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Staff Paper

MANURE MANAGEMENT AND CAPITAL INVESTMENTS - Some May Break the Bank

Gerald Schwab
Professor and Extension Specialist

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WAITE MEMORIAL BOOK COLLECTION
DEPT OF APPLIED ECONOMICS
UNIVERSITY OF MINNESOTA
1994 BUFORD AVE. 232 COB
ST. PAUL MN 55108 U.S.A.

Department of Agricultural Economics
MICHIGAN STATE UNIVERSITY
East Lansing , Michigan

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MANURE MANAGEMENT AND CAPITAL INVESTMENTS - SOME MAY BREAK THE BANK -[1]

I. INTRODUCTION:

The term "manure management" included in both the title of this conference and of this paper conveys a positive message. The term "manure" as opposed to "waste" identifies the topic with natural excreta most often associated with the animal production industry. As suggested by the words on the crass bumper stickers, it happens - as part of a natural biological process. Manure is a by-product (or co-product) of the animal industry and ought not to be considered only a waste product that requires a cost of disposal. The term "management" implies that conscious decisions can be made about the use and allocation of resources to achieve defined goals. The concept that manure can be managed as a resource to provide something of value is one of the endemic messages contained in this paper.

To view manure as a resource for use in providing value implies that manure is an asset. This suggestion may appear ludicrous to the animal industry person who has spent time and money to get rid of manure by hauling it away from where the animal is housed. Although manure may have value, there are some very real costs associated with most if not all manure management systems. If the costs associated with manure are more than its value, manure will not become a profit center. In summary of this introduction, the case can be made for manure as an asset because it has value. Or contrarily, because of the associated costs to own and operate a manure management system, manure can be viewed as a contingent liability. It is to that question of costs that we now turn.

II. MANURE SYSTEM COSTS:

The primary focus of our cost discussion will be only the individual farm firm. It is recognized that decisions and operations of individual farm firms can have effects beyond the boundaries of the farm but these externalities will not be addressed within the confines of this paper.

A. Alternative Cost Concepts: Confusion often reigns when costs are discussed. To clarify three alternative views of costs will be briefly discussed.

1. Accounting - The accounting cost includes the operating plus the ownership costs.

Operating costs are expenses that vary with the level of production and are often referred to as variable expenses. What is a variable expense is directly related to the future time period being considered. The longer the future time period being considered, the more costs that are identified as variable because management has more time to change the mix of inputs. Examples of costs associated with manure systems that tend to be classified as variable or operating would be labor, repairs, and purchased energy as fuel to distribute the manure.

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[1]Paper presented by Gerald Schwab at Sept. 22-23, 1993 conference entitled "Manure Management: The Hidden Cost of Feeding America" held at Kellogg Biological Station; Hickory Corners, Michigan.

Ownership costs are expenses associated with durable assets; i.e. resource inputs that are used over more than one year. Examples of ownership costs associated with manure systems are depreciation, property taxes, insurance premiums, and interest on term debt.

2. Economic - The economic cost includes the accounting cost plus the opportunity cost.

The opportunity cost is the profit foregone from the next best employment of the resource. In the question of capital investment in manure systems, the resource could be the dollars required for the investment. The opportunity cost would be the net return that could be earned by those dollars if employed elsewhere.

3. Cash Flow - Cash flow reflects the checkbook approach to managing the business. Included are the cash operating costs, the debt service expenditures, and often some provision for family living.

The cash flow concept includes expenditures not all of which can be correctly classified as business expenses. The primary example of an expenditure that is not an expense is the principal portion of the debt service requirement. Although cash flow is often used in common discussion, it is usually not the most correct approach to calculate expenses.

The cost concept used in this discussion will be the accounting view of costs. To compare alternative manure management systems, a net annual cost for each system will be determined. The operating costs will be added to the annualized portion of the investment costs while the estimated value of the manure remaining available for crop production will be subtracted out to determine a net cost. To be discussed are two cases - one dairy and one swine.

B. Dairy

Manure systems for dairy farms can range from daily haul of solids with very limited storage capability to liquid systems with much longer term storage capacity. Composting can be an additional permutation of the solid manure system but will not be included in this discussion.

