

Purdue University

**Purdue e-Pubs**

---

Historical Documents of the Purdue  
Cooperative Extension Service

Department of Agricultural Communication

---

10-1-1977

## Selecting Dairy Manure Handling Systems

Purdue University Cooperative Extension Service

Follow this and additional works at: <https://docs.lib.purdue.edu/agext>

Agricultural Engineers' Digest

---

Purdue University Cooperative Extension Service, "Selecting Dairy Manure Handling Systems" (1977).  
*Historical Documents of the Purdue Cooperative Extension Service*. Paper 68.  
<https://docs.lib.purdue.edu/agext/68>

For current publications, please contact the Education Store: <https://mdc.itap.purdue.edu/>

This document is provided for historical reference purposes only and should not be considered to be a practical reference or to contain information reflective of current understanding. For additional information, please contact the Department of Agricultural Communication at Purdue University, College of Agriculture: <http://www.ag.purdue.edu/agcomm>

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact [epubs@purdue.edu](mailto:epubs@purdue.edu) for additional information.

#### Introduction

A good manure handling system makes best use of land, labor, and capital. It also uses manure's value as a fertilizer and soil conditioner while avoiding pollution and nuisance problems. Before selecting a manure handling system, make these two decisions:

- Will you haul manure daily or store it before spreading?
- Will you handle manure as solids or liquids?

Then choose the collection, storage, and hauling units that fit your needs.

#### Handling Methods

##### Daily Hauling and Spreading

###### Advantages

- Hauling labor is distributed throughout the year.
- There is no accumulation of manure.
- Odor is minimized.
- Facilities cost less.

###### Disadvantages

- Manure must be hauled every day and in all kinds of weather.
- Crop cover, rain, or snow cover can interrupt spreading.
- Excessive runoff from sloping ground can reduce fertilizer value and cause water pollution.
- Wear on tractors and equipment increases in cold weather.
- Use bedding, which may be scarce or expensive, or liquid-tight spreaders to save the urine.

##### Storing and Spreading

###### Advantages

- Annual labor requirements can be reduced.
- Spreading can be delayed to avoid other field operations, bad weather, or poor field conditions.

###### Disadvantages

- Storage facilities are costly.
- Equipment for loading and unloading storages is needed.
- Odors and flies may be a problem.
- Poorly located storages can be unsightly.
- Extra agitation time and special equipment may be required for some storages.

#### Solid vs. Liquid

##### Storing and Handling as a Solid

Stack solid manure with elevators, throwers, large piston pumps or tractor loaders. Use bedding to absorb liquids and to make the manure handle as a solid.

Storages for solid manure can be:

- Open ground space
- All-weather base such as crushed limestone

- Concrete base with post and plank sidewalls
- Concrete base with concrete sidewalls, Fig 1
- Concrete base with low dikes can hold "semi-solid" manure from free stall barns. Use a picket dam or other method to drain off precipitation.
- Covered bunker

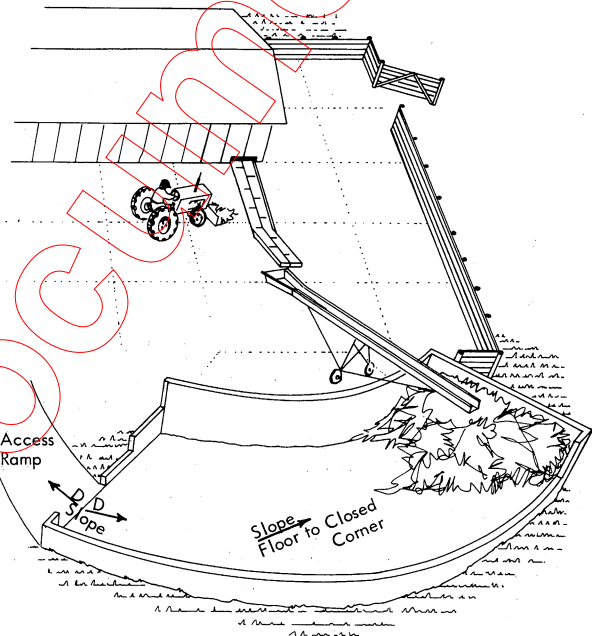


Fig. 1 Solid manure storage; barn cleaner to moveable stack.

