Manure Management Facts

Budgeting for Phosphorus – How Efficient is Your Farm?

Introduction

In recent years, concerns about surface water quality have brought increased attention to the use of phosphorus (P) in our daily lives. In agriculture, P is a necessary and costly component of livestock and crop production. However, it can also be a surface water contaminant and must be carefully managed.

Improved P management can provide several economic benefits for producers. Feed costs can be reduced without compromising livestock production by: minimizing wastage, formulating diets more closely to the animals' requirements and maximizing nutrient use by the animals. Manure application costs can be reduced by decreasing manure P concentrations and crop production costs can be reduced by decreasing the need to buy commercial P fertilizer.

Some producers may be unaware of the opportunities to improve P management on their farms. A whole farm P budget can identify areas where these improvements and economic gains can be made.

What is a whole farm P budget?

A whole farm P budget accounts for all of the P that comes into and goes out of an operation. If the budget reveals that more P is being imported than exported, then there is a surplus of P that will accumulate in fields receiving manure.

To complete a whole farm P budget, detailed production information is required to calculate the amount of P that is imported, retained and exported from the farm. The total amount of P retained and exported is subtracted from the total amount of P imported:

Imported P	–	Retained P	–	Exported P	=	Result
P imported in: feed and minerals bedding fertilizer manure (from a different operation)	–	P retained in: Livestock through weight gain	–	P exported as: livestock products (such as meat, milk, eggs, live animals) mortalities crop products manure sold or given away	=	**Result**

Manitoba

A positive result indicates a P surplus (more P imported than retained and exported), while a negative result indicates a P deficit for the farm. The ideal outcome is for the farm to be in balance.

What can you do if there is a P surplus on your farm?

If there is a P surplus on your farm, measures can be taken to bring the farm into balance. Some are relatively straightforward and inexpensive, while others are more complex and very costly. The solutions will depend on the individual circumstances of each operation. The following steps should be considered, in order, until balance is achieved.

1. Improve feed efficiency – Feed efficiency is the amount of feed used per unit of livestock product and it is the single most important factor that determines feed cost per animal. Improving feed efficiency is the first step in reducing a P surplus on your farm and can be achieved through:

- Minimizing wastage – Significant amounts of nutrients may end up in the manure simply because they were not consumed. Poor feeder design, improperly adjusted feeders and the form of feed can all contribute to feed wastage.
- Improving feed digestibility – Optimizing particle size, pelleting feed, using ingredients with highly digestible nutrients and using enzymes such as phytase (in pig and poultry operations) can all improve feed efficiency. Improving digestibility, however, only reduces nutrient excretion if total dietary nutrient intake is reduced.

- Improving animal productivity – Better herd health status will improve feed efficiency, reduce nutrient excretion and maximize the amount of P exported from the farm in meat, milk or eggs.

2. Optimize P content of the feed – Any surplus P in the feed ends up in the manure. This not only increases feed costs for the producer but also increases the land base required for manure application. The P content of the feed can be optimized by:

- Matching P requirements for maintenance and growth – Over-feeding P relative to the animals' requirements will increase P excretion.
- Formulating rations based on available P – Matching available P levels in the feed to the requirements of the animals.
- Adopting phase feeding where appropriate – Phase feeding adjusts rations to the nutrient requirements of the animals in a stepwise fashion as the animals grow. This strategy minimizes the excesses caused by feeding one ration through all growth stages.
- Adopting split-sex feeding where appropriate – Feeding males and females separately can also decrease nutrient excretion.

3. Reduce fertilizer P imports – Soil testing and realistic crop yield targets should be used to determine manure application rates. Commercial P fertilizer should only be used where crop P requirements cannot be met with manure nutrients.

4. Adopt cropping practices that maximize P removal – Export of P in crop products (i.e. the harvested portion of the crop that is exported off the field) may be increased by designing a crop rotation that maximizes P removal. Crops with higher P removal rates may be added to the rotation or grown more frequently (Table 1).

