will serve as initial certification for new applicators and recertification for commercial applicators who are renewing their applicator certificates. Certified commercial applicators will receive a registration brochure in the mail in December. New commercial applicators should contact their local county extension office for a list of training locations. There is no fee to attend this training workshop, but applicators are asked to register for the workshop.

Confinement site applicator workshops have been scheduled at 61 county extension

offices. These workshops will provide 2 hours of annual training as required by law. A complete list of workshops is listed below. For specific workshop locations and to confirm exact times or to determine meeting options in the event of bad weather, please call the county extension office where you plan to attend the workshop. Registration is not required for these meetings, but you may want to contact the extension office to ensure there will be adequate space and training materials available. There is no fee to attend these workshops.

Additional information regarding both of these training programs can be found at <http://extension.agron.iastate.edu/immag/mac.html>

County	Telephone	Date	Time
Adair	515-734-8412	January 17	1:30 p.m.
Adams	641-322-3184	January 21	1:30 p.m.
Allamakee	563-568-6345	January 22	1:30 p.m.
Benton	319-472-4739	February 4	9:30 a.m.
Black Hawk	319-234-6811	February 18	1:30 p.m.
Boone	515-432-3882	February 17	1:30 p.m.
Bremer	319-882-4275	January 28	9:30 a.m.
Buena Vista	712-732-5056	February 27	9:30 a.m.
Butler	319-267-2707	January 28	9:30 a.m.
Calhoun	712-297-8611	January 30	1:30 p.m.
Carroll	712-792-2364	February 25	1:30 p.m.
Cedar	563-886-6157	January 21	9:30 a.m.
Cerro Gordo	641-423-0844	February 10	1:30 p.m.
Cherokee	712-225-6196	January 29	9:30 a.m.
Chickasaw	515-394-2174	January 28	1:30 p.m.
Clay	712-262-2264	February 26	7:00 p.m.
Clayton	563-245-1451	January 30	1:30 p.m.
Clinton	563-659-5125	January 21	1:30 p.m.
Dallas	515-993-4281	January 28	7:00 p.m.
Davis	641-664-2730	February 6	1:30 p.m.
Delaware	563-927-4201	January 21	9:30 a.m.
Dubuque	563-583-6496	January 21	1:30 p.m.
Emmet	712-362-3434	January 28	9:30 a.m.
Fayette	563-425-3331	January 24 or February 19	1:30 p.m. 9:30 a.m.
Floyd	515-228-1453	January 28	9:30 a.m.
Franklin	641-456-4811	February 10	9:30 a.m.
Hamilton	515-832-9597	January 29	1:30 p.m.

County	Telephone	Date	Time
Hardin	641-648-4850	January 30	1:30 p.m. or 7:00 p.m.
Henry	319-385-8126	February 5	9:30 a.m.
Howard	563-547-3001	February 12	9:30 a.m.
Jasper	515-792-6433	January 23	9:30 a.m.
Jefferson	641-472-4166	February 18	9:30 a.m.
Johnson	319-337-2145	February 4	1:30 p.m.
Keokuk	641-622-2680	January 22	9:30 a.m.
Kossuth	515-295-2469	January 28	1:30 p.m.
Lee	319-835-5116	February 5	1:30 p.m.
Louisa	319-523-2371	January 22	1:30 p.m.
Lyon	712-472-2576	February 6	9:30 a.m.
Mahaska	641-673-5841	February 18	1:30 p.m.
Marshall	515-752-1551	February 11	1:30 p.m.
Mitchell	515-732-5574	February 12	1:30 p.m.
Monona	712-423-2175	February 28	1:30 p.m.
Muscatine	563-263-5701	February 12	1:30 p.m.
O'Brien	712-757-5045	February 19	7:00 p.m.
Osceola	712-754-3648	January 14	1:30 p.m.
Page	712-542-5171	February 6	1:30 p.m.
Plymouth	712-546-7835	January 29	1:30 p.m.
Pottawattamie	712-482-6449	February 3	7:00 p.m.
Sac	712-662-7131	February 18	7:00 p.m.
Scott	563-359-7577	February 12	7:00 p.m.
Shelby	712-755-3104	February 13	1:30 p.m.
Sioux	712-737-4230	January 15	1:30 p.m.
Story	515-382-6551	February 11	9:30 a.m.
Wapello	641-682-5491	February 6	7:00 p.m.
Warren	515-961-6237	February 19	1:30 p.m.
Washington	319-653-4811	February 19	7:00 p.m.
Wayne	641-872-1755	February 12	1:30 p.m.
Webster	515-576-2119	February 5	7:00 p.m.
Winnebago	641-584-2261	February 11	9:30 a.m.
Woodbury	712-279-2157	February 4	9:30 a.m.
Wright	515-532-3453	January 31	9:30 a.m.