Solid manure storages usually cost less than most liquid systems and are easily adapted to stall barn operations.

Use a front end loader with forks and/or a bucket to empty the storage into manure spreader. "Semi-solid" manure requires a liquid tight spreader and a large "snow" bucket loader.

##### Storing and Handling as a Liquid

Storages for liquid manure can be:

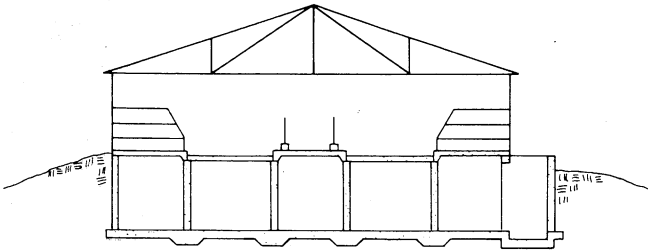
- Below ground reinforced concrete tanks, Fig 2
- Earth storage basins; excavated or cut and fill earth sides; see types of storages in Fig 3
- Above ground storage tanks (silos); 25'-72' diameter, 10'-20' high; stave or cast concrete, or coated steel, Fig 4

Liquid manure storages are loaded with:

- Tractor scraper
- Mechanical scraper
- Slotted floor
- Liquid manure pump
- Large piston pump

Stored liquid manure requires specialized equipment for agitating and pumping, hauling, and spreading. Odors can be a problem during agitation and spreading.

Take special precautions when using a liquid manure system. Avoid agitating and pumping problems by minimizing bedding and keeping foreign material and frozen manure out of the storage. Guard openings into the storages to keep livestock and people out. Rain, ice, and snow entering a storage reduce the storage volume.



**Fig 2. Reinforced concrete tank under slats.**

### Irrigating with liquid manure

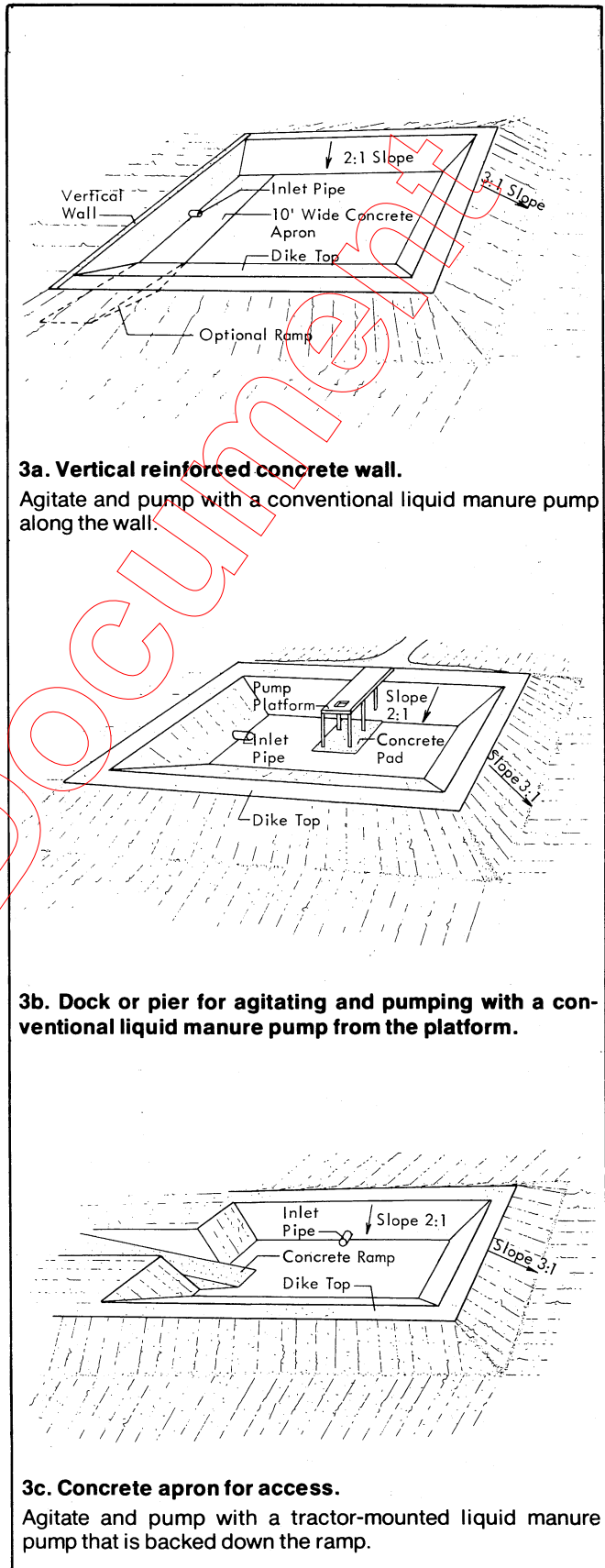
Liquid manure can be put on cropland with irrigation equipment. Dilute the manure to more than 90% moisture content by adding about  $\frac{1}{3}$  extra water. Agitate the manure with a liquid manure pump before irrigating. Irrigation of dairy manure requires a pump with 80-100 psi pressure and a large volume gun type sprinkler with a  $\frac{3}{4}$ "-1  $\frac{1}{4}$ " smooth bore nozzle. Avoid runoff, soil plugging, and excess nutrient application—check state and local regulations.

