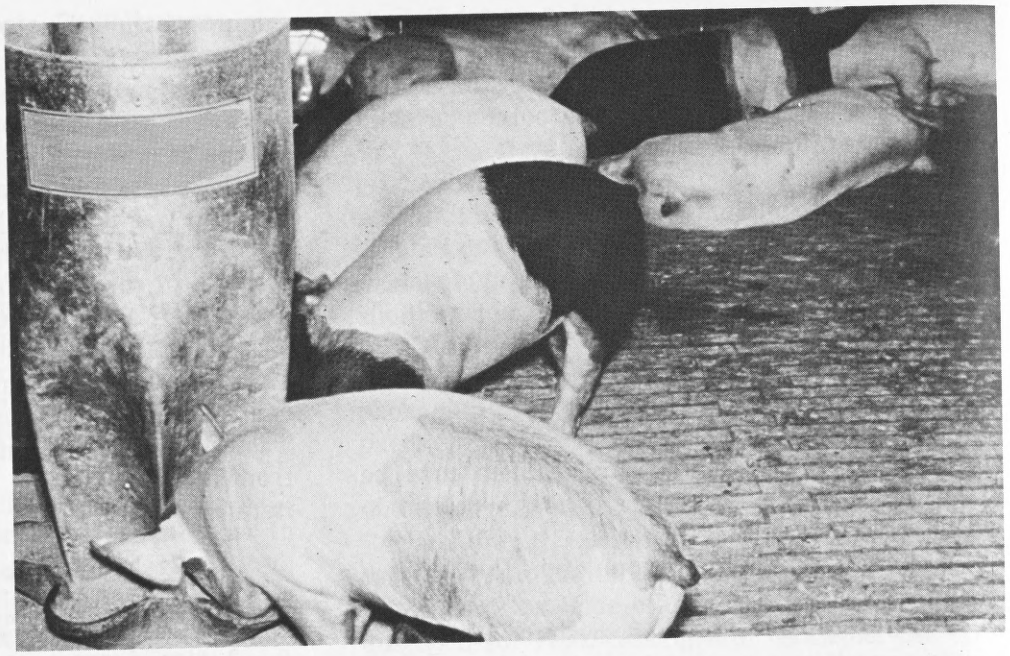

Slatted floor housing for swine provides a system for automated manure handling.

HANDLING LIVESTOCK WASTE

G. L. Pratt, Dexter W. Johnson, and M. L. Buchanan

Congress has been developing legislation since 1948 to prevent water pollution. The Federal Water Quality Act of 1965 was the culmination of this development. This act established the Federal Water Pollution Control Administration, provided for construction aid to municipalities, and established water quality standards for all interstate waters. The act further provided that states could set such standards and administer them.

A comprehensive water pollution control act was adopted by the 1967 North Dakota legislature that became effective in July that year. This legislation provided for establishing water quality standards for the surface waters of North Dakota. These are now in effect. In addition, air pollution control regulations and solid waste management regulations became effective in 1970. Regulations for the control of wastes from livestock enterprises are being drafted now under the Federal Water Quality Act and plans are that these will become effective late in 1971.

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Major research efforts on managing and disposing of livestock wastes have been in progress in North Dakota since 1962. At that time Experiment Stations in 13 states in the North Central Region of the country agreed to develop cooperative research on this problem. The North Dakota Water Resources Research Institute and the Great Plains Council have also supported this work.

As a result of these research projects, the states in the central part of the country have made substantial progress in understanding the problems of air and water pollution control. Along with this understanding, refinements in the design of livestock production systems were developed, and an educational program was established through the State Agricultural Extension Services.

Many of the early projects were concerned with determining some of the basic physical, chemical, and biological characteristics of livestock manure. Production rates, requirements for waste treatments, and effects of wastes on the environment have been determined for most domestic animals.

Table 1 shows manure production figures. These are approximate, and will vary depending on the ration fed, age, and size of animals.

Table 1. Approximate Daily Manure Production Per 1,000 Pounds of Animal Weight.

