Manure Management Facts

Prioritization and Rotation of Fields for Manure Application

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Introduction

Farmers apply synthetic fertilizer and manure to their land to replace the nutrients removed in harvested crops so that their soils remain productive over the long term. Nutrient applications should strive to follow the principles of 4R Nutrient Stewardship developed for synthetic fertilizer: right source at the right rate, right time and right place. Manure, however, is more challenging to manage than synthetic fertilizer as nutrient concentrations and availabilities are difficult to predict and the balance of nutrients in manure does not match all of a crop's nutrient requirements or removals.

Manure contains many nutrients, but is applied most efficiently and economically to meet the nitrogen (N) requirements of the crop. In meeting the crop's N requirements, phosphorus (P) is simultaneously applied at rates that, in many cases, are greater than the P needs of that crop. In fact, an N-based application of manure can supply P for several years of crop production. This can restore P fertility in cropping systems that are prone to depleting soil P (ex: organic crop production and rotations with high P export). However, if manure P is applied annually in excess of crop removal, the extra P results in a buildup of soil P. As soil test P (STP) increases, the risk of P entering surface water in runoff also increases. This is of environmental concern because P is the nutrient that is primarily responsible for the accelerated eutrophication of surface water bodies, such as Lake Winnipeg, and resulting algae blooms. To limit nutrient loss to surface water, manure application must be in accordance with regulated STP thresholds, buffer strips and setbacks.

In Manitoba, for fields that test 60 ppm Olsen P or higher, the restrictions on manure application rates shift from being N-based to also including P. To minimize restrictions and maintain flexibility, it is recommended that fields be kept below 60 ppm Olsen P wherever possible. One of the most practical ways to keep below this threshold is to apply manure to an individual field less frequently than every year. However, selecting which fields should receive manure in a given year is a complex process. There are many factors that livestock producers and manure management planners must consider when determining the most appropriate field for manure application. All of the factors that may influence field selection are discussed below, but not all factors will apply to all situations. They will vary from operation to operation, field to field and season to season.

Manitoba

Factors that Influence the Prioritization and Rotation of Fields for Manure Application

Manure Storage Capacity

The capacity of the manure storage structure determines how frequently the storage must be emptied. The greater the manure storage capacity, the greater the flexibility in timing manure applications around crop production and weather conditions. By regulation, all new and expanding earthen manure storage structures must be built to contain at least 400 days worth of manure, whereas steel and concrete storage structures must be built to contain at least 250 days worth. Whenever affordable, a minimum of 400 days manure storage capacity is recommended.

Distance from the Source of Manure

Manure transportation is expensive, particularly for liquid manure, which is almost all water. The distance manure must be transported will affect which fields are prioritized for manure application.

Fields that are within a couple of miles of the barn tend be a high priority for manure. For established operations, these fields often have higher STP levels than fields that are further away. Field rotation is recommended before any field reaches 60 ppm Olsen P. This may require transporting manure significant distances to fields that are further away and lower in STP. It may be most economical to transport solid manure or thicker, nutrient-rich, liquid manure (such as the manure in the primary cell of a multi-celled liquid manure storage structure, or manure that has settled to the bottom of a storage cell) to these fields.

Land Availability/Ownership

Land owned or under control of the operation will be prioritized for manure application because manure is a valuable source of nutrients and its use will reduce the operation's fertilizer bill. If more

nutrients are available in the livestock manure than are needed on their farms, farmers should consider acquiring additional lands through manure spreading agreements with neighbouring crop producers. Producers willing to pay for the manure are a higher priority for receiving manure.

Field Availability/Season of Application

Field availability is affected by planting dates, road restrictions, harvest dates, soil texture, soil moisture and weather. Soil moisture content is one of the most important factors in determining the availability of a field for manure application. Wet soils present a higher risk of compaction from field equipment than drier soils.

In a typical year, soils tend to be very wet in the spring following snowmelt, leaving a very limited window of opportunity for spring application of manure before seeding. This is particularly true for the heavy clay soils of the Red River Valley. Spring application on these soils is rare due to the risk of yield losses associated with delayed seeding, seed bed disturbance and spring soil compaction. In a good year, at best, there may be two to three weeks before seeding when manure can be applied to coarser textured soils, although road restrictions in the spring may limit when heavy equipment is permitted. In a wet year, there is little or no opportunity for spring application prior to seeding regardless of soil type.

Generally, all soils tend to be drier in the fall when there is a much larger window of opportunity for manure application following harvest. Very early season crops like winter wheat may be harvested as early as mid-August, providing a 12-week window of opportunity prior to the November 10 deadline for manure application. For this reason, most manure application in Manitoba occurs during the fall. In a year when the fall is wet, any compaction that does occur due to fall manure application is abated by freeze thaw cycles over the winter and spring.

In Manitoba, well-timed in-season applications are preferred for perennial forages, including pasture, as these crops can tolerate heavy equipment and respond well to in-season nutrient applications.

Equipment Logistics

Equipment availability will influence field selection for manure application. Harvest and other operations must be co-ordinated with the availability of tractors or rental equipment, further limiting which fields are available for manure application. Commercial manure applicators must also co-ordinate manure application with numerous producers. Downtime for equipment cleaning and biosecurity protocols puts additional pressure on when manure can be applied.

