Animal Manure Management

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Did you know ...

...that the manure from a dairy milking 200 cows produces as much nitrogen as is in the sewage from a community of 5,000-10,000 people? Or that the annual litter from a typical broiler house of 22,000 birds contains as much phosphorus as is in the sewage from a community of 6,000 people?

...that any increase in animal numbers results in an equal increase in the problems arising from manure collection, storage, treatment, and utilization?

...that beef production in the United States decreased almost 15 percent between 1982 and 1992, while broiler production increased 59 percent and turkey production increased 62 percent, with a corresponding increase in manure and other residual materials?

What are organic by-products, and how are they quantified?

Organic by-products, or "wastes," of the livestock industry include a variety of materials such as solid and liquid animal manures, used bedding, spilled feed, and a variety of other substances. Most livestock-associated organic by-products are animal manures.

The amount and consistency of manures varies with animal type, climate, feed ration, animal age and health, and other factors. To compare manure production between animal types or between animals of the same type, manure production is expressed in terms of 1,000-pound animal units. For reference, a single dairy cow weighs about 1,400 pounds, or 1.4 animal units. A typical steer weighs about 1,000 pounds, or 1 animal unit, and most hogs weigh between 200 and 300 pounds, or 0.2 to 0.3 animal unit. A mature broiler, on the other hand, weighs between 4 and 5 pounds, so it takes as many as 250 birds to make up an animal unit.

Manure production and characteristics have changed over time. Livestock tend to be larger and thus produce more manure. Individual herds or flocks are generally larger, and production is tending toward geographic concentrations of specific kinds of animals, such as

Words are important!

Richard Kashmanian, in an editorial for *BIOCYCLE*, stresses the importance of words. He points out that words such as "wastes," "garbage," and "trash" send *negative* signals to readers or listeners and set in motion a sequence of events that is difficult to reverse.

The following definitions are taken from Webster's New Collegiate Dictionary: "Waste: garbage, rubbish, discarded as worthless, defective, or of no use." Dispose: "to get rid of." Various synonyms listed in Webster's New World Thesaurus for waste are "garbage, refuse, filth, litter, debris, and junk." Not very attractive!

Efforts are underway by various groups to change the vocabulary used to define their products or services. For example, the American Forest and Paper Institute is discontinuing the use of the term "waste paper" when referring to recycled paper. The Water and Environment Federation, formerly the Water Pollution and Control Federation, is using the term "biosolids" to refer to or define the largely organic material commonly called "sludges."

More and more, the agricultural sector recognizes that the reference to livestock manure as livestock "waste" has helped lead to the undervaluation of manure as a source of nutrients, the loss of manure nutrients through mishandling and misapplication, and the overapplication of manure to the land. Understanding that a term's use implies a value, the agricultural sector can replace the use of the word "waste" with "manure," "residuals," or "by-products."

Do you know ...

...that the Environmental Protection Agency has targeted a reduction in biogas emissions from livestock waste of 1.5 million metric tons of carbon equivalent by the year 2000? And that meeting this goal would allow the United States to help meet the target for reducing greenhouse gas emissions as agreed to at the 1992 Earth Summit in Rio de Janeiro, Brazil?

...that the operator of a pork production facility in the West reduced his annual operating costs by $36,000 when he installed a methane recovery system that generated electricity from the captured gas?

...that the nutrients in litter cleaned annually from a typical 22,000-bird broiler house contain the equivalent of 5 tons of commercial nitrogen fertilizer worth about $2,500?

poultry in the Southeast. Confinement is the rule for most livestock and poultry.

The move to confinement has improved the quality of ration fed to the animals, increased the amount of manure produced, and changed the composition of that manure. For example, the typical daily nitrogen produced in the manure from a dairy cow has increased in the past 20 years from 0.37 pound per day per animal unit to 0.45 pound—an increase of about 20 percent. The increase in the nutrient content of manure, coupled with an increase in the size of the typical dairy animal, increases the potential for environmental degradation.

How much manure can actually be collected?

In the 1970's, Van Dyne of the University of Missouri and Gilbertson of USDA's Agricultural Research Service estimated the portion of livestock manures that could realistically be collected and managed. This "recoverable" manure, by their definition, was roughly equal to the amount of manure produced by livestock in confinement. A broader definition of recoverable manure is now used to account not only for the percentage of manure deposited in confinement, but also for the amount of manure deposited in confinement that can feasibly be collected and utilized.

Responses to a questionnaire completed by Natural Resources Conservation Service personnel as

How much manure do different types of livestock produce?

