

# Economic Considerations for Dairy Waste Management Systems

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The dairy waste management systems commonly used in Missouri are the solid, liquid tank (slurry) or lagoon. Solid systems have been the traditional way to handle waste, but in the future they are expected to be used only in smaller operations (less than 100 cows).

Liquid tank systems are commonly combined with scraping and allow the maximum use of waste nutrients for crop production. These systems are often used when a lagoon is not economical due to soil types and/or geological considerations. Operations may switch from the solid system to the liquid tank system to reduce labor, to improve water quality and to fix other problems. To be viable, these systems must minimize the amount of excess water being transported to the field by tank wagons.

Lagoon systems are favored by large operations because labor and investment costs are minimized and a flushing system can be used to collect and transport waste to the lagoon. These systems normally use an irrigation system with pump, pipe and traveling gun to transport and spread the waste.

## Economic data

Statewide liquid tank and lagoon systems were studied because they are the most likely alternatives to upgrade dairy operations. Data collected was used to project waste management system costs associated with operations ranging in size from 100 to 1,000 cows. Because the solid system is best suited to herds of less than 100 cows, it was not analyzed.

An economic analysis based on the data collected was published in MU publication [MP666](#), *Waste Management Systems for Dairy Herds*. The data in this guide was taken from that publication. Refer to it for more complete details.

# Assumptions

## Lagoon-gutter flush system

Lagoon size is based on a 365-day storage capacity with 100 percent of the waste going into the lagoon, including dry cow waste but excluding calf and replacement heifer waste. Land required for spreading the effluent is based on 100 pounds of nitrogen per acre used annually by plant production.

The lagoon system is assumed to hire a custom irrigation system at \$60/hour. Other components are assumed to be owned. Other equipment includes the water storage tanks for flushing gutters and the electric pump and pipe needed to recycle water from the lagoon to the flush tanks. The estimated costs include a clay lagoon seal compacted by a sheepsfoot roller.

The irrigation system includes a traveling gun irrigator that will distribute 1 acre-inch (27,154 gallons) of effluent per hour. The custom operator provides everything except "equipment check labor." The dairy operator is responsible for properly operating equipment. A cost comparison per hour for owned and custom traveling gun irrigation systems is shown in Figure 1.

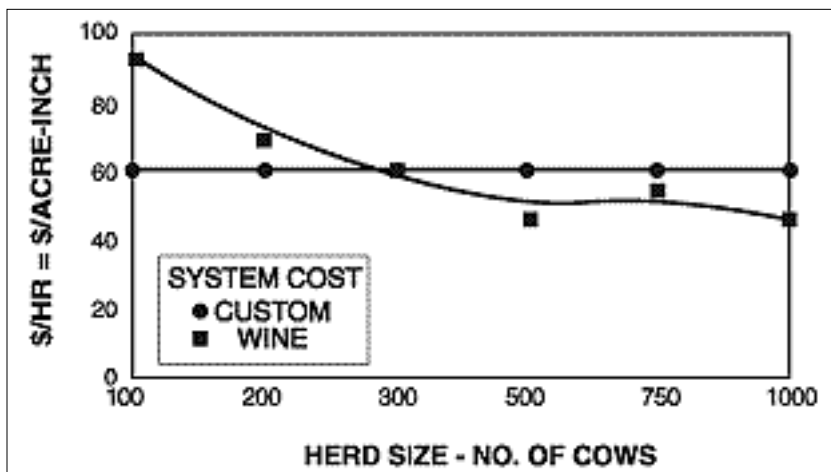


Figure 1. Cost per hour for owned and custom traveling gun irrigation systems.

## Liquid storage tank system

The liquid tank system is assumed to include a cast-in-place, reinforced, in-ground, concrete storage tank with 120-day capacity, to be loaded by gravity. Above-ground tanks would need a mechanized pump for daily loading into the tank. A concrete stave silo with adequate reinforcement can be purchased for 70 percent of the cost stated in this analysis. Other storage facilities will normally cost more than the in-ground concrete tank.

The equipment cost includes an open-impeller, centrifugal chopper pump used to agitate

the slurry in the tank while pumping from storage to tank wagon(s). Other equipment includes a manure scraper operated by a 40-horsepower tractor and a 3,000-gallon tank wagon pulled by a 100-horsepower tractor. The number of tank wagons varies by herd size (e.g., one wagon for 100- and 200-cow herds, but two tank wagons for 300-cow herds) to permit waste distribution within a 10-day period during the 120-day storage period.

Labor required for loading, hauling and spreading the waste assumes one person at the storage tank to operate the tractor and agitator pump to fill the tank wagons and a tractor operator for each tank wagon used to distribute waste to the fields.

## Fertilizer nutrient equivalent value

Dairy waste applied to the land has an equivalent fertilizer nutrient value for the replaced commercial fertilizer and/or for the increased production of plant growth used by animals or harvested. The assumed value of the fertilizer nutrients is as follows: nitrogen, 23 cents per pound; phosphate, 22 cents per pound; potash, 14 cents per pound.

