# UNDERSTANDING THE POTENTIALS AND PROBLEMS IN RECYCLING ANIMAL WASTES

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## THE BASIC LAGOON SYSTEM

Any animal feeding operation must have some form of waste handling system. This system usually consists of the feeding facility, a holding tank if the facility is confined, and a lagoon (Figure 1).

The retention lagoon is normally of earthen construction, and has no aeration. Evaporation controls the liquid level, and pumping occurs only when there is appreciable solids build up, or the lagoon is in danger of overflow. Lagoon size must accomodate normal flows plus additional load during heavy rainfall. Discharge to surface water is limited to emergencies.

Facilities with bare lots are largely limited to the lagoon system because of limitations in collection and uniformity of the waste. Lagoons require considerable land area, and few alternatives are available if capacity is exceeded or operational problems are encountered. In some cases, aeration equipment has been added to the lagoon to increase its capacity to treat wastewaters, and to control odors and operational problems. Few opportunities exist with this system for recycling through refeeding. Some waste may be recycled back to the land if the lagoon is pumped. Solid waste collected within the lot can also be land applied.

## ADDITIONAL TREATMENT

### Solids Separation

The simplest type of additional treatment is solids separation. Removal of solids from the waste flow significantly reduces the load on the rest of the system. Solid material removed is readily available for recycling by refeeding or land application. Large quantities of water are used to move or "flush" the solids from the collection area to the separation device. In some cases liquids recovered can be reused as flush water. For efficient mechanical separation, the waste flow must be clean and consistent in quality. Thus, mechanical separation is usually limited to confinement type lots. For bare lots, settling "trenches" or "pits", can be provided before runoff reaches the lagoon. The velocity of the waste stream is slowed to allow solid material to settle. Flow can be diverted from one settling pit to another to allow drying. Solid material can then be removed with conventional farmstead equipment. If the bottom of the pit is concrete, solids can be removed as soon as liquids have been drained.

Solids separation provides so many advantages in terms of reduction of load on the waste treatment system, and recycling possibilities, that it should be a part of all treatment systems.

## Biological Treatment

Additional biological treatment allows for increased decomposition of waste to carbon dioxide, ammonia, water, and methane. Residual solids from advanced treatment are relatively stable and may have value as a supplemental feed, or in land application. The waste flow into such processes must be consistent in volume and quality. A good collection system and holding or equalization tank is required.

## Anaerobic Digestion

Although relatively slow in treatment, anaerobic digestion can provide as much as 50 percent reduction in total solids (2). About 10-15 percent of the total organic matter is converted to new cells. Methane is the primary gas produced along with smaller amounts of carbon dioxide and hydrogen sulfide. Since much of the organic material loaded to the digester is either undigestable, or remains in the form of partially decomposed intermediates, the strenth of the effluent liquid is quite high (2) and is not suitable for direct discharge. It may be land applied, along with the stabilized digester solids. Nitrogen is not well conserved in the anaerobic process. Much organic nitrogen is converted to soluble ammonia which leaves with the liquid effluent. Since only 10-15 percent of the waste is converted to new cells, incorporation of nitrogen in new cell protein is not efficient. Some amino acids from organic protein breakdown may be in the liquid effluent, but are lost without concentration of the liquid fraction.

## Sprinkler Irrigation and Land Injection

Land disposal has lately seen increased interest as a means of treating wastes. After solids have been removed from the waste flow, the effluent can be land applied by sprinkler irrigation. This method provides very accurate application while allowing for control of runoff. Liquids pumped from lagoons may be applied this way.

The liquid-solid waste slurry may also be directly land applied by subsurface injection. In a system developed at Colorado State University (1), waste slurry from a holding pit beneath a milking parlor was thoroughly agitated and then pumped through underground pipe to one of several risers in the disposal field. A tractor-mounted subsurface injection plow (a modified chisel plow) was connected to the riser by 660 feet of 3 inch diameter rubber hose. The waste slurry was injected about 6 inches beneath the surface, allowing for good incorporation into the soil, and rapid decomposition aerobically. The system was operable throughout most of the year, and the waste dried rapidly enough so that injection areas could be treated again within 3-4 days during normal weather. There was no run-off, and visual and odor problems were not observed. Loadings as high as 20 dry tons per acre were applied. Crops grown at the site produced yields similar to crops grown in adjacent untreated fields. Table 1 summarizes the specifications of the system.

## Refeeding of Wastes

When considering recycling through refeeding, one of the most difficult tasks is to determine the value of the recycled manure as a feed. Research at OSU and other Universities is aimed at this problem. The nutritional characteristics for raw waste, anaerobic or digester solids, and aerobic solids are shown in Table 2. It is interesting to note that fresh manure has about the same quality as that for digester solids. This is in contrast to claims often made for protein values of 20 percent or higher. The problem is that protein is often determined based on the total nitrogen content of a sample. In the case of digester solids, much of the organic nitrogen has been converted to soluble ammonia (2), and is thus lost in the digester effluent. This is in line with the fact that the main accomplishment of the digester is the reduction of solids to methane, carbon dioxide, and other intermediates. Very little carbon and nitrogen is synthesized into new cell growth. The overall feeding value of digester solids is about equivalent to a medium quality alfalfa hay. One conclusion stands out from this analysis: A digester is unlikely to pay for itself based on any improvement in the feed value of the manure other than basic stabilization.

