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MANAGEMENT AND THE NUTRIENT VALUE OF MANURE

As animal production has evolved from pastoral and low density housing through to large-scale total confinement operations, the problems associated with managing manure have increased. Before the advent of cheap, easily handled inorganic fertilizers, the nutrients contained in manure were valued and efforts were made to utilize these nutrients by returning them to the land. Managing manure through use of special collection equipment, storage facilities and planned times and rates of application to soils requires additional time and effort, and in many cases, additional expenditures.

When fertilizer prices were low, these costs did not appear to be worth the benefits which could be derived by the crops from the nutrients in the manure. As a result, the handling of manure on farms became a problem of “how to get rid of it”. Has the time finally arrived when proper management of manure for nutrient value is worth the time, effort and expense?

The nutrients in manures originate in animal feeds. By measuring the amount of feed intake and the product produced (e.g. milk, eggs, meat) it is possible to predict the quantities of nutrients which will be excreted by each class of livestock.

Although manure contains many elements which are required for plant growth, the three which are of principal interest are nitrogen (N), phosphorous (P) and potassium (K). Table 1 gives examples of the expected nutrient content of manures for three different classes of animals on typical feeding programs.

In general, great care is given to matching the quantity of nitrogen and possibly phosphorous in feeds to the needs of the animal and less care to potassium. As a result, the quantity of potassium in manure may vary quite markedly depending on the feed used. Generally, if a farm is using total confinement and has very little run-off from feeding and holding areas, all of the phosphorous and potassium excreted by the animals will be moved to the manure pit and remain there.

The same is not true for nitrogen. Since excreted nitrogen is rapidly converted to ammonia and ammonia is readily released to the environment, major losses of this valuable nutrient may occur and the magnitude of these losses will vary based on the farm manure management system.

The magnitude and cost of these losses can be illustrated by looking at two typical total confinement dairy operations. (Table 2) The first farm manages its manure by using a system which minimizes the loss of nitrogen (a minimum loss system). The second farm uses a similar system with one change. Instead of applying manure to the fields using injectors, it does not incorporate the manure into the soil after application.

Table 1 **NUTRIENTS INGESTED AND EXCRETED BY THREE CLASSES OF LIVESTOCK OVER A 365-DAY PERIOD PER ANIMAL PLACE**

			kg/animal year					
			Ingested		Product		Excreted	
a dairy cow (640 kg)	nitrogen	(N)	164	-	48	=	116	
(7760 kg milk)	phosphorous	(P)	23	-	10	=	13	(30 kg P_20_5)
	potassium	(K)	110	-	12	=	97	(117 K_2O)
1 feeder pig (5-91 kg)	nitrogen	(N)	16.8	-	5	=	11.8	
finished in 19 wks equal to 2.75 pigs	phosphorous	(P)	4.2	-	1.3	=	2.9	(6.6 kg P_20_5)
finished per year	potassium	(K)	4.2	-	0.7	=	3.5	(4.2 kg K_20)
100 layers (1.8 kg)	nitrogen	(N)	107	-	27	=	80	
(25,000 eggs per year)	phosphorous	(P)	26	-	3	=	23	(52 kg P_20_5)
	potassium	(K)	30	-	2	=	28	(34 K_20)

The typical minimum loss manure management system for a total confinement dairy would scrape all manure to a covered concrete storage tank daily. At the time of spreading, preferably in the spring, the manure would be completely mixed first and then applied to the land using a manure injector at a rate which will just meet the fertilizer needs of the crop to be grown.

Even for this minimum loss system, it is estimated that 10% of the 116 kg of nitrogen excreted by each cow each year is lost during collection. In addition, 10% of the collected nitrogen is lost during six months of storage and 5% of the stored nitrogen is lost during injection. As a result, on the average the manure produced annually by each 640 kg cow contains, by the time it actually reaches the field, about 89 kg N, 30 kg P_2O_5, and 117 kg K_2O.