Cost data from the TELFARM information system at Michigan State University can provide some perspective on the magnitude of actual costs incurred by real Michigan dairy farms. Presented in Table 1 are 1992 average cost data for two size sorts on Michigan dairy farms. Although there are some differences in cost between the larger and smaller farm, total costs per cow per year are in the $2400 neighborhood. It is not possible to determine from Table 1 the average cost to own and operate the manure management system. Ownership costs in the form of interest and depreciation for the manure management hardware would be imbedded in the machinery and buildings entries. Operating expenses for labor, repairs, and fuel would be included in the labor and machinery entries.

Table 1. Dairy Cost of Production - 1992

	Herd Size - # Cows 80	219	Average % of Costs
Non-Feed			
Labor	$ 346	$ 349	14.6%
Machinery	136	141	5.8
Buildings	90	123	4.5
Veterinary & Medicine	55	89	3.0
Land Charge	14	17	.7
Utilities	62	56	2.5
Other	18	14	.7
Marketing	151	152	6.3
AI, Int.	203	249	9.5
	$ 1,075	$ 1,190	47.5%
Feed			
Corn	$ 285	$ 276	11.3%
Corn Silage	158	153	6.5
Oats	4	6	.2
Barley	9	0	.2
Hay	349	236	12.2
Pasture	9	5	.3
Commercial Feed	425	589	21.2
	$ 1,238	$ 1,265	52.5%
Total:	**$ 2,313**	**$ 2,455**	**100.0%**

Source: Nott, S. and R. Romero, "Business Analysis Summary for Specialized Michigan Dairy Farms, 1992 TELFARM Data," Agricultural Economics Report No. 571.

A study by Garsow, et al.[2] estimated the costs for alternative manure management systems on Michigan dairy farms. Presented in Table 2 are the initial investment costs for an eight month storage capacity. The total investment cost for the manure management system is presented in Table 3. What becomes evident is the lack of size neutrality for these investments. That is, smaller farms are affected more adversely than are the larger farms. There are economies of size that provide lower investment cost per cow for the larger farms.

[2]Garsow, James D., L. Connor, and S. Nott. June 1992. "Impact of Michigan Dairy Manure Handling Alternatives," Agricultural Economics Report No. 561, Michigan State University.

Table 2. Manure Storage Investment Costs for Eight Months Capacity on Dairy Farm

	Number of Milk Cows		
	60	120	250
LIQUID SYSTEM:			
Steel Tank	$ 73,500	$ 129,800	$ 203,600
Concrete Tank Above Ground	57,100	71,000	107,800
Concrete Tank Partially in Ground	53,300	80,300	128,000
Earthen Pit with Concrete Liner	51,000	74,600	115,400
Earthen Pit with Membrane Liner	39,000	56,000	84,500
Earthen Pit with 3 ft. Clay Liner	28,300	39,500	57,100
Earthen Pit	20,700	27,700	37,300
SOLIDS SYSTEM:			
Concrete Slab with 3 Walls	31,700	N/A*	N/A*
DAILY HAUL	0	0	0

*N/A = not analyzed.

Source: Garsow, T.J., 1990a. Nutrient balance template. Wisconsin Soil Conservation Spreadsheet Program, Oconto, Wisconsin.

Table 3. Investment in Manure Systems by Representative Farm*
Cow and Heifer Manure Handled the Same

	Storage Structure	Collection Equipment	Agitation, Application Equipment*	Total Investment	Investment Cost Per Cow
			Dollars		
HANDLE MANURE AS SOLIDS:					
8-Month Storage					
60 Cows, Tie Stall	$31,700	$ 15,000	$ 5,500	$ 52,200	$ 870
HANDLE MANURE AS LIQUID:					
60 COWS, TIE STALL					
Daily Haul	0	7,936	5,000	12,936	216
8-Month Storage	20,700	7,936	17,000	46,336	772
60 COWS, FREE STALL					
Daily Haul	0	980	5,000	5,980	100
8-Month Storage	20,700	500	17,700	38,900	648
120 COWS, FREE STALL					
Daily Haul	0	980	7,500	8,480	71
8-Month Storage	27,700	500	25,500	53,700	448
250 COWS, FREE STALL					
Daily Haul	0	14,980	7,500	22,480	90
8-Month Storage	37,300	14,500	25,500	77,300	309

*Injectors would add $2,500 to investments.
**Assumptions at 1990 prices.
Source: Garsow, J.D. 1991. A managerial perspective of the likely economic benefits and costs of environmental regulations to the Michigan dairy industry. M.S. Thesis, Michigan State University, East Lansing, Michigan.