The feeding value of solids recovered from aerobic processes on the other hand, has high feed value. Much of the nitrogen in the waste is incorporated as protein in new cell growth. New cells may have as much as 50 percent protein content (2). This suggests another possibility in the area of refeeding waste products: Biosolids from aerobic treatment of food processing wastes. This concept is gaining increasing interest in areas where food processing wastes are available near feeding facilities. Frito-Lay

Company of Dallas has been successful in marketing some of their waste products to area feeders. They market both untreated wastes, and Biosolids from aerobic treatment. The nutritional value of the by-products have been established in these studies, and both the company and the feeder have been satisfied with the arrangements. The result is a decrease in disposal problems for the plant, and a lower cost feed ingredient for the feedlot operator.

## Problems Associated with Waste Treatment

There are limitations and operational problems associated with all types of waste treatment systems. These problems become more severe as the system becomes more complex. Several important issues which must be resolved in planning waste handling systems are listed below:

1. Collection. Collection of wastes in a timely and efficient manner is essential in systems where waste solids are to be recycled in feeding or are to be treated anaerobically. Foreign material in the waste is undesirable, and value decreases rapidly with age. Collection on bare lots will probably be limited to collection of solids periodically within the lot, and the recovery of solids which may be separated in a settling basin. Such solids would most likely be recycled back to the land.

2. Transportation. The moisture content (MC) for fresh manure is often 80-90 percent, while that for waste in holding pits may be as high as 98 percent. Wet settled solids (from a settling basin) may approach 85-90 percent moisture unless they are allowed to dehydrate without additional water loading. Screening of solids from waste yields a solids fraction of 85 percent MC. Pressing of the solids can produce a residue with only 75-80 percent MC. Reducing the moisture content of waste from 90 percent to 80 percent reduces the amount of water to be handled by more than one-half.

3. Management Skills. Obviously the management skill required for a particular treatment method increases with the complexity of the system. Lagoons often operate properly with little attention. Anaerobic systems require considerable attention and knowledge of the treatment process. Technology for lagoon systems, and solids separation is well developed. Although anaerobic systems have been part of municipal and industrial waste treatment systems for years, application to animal waste is still

developing, and an "off-the-shelf, fits-all" anaerobic digester has yet to be developed. Improvements are being made, yet serious questions remain concerning the requirements for successful application and management of anaerobic systems on the farm or feedlot.

## Summary: What Looks Promising?

Current. The minimum waste treatment system should probably consist of a holding pit (where appropriate), some method of solids separation, and a lagoon. The solids separation can simply be a settling trench or pit to remove most of the solids before they can enter the lagoon. The lagoons should be adequately sized to provide for normal loading and rainy periods. Land application from the holding tank or lagoon may be attractive in some cases. Fact Sheets dealing with design of this type of treatment system are available from OSU.

Near Term Future. Where the feedlot can be adapted for collection and separation of fresh waste solids, recycling through refeeding seems to offer potential. The quality of the recovered waste will be closely tied to the ability of the collection system to supply clean waste at a uniform consistency and flow rate. Some type of mechanical separation will be required. It will be difficult to retrofit existing lots for this function, and the amount of capital required will be considerable. In areas where waste products are available from food processing plants, it may be possible to obtain some economic advantage by incorporating them into feeding programs. This is also true of Biosolids from aerobic treatment plants processing food plant wastes.

Far Term Future. Anaerobic systems or digesters continue to offer potential, but the economics of such systems remain questionable at this time. Additional developments in the equipment and processes for such systems is needed. As pointed out earlier, there is little improvement in feeding value of digester solids except that they are stablized by the process. Thus the economics of the process must depend on the production and utilization of digester gas. Such systems will have to be well planned and integrated with the farming operation. Efficient use must be made of both energy products, and the manure residues. Anaerobic systems will be most attractive to large, confined feeding operations, or to large dairy or swine operations. Where such treatment systems can be part of a successful integrated energy concept, the economics may become attractive more rapidly.

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4 Larkin, Joseph J., J. L. Revel and R. J. Sherman. 1981. Use of Waste Activated Biological Solids As a Cattle Feed Ingredient. ASAE paper No. 81-6503, presented at the annual winter meeting of the American Society of Agricultural Engineers, Chicago, IL, December 15-18, 1981.

