Dairy production systems in the United States: Nutrient budgets and environmental impacts.

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INTRODUCTION

To illustrate nutrient management challenges and opportunities across the US dairy industry, the USDA Agricultural Research Service Dairy Agroecosystems Working Group (DAWG) investigated eight confinement and two grazing operations in the seven largest U.S. dairy producing states (Figure 1) using the Integrated Farm System Model (IFSM).

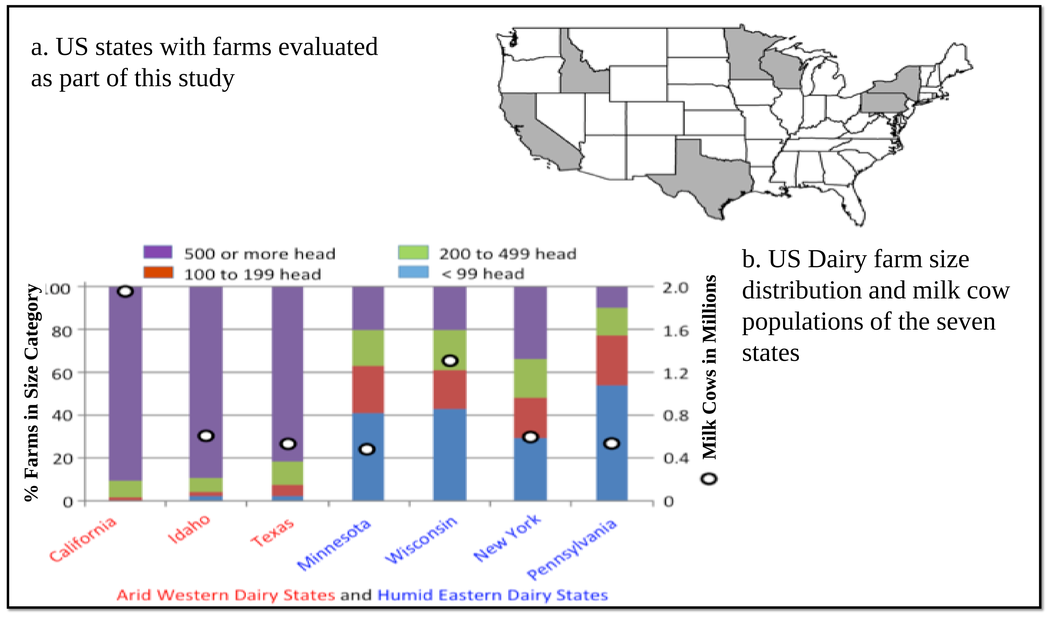

Figure 1. Dairy herd sizes and milk cow populations for the seven major US dairy states.

METHODS

The IFSM tracked nutrient flows across the farm, from housing facilities, through manure storage, to the field on an annual basis (Rotz, 2017). Whole-farm mass balances of N and P are determined at the farm gate for major pools and pathways of farm import and export, including imports in feed, fertilizer, atmospheric deposition, and legume fixation and exports in milk, excess feed, animals, manure, and environmental losses (Figure 2).