Fertilizer nutrient availability is shown in Tables 7 and 14 for the two systems, based on data in Tables 8 and 9. Less nitrogen is available from the lagoon system due to oxidation, denitrification and dilution. Figure 2 illustrates how ammonia-nitrogen loss varies with time until incorporation (see Table 8). In the case of irrigated lagoon effluent, incorporation occurs if the soil is dry enough for the liquid to soak in and the application rate does not exceed the soil infiltration rate. Figure 3 shows the organic nitrogen availability versus years after application (see Table 9).

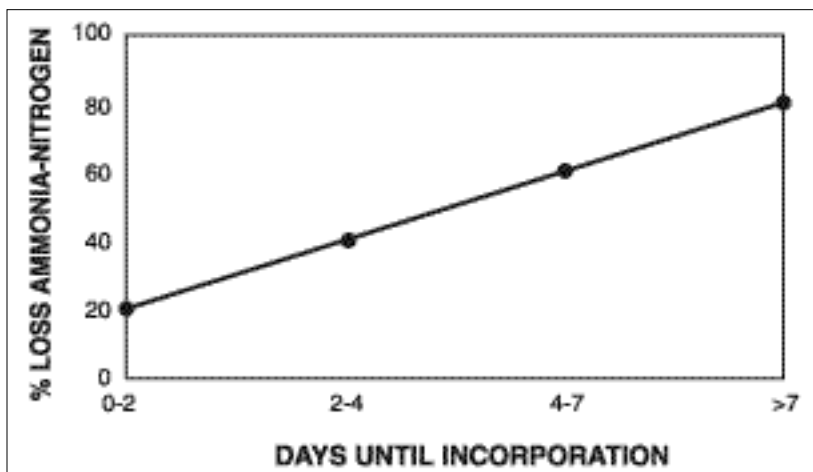


Figure 2. Manure ammonia-nitrogen loss versus days until incorporation.

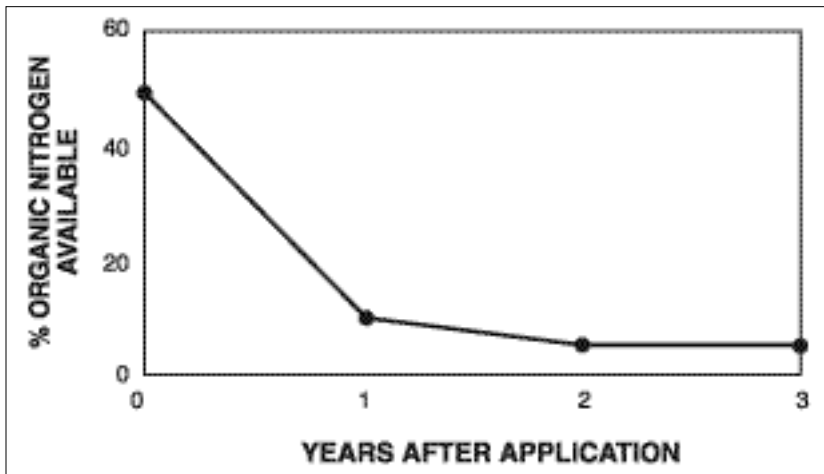


Figure 3. Manure organic nitrogen available versus years after application.

With the liquid tank system, the waste volume and concentration per cow is constant with herd size; the calculated nutrient value of the waste is a constant \$63 per cow per year. With the lagoon system, the assumed annual pumpdown per cow per year decreases with herd size, therefore, the calculated nutrient value per cow per year decreases from \$23/cow/year for the 100-cow herd to \$10.50/cow/year for the 1,000-cow herd. Figure 4 compares the annual value of waste per cow for the two systems.

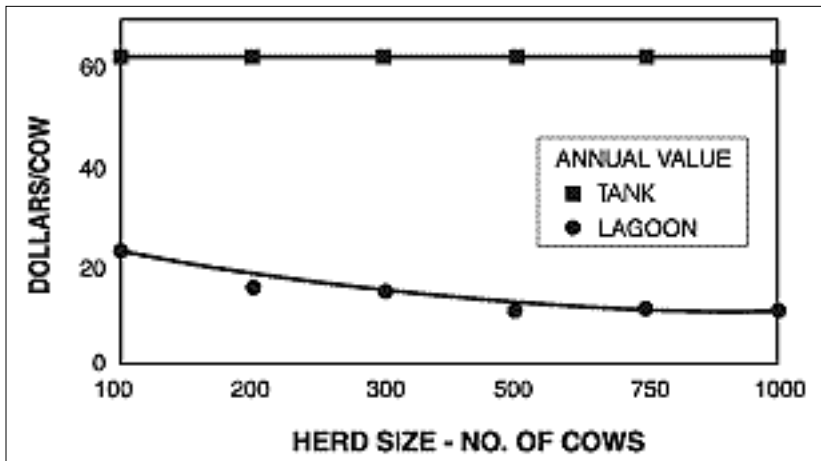


Figure 4. Annual value of waste per cow for tank and lagoon systems.