Livestock type	Total manure	Nitrogen	Phosphorus
	Lbs/day/1000-lb animal unit		
Beef[1]	59.1	0.31	0.11
Dairy[2]	80.0	0.45	0.07
Hogs and pigs[3]	63.1	0.42	0.16
Chickens (layers)	60.5	0.83	0.31
Chickens (broilers)	80.0	1.10	0.34
Turkeys	43.6	0.74	0.28

[1]High forage diet. [2]Lactating cow. [3]Grower.

Source: Natural Resources Conservation Service, Agricultural Waste Management Handbook (1992).

Recoverable manure, by livestock type

	Natural Resources Conservation Service region					
Animal type	West	South Central	South	East	Midwest	Northern Plains
	Percent					
Beef (grazing)	5	7	10	10	10	5
Beef (feeder)	85	80	75	85	75	80
Dairy (milker)	80	70	60	80	80	80
Dairy (other)	75	65	50	70	60	70
Hogs and pigs	85	80	65	80	70	75
Layers	90	90	90	95	95	95
Broilers	90	90	95	95	95	95
Turkeys	65	80	85	95	70	75
Sheep	35	35	50	15	35	30

Source: USDA Natural Resources Conservation Service, State animal manure survey.

to the percentage of manure that could be feasibly recovered show some differences in recoverable manures from Van Dyne and Gilbertson, but no clear patterns were evident. It is believed that the major differences between the two surveys reflect the movement toward more confinement of all livestock types.

The departure from 100-percent-recoverable manure is largely related to the percentage of animals in confinement; however, location of the facility (climate), the area of confinement, and the methods used to collect the manure are also important factors. Only 90 to 95 percent of the manure can be recovered under the best of circumstances.

What natural resource problems are associated with manure management?

Most confined livestock are fed a ration primarily produced offsite. In other words, the feed is brought to the confined animal enterprise, the animal product—whether meat, milk, or eggs—is removed, and the manure remains. The impact of this dislocation of manure from the production area of foodstuffs increases as animal enterprises are concentrated. Land for manure application at agronomic rates is often not available without prohibitive transportation costs, and the tendency to *dispose* of the manure (as opposed to using its nutrients) increases.

Grazing animals also contribute to natural resource problems when they are allowed access to water bodies. Animals with direct access to streams can degrade water quality partly by dropping manure directly into the water, and partly by destabilizing the streambanks and accelerating the loss of riparian corridor vegetation and buffer strips.

Unmanaged manure contributes nutrients, disease-causing microorganisms, and oxygen-demanding organics to the Nation's waters. Nonpoint source pollution is recognized as the primary category of water pollution that is not yet controlled, and unmanaged animal manures contribute to nonpoint source pollution in most States.

Surface water pollution is not the only concern. Overapplication of animal manures to the land can degrade soil quality. Increases in nutrients such as phosphorus and potassium in the soil profile are undesirable and in some isolated cases can lead to problems in pasture situations. Excess manure salts in western soils decrease crop yields and can lead to the abandonment of some waste application sites.

Air quality can also be degraded. Historically, the singular air quality issue associated with livestock production was odors. Present concerns continue to focus on odors but include ammonia and methane emissions as well. Ammonia volatilization can contribute to elevated nitrogen in precipitation, which leads to excess nitrogen in water bodies and the acidification of soils. Methane has been identified as one of the primary contributors to the group of *greenhouse gases* linked to global climate change. Pork and dairy production facilities account for 80 percent of the methane emissions from manure.

What are the trends in manure production?

Trends in manure production mirror the trends in animal numbers. There was a significant increase in the production of poultry for meat in the 1982-92 period, a slight increase in swine numbers, and a general decline in other livestock types. These trends generally reflect changing patterns in demand for meat as a result of the American consumer's move to a healthier, leaner lifestyle.

As important as the increase in poultry numbers is the shift in locations of production, even for those livestock types that are declining in numbers. The changes within the dairy and swine industries are examples (see chart). Increases in dairy numbers in some States are more than offset by a general decline in dairy numbers in most other States, especially those in colder climates; States with declining swine numbers in the 1982–92 period include Florida (-60.3 percent), Georgia (-24.1 percent), and Missouri (-20.0 percent).

What can be done?

The Natural Resources Conservation Service continues to help livestock and poultry operators who voluntarily choose to manage livestock manures. Animal manure management is complex, combin-

Animal population summaries: 1994

Livestock type	Population in 1994*	Percent change from 1984
	(Millions)	
Beef	89.6	-5
Dairy cows and heifers	13.7	-5
Hogs and pigs	60.0	-12
Chickens		
Layers	290.8	+5
Broilers	7,017.5	+64
Turkeys	289.0	+69

*Data for dairy and swine as of January 1995.