### Before Building

Before building any component of a waste management system, check with local and state regulatory agencies. Special requirements may have to be met and some type of cost sharing may be available. Design storages to keep livestock and people out. Construct storages for easy loading and emptying. Storages must be large enough to hold manure produced during periods when spreading is undesirable; storage for 1 year provides more management flexibility. Spreading may be restricted by weather and ground conditions (winter and spring) or crop conditions (summer and fall).

Consider the following factors when deciding where to locate a storage:

- the sources and location of *all* manure or wastewater
- distance to wells
- potential for pollution of nearby lakes or streams and groundwater
- prevailing winds
- distance and direction to the farm home and neighbors
- drainage
- access to the storage for loading, unloading and hauling
- cattle should not have access to the storage



### 3a. Vertical reinforced concrete wall.

Agitate and pump with a conventional liquid manure pump along the wall.

### 3b. Dock or pier for agitating and pumping with a conventional liquid manure pump from the platform.

### 3c. Concrete apron for access.

Agitate and pump with a tractor-mounted liquid manure pump that is backed down the ramp.

### Fig 3. Liquid manure storage basins.

Some soils require less bank slope than shown; check with your local SCS office.

# Comparative Costs of Dairy Waste Systems 1977 Data from Wisconsin

## 50-Cow Stanchion Barn

### Stacking manure

	Investment	DIRI <sup>a</sup> Factor	Hours	Hourly Rate	Annual Cost
Manure platform <sup>i</sup>	\$ 3,000	.14	--	--	\$ 420
Barn cleaner	3,200	.20	--	--	640
Stacker	3,000	.20	--	--	600
Manure spreader, 150 cu ft	2,100	.20	--	--	420
Manure loader	1,400	.20	--	--	280
Tractor loading, 70 hp	--	--	70	\$6.00	420
Tractor hauling, 50 hp	--	--	70	4.50	315
Labor haul and spread	--	--	70	4.50 <sup>e</sup>	315
Labor daily cleaning	--	--	140	3.00	420
<b>Total</b>	<b>\$12,700</b>				<b>\$3,830</b>
Bedding, 50 ton @ \$50/ton <sup>j</sup>					2,500
<b>Total with bedding</b>					<b>\$6,330</b>

### Daily hauling

Barn cleaner	\$ 3,200	.20	--	--	\$ 640
Manure spreader, 150 cu ft	2,100	.22 <sup>b</sup>	--	--	462
Tractor, 50 hp	--	--	365 <sup>h</sup>	\$4.50	1,643
Labor daily	--	--	365	3.00	1,095
<b>Total</b>	<b>\$ 5,300</b>				<b>\$3,840</b>
Bedding, 50 ton <sup>j</sup>					2,500
<b>Total with bedding</b>					<b>\$6,340</b>