## Cost comparison of systems

Important cost comparisons of the two systems, using data from the tables, are presented graphically in Figures 5-8. From Figures 5 and 6 (or Table 3, lines 6 and 7 and Table 10, lines 6 and 7), the total investment and the investment per cow, respectively, for a lagoon system ranges from about 60 percent less than a liquid tank system for a 100-cow operation to 43 percent less for the 1,000-cow operation. Economy of scale for the liquid tank system is reached with a herd size of 500 cows.

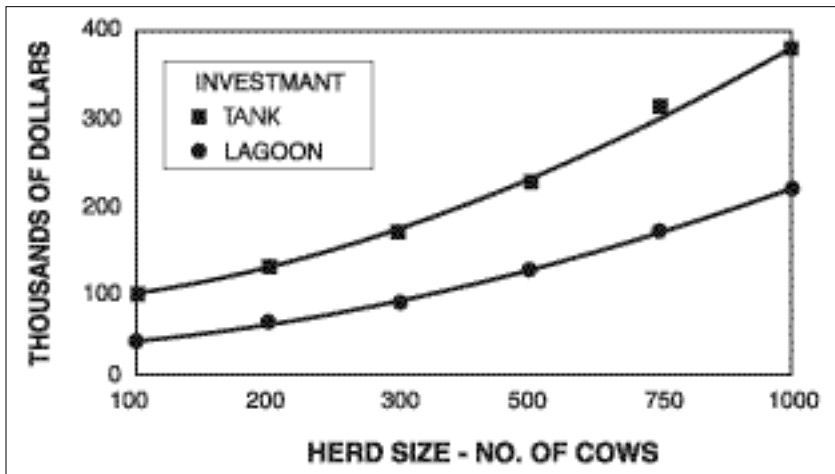


Figure 5. Total investment for tank and lagoon systems.

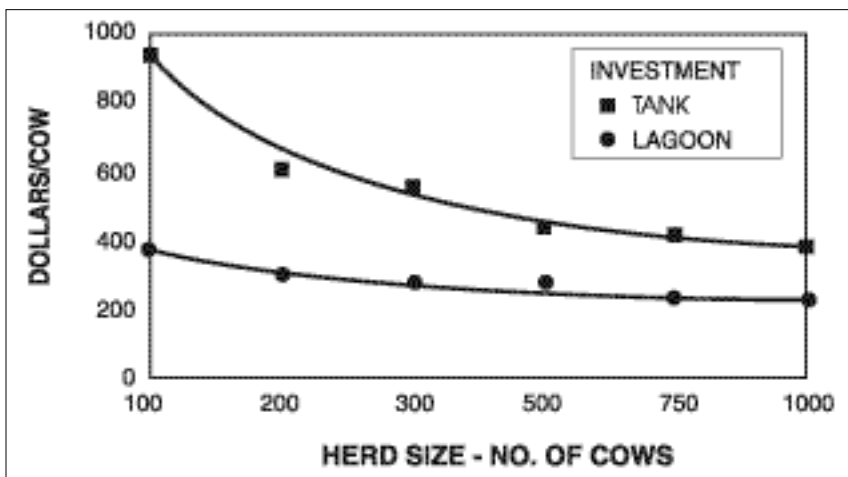


Figure 6. Investment per cow for tank and lagoon waste systems.

Depending somewhat on herd size, the lagoon system's annual cost per cow (fixed cost plus operating cost) ranges from 55 to 60 percent less for the lagoon system than for the liquid tank system (see Figures 7 and 8, or Tables 1 and 2, line 5).

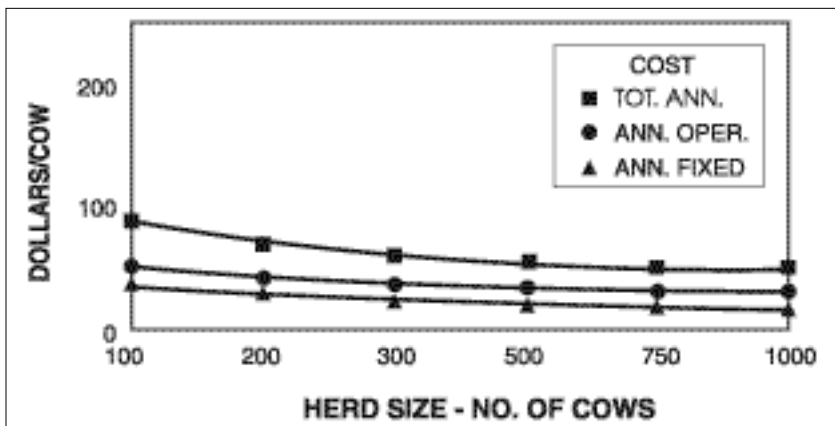


Figure 7. Annual costs per cow for lagoon dairy waste systems.