Soil Nutrient Status

Soil testing is recommended for all agricultural fields to determine nutrient status and additional nutrients needed to optimize yields. Most soils in Manitoba are naturally deficient in both N and P. Crops require considerable additions of these nutrients to achieve optimum yields over the long-term and to replace nutrients that are exported.

Residual soil nitrate-N is used to determine the amount of N in the soil that will be available to the crop and the amount of additional N to be applied. Soils with low residual nitrate-N where high N demand crops will be grown should be a high priority for manure.

Testing for Olsen P is recommended to determine the P status of the soil and additional P fertilizer requirements. Soils that would benefit from building soil fertility—such as low STP soils—should be a high priority for manure and may be the best choice for P rich manures. Unfortunately, as STP increases, the risk of nutrient loss in runoff also increases. As well, crops grown on soils with high soil fertility are less likely to experience a yield benefit from nutrient applications beyond starter requirements. Therefore, fields with high STP levels should be rotated before they reach 60 ppm Olsen P when their use will be restricted by regulation. Alternatively, annual P applications to these fields could be reduced with lower manure application rates or by applying manures with lower P content, such as manure from the secondary cell of a multi-celled manure storage facility.

Crop Type and Rotation

The amount of N and P required and removed by crops varies with crop species and yield. For example, oats are a relatively low user of nutrients. A 100 bu/acre oat crop only removes about 62 lbs of N and 26 lbs P_2O_5/acre. Grain corn, on the other hand, is a high nutrient user. About 97 lbs N and 44 lbs P_2O_5/acre can be removed from the field in a 100 bu/acre grain corn crop. High yielding alfalfa is the greatest nutrient user. A five ton/acre alfalfa crop harvested for hay or silage can remove up to 300 lbs N and 70 lbs P_2O_5/acre.

Crop choices are rarely (if ever) determined by nutrient removal capability. Instead, crop choices are determined by markets, crop rotation, livestock needs (for operations that grow their own feed), soil limitations, weather, seeding dates and equipment availability. High nutrient using crops are excellent recipients for manure and may be the best choice for nutrient rich manures such as the thick manure in the primary cell of a multi-celled liquid manure storage structure. As well, they can be included in the rotation without fertilization with manure to draw down soil nutrients where levels are excessively high.

Soil Capability

Crop yields and nutrient removal capabilities are limited by a soil's inherent agricultural capability, even under ideal weather conditions and good management. Highly productive soils with excellent yield potentials are preferred for manure application. If a less productive soil is used, the yield potential and crop nutrient removal capability will be lower and more land will be required for sustainable manure application and field rotation.

To determine nutrient removal capability, detailed fertilization and yield records are recommended.

Risk of Nitrate Leaching and Groundwater Contamination on Coarse Textured Soils

Coarse textured soils (ex: sandy or gravelly) under annual crop production present a higher risk of nitrate leaching and groundwater contamination, particularly in areas where the water table is high. There is much less risk of nitrate leaching from these soils, however, when they are under perennial forage production. Therefore, manure application to coarse textured soils under annual crop production should be limited to spring and post-emergence, if these timings are possible. Where fall application to annual crops on coarse textured soils is necessary, late fall application when temperatures are much cooler is preferred over earlier fall application to minimize the conversion of the manure N to water soluble nitrate.

Risk of Flooding, Inundation, Runoff, Water Erosion and Surface Water Contamination

In Manitoba, the freezing of soils results in little or no movement of fall-applied nutrients during winter, which is significantly different from most other regions of North America. Most of the nutrients that are lost to surface water in Manitoba are transported in runoff during the spring when large amounts of snow rapidly melt over frozen soil. Runoff losses tend to be greatest from soils with slow water infiltration rates (ex: clayey soils). Therefore, fields that experience infrequent flooding in spring should be the first priority for manure application.

Since most fields in Manitoba experience some amount of flooding or runoff in the spring, injecting or incorporating fall-applied manure within 48 hours is recommended for all tilled lands and is required by regulation on floodplains and in the Red River Valley Special Management Area. Since injection or incorporation is not practised on no-till or perennial forages, early fall, spring or in-season application is preferred on these lands. This will provide greater opportunity for the manure nutrients to enter the soil or be used by the crop and reduce the risk of nutrient loss to surface water during spring thaw.

Slope also plays a significant role in accelerating runoff and causing soil erosion. Therefore, manure application should be avoided on areas with moderate to strong slopes, particularly where infiltration rates are slow.

Risk of Surface Water Contamination from Agricultural Tile Drainage

Tile drainage is becoming increasingly popular in Manitoba. While there has been little research on the impact of manure application to lands that have been tile drained in Manitoba, research from Ontario suggests that these soils should be tilled prior to manure application to destroy any vertical channels from the soil surface that might allow manure to flow directly to the tile drains.

Conclusion

Manure is an excellent source of nutrients for crop production; however, annual manure applications at N-based rates have often resulted in elevated soil test P and increased risk of phosphorus loss to surface water. One way to reduce the risk of manure P entering surface water is by limiting soil test P build-up through field rotation and increasing the intervals between manure applications.

Farmers, agronomists and manure management planners must consider many factors when prioritizing fields for manure application or rotation. Not all of the factors that influence field selection will apply to all situations. They will vary for each region, operation, field and season.

For More Information

- MAFRD Growing Opportunities (GO) Centre or Office
- **www.manitoba.ca/agriculture**