### Liquid manure storage basin

Basin <sup>d,i,m</sup>	\$ 4,400	.14	--	--	\$ 616
Barn cleaner	3,200	.20	--	--	640
Mats and grates	4,000	.14	--	--	560
Large piston pump	6,000	.20	--	--	1,200
Load out pump	3,000	.22	--	--	660
Spreader tank, 1500 gal	3,500	.20	--	--	700
Tractor pumping, 70 hp	--	--	90 <sup>f</sup>	\$6.00	540
Tractor hauling, 100 hp	--	--	70 <sup>m</sup>	3.50 <sup>c</sup>	595
Labor haul and spread	--	--	80 <sup>f,m</sup>	4.50	360
Labor daily cleaning	--	--	140	3.00	420
<b>Total</b>	<b>\$24,100</b>				<b>\$6,291</b>
Bedding, 25 ton <sup>j</sup>					1,250
<b>Total with bedding</b>					<b>\$7,541</b>

### Liquid manure storage tank

Storage tank <sup>d,i</sup>	\$16,300	.14	--	--	\$2,282
Barn cleaner	3,200	.20	--	--	640
Cow mats and grates	4,000	.14	--	--	560
Spreader tank wagon, 1500 gal	3,500	.20	--	--	700
Load out pump	3,000	.22	--	--	660
Tractor pumping, 70 hp	--	--	80 <sup>f</sup>	\$6.00	480
Tractor hauling, 100 hp	--	--	60 <sup>f</sup>	8.50 <sup>c</sup>	510
Labor haul and spread	--	--	70 <sup>f</sup>	4.50 <sup>e</sup>	315
Labor daily cleaning	--	--	140	3.00	420
<b>Total</b>	<b>\$30,000</b>				<b>\$6,567</b>
Bedding, 25 ton <sup>j</sup>					1,250
<b>Total with bedding</b>					<b>\$7,817</b>

## 100-Cow Free Stall Barn

### Semi-solid storage, tractor scraper

	Investment	DIRI <sup>a</sup> Factor	Hours	Hourly Rate	Annual Cost
Manure storage, picket dam <sup>i</sup>	\$ 8,800	.14	--	--	\$1,232
Tractor scraper, 30 hp	5,200	.20	--	--	1,040
Stacker	4,800	.20	--	--	960
Spreader, tank flail 1400 gal	4,500	.20	--	--	900
Manure loader	1,400	.20	--	--	280
Tractor loading, 70 hp	--	--	125	\$6.00	750
Tractor hauling 100 hp	--	--	125	8.50	1,063
Labor haul and spread	--	--	125	4.50 <sup>e</sup>	563
Labor daily cleaning	--	--	300 <sup>n</sup>	3.00	900
<b>Total</b>	<b>\$24,700</b>				<b>\$7,688</b>
Bedding, 50 ton <sup>j</sup>					2,500
<b>Total with bedding</b>					<b>\$10,188</b>

### Daily hauling, tractor scraper

Ramp, push off	\$ 1,100	.14	--	--	\$ 154
Tractor scraper, 30 hp	5,200	.20	--	--	1,040
Spreader, tank flail 1400 gal	4,500	.22 <sup>b</sup>	--	--	990
Tractor hauling, 100 hp	--	--	440 <sup>h</sup>	\$8.50	3,740
Labor daily cleaning	--	--	300 <sup>n</sup>	3.00	900
Labor daily hauling	--	--	440	3.00	1,320
<b>Total</b>	<b>\$10,800</b>				<b>\$8,144</b>
Bedding, 50 ton <sup>j</sup>					2,500
<b>Total with bedding</b>					<b>\$10,644</b>

### Liquid manure storage basin, alley scraper

Basin <sup>d,i,m</sup>	\$ 7,100	.14	--	--	\$ 994
Alley cleaner	6,000	.20	--	--	1,200
Cross conveyor	2,300	.20	--	--	460
Large piston pump	6,000	.20	--	--	1,200
Load out pump	3,000	.22	--	--	660
Spreader tank, 2300 gal	5,000	.20	--	--	1,000
Tractor pumping, 70 hp	--	--	105 <sup>f</sup>	\$6.00	630
Tractor hauling, 100 hp	--	--	85 <sup>m</sup>	8.50 <sup>c</sup>	723
Labor haul and spread	--	--	95 <sup>f,m</sup>	4.50 <sup>e</sup>	428
Labor daily cleaning	--	--	170 <sup>n</sup>	3.00	510
Electrical energy <sup>k</sup>	--	--	--	--	250
<b>Total</b>	<b>\$29,400</b>				<b>\$8,055</b>
Bedding, 50 ton <sup>j</sup>					2,500
<b>Total with bedding</b>					<b>\$10,555</b>