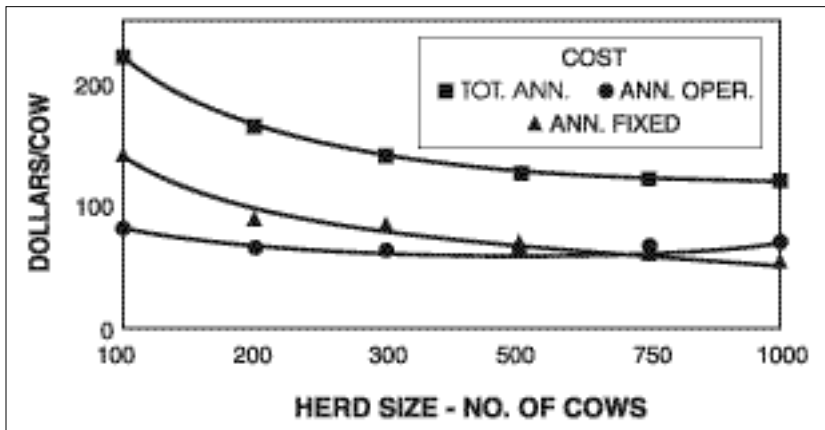


Figure 8. Annual costs per cow for liquid tank dairy waste systems.

For details on annual fixed costs and annual operating costs, see Tables 4, 5 and 6 for the lagoon system and Tables 11, 12 and 13 for the liquid manure tank system.

From Figures 9 and 10 (or Table 1 and 2, line 8), the net annual cost per cow for a lagoon system ranges from about 59 percent less than a liquid tank system for a 100-cow operation to 35 percent less for a 500-cow operation. The net annual cost per cow accounts for the fertilizer equivalent value of the plant nutrients in the waste, if spread on the land and used by crops.

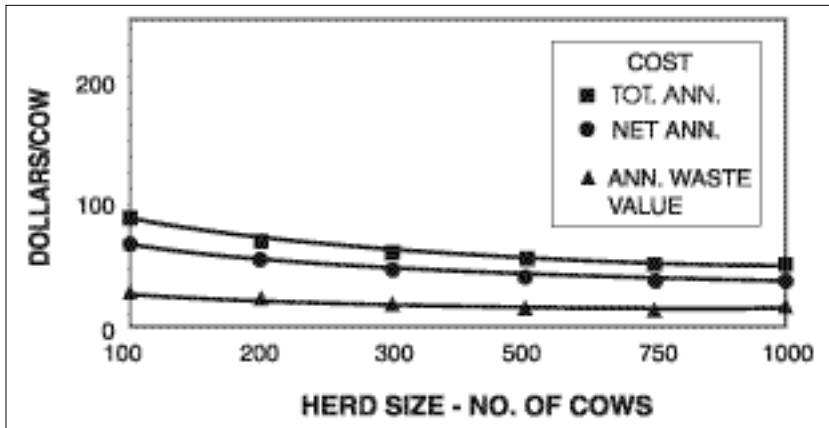


Figure 9. Net annual cost per cow for lagoon dairy waste systems.

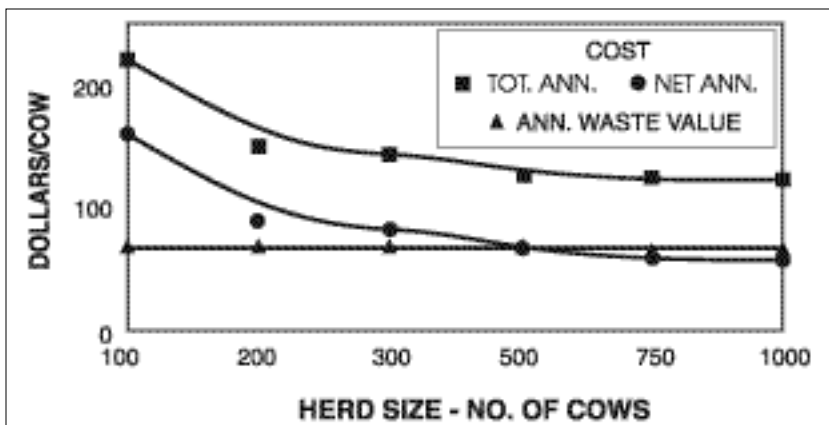


Figure 10. Net annual cost per cow for liquid tank dairy waste systems.

Dairies with herds exceeding 150 cows are required to have a letter of approval from DNR in order to operate. This may cause some operations to install a new waste management system. Cost-sharing assistance may be available from the Agricultural Stabilization and Conservation Administration (ASCS) up to \$17,500 per operation, limited to 75 percent of the average cost. (Some husband-wife operations may qualify for \$35,000 cost-share.) Cost-sharing may reduce waste management costs by 20 to 30 percent for herds of 300 cows or less.

## Conclusions

The net cost of the lagoon system ranges from \$0.24/cwt. of milk produced by the 1,000-cow herd to \$0.43/cwt. for the 100-cow herd. The net cost of the liquid tank system ranges from \$0.39 per cwt. of milk produced by the 1,000-cow herd to \$1.04/cwt. for the 100-cow herd.

Even though waste from liquid tank systems are more concentrated and valuable than the waste from lagoon systems, the liquid system's net cost is from 1.5 to 2.4 times greater than the lagoon system's net cost, depending on herd size.

The liquid tank system requires 4 to 5 hours of labor per cow per year (mostly for tractor operators) compared to virtually no labor for the lagoon system (with custom irrigation).

The liquid tank system requires 5 to 10 times larger plant filter area than the lagoon system. This can be a major consideration for operations with limited acreage.