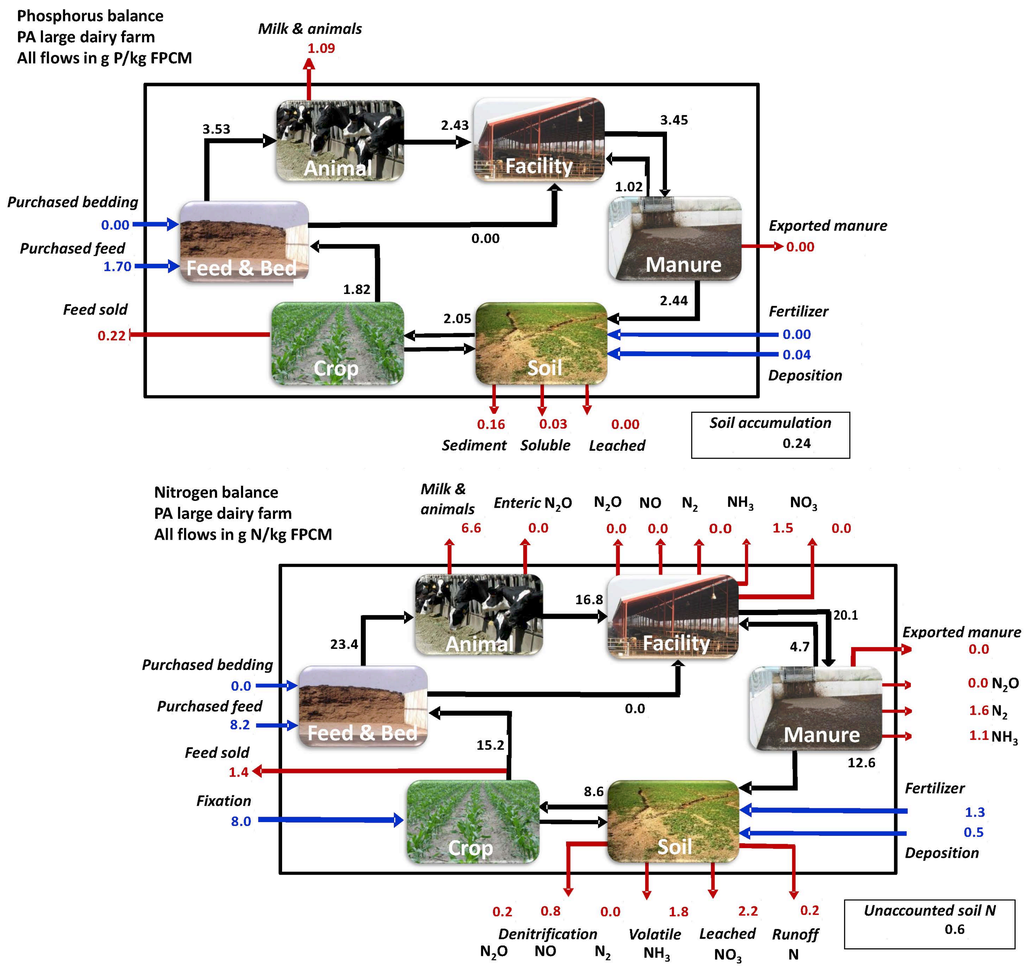

Figure 2. IFSM output: nitrogen and phosphorus as g per kg of fat and protein corrected milk on a Pennsylvania, USA confinement dairy farm.

RESULTS AND DISCUSSION

The greatest opportunities to prevent on-farm accumulation of P in excess of crop requirement were associated with the export of dry manures from the large, open lot dairy systems of CA, ID, TX. In comparison, the liquid manure management systems of confinement dairies in the more humid areas of the U.S. (MN, PA, central TX, WI) restricts manure export, resulting in greater accumulation of P in farm soils (Figure 3).