### Liquid manure with slotted floor over tank

Storage tank, with slotted floor <sup>d,i</sup>	\$32,600	.14	--	--	\$4,564
Load out pump	3,000	.22	--	--	660
Spreader tank wagon, 2300 gal	5,000	.20	--	--	1,000
Tractor pumping, 70 hp	--	--	90 <sup>f</sup>	\$6.00	540
Tractor hauling, 100 hp	--	--	70 <sup>f</sup>	8.50 <sup>c</sup>	595
Labor haul and spread	--	--	80 <sup>f</sup>	4.50 <sup>e</sup>	360
Labor daily cleaning	--	--	120 <sup>n</sup>	3.00	360
Ventilation <sup>g</sup>	--	--	--	--	200
<b>Total</b>	<b>\$40,600</b>				<b>\$8,279</b>
Bedding, 50 ton <sup>j</sup>					2,500
<b>Total with bedding</b>					<b>\$10,779</b>

### Liquid manure storage silo

Silo, 45 x 15 <sup>d,i,m</sup>	\$14,500	.14	--	--	\$2,030
Barn cleaner	3,200	.20	--	--	640
Mats and grates	4,000	.14	--	--	560
Large piston pump	6,000	.20	--	--	1,200
Load out pump	3,000	.22	--	--	660
Spreader tank, 1500 gal	3,500	.20	--	--	700
Tractor pumping, 70 hp	--	--	85 <sup>f</sup>	\$6.00	510
Tractor hauling, 100 hp	--	--	70 <sup>m</sup>	8.50	595
Labor haul and spread	--	--	80 <sup>f,m</sup>	4.50 <sup>e</sup>	360
Labor daily cleaning	--	--	140	3.00	420
<b>Total</b>	<b>\$34,200</b>				<b>\$7,675</b>
Bedding, 25 ton <sup>j</sup>					<u>1,250</u>
					<b>Total with bedding \$8,925</b>

<sup>a</sup> DIRI = Depreciation, interest, repairs, insurance—and taxes where applicable.

<sup>b</sup> Manure spreaders used daily wear out faster.

<sup>c</sup> Larger tractor is used for a 1500 and 2300 gallon tank.

<sup>d</sup> Tank capacity for 180 days is based on the number of cows, 2 cu ft/cow/day, 85% useable and 70¢/cu ft.

<sup>e</sup> Labor cost increases slightly due to busy season competition.

<sup>f</sup> Includes agitation.

<sup>g</sup> Estimated increase in annual cost due to added ventilation required.

<sup>h</sup> Includes time to start tractor, hitch to spreader, load, travel to and from fields, unloading, unhitching, and parking tractor.

<sup>i</sup> To modify this item for other storage periods, divide this cost by 180 days and multiply by the desired number. Thus, for 150 days, multiply by 0.83; for 120 days, multiply by 0.66; for 90 days, multiply by 0.5.

<sup>j</sup> Assumes 1 ton of bedding/cow/year in stanchion barns and ½ ton/cow/year in free stall systems and stanchion barns with cow mats.

<sup>k</sup> The electricity cost for the systems with an alley cleaner, cross conveyor, and piston pump is included as a separate item. Most all of the systems have some electrical energy cost for operating equipment, but in many cases it is not significant amount.

<sup>l</sup> Mainline plus two laterals—40 min sets.

<sup>m</sup> Volume handled is increased by about 20% to account for additional water from water added at pumping and rainfall.

<sup>n</sup> Volume handled increased by about 10% to account for water added at pumping.