Large dairies, more than 300 cows, may benefit from purchasing a traveling gun irrigator rather than relying on a custom operator charging \$60 per hour.

Data to support such a decision is presented in Tables 15, 16 and 17. Lack of available labor and management may make hiring a custom irrigation system a better choice, even for the largest of operations.

**Table 1. Summary of lagoon system costs.**

	Herd size					
	100	200	300	500	750	1000
1. Average investment per cow (\$)	363	297	268	242	224	217
2. Annual operating costs (\$) (From Table 6, line 10)	3,663	5,367	6,821	10,053	13,363	16,765

3. Annual fixed costs (\$) (From Table 5, line 7)	5,051	8,271	11,219	16,810	23,247	29,914
4. Total annual costs (\$) (line 2 + line 3)	8,714	13,638	18,040	26,863	36,610	46,679
5. Annual costs per cow (\$)	87	68	60	54	49	47
6. Value of waste (\$) (from Table 7, line 12)	2,304	3,435	4,292	6,265	8,245	10,509
7. Net annual cost (\$) (line 4 minus line 6)	6,410	10,203	13,748	20,598	28,365	36,170
8. Net annual cost per cow (\$)	64	51	46	41	38	36

**Table 2. Summary of liquid manure tank system costs.**

	Herd size					
	100	200	300	500	750	1000
1. Average investment per cow (\$)	910	599	546	443	412	381
2. Annual operating costs (\$) (From Table 6, line 10)	8,025	12,502	18,814	31,457	47,265	68,674
3. Annual fixed costs (\$) (From Table 5, line 7)	13,887	17,435	24,416	31,565	43,863	52,715
4. Total annual costs (\$) (line 2 + line 3)	21,912	29,937	43,230	63,022	91,128	121,389
5. Annual costs per cow (\$)	219	150	144	126	122	121
6. Value of waste (\$) (from Table 7, line 12)	6,291	12,580	18,872	31,454	47,180	62,908
7. Net annual cost (\$) (line 4 minus line 6)	15,621	17,357	24,358	31,568	43,948	58,481
8. Net annual cost per cow (\$)	156	87	81	63	59	58

**Table 3. Lagoon system: investment.**

	Herd size					
	100	200	300	500	750	1000
1. Lagoon	\$25,416	\$44,253	\$61,196	\$97,121	\$138,922	\$182,455
2. Fencing (0.727/ft.)	872	1,091	1,163	1,454	1,599	1,745
3. Storage tanks (gutter flush)	3,000	6,000	9,000	12,000	15,000	18,000
4. Recycling pump and pipe	3,500	4,000	4,500	5,500	6,500	7,500
5. Consultation	3,500	4,000	4,500	5,000	6,250	7,500
6. Total investment	\$36,288	\$59,344	\$80,359	\$121,075	\$168,271	\$217,200
7. Average investment per cow	\$363	\$297	\$268	\$242	\$224	\$217

**Table 4. Lagoon system: annual fixed costs as a percent of new cost.**

	Lagoon and fence	Equipment	Consultation
Years useful life	20	10-20	
<b>Fixed costs as percent</b>			
Depreciation	5.0	9.0 <sup>1</sup>	5.0
Interest	6.0 <sup>2</sup>	6.0 <sup>2</sup>	6.0
Repairs and maintenance	1.5	1.5	
Taxes	0.8 <sup>3</sup>	1.0 <sup>3</sup>	
Insurance		0.5	
Total percent	13.3	18.0	11.0

<sup>1</sup>Allows for 10 percent salvage.

<sup>2</sup>Annual interest charge is 6 percent of original investment (equivalent to investment x 50 percent x 12 percent APR.)

<sup>3</sup>Tax assessment varies based on value added to the property. A lagoon established on a suitable site in an area where unfavorable geological conditions predominate will add more value to the property than one established in an area with many favorable sites.

**Table 5. Lagoon system: total annual fixed costs.**

	Herd Size					
	100	200	300	500	750	1000
1. Lagoon and fence <sup>1</sup>	\$26,288	\$45,344	\$62,359	\$98,575	\$140,521	\$184,200
2. Equipment, initial investment <sup>1</sup>	6,500	10,000	13,500	17,500	21,500	25,500
3. Consultation <sup>1</sup>	3,500	4,000	4,500	5,000	6,250	7,500
4. Lagoon and fence (line 1 x 13.3% <sup>2</sup> )	3,496	6,031	8,294	13,110	18,689	24,499
5. Equipment, annual costs (line 2 x 18%)	1,170	1,800	2,430	3,150	3,870	4,590
6. Consultation (line 3 x 11% <sup>2</sup> )	385	440	495	550	688	825
7. Total annual fixed costs (line 4 + line 5 + line 6)	\$5,051	\$8,271	\$11,219	\$16,810	\$23,247	\$29,914
8. Annual cost per cow	\$50	\$41	\$37	\$34	\$31	\$30

<sup>1</sup>Transferred from Table 3.

<sup>2</sup>Transferred from Table 4.

