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How much can diet modification do to reduce manure phosphorus surpluses?

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INTRODUCTION

In areas with intensive animal production, more phosphorus (P) is often produced in manure than local crops require and there is now a surplus of manure P in many US counties. These manure surpluses are commonly applied to land which can lead to increases in soil test P and P losses to surface waters leading to decreased water quality. One strategy to address excess manure-P is to reduce the P concentration of animal diets and hence manures generated. Feeding to animal P requirements, increased use of phase feedings, more accurate prediction of P availability in feeds, feed additives such as phytase and novel feed ingredients, are all strategies that can reduce the P concentration in feed ingredients.

While work remains to be done on diet modification to maximize reductions in manure P while maintaining animal performance, sufficient literature now exits to show the approximate scale of P reductions that can be achieved. There is now a need to understand how these reductions in manure P can address surpluses of manure P in areas of intensive animal production, and how this varies regionally. Therefore, our objectives were to look at existing surpluses of manure P and compare these to surpluses that would exist if diet modification to reduce P were fully implemented. This will give a guide to how much of the problems associated with P surpluses can be remediated through diet modification and identify areas where additional approaches are needed.

METHODS

The crop production and animal inventory were obtained from the 2002 Census of Agriculture (USDA-NASS, 2006). We used the animal categories reported by the USDA and manure P production numbers from Kellogg et al. (2000). Manure P balances were calculated as follows:

Manure P production (kg) = animal inventory × manure P produced per animal (kg) [1]

Assimilative capacity = (crop production (bu) × concentration of P (kg bu^{-1})) + (area of pasture × assimilative capacity above) [2]

Net manure P = manure P production - assimilative capacity of land for P [3]

Mass balance (kg ha^{-1}) = net manure P (kg) / cumulative harvested area (ha) [4]

CAST (2002) reported possible manure P reductions of 40% for poultry, 50% for swine and 25% for dairy cows. These data were fed into equations [3] and [4] for manure surpluses from modified diets.

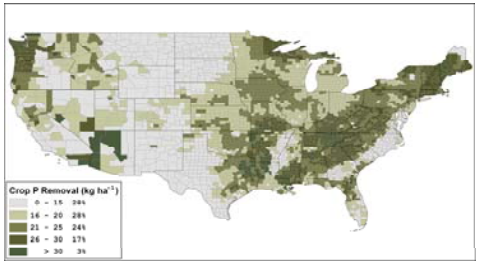

Figure 1. Phosphorus, in units of kg ha^{-1}, removed in harvested portion of crop, averaged across the census years 1987, 1992, 1997 and 2002..

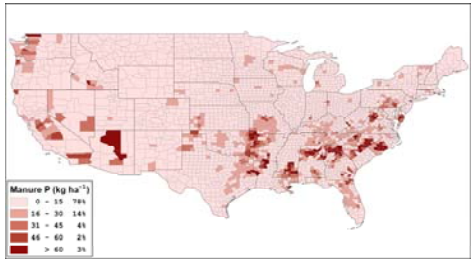

Figure 2. Cumulative excreted livestock-manure P (2002). Presented as kg P per hectare of crop harvested area, averaged across the census years 1987, 1992, 1997 and 2002.

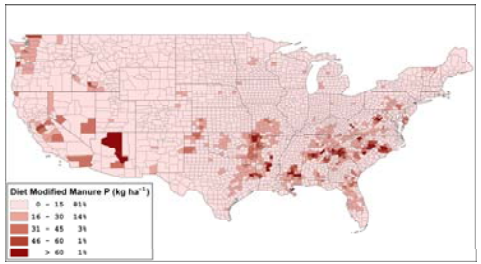

Figure 3. Cumulative excreted manure P from livestock with modified diets (2002). Presented as kg P per hectare of crop harvested area, averaged across the census years 1987, 1992, 1997 and 2002.

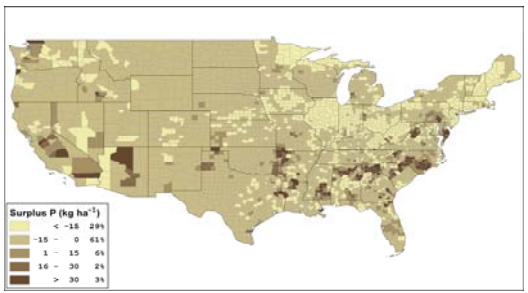

Figure 4. Manure P surplus or deficit relative to crop P removal.

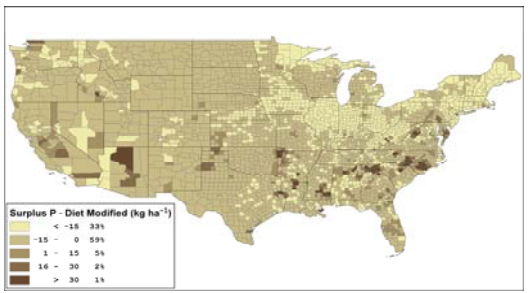

Figure 5. Diet modified manure P surplus or deficit relative to crop P removal.

SUMMARY

1) Manure P production and crop P requirements are extremely spatially variable across the US.
2) Surpluses of P are most common in the West and Southeast, while deficits are most common in the Midwest.
3) Surpluses of P at the county scale currently exist in approximately 10% of US counties. However, even in counties with no surplus of manure P, localized surpluses may exist that would benefit from diet modification.
4) Diet modification to reduce P surpluses will help in many areas, but additional strategies will be needed in at least 8% of US counties.
5) Other strategies to deal with manure P surpluses in the long term include manure transport and alternate uses for manure, such as value added products or combustion. Redistribution of animal production to more closely match crop production is another possibility, but has large economic hurdles.

REFERENCES

CAST (Council for Agricultural Science and Technology). 2002. Animal diet modification to decrease the potential for nitrogen and phosphorus pollution. Issue paper no. 21.

USDA-NASS. 2006. United States Department of Agriculture - National Agricultural Statistics Service. http://www.nass.usda.gov/Census_of_Agriculture/index.asp.