### Liquid manure storage basin, irrigation spreading twice yearly, alley scraper

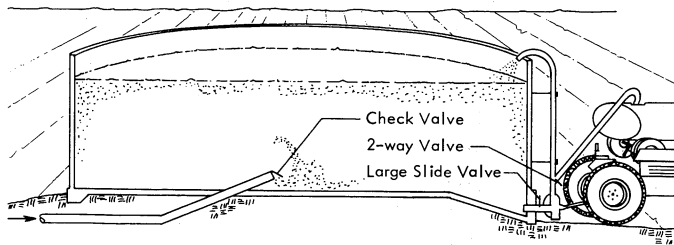
Basin <sup>d,i,m</sup>	\$ 7,100	.14	--	--	\$ 994
Alley cleaner	6,000	.20	--	--	1,200
Cross conveyor	2,300	.20	--	--	460
Large piston pump	6,000	.20	--	--	1,200
Agitation pump	3,000	.22	--	--	660
Irrigation pump, 250 gpm	2,750	.22	--	--	605
Pipe for 40 - 80 acres	7,800	.20	--	--	1,560
Tractor agitating and pumping, 70 hp	--	--	60 <sup>f</sup>	\$6.00	360
Tractor moving pipe, 70 hp	--	--	54	6.00	324
Labor moving pipe, agitation	--	--	54	4.50	243
Labor daily cleaning	--	--	170 <sup>n</sup>	3.00	510
Electrical energy <sup>k</sup>	--	--	--	--	250
<b>Total</b>	<b>\$34,950</b>				<b>\$8,366</b>
Bedding, 50 ton <sup>j</sup>					<u>2,500</u>
					<b>Total with bedding \$10,866</b>

### Liquid manure storage tank, tractor scraper

Storage tank <sup>d,i</sup>	\$32,600	.14	--	--	\$4,564
Tractor and scraper	5,200	.20	--	--	1,040
Load out pump	3,000	.22	--	--	660
Spreader tank, 2300 gal	5,000	.20	--	--	1,000
Tractor pumping, 70 hp	--	--	90 <sup>f</sup>	\$6.00	540
Tractor hauling, 100 hp	--	--	70 <sup>f</sup>	8.50 <sup>c</sup>	595
Labor haul and spread	--	--	80 <sup>f</sup>	4.50 <sup>e</sup>	360
Labor daily cleaning	--	--	300 <sup>n</sup>	3.00	900
<b>Total</b>	<b>\$45,800</b>				<b>\$9,659</b>
Bedding, 50 ton <sup>j</sup>					<u>2,500</u>
					<b>Total with bedding \$12,159</b>

### Liquid manure storage silo, alley scraper

Silo, 60 x 15 <sup>d,i,m</sup>	\$21,600	.14	--	--	\$3,024
Alley cleaner	6,000	.20	--	--	1,200
Cross conveyor	2,300	.20	--	--	460
Large piston pump	6,000	.20	--	--	1,200
Load out pump	3,000	.22	--	--	660
Spreader tank, 2300 gal	5,000	.20	--	--	1,000
Tractor pumping, 70 hp	--	--	95 <sup>f</sup>	\$6.00	570
Tractor hauling, 100 hp	--	--	85 <sup>m</sup>	8.50	723
Labor haul and spread	--	--	95 <sup>f,m</sup>	4.50 <sup>e</sup>	428
Labor daily cleaning	--	--	170 <sup>n</sup>	3.00	510
Electrical energy <sup>k</sup>	--	--	--	--	250
<b>Total</b>	<b>\$43,900</b>				<b>\$10,025</b>
Bedding, 50 ton <sup>j</sup>					<u>2,500</u>
					<b>Total with bedding \$12,525</b>



**Fig. 4. Above ground liquid manure storage.**

Use a large piston manure pump to load. Agitate and pump with a side-mounted liquid manure pump.

### Value of Cattle Manure

Decomposing manure releases nutrients for plant growth, and the organic matter improves tilth and water holding capacity.

Dairy cattle manure—feces and urine—ranges in consistency from a wet solid to a semi-solid. The housing system affects the physical state of the manure. The amount and type of bedding, if any, affects both the manure moisture content and the fertilizer value. Moisture content is also related to the type of storage.

As manure breaks down biologically, ammonia (a form of nitrogen) is released and lost to the air. Therefore, the longer manure remains in the housing area or storage before spreading, or on the soil surface after spreading, the greater the potential nitrogen loss.

Immediately incorporate—plow, disc, or cultivate—the manure into the soil to save much of the nutrients and prevent loss by runoff. Up to 25% of the nitrogen can be lost to the air in the first 24 hours after spreading stored manure if it is not incorporated.