Source: USDA National Agricultural Statistics Service

The United States Department of Agriculture, through the Natural Resources Conservation Service (formerly Soil Conservation Service), is preparing an environmental scan of the status, conditions, and trends of natural resources on America's non-Federal land, as required by the Soil and Water Resources Conservation Act of 1977 (RCA), Public Law 95-192. The appraisal will help guide the updating of the National Conservation Program, which directs USDA's natural resource conservation policies and programs. Ten other USDA agencies and 10 non-USDA agencies are full partners in this effort.

This issue brief is one in a series being prepared by the Natural Resources Conservation Service. It was written by David C. Moffitt, NRCS, environmental engineer, Fort Worth, Texas. For more information or if you have comments or suggestions, please contact James Maetzold, USDA, Natural Resources Conservation Service, Natural Resources Inventory Division, P.O. Box 2890, Washington, DC 20013; Phone (202) 720-0132; Fax (202) 690-3266.

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ing physical aspects of nature such as rainfall, temperature, and soil characteristics; constructed features such as ponds and waterways; and a concerted management strategy to protect or enhance the ecological setting of the animal enterprise.

Proper planning and installation of a manure management system open up opportunities for a variety of uses of manure as a source of energy, protein, and nutrients. No system is right or wrong for every situation, but the way manure is handled affects its value as plant nutrients or for other purposes. For example, manure can be kept dry and handled as solids or diluted and handled as liquids, depending on the operator's needs and capabilities. Liquid manure can be covered and anaerobically digested (decomposed in the absence of oxygen) to capture biogas—principally methane—for energy production. The same digestion process *uncovered*, however, releases the biogas (a common "greenhouse gas") into the atmosphere and loses nitrogen through ammonia volatilization. Keeping the manure dry reduces the opportunity for anaerobic digestion but increases the opportunity for the manure to be used as an animal feed supplement, as is being done with poultry litter as a supplement to cattle feed in the Southeast.

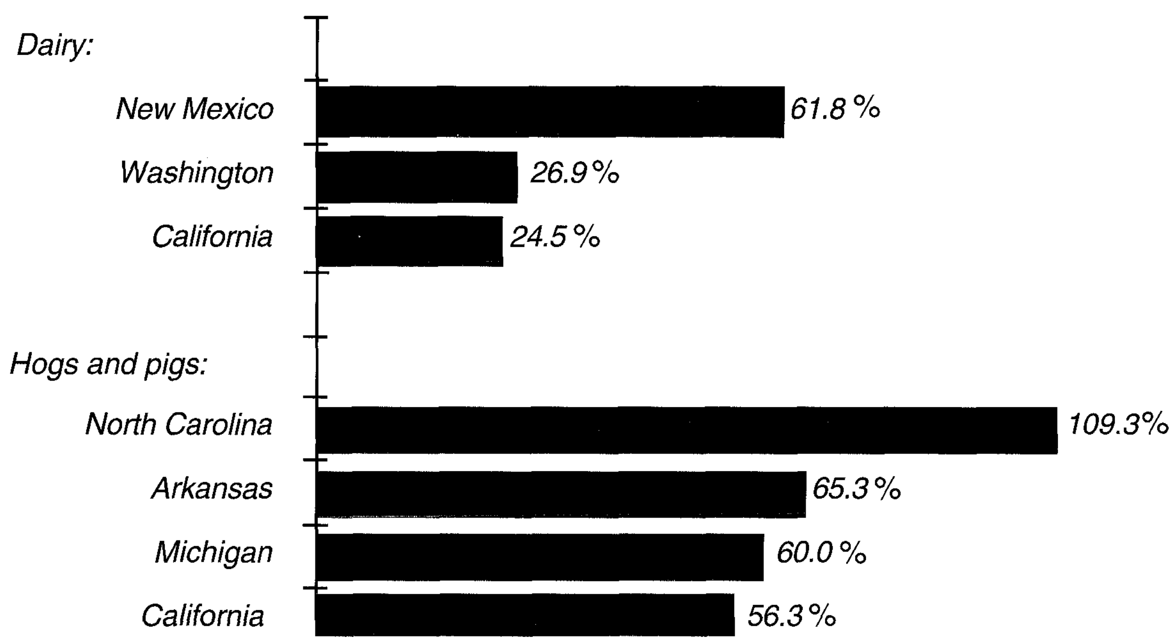
In 1980, the owner of a 1,000-head sow farrow-to-finish operation in the West covered a portion of his existing lagoon to collect methane for on-farm energy applications. The collected methane now fuels a 75-kilowatt engine generator, and waste heat is used for space heat and grain drying. **The investment reduced annual operating costs at the facility by $36,000, providing a 34-percent annual rate of return.**