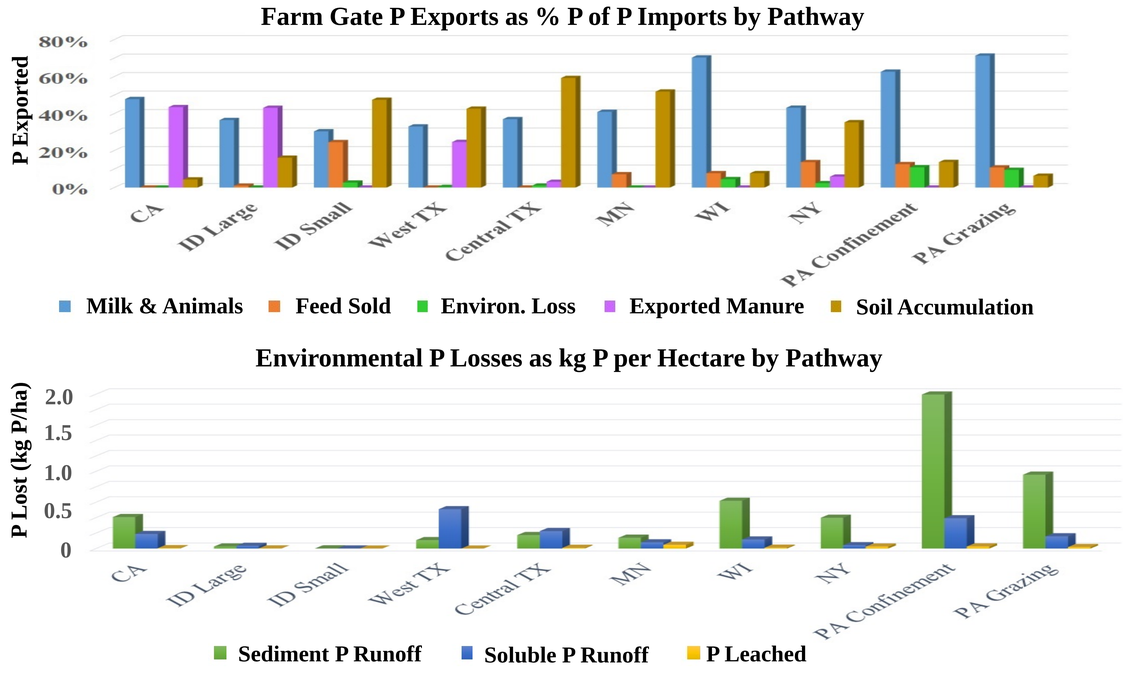

Figure 3. Farm gate P exports and environmental losses in the seven largest dairy producing states.

Environmental N losses were equivalent to 50 to 75% of N imported annually onto the farms, the majority of which was by ammonia volatilization, especially in western dairies in warmer climates. Nitrate leaching combined with denitrification loss pathways account for >50% of environmental losses from the eastern dairies (Figure 4).

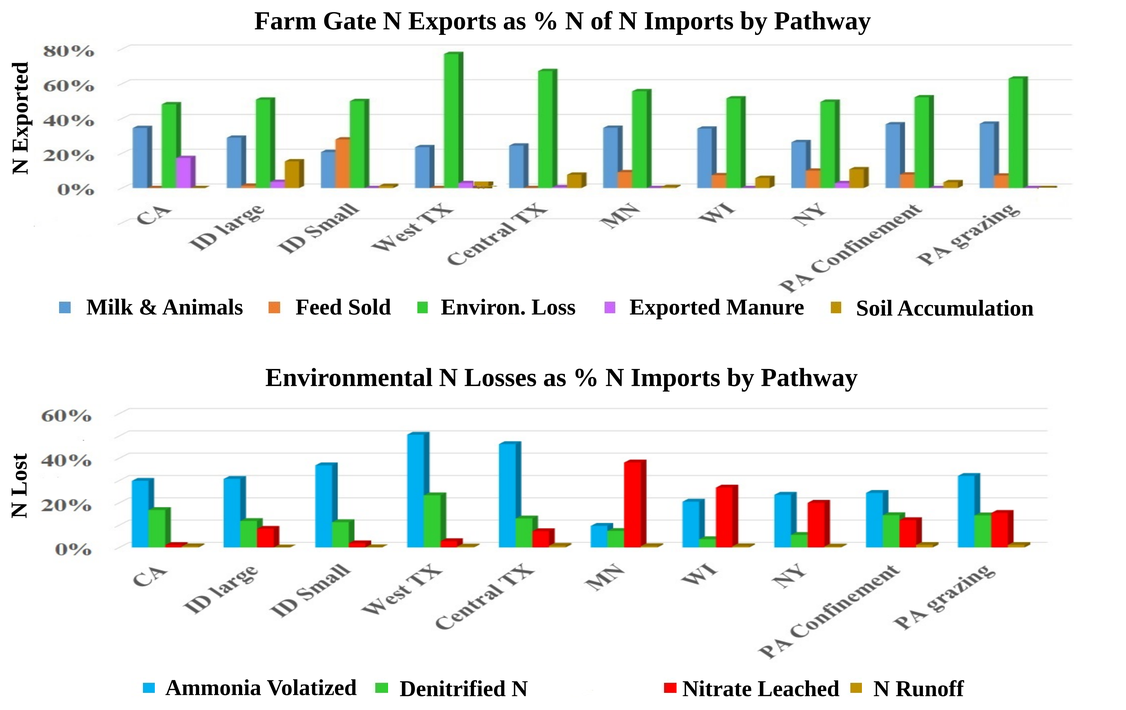

Figure 4. Farm gate N exports and environmental losses in the seven largest dairy producing states.

CONCLUSIONS

Depending on regional climate conditions and management system characteristics, nutrient losses may be mitigated by changes in feeding strategies, manure management technologies, or targeted soil and water conservation practices.

REFERENCES

Rotz, C.A. 2017. Integrated Farm System Model, v.4.3. https://www.ars.usda.gov/northeast-area/up-pa/pswmru/docs/integrated-farm-system-model/ (6 Mar. 2017). USDA ARS, University Park, PA.