A 1000 lb dairy cow produces about 82 lb/day (1.32 cu ft/day or 9.9 gal/day) of urine and feces at about 87% moisture content. A 1400 lb cow produces about 115 lb/day (1.85 cu ft/day or 13.9 gal/day). Fresh dairy manure weighs about 62 lb/cu ft. Table 1 gives the approximate chemical nutrients in 1 ton of fresh manure. Manure also contains many trace elements used by various crops. Use absorbent bedding, tight storages, and liquid-tight manure spreaders to conserve large amounts of nitrogen and potassium in urine.

**Table 1. Approximate nutrient value of fresh dairy manure.**

To convert  $P_2O_5$  to elemental P, multiply by 0.44.

To convert  $K_2O$  to elemental K, multiply by 0.83.

Nutrient	Feces	+	Urine Lb/ton	=	Total
Nitrogen, N	5		5		10
Phosphate, $P_2O_5$	4.75		0.25		5
Potash, $K_2O$	1.5		8.5		10

The nutrients in Table 1 are not all available for plant growth. The commercial fertilizer equivalent of manure is affected by:

- chemical form of the nutrients
- changes in chemical form during storage
- physical losses from spillage, runoff, leaching or volatilization.

Adding bedding and/or dilution water reduces the quantity of nutrients per ton of material spread.

After selecting the handling and storage systems and the method of application, estimate the amount of available manure nutrients by using MWPS-18, Livestock Waste Facilities Handbook. Note: A manure analysis gives the best estimate of manure nutrient content.

### Economic Comparison of Manure Handling Systems

The following tables give relative cost estimates for the principal cost factors so different manure handling systems can be compared. Similar tables can be developed for other herd sizes by substituting appropriate cost factors. The estimates are based on 1977 costs. Do not use estimates as actual costs.

Note the liquid manure tank cost is based on contractor labor rather than farm labor and that the tank size allows 180 days of usable storage with an allowance of 85% useable space. The 180 days of storage—about 6 months—may be required by some regulatory agencies and usually allows spreading on fields free of snow and dry enough for heavy equipment.

The tractor investment is not included in the total investment but hourly charges for the use of the tractor are included. The footnotes for the tables are on page 5.

**Table 2. Value of Available Nutrients per Ton of Dairy Cattle Manure.**

Nutrient	Lbs/ton	x	Estimated* cost/lb =	Estimated value/ton	Your farm	
					Cost	Value/ton
Nitrogen	4.0		16¢	\$ .64	_____	_____
Phosphate	2.7		20¢	.54	_____	_____
Potash	6.7		10¢	.67	_____	_____
				\$1.85		

\*1977 estimates

**Summary comparison of investment of annual cost of manure handling alternatives.**

**50-Cow Stanchion Barn**

System	Investment*	-----Annual Cost-----		
		Without Bedding	Add Bedding	Total With Bedding
Stacking	\$12,700	\$3,830	\$2,500	\$6,330
Daily hauling	5,300	3,840	2,500	6,340
Liquid basin storage	24,100	6,291	1,250	7,541
Liquid tank storage	30,000	6,567	1,250	7,817
Liquid silo storage	34,200	7,675	1,250	8,925

**100-Cow Free Stall Barn**

System	Investment*	-----Annual Cost-----		
		Without Bedding	Add Bedding	Total With Bedding
Semi-solid storage, tractor scraper	\$24,700	\$ 7,688	\$2,500	\$10,188
Daily hauling, tractor scraper	10,800	8,144	2,500	10,644
Liquid basin storage, alley scraper	29,400	8,055	2,500	10,555
Liquid slotted floor	40,600	8,279	2,500	10,779
Liquid basin, irrigation, alley scraper	34,950	8,366	2,500	10,866
Liquid tank, tractor scraper	45,800	9,659	2,500	12,159
Liquid silo storage, alley scraper	43,900	10,025	2,500	12,525

\*Investment in tractors not included here, but is included in the hourly charges for use of tractor.

Major credit for this publication goes to O. I. Berge, T. J. Brevik, L. A. Brooks, M. F. Brugger, E. G. Bruns, R. E. Graves, L. R. Massie and D. J. Meyer, Agricultural Engineers at the University of Wisconsin.

..... *And Justice for All.*  
Midwest Plan Service publications are available to all potential clientele without regard to race, color, sex, or national origin. Anyone who feels discriminated against should send a complaint within 180 days to the Secretary of Agriculture, Washington, DC 20250. We are an equal opportunity employer.