Table 1. Estimated crop removal rates for phosphorus as P_2O_5[1]

Crop		P_2O_5 removed per unit of crop[2]	Example Manitoba Target Yields	P_2O_5 removed from a field (lb/ac)[3]
Alfalfa		13.8 lb/ton	5 tons/ac	69
Corn	Silage	12.7 lb/ton	5 tons/ac	64
	Grain	0.44 lb/bu	100 bu/ac	44
Barley	Silage	11.8 lb/ton	4.5 tons/ac	53
	Grain	0.42 lb/bu	80 bu/ac	34
Winter wheat		0.51 lb/bu	75 bu/ac	38
Potatoes		0.09 lb/cwt	400 cwt	36
Canola		1.04 lb/bu	35 bu/ac	36
Peas		0.7 lb/bu	50 bu/ac	35
Grass hay		10.0 lb/ton	3 tons/ac	30
Soybeans		0.84 lb/bu	35 bu/ac	29
Oats		0.26 lb/bu	100 bu/ac	26
Edible beans		0.014 lb/lb	1,800 lb/ac	25
Rye		0.45 lb/bu	55 bu/ac	25
Spring wheat		0.59 lb/bu	40 bu/ac	24
Sunflower		0.32 lb/bu	50 bu/ac	16
Flax		0.65 lb/bu	24 bu/ac	16

[1] Adapted from Nutrient Uptake and Removal by Field Crops, Western Canada, 2001. Compiled by the Canadian Fertilizer Institute.

[2] Phosphorus (P) contents of crops and crop residue vary based on environmental conditions, field history and nutrient supply of the soil. Mean values are suitable for general use but for more accurate farm specific values, producers should consider using tissue test analysis. Phosphorus (P) x 2.28 = P_2O_5.

[3] Phosphorus (expressed as the fertilizer equivalent P_2O_5) removed in the harvested portion of the crop with example yield achieved.

5. Expand the land base for manure application – Accessing new land for manure application will increase crop P export and provide greater flexibility for manure application. A larger land base will allow rotation of fields in order to manage soil nutrient build-up. Crops grown on fields with low P need additional P to reach target yields and are ideal candidates for manure. Crops grown on fields with sufficient to high P will often not respond to additional P. These latter fields may also pose an increased risk to surface water as soil P levels become excessive.

More land can be obtained for manure application through purchase, rent, lease or agreements with neighbours.

6. Manure Treatment – If the land base can not be expanded within an economical hauling distance to achieve P balance on the farm, manure treatment may be required to export the surplus P from the farm. However, manure treatment systems often have extremely high capital and operational costs and require a high level of management. Two of the least costly systems are solid-liquid separation for liquid manure and composting for solid manure.

- Solid-Liquid Separation – Many livestock producers manage their manure as a liquid. Because liquid manure is mostly water, it is very expensive to haul long distances. Since most of the P is excreted in the solid portion of the manure, solid-liquid separation systems can be used to remove the high P solids so that they can be managed separately. The most effective way to remove P from liquid manure is to run the manure through the separator as soon as possible after excretion. This means that the separator must be piped into the manure handling system from the barn before it reaches the manure storage. Since the separator must be operated throughout the year it must be placed in a heated building to withstand Manitoba's winter conditions. The piping and building raise the capital cost of the technology well above the initial cost of the separation equipment. The ongoing management of the equipment means additional operational costs.

- Composting Solid Manure – Solid manure also contains a significant amount of water and low concentration of nutrients, making it expensive to haul relative to commercial fertilizer. For some operations, composting may help reduce hauling costs. Composting breaks down plant and animal materials using microorganisms. For successful composting, there must be enough water and air to allow the microbes to decompose the material and the compost should reach 55°C (131 °F) to kill pathogens. Although composting does not reduce the P content of the manure, it reduces the volume to be hauled. This decreases transportation costs and provides greater flexibility for manure application by making it more economical to reach fields that are further away and lower in P. However, there are increased costs with actively managing the compost pile.

Phosphorus is an essential and expensive nutrient in livestock and crop production. It must be properly managed in order to maximize its efficient use and minimize risk to surface water. Producers benefit directly from improved P management by reducing feed, fertilizer and manure application costs.

Whole farm P budgeting can be used to identify if there is a P surplus on your farm. Where a surplus exists, there are a number of strategies that can bring the farm into P balance.

For More Information

- Your local Manitoba Agriculture, Food and Rural Initiatives Growing Opportunities (GO) Centre or Office.
- Manitoba Agriculture, Food and Rural Initiatives website: **manitoba.ca/agriculture**