Animal	Per cent Water	Gallons of solids and liquids per day
Hog	75	10
Dairy Cow	80-90	11
Steer	80-90	7½
Horse	65	5½
Sheep	70	4
Laying Hen	55-75	7

Wash water, rainwater, snow, and frequency of cleaning must be considered in addition to kind and number of animals when planning waste handling facilities. One acre of drainage can provide 3,630 cubic feet or 27,152 gallons for each inch of rain.

Systems for handling manure can be analyzed by considering the processes involved in the separate phases. These phases include the collection, storage, treatment, and disposal or utilization of the manure.

Manure Collection

In open lot livestock housing, manure is normally collected by permitting it to accumulate in the lot. Use of labor and equipment is efficient in this type of operation, but automatic collection is difficult.

Housing livestock in confinement barns makes automatic manure collection more feasible. Some systems utilize solid concrete floors that are scraped with a tractor or a cable-drawn scraper. Slatted floors have been developed for housing cattle and hogs. Manure passes through these floors, and may be stored either in the space below the slats, or conveyed out of this space.

Manure Storage

In North Dakota, it is difficult to start and operate manure spreading equipment during cold weather. Deep snow also creates a problem for equipment. For these reasons, manure storage facilities provide for much improved waste disposal management. It also avoids spreading manure on frozen ground and thus reduces or eliminates spring runoff water pollution. In open feedlots, livestock manure solids are stored on the feedlot surface. In confinement housing systems, underground concrete storage tanks are proving satisfactory. Some of these are being installed under fully slatted floors, and collect the waste directly as it passes through the floor. In other cases, the manure is scraped to the tanks, and dropped through openings in the tank top.

Manure lagoons are another form of storage. Several have been installed for use on Experiment Station farms in North Dakota, and have been included as part of the research conducted in the state. Lagoons are either anaerobic or aerobic. Most livestock manure lagoons are anaerobic, which means that organisms growing in these lagoons do not require dissolved oxygen in the water. The lagoons are relatively small, and contain large amounts of solids in proportion to the water. Anaerobic digestion is relatively efficient, but gases generated in the process generally tend to have offensive odors. Very little anaerobic digestion takes place during the winter months. We do not have enough warm summer weather to digest the solids completely. So, lagoons of this kind tend to fill with solid matter.

Organisms that develop in aerobic lagoons need dissolved oxygen in the water. Gases from this kind of lagoon generally are fairly odor-free. Wind action on lagoons can maintain aerobic conditions if the waste material is diluted with enough water. Large amounts of dilution water are needed to maintain this kind of condition with manure. Since aerobic lagoons must have larger surface areas than anaerobic lagoons, few aerobic lagoons for livestock wastes are found in North Dakota. Organisms digest manure, so that lagoons may be considered a combined storage and treatment system.

Manure Treatment

Treatments for wastes may be used to accomplish several purposes. They may convert solid matter to gases and liquids, and in this way reduce the total quantity of solids that must be disposed of. Treatments can maintain stored manure in an odor-free condition. Treatments also can convert solid matter into a form that will settle from the water more efficiently.

One system for aerating manure is the oxidation ditch. No oxidation ditches have been reported yet in North Dakota. These ditches are designed in the oval form of a race track. Aeration wheels are installed in these ditches at the surface of the water. These wheels generally look somewhat like spike-toothed combine cylinders. The wheels agitate the surface of the water to propel the manure and water around the ditch, and at the same time, put oxygen in the water. Most such ditches in the U.S. are installed under slatted floors inside confinement swine or beef production buildings.

In lagoon storage, installing surface aerators or moving air through submerged perforated tubing systems with a compressor for aeration results in benefits similar to those from the oxidation ditch system.

North Dakota is evaluating separate disposal of liquid and solid components of livestock wastes. Dry manure tends to generate less odor than wet manure. Drying the manure reduces the amount of materials to be carried to the fields, and also

requires less storage space. Mechanical centrifuges, filtration, and dehydration may be used for dewatering. The liquid component of manure can be disposed of in lagoons. Most treatment processes do not dispose of manure completely, but such benefits as odor control and reducing the solids may justify the costs involved.

Manure Disposal

Spreading on cropland has long been the standard method to dispose of livestock manure. Research to date indicates that it is still the most practical method for preventing pollution, and is recommended for new livestock housing. Power equipment is used for cleaning feedlots. Large tractor-powered pumps and tank wagons are available for loading and spreading undiluted liquid manure.