An estimate of the annual operating and ownership costs (the accounting cost approach) for manure management systems on the 60-cow farm and on a per cow basis are presented in Tables 4 and 5 respectively. Similar cost data for the larger farms of 120 and 250 cows on the total farm basis and then on a per cow basis are presented in Tables 6 and 7 respectively. An estimated value of the available manure nutrients is deducted from the total cost to determine a net annual cost per cow for each manure management system.

Table 4. Net Annual Cost for 60 Cow Dairy Manure Management System Cows and Heifers

Cost Items	Daily Haul, No Storage		8-Month Storage		
	Tie Stall	Liquid Free Stall	Solids Tie Stall	Liquid Tie Stall	Liquid Free Stall
Bedding @ $40/ton	$ 2,267	$ 1,136	$ 2,267	$ 1,297	$ 648
Energy @ $.08/kwh	497	656	531	514	671
Fuel, Repairs, Tractor Expense @ $.20/hp hr.	1,330	1,169	1,453	922	1,999
Labor @ $6.50/hr.	2,015	2,886	1,892	1,547	2,230
Depreciation, Interest, Repairs, Insurance*	2,522	1,818	10,175	8,844	7,586
Total Cost:	$ 8,631	$ 7,665	$ 16,318	$13,124	$ 13,134
Less Value of Nutrients Saved	(2,482)	(2,482)	(3,049)	(3,374)	(3,374)
Net Annual Cost:	**$ 6,149**	**$ 5,183**	**$ 13,269**	**$ 9,750**	**$ 9,760**

*11.1 percent interest used to calculate the capital recovery charge.

Source: Garsow, J.D. 1991. A managerial perspective of the likely economic benefits and costs of environmental regulations to the Michigan dairy industry. M.S. Thesis, Michigan State University, East Lansing, Michigan.

Table 5. Net Annual Cost per Dairy Cow for Manure Management System 60 Cow Herd Size

Cost Items	Daily Haul, No Storage		8-Month Storage		
	Tie Stall	Liquid Free Stall	Solids Tie Stall	Liquid Tie Stall	Liquid Free Stall
Bedding	$ 37.78	$ 18.93	$ 37.78	$ 21.62	$ 10.80
Energy	8.28	10.93	8.85	8.57	11.18
Fuel, Repairs, Tractor Expense	22.17	19.48	24.22	15.37	33.32
Labor	33.58	48.10	31.53	25.78	37.17
Depreciation, Interest, Repairs, Insurance*	42.03	30.30	169.58	147.40	126.43
Total Cost:	$ 143.84	$ 127.74	$ 271.96	$ 218.74	$ 218.90
Less Value of Nutrients Saved	41.37	41.37	50.82	56.23	56.23
Net Annual Cost:	**$ 102.48**	**$ 86.37**	**$ 221.14**	**$ 162.51**	**$ 162.67**

*11.1 percent interest used to calculate the capital recovery charge.

Table 6. Net Annual Cost of Liquid Manure Systems by Herd Size Daily or Stored, Cows and Heifers

Cost Items	120 Cows		250 Cows	
	Daily Haul	8-Month Storage	Daily Haul	8-Month Storage
Bedding @ $40/ton	$ 2,270	$ 1,297	$ 4,730	$ 2,702
Energy @ $.08/kwh	1,046	1,284	2,079	2,614
Fuel, Repairs, Tractor Expense @ $.20/hp hr.	2,827	3,792	5,579	7,692
Labor @ $6.50/hr.	5,070	4,212	10,186	8,522
Depreciation, Interest, Repairs, Insurance*	1,657	10,472	1,656	12,344
Total Cost:	$ 12,870	$ 21,057	$ 24,230	$ 33,874
Less Value of Nutrients Saved	(4,963)	(6,748)	(10,340)	(14,058)
Net Annual Cost:	**$ 7,907**	**$ 14,309**	**$ 13,890**	**$ 19,816**

*11.1 percent interest used to calculate the capital recovery charge.