Based on current prices and assuming that the N, P and K in manure are exactly equivalent to inorganic N, P and K, then the manure from 1 dairy cow is worth about $123 (Table 2), or for a totally confined dairy herd in which 100 cows are being milked at any one time, about $12,300/year. This assumes that full amounts of N, P and K are required for crop production in lieu of inorganic fertilizer.

If the manure handling system is altered as for the second farm, substantial changes in the value of manure will result. If the second farm spreads the manure on the land, but does not disc the manure into the soil within 48 hours, a major portion of the ammonia from the manure is lost. The manure's fertilizer value is decreased to $98/cow year.

For a typical 100 cow dairy herd, this difference amounts to a $2,500 loss each year, assuming that the farmer has to make up the difference through the purchase of inorganic N.

A second example of the impact of a single change in management on manure value is the choice of storage structure. It is estimated that storing manure over the winter in an open earthen pit or yard results in a loss of about 60% of the nitrogen, which is equivalent to a loss of about $30/animal per year.

Another simple change in manure handling which is worth considering is the change from open top to covered manure storage tanks. In this case, the covered storage will reduce the loss of ammonia by about 10% over uncovered storage, and in addition, minimize the amount of rainfall and possible yard runoff entering the tank. This unwanted water reduces the storage capacity of the tank (1 metre average rainfall Nov. to April in the Fraser Valley), and increases the volume of manure which must be transported to the field.

Table 2 VALUE OF NITROGEN, PHOSPHORUS AND POTASSIUM IN MANURE COLLECTED OVER 1 YEAR

1 Cow for Two Manure Management Systems

System 1: Minimum loss systems: (daily scrape, covered concrete storage, manure injected in the spring)

	kg into soil		$/kg		
N	89	x	0.69	=	$ 61.41
P_2O_5	30	x	0.64	=	19.20
K_2O	117	x	0.37	=	43.29
					$123.90

System 2: As in minimum loss system but replacing manure injection with vacuum tanker application, no incorporation.

	kg into soil		$/kg		
N	52	x	0.69	=	$ 35.88
P_2O_5	30	x	0.64	=	19.20
K_2O	117	x	0.37	=	42.29
					$ 98.37

The dairy farm is used here purely as an example. Similar effects of manure management alternatives on nutrient content and subsequent value of manures can be determined for each class of livestock. For basic minimum loss systems, calculations indicate that the manure collected over one year from a 10,000 hen egg laying operation. after allowing for minimum normal losses, is worth about $7,900 and the nutrients in the manure available from the finishing (5-91 kg) of 2,000 hogs is worth about $7,800.

The second major area to be considered in managing manures is the time of year and rate of application to land to maximize the recovery of the nutrients in the manure by plants. In order to determine the most suitable application rate, not only is it necessary to know the nutrient content of the manure, it is also important to take into consideration a great many complicating factors such as: local climatic conditions, time of year of application, type of crop, effect of water and nutrients on crop growth, rate of mineralization of manure nitrogen and soil nitrogen, availability and movement of the nutrients in the soil as related to the changing root distribution and crop needs, rate of movement of water and nitrogen through the soil and water holding capacity of the soil.
The Department of Bio-Resource Engineering at UBC, in co-operation with the BC Ministry of Agriculture and Food, has been studying this problem over the past few years. Special models have been developed which can provide assistance to farmers in trying to evaluate the best manure application rates and management systems for their specific farms and their specific growing conditions.

Based on these studies, guidelines for manure application rates for BC dairy farmers have been prepared and are available for distribution. Additional information can be obtained from the Department of Bio-Resource Engineering, UBC or the BC Ministry of Agriculture and Food, Resource Management Branch.

Based on the results of the studies, and as is illustrated here, manure is now worth time and effort. Farmers planning new facilities or expanding or modifying old ones should give careful consideration to the economic advantage which can be gained from different manure management systems.

FOR FURTHER INFORMATION CONTACT
Phone: 604.556.3001
Toll Free: 1.888.221.7141

MINISTRY OF AGRICULTURE
1767 Angus Campbell Road
Abbotsford, B.C. V3G 2M3