**Table 6. Lagoon system: annual operating costs.**

	Herd size
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	100	200	300	500	750	1000
<b>Operating recycle pump</b>						
1. Size electric pump (hp)	1.5	1.5	3.0	5.0	7.5	7.5
2. Annual pumping time (5 hrs. daily x 365 days)	1,825	1,825	1,825	1,825	1,825	1,825
3. Cost/hour (1kw x hp x .07/kw)	\$0.11	\$0.11	\$0.21	\$0.35	\$0.53	\$0.53
4. Annual pumping costs (line 2 x line 3)	\$201	\$201	\$383	\$639	\$967	\$967
<b>Irrigation lagoon annual pumping cost</b>						
5. Estimated acre-inches to pump annually	57	85	106	155	204	260
6. Custom pumping charge/hour <sup>1</sup>	\$60	\$60	\$60	\$60	\$60	\$60
7. Annual lagoon pumping costs (line 5 x line 6)	\$3,420	\$5,100	\$6,360	\$9,300	\$12,240	\$15,600
8. Check labor hours/year <sup>2</sup>	7	11	13	19	26	33
9. Annual labor costs (line 8 x \$6/hour)	\$42	\$66	\$78	\$114	\$156	\$198
10. Total operating costs (line 4 + line 7 + line 9)	\$3,663	\$5,367	\$6,821	\$10,053	\$13,363	\$16,765
<sup>1</sup> Assume a traveling gun pumps 500 gallons per minute, which allows pumping one acre-inch per hour. <sup>2</sup> Check labor required to inspect the irrigation system periodically to determine if the traveling gun and equipment are operating adequately. Assume one hour per 8 hours operation.						

**Table 7. Lagoon system: value of waste to plant production.**

	Herd size
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	100	200	300	500	750	1000
<b>Nutrients produced (lbs./yr.)<sup>1</sup></b>						
1. Ammonia nitrogen	2,623	3,912	4,876	7,130	9,384	11,960
2. Organic nitrogen	1,312	1,956	2,438	3,565	4,692	5,980
3. Phosphorus	1,994	2,973	3,710	5,425	7,140	9,100
4. Potassium	6,838	10,198	12,770	18,600	24,480	31,200
<b>Pounds of fertilizer nutrient equivalent available</b>						
5. Ammonia nitrogen (line 1 x 50% <sup>2</sup> )	1,312	1,956	2,438	3,565	4,692	5,980
6. Organic nitrogen (line 2 x 70% <sup>2</sup> )	918	1,369	1,707	2,496	3,284	4,186
7. Phosphate (line 3 x 2.3 <sup>2</sup> )	3,440	5,128	6,400	9,358	12,317	15,698
8. Potassium (line 4 x 1.2 <sup>2</sup> )	7,385	11,014	13,792	20,088	26,438	33,696
<b>Value of fertilizer equivalents</b>						
9. Nitrogen (line 5 + line 6 x \$0.23/lb.)	\$ 513	\$ 765	\$ 953	\$1,394	\$1,834	\$2,338
10. Phosphate (line 7 x \$.22/lb.)	757	1,128	1,408	2,059	2,710	3,454
11. Potash (line 8 x \$0.14/lb.)	1,034	1,542	1,931	2,812	3,701	4,717
12. Total value of fertilizer equivalent	\$2,304	\$3,435	\$4,292	\$6,265	\$8,245	\$10,509
13. Minimum no. acres to irrigate <sup>5</sup>	22	33	41	61	80	102
14. Value of fertilizer equivalent/acre (line 12 divided by line 13)	\$105	\$104	\$105	\$103	\$103	\$103

- <sup>1</sup>Average analysis of lagoon waste.  
<sup>2</sup>Average percent available to plant.  
<sup>3</sup>Conversion of phosphorus to phosphate.  
<sup>4</sup>Conversion of potassium to potash.  
<sup>5</sup>Application of 100 pounds of available nitrogen per acre.

**Table 8. Manure ammonia-nitrogen loss by days until worked into the soil.**

Days until incorporation	Percent ammonia-N available for crops
0-2	80
2-4	60
4-7	40
more than 7	20

**Table 9. Manure organic nitrogen available by year.**

Manure applied	Percent organic N available during current year
current year	40-60
1 year ago	10
2 years ago	5
3 years ago	5

**Table 10. Liquid manure tank system: investment.**

	Herd size					
	100	200	300	500	750	1000
1. Manure tank <sup>1</sup>	\$62,727	\$91,207	\$119,681	\$176,624	\$247,791	\$318,952
2. Agitating and loading pump	10,000	10,000	10,000	10,000	10,000	10,000
3. Scraper	750	750	750	1,000	1,000	1,000

4. Tank wagon, 3,000 gal, capacity <sup>2</sup>	15,000	15,000	30,000	30,000	45,000	45,000
5. Consultation	2,500	2,900	3,300	4,100	5,100	6,000
6. Total new investment	\$90,977	\$119,857	\$163,731	\$221,724	\$308,891	\$380,952
7. Average investment/cow	\$910	\$599	\$546	\$443	\$412	\$381

<sup>1</sup>Cost based on concrete construction.

<sup>2</sup>Number of tank wagons: 100-200 cows — 1; 300-500 cows — 2; 750-1,000 cows — 3.

