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DAIRY NUTRIENT MANAGEMENT ALTERNATIVES

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There are many types and combinations of nutrient management systems. Most systems accommodate six basic functions: (1) production, (2) collection, (3) storage, (4) treatment, (5) transfer and (6) utilization of manure nutrients. Alternative systems are created when different methods are used for any of the nutrient handling system components or when any of the components are rearranged or modified. Dairy nutrient management can be classified into three general types—solid, lagoon, and slurry.

Alternatives Available to Dairy Farmers

Solid nutrient systems are commonly used in smaller operations with bedded loafing barns or stanchion stalls. These systems minimize the volume of manure handled. Manure with 75 to 80 percent moisture content can usually be handled as a solid. Manure at this moisture content has a consistency of peanut butter. Twelve pounds of bedding per 100 pounds of fresh manure (about 4 pounds of dry straw per cow per day) is needed to permit dairy manure to be handled as a solid. Solid nutrient systems require scraping devices, loaders, manure storage, and manure spreaders.

Lagoon nutrient systems, which often include a solids separator, are favored by many dairies because they have lower cost relative to other liquid management systems. Lagoons are required where flushing is used; thus, a significant amount of lot runoff must be contained. Lagoon systems handle highly diluted material (96 percent or more water) that can be pumped through irrigation systems. Material with 96 to 98 percent water content can be handled with ordinary pumps and flushing equipment if excessive straw or fibrous material is not present. For conventional pumping, two gallons of water must be added to dilute a gallon of fresh manure to 96 percent. Of course, this greatly increases the volume of material to be stored and transported. Most lagoon effluent is more than 99 percent water. These systems require pumps and irrigation equipment. The latter are generally sprinkler systems and may be either stationary, hand-carried, or moving systems. A significant amount of solids are often mechanically separated and distributed directly on the land rather than being stored in the lagoon.

Slurry nutrient systems maximize recovery of plant nutrients from manure and bedding and are often used where geologic conditions are unsuitable for a lagoon system. Compared with solid nutrient systems, slurry systems increase the volume handled because water content is higher than in solid systems, but they allow the manure to be handled as a fluid. Manure with 90 to 96 percent moisture content can usually be handled as a fluid, but may require special pumps. These systems require slurry storage, earth basins, scraping devices, pumps and tank wagons. Slurry nutrient systems require more land for application than do lagoon systems because more nitrogen is retained.

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Most operations with fewer than 100 dairy cows use some form of solid nutrient storage. Use of methods for storing manure in a liquid form increases with herd size. With the slurry method, manure is stored as a thick liquid in a pit under the barn floor or in a tank or earth-basin until it is applied onto land. With lagoons, manure is diluted with water, often from flush systems and milking parlor wash water. Slurry systems are more common than lagoon systems for herds of fewer than 200 cows. Both systems are equally popular among producers with 200 or more cows. Over 90 percent of herds with 200 or more cows have some type of liquid manure storage. Since evaporation reduces total lagoon volume more than slurry volume, especially in more arid parts of the country, it is not surprising that lagoons are most common in the western United States. Producers with liquid manure systems in the Midwest and Northeast often prefer slurry systems over lagoons (USDA, 1999).

Which Alternative is Best for My Herd?

Since nutrient handling does not generally produce significant revenues, impact on profitability can be measured in terms of net cost. Net cost is the cost of owning and operating the system minus revenues from the sale and/or value of distributed nutrients. The system with the lowest net cost is the most profitable. For most Washington dairies, the most profitable nutrient management system includes one or more lagoons.

In addition to economic considerations, factors such as environmental impacts, animal characteristics, facility investments, and nutrient distribution area must also be considered in selecting an appropriate nutrient-handling alternative. For example, the most economic alternative may not be relevant if soil conditions or limited land area make it infeasible.

Investment Costs

The most successful dairy waste handling and distribution system is often a combination of several types. The choice depends on herd size, accessible lands, soil types, crops raised, and weather.

Lagoon System

The storage lagoon is the most basic component of the lagoon nutrient management system. It is a treatment facility for slurry and liquid material. While it can also be used to temporarily store all forms of nutrients, subsequent removal of solid and semisolid material can be difficult and expensive. Location is important. The lagoon should be located far away from houses and downwind so that prevailing winds carry odors away. Lagoon odors can be objectionable at distances of 1/2 mile and detectable at distances of a mile or more. The lagoon should be located as close to the nutrient source as possible. If the lagoon is downhill from the nutrient source, gravity can transport the material (NRCS, 1999).

Where possible, the lagoon should be located over impervious soil so that the bottom and sidewalls don't require sealing. The USDA Natural Resources Conservation Service and WSU Cooperative Extension personnel can help evaluate soils. On many soils, lagoons require sealing with liners, clay, or soil cement.

A key factor in the design of any liquid storage structure is provision for agitating the material prior to irrigating or loading the tank spreader. Without complete agitation, solids will accumulate in the structure and reduce storage capacity.

Irrigation equipment has been adapted for application of liquid manure and wash water on cropland. The primary concern is to apply the material at agronomic rates on cropland that needs the nutrients and apply them in an environmentally acceptable manner. The use of manure or wash water for "true" irrigation is seldom accomplished because of the relatively small volume applied and annual application rate restrictions. Those who desire to irrigate in addition to spreading manure must be certain of an adequate water supply.