Design of manure disposal systems depends on the quantities of water that are associated with the solid manure. Waste from milk houses in dairy operations may be highly diluted with water. A poultry house and hog barn at the North Dakota Agricultural Experiment Station are both designed to be cleaned with water. In both of these systems, the manure is much more diluted than from systems where the water is not utilized. Disposal systems for handling this type of waste are being evaluated as part of the research in North Dakota.

A system that has been developed for this kind of installation involves a settling tank or settling ditch, along with a lagoon for the overflow. The settling tank helps remove much of the solid matter from the dilute waste. Overflow from the settling tanks can be pumped to a lagoon. If the lagoon is not large enough, excess water can be spread on adjoining land by irrigation equipment.

Runoff from outside feedlots can also be considered as diluted manure. As rainfall water runs over the surface, it picks up organic material and nutrients from the manure. A similar condition exists in feedlots when snow melts in the spring.

Limited research data from Nebraska is available on beef cattle feedyard runoff. Results from there indicate the amount of solid materials and runoff depends on management, topography, physical layout, climatic exposure, and soil type. Rainfall patterns appear to dictate runoff concentration to a greater degree than the slope of the feedyard or cattle density. Individual rainstorms there produced variable amounts of runoff ranging from 0 to 72 per cent of the rainfall. The annual runoff was approximately 40 per cent of the total annual precipitation. The solids concentration in winter runoff were about 10 times that of rainfall runoff. Material removed from dirtyard feeding areas can include several times more dirt than actual manure.

Ground water pollution may also develop from feedyard runoff. This appears to depend on such factors as stocking rate, manure removal, depth of water table, soil structure, and texture. More data is needed on the relationship between feedlot runoff and such factors as soil conditions and climate in North Dakota.

To meet some of the immediate needs of livestock producers, the USDA Agricultural Stabilization and Conservation Service has put into effect cost-sharing programs for pollution abatement practices.

Information concerning these practices may be obtained from the county extension agent, the county Agricultural Stabilization and Conservation Service office, the Soil Conservation Service, agricultural engineers of the North Dakota Agricultural Extension Service and research scientists of the North Dakota Agricultural Experiment Station.

Installation of recommended practices and proper operation will help livestock producers maintain and improve the quality of surface and ground water.

PLANS AND PLANNING INFORMATION

The following plans, Agricultural Engineers Digest leaflets, and handbooks contain detailed planning and construction information. The materials are available through county extension agents or from the Extension Agricultural Engineer at North Dakota State University.

USDA Plan 5981, Rectangular Manure Tank (75¢) shows the construction details for a reinforced concrete tank 20 ft. wide, depth variable from 6 to 10 ft. deep and length variable from 20 to 100 ft. Capacities from 18,000 to 150,000 gallons.

USDA Plan 5984, Circular Manure Tank (75¢) shows construction details for a round, reinforced concrete tank 32' or 48' diameter and variable depth 6 to 8 ft. deep. Capacities from 36,000 to 135,000 gallons.

USDA Plan 5987, Liquid Manure Tank (25¢) has details for a rectangular, reinforced concrete tank 10 ft. deep. The width can vary from 12 to 24 ft. and tank can be built any length.

Plan MW 72351, Confined Dairy Layout ($1.25) includes details for 10 ft. wide pit under alleys of free stall barn.

AED-1, Anaerobic Manure Lagoons. This leaflet explains the design and installation considerations for lagoons.

AED-8, Handling Liquid Manure. This leaflet explains the design and installation considerations for liquid manure pits.

AED-11, Handling Swine Manure. This leaflet explains alternatives and design information for handling swine manure.

AED-14, Oxidation Ditch for Treating Hog Wastes. This leaflet explains the design and operation criteria for using oxidation wheels in liquid manure pits under hog buildings.

Swine Housing and Equipment Handbook ($1.00) includes a concrete holding tank design for up to 21,000 gallons plus other planning information on swine waste disposal.

Beef Housing and Equipment Handbook ($1.00) includes cattle feedyard layouts with run-off control ideas and planning information on waste handling plus equipment plans for beef cattle equipment.

Dairy Housing and Equipment Handbook ($1.00) includes manure handling and milk-house waste disposal information.