**Table 11. Liquid manure tank system: annual fixed costs as a percent of new cost.**

	Tank	Equipment	Consultation
Years useful life	20	20	
<b>Fixed costs as percent</b>			
Depreciation	5.0	12.9 <sup>1</sup>	5.0
Interest	6.0 <sup>2</sup>	6.0 <sup>2</sup>	6.0
Repairs and maintenance	0.5	2.5	
Taxes	0.8 <sup>3</sup>	1.0 <sup>3</sup>	
Insurance		0.5	
Total percent	12.3	22.9	11.0

<sup>1</sup>Allows for 10 percent salvage.

<sup>2</sup>Annual interest charge is 6 percent of original investment (equivalent to investment x 50 percent x 12 percent APR).

<sup>3</sup>Tax assessment varies based on value added to the property. A lagoon established on a suitable site in an area where unfavorable geological conditions predominate will add more value to the property than one established in an area with many favorable sites.

**Table 12. Liquid manure tank system: total annual fixed costs.**

	Herd size					
	100	200	300	500	750	1000
1. Tank	\$62,727	\$91,207	\$119,681	\$176,624	\$247,791	\$318,952
2. Equipment, initial investment <sup>1</sup>	25,750	25,750	40,750	41,000	56,000	56,000
3. Consultation <sup>2</sup>	2,500	2,900	3,300	4,100	5,100	6,000
4. Tank (line 1 x 12.3%)	7,715	11,219	14,721	21,725	30,478	39,231
5. Equipment, annual costs (line 2 x 22.9% <sup>3</sup> )	5,897	5,897	9,332	9,389	12,824	12,824
6. Consultation (line 3 x 11%)	275	319	363	451	561	660
7. Total annual fixed costs (line 4 + line 5 + line 6)	\$13,887	\$17,435	\$24,416	\$31,565	\$43,863	\$52,715
8. Total annual costs per cow	\$139	\$87	\$81	\$63	\$58	\$53

<sup>1</sup>From Table 10, line 2 + line 3 + line 4.

<sup>2</sup>Transferred form Table 10.

<sup>3</sup>Transferred form Table 11.

**Table 13. Liquid manure tank system: annual operating costs.**

	Herd size					
	100	200	300	500	750	1000
<b>Power supply, hours use annually</b>						
1. Scraper tractor, 40 hp	183	304	426	669	852	1,278

2. Agitation pump tractor, 100 hp <sup>1</sup>	7.2	10.8	14.5	21.9	31.0	40.2
3. Tank wagon tractor(s), 100 hp <sup>2</sup>	172	260	406	699	1,118	1,610
<b>Power costs</b>						
4. Scraper tractor (line 1 x \$7.62/hour <sup>3</sup> )	\$1,394	\$2,316	\$3,246	\$5,098	\$6,492	\$9,738
5. Agitation and wagon tractor (line 2 + line 3 x \$19.36/hr. <sup>3</sup> )	\$3,469	\$5,242	\$8,140	\$13,957	\$22,245	\$31,948
<b>Labor costs</b>						
6. Tractor operators (line 1 ÷ (2 <sup>4</sup> x line 3) x \$6/hr.)	\$3,162	\$4,944	\$7,428	\$12,402	\$18,528	\$26,988
7. Total operating costs (line 4 ÷ line 5 ÷ line 6)	\$8,025	\$12,502	\$18,814	\$31,457	\$47,265	\$68,674
8. Total operating costs per cow	\$80	\$63	\$63	\$63	\$63	\$69
<sup>1</sup> Based on one hour per 16,000 cu. ft. waste. <sup>2</sup> Hauling time per load by herd size (min.): 100 cows — 36 min.; 200 — 36; 300 — 42; 500 — 48; 750 — 54; 1,000 — 60. <sup>3</sup> Based on "Doane's Machinery Operating Costs, 1991." <sup>4</sup> Time on line 3 is doubled because one person is at agitation pump site plus hauling time.						

**Table 14. Liquid manure tank system: value of waste to plant production.**

	Herd size					
	100	200	300	500	750	1000
<b>Nutrients produced (lbs./yr.)</b>						
1. Ammonia nitrogen	7,027	14,054	21,081	35,135	52,703	70,270

2. Organic nitrogen	11,225	22,450	33,675	56,125	84,188	112,250
3. Phosphorus	4,212	8,424	12,636	21,060	31,590	42,120
4. Potassium	15,444	30,880	46,332	77,220	115,830	154,440
<b>Fertilizer nutrient equivalent (lbs./yr.)</b>						
5. Ammonia nitrogen (line 1 x 50% <sup>1</sup> )	3,514	7,027	10,541	17,568	26,352	35,135
6. Organic nitrogen (line 2 x 60% <sup>2</sup> )	6,735	13,470	20,205	33,675	50,513	67,350
7. Phosphate (line 3 x 2.3 <sup>5</sup> )	7,266	14,531	21,797	36,329	54,493	72,657
8. Potassium (line 4 x 1.2 <sup>5</sup> )	16,680	33,350	50,039	83,398	125,096	166,795
<b>Value of fertilizer equivalents</b>						
9. Nitrogen (line 5+line 6 x \$0.23/lb.)	\$2,357	\$4,714	\$7,072	\$11,786	\$17,679	\$23,572
10. Phosphate (line 7 x \$0.22/lb.)	1,599	3,197	4,795	7,992	11,988	15,985
11. Potash (line 8 x \$0.14/lb.)	2,335	4,669	7,005	11,676	17,513	23,351
12. Total value of fertilizer equivalent	\$6,291	\$12,580	\$18,872	\$31,454	\$47,180	\$62,908
13. Minimum no. acres to irrigate <sup>6</sup>	103	205	307	512	769	1,024
14. Value of fertilizer equivalent per acre (line 12 ÷ line 13)	\$61	\$61	\$61	\$61	\$61	\$61