Updates on certification program

by Karen Grimes, Iowa Department of Natural Resources

The new livestock law, Senate File 2293, approved April 29, 2002, will result in some changes in the manure applicators program administered by the Department of Natural Resources (DNR). The changes mean that some smaller operations will need to have manure management plans and to become certified confinement site applicators for manure application. Conversely, a few larger operations will no longer need manure management plans or confinement site applicator certification. Changes in separation

distances for land application of manure could potentially affect all applicators. Finally, a large number of confinement site manure applicators will be required to take a test before renewing their certificates under current provisions of the law.

Size of operation. Both the new and the old law gave a number of exemptions to small animal feeding operations (SAFOs). For example, if an operation is an SAFO then it is not required to have a manure management plan or to have a certified confinement site

manure applicator. SAFOs are also exempt from some separation distance requirements for land application of manure.

Under the new livestock law some operations that previously had SAFO exemptions will no longer have them because the SAFO definition has changed. In the past, the size of the operation was based on animal weight capacity. An SAFO was any animal feeding operation with 200,000 pounds or less for pork or poultry operations (400,000 pounds or less for dairy or beef operations). The new definition is based on an animal unit capacity of 500 or less animal units.

To calculate the number of animal units in an operation, the number of animals is multiplied by an equivalency factor that is specific to each type of animal. For example, 500 beef cattle would be multiplied times an equivalency factor of 1.0 to equal 500 animal units. Also, 500 finishing swine would be multiplied times a factor of 0.4 to equal 200 animal units.

Under the old law a swine operation with more than 1,333 swine finishers needed a manure management plan. Under the new law, the threshold dips to approximately 1,250 swine finishers. However, the permit threshold went up for gestating or lactating sows, and for most poultry operations.

See Table 1 to determine whether your operation is affected and to compare the number of animals that make up an SAFO under the old and the new law. If your operation is no longer an SAFO, check with your county extension office this fall to find out when you can take the required manure applicator certification training in January or February.

Manure applicator testing.

Approximately 600 confinement site or private manure applicators will be required to take a test before they can renew their 3-year

certificates in January or February 2003. See the article on page 4 and 5 for a list of confinement site manure applicator training workshops. A law passed in 1998 allows confinement site manure applicators to choose between taking a test once or taking a 2-hour training session annually during each of the 3 years of certification. Confinement site manure applicators who started out by taking annual training in 1999 and then missed a training session must take a test to complete the training/testing requirement.

Exam Locations and Times

Because of limited space, preregistration is required to take a test. A photo identification card also is required. Please bring a number 2 pencil and a calculator to the exam site. Contact DNR field offices at the following phone numbers to preregister and to obtain more information.

North East Iowa

(563) 927-2640

January 16 and February 6, F & M Bank, Manchester, 9:00 a.m.

North Central

(641) 424-4073

January 8, Ellsworth Community College, Reg. Johnson Auditorium, Iowa Falls, 10:00 a.m.
January 14 and 23, Lime Creek Nature Center, Mason City, 10:00 a.m.

North West Iowa

(712) 262-4177

January 16 and 21, Iowa Lakes Community College, Room 108, Spencer, 9:00 a.m. and 1:00 p.m.
(2 sessions, both days)

South West Iowa

(712) 243-1934

January 14 and 23, Field Office 4, 1401 Sunnyside Lane, Atlantic, 9:00 a.m. and 1:00 p.m.
(2 sessions, both days)

South Central

(515) 725-0268

January 13 and February 10, Field Office. 5, 401 SW 7th, Suite I, Des Moines, 10:00 a.m. and 1:30 p.m.
(2 sessions, both days)
January 27, Field Office 5, 401 SW 7th, Suite I, Des Moines, 10:00 a.m.