Source: Garsow, J.D. 1991. A managerial perspective of the likely economic benefits and costs of environmental regulations to the Michigan dairy industry. M.S. Thesis, Michigan State University, East Lansing, Michigan.

Table 7. Net Annual Cost per Dairy Cow for Manure Management System 120 and 250 Cow Herd Size

Cost Items	120 Cows		250 Cows	
	Daily Haul	8-Month Storage	Daily Haul	8-Month Storage
Bedding	$ 18.92	$ 10.81	$ 18.92	$ 10.81
Energy	8.72	10.70	8.32	10.46
Fuel, Repairs, Tractor Expense	23.56	31.60	22.31	30.77
Labor	42.25	35.10	40.75	34.09
Depreciation, Interest, Repairs, Insurance*	13.81	87.27	6.62	49.38
Total Cost:	$107.26	$ 175.48	$ 96.92	$ 135.51
Less Value of Nutrients Saved	41.37	56.23	41.37	56.23
Net Annual Cost:	**$ 65.89**	**$ 119.25**	**$ 55.55**	**$ 79.28**

*11.1 percent interest used to calculate the capital recovery charge.

Comparing the estimated per cow cost of the alternative manure management systems indicates that the daily haul system competes very well when not considering externalities or mandated requirements. However with the Michigan environment that includes winter weather, environmental needs and responsibilities; it may not be reasonable to consider a manure management systems with no storage capacity.

The dramatic economic impact of requiring manure management systems to have at least six to eight month storage capacity is readily apparent. The significant investment costs will increase the net annual cost that needs to be covered by each cow. Because of the economies of size, structural impacts on the dairy production industry would be expected. Smaller sized producers would be affected more adversely in an economic sense than would the larger producers. When reflecting back on the actual TELFARM dairy cost data presented in Table 1, it can be seen that a new manure management system for a 60 cow herd size might result in a 60 to 70 per cent increase in the annual ownership costs per cow for buildings and machinery. For the larger herd sizes, the annual increase in ownership costs for buildings and machinery would be closer to 45 and 30 percent for the 120 and 250 cow herd size, respectively. Using a total annual cost per cow of $2400, the estimated increase in annual cost per cow for adding 8 months storage capacity on a liquid manure system would be in the neighborhood of 6.8, 5.0, and 3.3 percent for the 60, 120, and 250 cow herd sizes, respectively.

C. Swine

The issue of manure management is critical to the long-term success and sustainability of the swine production industry in Michigan. Manure management objectives for all livestock species but especially so for swine include not only the removal of manure and utilization of its nutrients but also the controlling of odor to improve life-style conditions for the farm family and its neighbors. A survey of Michigan swine producers indicated that half of all Michigan swine farms have 1 to 3 residences within a one-quarter mile radius of their farm.[3] Because of this relatively close proximity of neighbors to swine farms, an effective manure management system is critical to the long-term well-being of Michigan swine farm businesses.

Cost data for Michigan swine producers enrolled in the MSU TELFARM information system are presented in Table 8. As with the dairy cost data discussed earlier, it is not possible to determine from Table 8 the exact cost of the manure management system. The ownership costs for manure storage and handling would be imbedded in the building and machinery cost items. Total cost of production averages in the $40 per hundredweight when corn prices are around $2.25 per bushel. Ownership and repair cost for machinery and buildings that would include the manure management system average about $5.50/cwt or 13 to 14 per cent of the total cost of production.

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[3]Hines, S., G. Schwab, K. Norgaard, and H. Person. Sept 1987. "Description of MPPA Management Practices Survey," Research Report 487, pgs. 201-206, Agricultural Experiment Station, Michigan State University.