A 100,000-bird broiler producer in northern Florida discontinued all commercial fertilizer use 3 years ago on 150 acres of hayland. All plant nutrient needs are met by litter application. **The hay crop the past two seasons has been at record levels, while the level of nitrates in the shallow ground water has stabilized or declined.**

Natural Resources Conservation Service employees are guided in assistance to producers through technical standards contained in the Field Office Technical Guide. These practice standards describe the component or practice to be installed and specify the criteria to be used to ensure the quality of the overall system. Employees also have the 1992 *Agricultural Waste Management Field Handbook* to guide the planning and design of manure management systems. The handbook contains ready references to planning and design parameters and techniques.

Manure management systems encompass six functions: production, collection, storage, treatment, transfer, and utilization. Each function, or combination of functions, is addressed by components specifi-

Important dairy and swine States with the fastest growth in livestock numbers, 1982–92



cally designed to meet producers' manure management objectives.

Manure storage ponds or storage structures temporarily store manures or other by-products until they can be safely applied to the land or otherwise used. The storage facility and other appurtenances can be planned and designed to meet the objectives of the producer. Lagoons treat the manure and contaminated wash water, providing the opportunity for odor control and reducing the acreage needed for land application. Lagoons can be covered, which provides the opportunity for biogas capture and use.

Application of manures to cropland and pastureland provides nutrients for plant growth and improves soil tilth. This is by far the most common use of animal manures. The rate and timing of manure applications are key to the protection of soil, water, air, plant, and animal resources.

A typical dairy farm in the upper Midwest might have 50 to 100 milking cows. The herd is totally confined 6 months of the year, and during the remaining months spend part of each day in an earthen lot adjacent to the barn. Manure is collected daily from the barn by means of a tractor scraper. The semi-solid manure is scraped into a low-walled waste storage structure and applied to the land when it can be incorporated into the soil for plant nutrients. Liquids from the dairy, including wash water for milking equipment, are collected in a storage pond with a minimum 180-day storage capacity and applied to the land when the application fits into the overall management of the operation. Rainfall runoff from the earthen lots is also collected in the same storage pond. Clean water is diverted away from the earthen lot, and roof runoff from the barns is carried away from the waste storage facilities.

How does manure management help?

Manure management is as old as human history and as new as the latest adaptation of a time-honored practice. Proper manure management benefits the producer as well as the rest of the ecosystem.

Manure solids are being composted, often with urban residues such as leaves and grass clippings, to produce soil amendments high in organic-matter content. Lagoons are being covered to capture and use methane and other gases, reduce energy expenditures, control odors and methane emissions, and produce a manure product with nutrients that are more readily available for plant growth.

Application of manures to the land at the proper time—using proper management techniques and in proper amounts—recycles the nutrients through the soil profile, reducing the expense of commercial (inorganic) fertilizers as well as the need to add organic matter. Proper manure management improves water quality by preventing pollutants such as nutrients, organics, and pathogens from migrating to surface and ground waters. Soil quality is also improved through the addition of organic materials that improve soil tilth and increase the soil's water-holding capacity. Air quality also benefits from reduced emissions of methane and ammonia compounds, as well as reduced odors.

State animal manure survey

The Natural Resources Conservation Service surveyed the States in 1994 to gain information on how State laws, rules, and regulations affected animal production and the generation, storage, and use of animal manures. Livestock classes considered in the survey were beef cow-calf, beef feeder, dairy cows and heifers, chickens, turkeys, and swine.

The 15-item questionnaire was directed primarily to NRCS state agronomists and state conservation engineers. Forty-one States responded to all or part of the survey. The questions on the survey were designed to maximize the information provided on the laws, rules, and regulations impacting manure management, and to gain as much information as possible about the types of systems used in each State for each livestock type.

The survey will be summarized in section V of the nutrient portion of the Third Resources Conservation Act Appraisal report. For more information, contact David C. Moffitt, environmental engineer, USDA, NRCS, Fort Worth, Texas, (817) 334-5242, or Charles Lander, agronomist, NRCS National Headquarters, Washington, DC, (202) 690-0249.