John Gillies (2001), a district conservationist for the Natural Resources Conservation Service, estimates waste storage pond construction costs in northwest Washington to be $28–$33 per 1,000 gal. ($9,100–$10,600 per acre-foot) for the first 1 million gallons and $23 per 1,000 gal. ($7,500 per acre-foot) for additional storage volume above 1 million gallons. This estimate includes the cost of imported fill

material for the embankment or the earthen liner as well as fencing, access ramps and dike seeding. It can be somewhat higher if a private engineering firm is used for consultation. However, many farmers rely on help from local NRCS staff rather than hiring an engineering firm. Consequently, the cost of constructing the lagoon ranges from $90,000 for a 250-cow herd to $628,000 for a 3,000-cow herd.

The lagoon capital investment includes many expenditures in addition to construction costs. Even if a custom irrigation system is hired, other equipment required for the lagoon system includes a storage tank for flushing, tractor, recycling pump and pipe, agitator, and a separator. Generally, the separator is an integral component of the lagoon's flush system. In addition, a storage area for the separated solids is required. Larger herd sizes may require multiple separators to handle the flow. The total investment costs per cow for farmers who hire a custom irrigation system range from $688 for a 250-cow herd to $319 for a 3,000-cow herd. Average investment per cow is less than half for the largest herd than for the smallest.

Additional equipment is needed if the farmer doesn't hire a custom irrigation system. Equipment typically required includes a big gun sprinkler, irrigation pump, and pipe. This equipment would raise nutrient management investment costs by about a quarter. Due to environmental considerations and more effective manure nutrient utilization, direct injection systems are replacing the older big gun systems. Costs for the injection system depend on whether it is custom applied or purchased and operated with on-farm labor.

Although expensive, purchasing the irrigation system reduces annual operating costs sufficiently to be economic for most herd sizes. It may also be necessary in areas where custom irrigation systems are not available for hire and where equipment cannot be shared. A traveling gun irrigation system, which is the option included in our cost calculations, is most often purchased. However, injection systems are increasingly used, especially near urban and environmentally sensitive areas, in order to reduce air pollution. An injection system can add further to the nutrient management investment cost.

Liquid Manure Tank System

In locations where a lagoon is not feasible because of geological or other conditions, a liquid tank system is often selected. Many times the liquid manure tank system is chosen to contain the manure and its odor. The liquid tank system is typically either a cast-in-place, in-ground, concrete tank, or a fiberglass, bolted steel storage tank. It is often covered, has a 180-day capacity, and is loaded by gravity. Aboveground tanks would need a mechanized pump for loading material into the tank. The primary investment cost of the liquid tank system is for construction of the manure tank. Typical construction costs are about $120,000 per million gallons of storage capacity (Dyk, 2001). Liquid tank construction costs are estimated to range from $227,000 for a 250-cow herd to $2,152,000 for a 3,000-cow herd. Equipment requirements include a manure scraper, tractors, tank wagons, open impeller, and irrigation reel or manure injector system. Total investment costs per cow for the liquid tank system are considerably higher than for the lagoon system (ranging from $1,372 for a 250-cow herd to $803 for a 3,000-cow herd).

Annual Fixed Costs

Considering interest on the investment, depreciation, repair, maintenance, taxes, and insurance, average annual fixed costs per cow typically range from $87 for 250-cow herds to $39 for 3,000-cow herds for farmers with a lagoon system who hire custom irrigation. For farmers with a lagoon system who own their irrigation system, the corresponding per-cow figures are $119 and $54. For farmers with a liquid tank system, they are $182 and $96. Even for the largest herd size, fixed costs per cow are greater with the liquid tank system than for most herd sizes with a lagoon system.

Annual Operating Costs

For the lagoon system, annual operating costs are mainly from recycle pumping and application costs. When the irrigation system is custom hired, typical annual operating costs range from $97 per cow for a 250-cow herd to $70 per cow for a 3,000-cow herd. The corresponding figures for farmers with a

lagoon system who own their irrigation system are $47 and $32.

Annual operating costs for the liquid tank system are nearly as high as for the lagoon system with a hired custom irrigation system. The liquid tank system requires much more power than the lagoon system. Most of the increased power requirements occur during the manure-handling period, but the requirements for manure application also exceed those for the lagoon. The annual operating cost per cow ranges from $87 for 250-cow herds to $69 for 3,000-cow herds.

Where Can I Get Help to Determine the Best Alternative for My Herd?

It is important to take into account all factors before constructing a dairy nutrient management facility. It can be a very difficult decision when considering all the different options and costs. The extension bulletin, *The Economics of Dairy Nutrient Management*, will give you a more in-depth explanation of the costs and procedures involved in both the lagoon and liquid tank systems. There are also a series of linked spreadsheets that will walk you through the economic decision for your dairy. Both are available online. They can be downloaded or ordered on compact disk from <farm.mngt.wsu.edu/dairy.html>. You should also contact your local USDA Natural Resources Conservation Service and WSU Cooperative Extension office for additional information.

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