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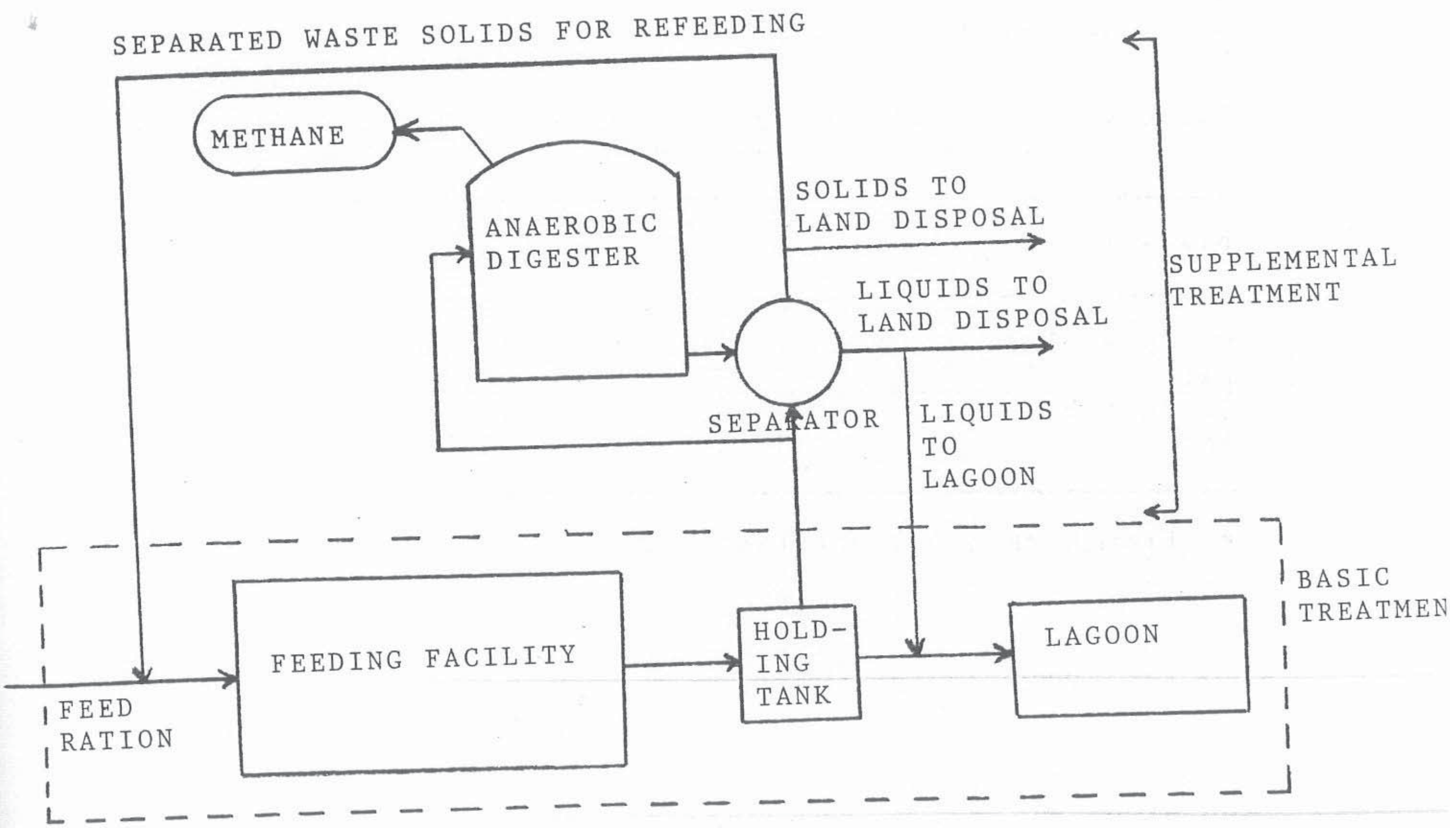


FIGURE 1

WASTE TREATMENT POSSIBILITIES
FOR LIVESTOCK WASTES

Table 1. Injector Specifications

| | |
|---|---|
| Operating speed | 0.8 to 2.4 km/h (0.5 to 1.5 mph) |
| Capacity per sweep | 0.23 to 0.45 $m^3$/min (60 to 120 gpm) |
| Operating depth | 8 to 20 cm (3 to 8 inches) |
| Tractor power required | |
| Crawler type | 31 kW (42 hp) |
| Wheel type | 75 kW (100 hp) |
| Field capacity | 190 to 750 $m^3$/hectare (20 000 to 80 000 gal/acre) |
| Maximum area covered per hose attachment | 7.5 hectares (18.5 acres) |
| Pressure required at hose attachment | 480 kPa (70 psi) |
| Maximum sludge solids content | 8% |

Table 2.* Chemical Composition of Raw Manure and Bio-Treatment Residues (percent on a dry matter basis)

| Parameter | Raw Manure | Digester Residue | Aerobic Biosolids |
|---|---|---|---|
| Crude Protein | 14.40 | 15.51 | 44.9 |
| Fat | 1.47 | 0.68 | 3.0 |
| Crude Fiber | 15.74 | 16.77 | 2.4 |
| Ash | 31.86 | 34.90 | 20.8 |

* From Larkin (4) and Licht (5)