Table 8. Cost of Swine Production in Farrow-To-Finish Swine Operations Telfarm Data, Michigan Swine Farms From 1986-1991 Dollars/100 Pounds of Hogs Produced

Cost Item	1986	1987	1988	1989	1990	1991	Avg.	% of Cost
	$ Amounts/100 Lbs. of Hogs Sold							
Nonfeed								
Labor	3.87	4.12	3.31	3.67	3.43	3.54	3.66	8.96
Machinery (RPRS. Dep. Int.)	2.34	2.71	2.40	2.52	2.55	2.50	2.50	6.14
Buildings & Improvements (RPRS. Dep. Int.)	3.30	3.47	3.17	2.76	3.36	2.32	3.06	7.51
Livestock (Vet. Mktg. Int.)	3.45	3.55	3.23	3.23	3.30	3.59	3.39	8.31
Land Charge	.47	.43	.35	.35	.43	.42	.41	1.00
Utilities	1.36	1.14	.99	.96	1.45	1.07	1.16	2.85
Other	.15	.30	.22	.21	.69	.22	.30	.73
Total	**14.94**	**15.72**	**13.67**	**13.70**	**15.21**	**13.65**	**14.48**	**32.50**
Feed								
Corn	10.58	8.30	13.18	13.74	10.83	11.46	11.35	27.81
Oats	.08	.06	.01	.03	.03	.01	.04	.09
Barley	.16	.03	.03	.07	.02	.01	.05	.13
Hay & Pasture	.20	.20	.16	.24	.20	.19	.20	.49
Comm. Feed	13.26	15.05	15.93	14.20	14.68	14.96	14.68	35.98
Total	**24.28**	**23.64**	**29.31**	**28.28**	**25.76**	**26.63**	**26.32**	**64.50**
Total Cost Per Cwt. Hogs Sold	39.22	39.36	42.98	41.98	40.97	40.28	40.80	100.0
	Feed Statistics, Estimated Averages							
Cost/Bu. Corn	1.90	1.50	2.50	2.63	2.25	2.27		
Cost Feed Bought, Cwt.	10.30	11.15	14.75	12.00	11.40	12.60		
Cost/100 Lbs. Feed Total Mixed Ration	5.52	5.31	7.27	6.86	6.44	6.62		
Feed Conversion (Lbs. Feed/Lbs. Hogs Sold)	4.41	4.45	4.03	4.12	4.00	4.02		

A study by K. Norgaard[4] determined the manure storage costs for swine farms adding two months of storage capacity. Investment cost estimates were made for alternative sized swine farms. Definitions of farm size were small farms at 1200 pigs per year and large farms at 8000 pigs per year on a farrow-to-finish system. Previous survey data had indicated that the manure storage capacity on Michigan swine farms averaged approximately four months. To get the farms to the desired six months manure storage capacity, the cost for two additional months was determined.

From the manure storage cost data presented in Tables 9 and 10, it is evident that there are significant economies of size in these two sets of comparative data. The annualized after-tax ownership cost for the manure storage system ranges from $1.28 to 2.25/cwt for the small farm and 0.225 to .56/cwt. When comparing the same storage system and comparing size differences, the annualized cost increase for the larger farms is about 20 to 25% that of the smaller farms depending on the storage system. That is, the smaller farms cost change is four to five times greater than the larger farm. As with the dairy sector, this technology is not size neutral. There is a significant cost advantage for the larger farms due to the sizable lumpiness of the investment dollars required in addition to the cost of the fixed asset investment being spread over an increased number of pigs.

Table 9. Swine Manure Storage Costs -- 2-Month Capacity -- Small Farm 1,200 Pigs Per Year -- Farrow-to-Finish

	Investment Cost	Annualized Cost[a]	$/Pig Investment Cost	$/Pig Annualized Cost[a]	$/cwt. Annualized Cost
Earth Storage Basin (ESB)	$ 26,163	$ 3,751	$ 21.91	$ 3.14	$ 1.28
ESB with 1-Foot Clay Liner	29,126	4,105	24.39	3.44	1.40
ESB with 3-Foot Clay Liner	30,278	4,243	25.36	3.55	1.45
ESB with Flexible Membrane Liner	46,759	6,213	39.16	5.20	2.12
ESB with Geotextile Liner	48,069	6,369	40.26	5.33	2.18
Concrete Tank	50,033	6,604	41.90	5.53	2.25

*Analysis factors used were:
11.4% interest rate
10-year lifetime - MACRS depreciation
28% income tax rate
8% discount rate.

Source: Norgaard, Kurt. 1991. "A Study of Livestock Manure Issue as It Relates to Michigan Swine Industry." Master of Science, Plan B paper. Agricultural Economics Dept., Michigan State University. Pg. 119.