South East Iowa

(319) 653-2135

January 15 and February 11, Pizza Ranch, Washington, 10:00 a.m.

More than 85 percent of applicators pass the test the first time that they take it. The test questions are multiple choice or true/false, and are based mostly on common sense. Most applicators won't have to study for the test, but they should understand DNR manure application rules such as the required separation distances for land application, available on the DNR Web site at <http://www.state.ia.us/dnr/organiza/epd/wastewtr/feedlot/sepdstb4.pdf>.

Study materials will be available on the Web beginning December 1, 2002, at <http://extension.agron.iastate.edu/immag/mac.html>. If you don't have access to the Web, you may request copies of the materials at your county extension office. Fees may apply for copying or paper costs.

The DNR will notify all applicators who must take a make-up test. Testing will begin after December 31, 2002, when all confinement site applicator certificates issued in 1999 will expire. The tests will be offered during the January and February 2003, grace period by DNR field offices (see page 6). To renew their certificates, applicators can decide to take 3 years of training or pass another test for the next 3 years of certification.

After March 1, commercial and confinement site applicators must pay an additional late fee of \$12.50 before renewing their certificates. They cannot apply manure until they are certified.

Separation distances and land application. The new livestock law changed some of the laws for land application of

Table 1. Equivalent number of confinement animals to define an SAFO under the new law and previous law.

Animal types/ production phases	Iowa Ave. weight (lb)	A.U. factor	New law	Previous law
			SAFO ≤500 animal units (# of animals)	SAFO ≤200,000 lb for noncattle and ≤400,000 for cattle (# of animals)
Cattle				
Veal calves	150	1	500	2,667
Beef/dairy feeder cattle	500	1	500	800
Beef/dairy fat cattle	900	1	500	444
Beef/dairy replacement cattle	900	1	500	444
Mature beef cattle	1200	1	500	333
Mature dairy cattle	1300	1.4	357	308
Swine				
Nursery swine	25	0.1	5,000	8,000
Grower swine	70	0.4	1,250	2,857
Wean-finish swine	135	0.4	1,250	1,481
Grow-finish swine	150	0.4	1,250	1,333
Breeding replacement swine	150	0.4	1,250	1,333
Gestation swine	400	0.4	1,250	500
Lactation swine with piglets	450	0.4	1,250	444
Poultry				
Brooder turkey	2	0.018	27,778	100,000
Finishing turkey	14	0.018	27,778	14,286
Breeding turkey	14	0.018	27,778	14,286
Broiler-finishing chicken	10	0.01	50,000	20,000
Layer chicken	10	0.01	50,000	20,000
Sheep				
Sheep or lambs	75	0.1	5,000	2,667

Livestock producers with animal feeding operations that have an animal unit capacity >500 animal units must be certified to apply manure and must have a DNR-approved manure management plan. To determine whether you need a manure management plan, or need to be certified to apply manure, multiply the number of animals you have times the appropriate equivalency factor listed above. If the product is >500 animal units, you must have a manure management plan and be certified to apply manure. A.U., animal unit.

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manure. Starting on March 1, 2003, manure applicators who incorporate manure near a designated or protected area after land application must incorporate on the same date that the manure was applied.

Other changes for land application that take effect starting March 1, 2003, include the following:

- a 200-foot separation distance must be maintained around unplugged agricultural drainage wells or surface intakes to ag drainage wells if manure is not injected or incorporated on the same day;
- the DNR is allowed to require a larger separation distance (up to 4 times the normally required separation distance or 800 feet) from high-quality water resources;

- farm ponds or privately owned lakes will be removed from the list of designated areas; and
- water sources (including lakes, rivers, streams, and ditches) and designated wetlands will be added to the list of designated areas (see the fact sheet *Separation Distances for Land Application of Manure* on the DNR Web site on page 7 for more information).

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