<sup>1</sup>Assumes 50 percent incorporated with 80 percent loss and 50 percent incorporated within two days with 20 percent loss. Value will increase if 100 percent incorporated within two days.

<sup>2</sup>Assumes not spread on same fields each year (50 percent year 1 plus 10 percent year 2).

<sup>3</sup>Conversion of phosphorus to phosphate.

<sup>4</sup>Conversion of potassium to potash.

<sup>5</sup>Average percent available to plant.

<sup>6</sup>100 pounds of nitrogen per acre.

**Table 15. Annual fixed costs expressed as percent of initial cost of irrigation system.**

	Acre-inches lagoon waste pumped annually	
	50 to 175	175 to 300
Years useful life	15	10
Depreciation	6.0%	9.0%
Interest	6.0	6.0
Repairs and maintenance	7.0	10.0
Taxes	1.5	1.5
Total fixed costs	20.5%	26.5%

<sup>1</sup>Based on used equipment with above average maintenance and care.

**Table 16. Traveling gun system: annual fixed costs.**

	Acre-inches lagoon waste pumped annually				
	50 to 175		175 to 300		
	Initial cost	%	Annual fixed costs	%	Annual fixed costs
1. Traveling gun	\$10,000 <sup>1</sup>	20.5	\$2,050	26.5	\$2,650
2. PTO pump, 500 gpm	3,000 <sup>1</sup>	20.5	615	26.5	795

3. Agitation pump	3,500 <sup>2</sup>	20.5	718	26.5	928
4. Aluminum pipe	4,200 <sup>1</sup>	20.5	861		
	8,400 <sup>1</sup>			26.5	2,226
5. Total annual fixed cost			\$4,244		\$6,599

<sup>1</sup>Workable used equipment.

<sup>2</sup>Not needed if you have a solids separator.

**Table 17. Annual operating costs of traveling gun irrigation system.**

	Herd size					
	100	200	300	500	750	1000
<b>Annual operating costs</b>						
1. Acre-inches of waste <sup>1</sup>	57	85	106	155	204	260
2. Agitation pump time (hrs.) <sup>2</sup>	4	8	12	20	30	40
3. Minimum acres spread over <sup>3</sup>	22	33	41	61	80	102
4. No. times system set up <sup>4</sup>	2	3	4	6	8	10
5. Set up time (hrs.)	16	24	32	48	64	80
<b>Power costs</b>						
6. Irrigation pump (line 1 x \$14.14/hr. 80 hp) <sup>7</sup>	\$806	\$1,202	\$1,499	\$2,192	\$2,885	\$3,676
7. Agitation pump (line 2 x \$19.36/hr. 100 hp) <sup>7</sup>	77	155	232	387	581	774
8. Laying pipe (line 5 x 25%) <sup>7</sup>	77	116	155	232	310	387
<b>Labor costs</b>						

9. Check labor hrs. <sup>8</sup> (line 1 x 12.5%)	7	11	13	19	26	33
10. Total labor hours (line 5 + line 9)	23	35	45	67	90	113
11. Total labor costs (line 10 x \$6/hr.)	\$138	\$210	\$270	\$402	\$540	\$678
12. Total annual operating costs (add lines 6, 7, 8 and 11)	\$1,098	\$1,683	\$2,156	\$3,213	\$4,316	\$5,515
13. Total annual fixed costs (Table 12, line 5)	\$4,244	\$4,244	\$4,244	\$4,244	\$6,599	\$6,599
14. Total annual costs (line 12 + line 13)	\$5,342	\$5,927	\$6,400	\$7,457	\$10,915	\$12,114
15. Cost per acre-inch (line 14 ÷ line 1) or per hour operation	\$93.72	\$69.73	\$60.38	\$48.11	\$53.50	\$46.59

<sup>1</sup>Transferred from Table 6, line 5; also irrigation operating hours.

<sup>2</sup>Four hours per 100 cows.

<sup>3</sup>Transferred from Table 7, line 13.

<sup>4</sup>One set-up per 10 acres.

<sup>5</sup>Eight hours labor per set up.

<sup>6</sup>Assume tractor operates 25 percent of time required to lay pipe.

<sup>7</sup>Tractor power cost taken from "Doane's Machinery Operating Costs, 1991."

<sup>8</sup>Check labor is used to check the irrigation system periodically to determine if the system is operating adequately. Assume one hour per eight hours operation.