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Evaluation of Dairy Manure as Fertilizer: Manure N and P supplies for crop production

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The amount of fresh manure, excluding bedding and added water, produced from dairy operations in Ohio is approximately 51 million lb/day, making dairy farms the largest manure producers among livestock operations in Ohio. Dairy cows fed typical North American diets excrete manure that contains nutrients valuable for crops, including nitrogen (**N**), phosphorus (**P**), potassium (**K**), and many micronutrients (N and P will be emphasized in this publication). Approximate nutrient excretion rates from dairy animals are in Table 1. After manure is produced by cows, it is often stored for weeks or months until applied to the field as fertilizer. Based on concentrations of nutrients needed for crops, fresh manure is a good fertilizer. For example, N, P, and K requirements for corn (140 bu/acre) are 160, 22, and 50 lb/acre, respectively [if soil P and K levels are 30 to 60 and 250 to 310 lb/acre, respectively, which are the maintenance levels recommended by Tri-State Fertilizer Recommendations (1995)]. Fresh manure (24,000 lb/acre) from lactating dairy cows can provide 160, 24, and 74 lb/acre of N, P, and K, indicating that the ratio of nutrients required for crops is fairly balanced with the ratio of nutrients in fresh manure. However, nutrient composition of manure changes considerably during storage. Those changes cause an imbalance of nutrients relative to crop needs, which may affect yields and increases the risk of environmental problems when the manure is improperly applied to the field.

Nutrient concentration change is mostly caused by N losses during manure storage. Lactating dairy cows excrete approximately 70% of intake N in feces (35%) and urine (35%). Most N excreted in feces is organic (undigested feed N and microbial N), while N excreted in urine is inorganic (urea accounts for up to 70% of total N in urine). Once urine and feces are excreted and mixed on barn floors (i.e., fresh manure), inorganic N originating from urinary N immediately begins conversion to ammonia due to enzymes in feces. Then, the ammonia in manure starts to volatilize. Although the amount of ammonia emitted from manure differs depending on many factors, such as season (i.e., temperature), manure type (liquid, solid), bedding, and manure storage type, up to 80% of the N can be lost from fresh manure (e.g., liquid manure stored in lagoons for months) through ammonia volatilization by the time the manure is applied to the field. The resulting imbalance of nutrients in manure can possibly affect not only crop yields but also the environment. For example, if manure application is P-based, N provided to crops is less than the crop's requirement, which may affect the respective yields. If manure application is N-based, excessive P will be applied to the field, which may risk water pollution through P runoff (e.g., eutrophication, harmful algae blooms). Shortly before field application, manure needs to be sampled and analyzed in order to apply appropriate amounts of nutrients to the field. Usually added commercial N fertilizer is required

Table 1. Nutrient excretion from fresh manure on dairy farms (OSU Extension, 2006)

	Daily excretion, lb/day		
Animal (size)	N	P_2O_5 (P)	K_2O (K)
Calf (150 lb)	0.05	0.01 (0.004)	0.04 (0.033)
Heifer (750 lb)	0.23	0.07 (0.031)	0.22 (0.183)
Dry cow (1,400 lb)	0.50	0.17 (0.074)	0.40 (0.332)
Lactating cow (1,400 lb)	1.00	0.34 (0.148)	0.56 (0.465)

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to balance nutrient composition of dairy manure for crops. The less N that is lost from manure during handling and storage on the farm, the less commercial N fertilizer that will be needed which can represent significant cost savings.

Several strategies can improve the quality of manure as fertilizer. Feeding diets with excess P (diets with about 0.35% P meets the requirement for most lactating cows) increases the P concentration in manure which will increase the N imbalance. Since the model was published (NRC, 2001), further long-term studies demonstrated that 0.28 to 0.30% P in dietary DM is adequate without negative effects on performance and health of dairy cows. However, even when dietary P is fed at the requirement, manure still has an excess of P relative to N and commercial N fertilizer is usually still needed.

Covering lagoons where liquid manure is stored with impermeable or permeable materials can significantly lower ammonia volatilization from manure. Covering with impermeable materials, such as concrete, steel, or plastics, are more effective at lowering ammonia emissions than covering with permeable materials, such as straw and wood chips. Manure from covered lagoons is expected to have a N concentration 3 to 4 times greater at the time of field application than manure from lagoons without a covering. Therefore, N and P concentrations in manure stored under cover are much more balanced and the amount of inorganic N (i.e., ammonium), which is more easily utilized by crops, increases. Nevertheless, covering lagoons requires additional costs to build and for maintenance.

Crop rotations can encourage greater crop yields, better pest management, and weed control, and they can reduce the N required from fertilizer because of the ability of legumes to fix N. For example, corn following soybeans is a common cropping rotation, and N from fertilizer needed for corn yields (140 bu/acre) after soybeans is about 130 lb N/acre compared with 160 lb/acre of N for continuous corn. In addition, greater corn yields are expected from rotational cropping in spite of less N required from fertilizer. Therefore, crop rotations compared with continuous cropping require a lower N:P from manure. Although crop rotations will lower the amount of N required, application of dairy manure will need to be supplemented with commercial N fertilizer.

Bottom Line: Although nutrient composition of fresh dairy manure is closely balanced with that required for crops, considerable N losses through ammonia volatilization during storage causes an imbalance in manure nutrients (relatively less N and high amounts of other nutrients, especially P). Therefore, producers should determine nutrient composition in manure at the time of field application and base application rates on those values. Usually manure should be used to meet the P needs of the crop and then additional N fertilizer can be applied as necessary.

References

NRC. 2001. Nutrient Requirements of Dairy Cattle. 7th rev. ed. Natl. Acad. Sci., Washington, DC.

MSU Extension. 1995. Tri-State Fertilizer Recommendations for Corn, Soybeans, Wheat, and Alfalfa. Bulletin E-2567. Michigan State University. East Lansing, MI.

OSU Extension. 2006. Ohio Livestock Manure Management Guide. Bulletin 604. Ohio State University Extension, Columbus. OH.

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