[4]Norgaard, Kurt. 1991. "A Study of the Livestock Manure Issue as It Relates to the Michigan Swine Industry," Master of Science Plan B paper, Department of Agricultural Economics, Michigan State University.

Table 10. Swine Manure Storage Costs -- 2-Month Capacity -- Large Farm 8,000 Pigs Per Year -- Farrow-to-Finish

	Investment Cost	Annualized Cost[a]	$/Pig Investment Cost	$/Pig Annualized Cost[a]	$/cwt. Annualized Cost
Earth Storage Basin (ESB)	$ 31,560	$ 4,396	$ 3.97	$ 0.55	$ .225
ESB with 1-Foot Clay Liner	40,954	5,519	5.15	0.69	.28
ESB with 3-Foot Clay Liner	43,540	5,828	5.47	0.73	.30
ESB with Flexible Membrane Liner	82,306	10,462	10.34	1.31	.535
ESB with Geotextile Liner	86,684	10,985	10.89	1.38	.56
Concrete Tank	82,884	10,531	10.41	1.32	.54

*Analysis factors used were:
11.4% interest rate
10-year lifetime - MACRS depreciation
28% income tax rate
8% discount rate.

Source: Ibid. Pg. 121.

Some anecdotal data from a swine case farm can contribute one observation of cost data for the manure distribution system. This farm producing approximately 10,000 pigs per year on a farrow-to-finish system has over $64,000 invested in equipment to load, haul, and distribute the swine manure. Using similar analytical assumptions as before of a 10 year useful lifetime, 11.4 percent interest rate, an 8 percent discount rate, and a 28 percent income tax rate; the annual average after-tax ownership cost is approximately $0.20 per hundredweight of swine produced.

Reflecting back on the TELFARM data, the cost of production was suggested to be in the $40 per hundredweight neighborhood with about $5.50 due to ownership and repair costs for buildings and machinery associated with the swine enterprise. If the manure storage capacity is increased by two additional months, the additional annualized costs ranged from $0.22/cwt for the large farms using the barebones earthen storage basin system to $2.25/cwt for the smaller farms using a concrete tank. The wide range in costs is due to size and technology differences. When adding in the annualized cost for the manure distribution system, the manure systems costs will approach $0.75/cwt for the large farms and $2.50/cwt for the small farms.

Nutrient value of the swine manure can reduce the net cost of the manure system if these nutrients are used in a cropping program that recognizes the nutrient contribution of manure by reducing other nutrient inputs. The nutrient content of swine manure is variable as influenced by amount of water, feed, or bedding that is added. Other contributing factors to the nutrient content of manure are the ration fed, the manure storage system, and the phase or animal size from which the manure is collected.

Nutrients remaining available for cropping programs will be influenced by the manure storage and distribution system. Nitrogen loss is the most significant consideration and losses will be minimized with anaerobic storage systems and distribution systems that quickly incorporate the manure with the soil. Phosphorus and potassium nutrients in the manure are not volatilized and should be available to the plant in the year of application.

To determine a value for manure, the manure should be tested to determine its nutrient content. Adjustments ought to be made for nutrient losses that are not available to the crops. One estimate of swine manure produced per sow and pigs per year on a farrow-to-finish basis and made available to crops when knifed-in is 181 lbs of nitrogen, 162 lbs of phosphate, and 174 pounds of potash.[5] Using prices of 16, 18, and 7 cents per pound of nitrogen, phosphate, and potash respectively; the value of the manure per sow per year is approximately $70. Assuming the sow productivity at 17 pigs per sow per year or 42 cwt; the value of the manure per hundredweight of market hog produced is $1.67.

III. Summary:

Manure management systems are very capital intensive; i.e. are expensive to buy. For both dairy and swine farms, this technology investment is not size neutral in that there are economies of size that can be captured by the larger farms. Mandates for manure management systems for confined livestock farms will further encourage the structural changes in agriculture that have resulted in fewer but larger livestock farms.

The value of the manure may not be sufficiently great that manure becomes a profit center on livestock farms. However the recognition of its value in a cropping program can significantly contribute to a reduction in the net cost of a manure management system.

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[5]Sutton, A. et al. Jan 1979. "Fertilizer Value of Swine Manure," Fact Sheet 19.44.03, Pork Industry Handbook.

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