Comparing Plant Essential Macronutrient Concentrations of Various Manure Sources from California Dairies

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BACKGROUND California dairy manure undergoes annual plant nutrient sampling and reporting.

Various dairy manure sources are composed of essential plant nutrients. California dairy farmers are required to sample all manure sources to comply with the Central Valley Dairy General Order for Existing Milk Cow Dairies[1]. Nutrient composition of solid and liquid manure samples are reported in annual reports: nitrogen (N), phosphorus (P) and potassium (K).

OBJECTIVES Analyze California dairy annual reports.

1. Extract essential plant macronutrient data from Central Valley dairy annual reports.
2. Remove and calculate outliers beyond reasonable biological ranges[2].
3. Summarize nutrient composition of manure sources, allowing for agronomic recommendations to promote efficient use of nutrients.

METHODS Compare essential plant macronutrient concentrations between manure sources.

Annual report data from 63 dairies were obtained to extract solid (n=275) and liquid (n=585) manure nutrient data. Macronutrient concentrations for each manure source were reviewed for outlier analysis and compared by source.

Table 1. Manure data size (n) pre- & post-data clean up.

Manure Source	Pre-data clean up	Post-data clean up
Corral Solids	174	96
Separator Solids	84	20
Compost Solids	7	3
Scraped Solids	8	2
Lagoon Liquids	585	381

Solid manure data (Table 1) were cleaned. Samples with data anomalies were compared with the original data source. Typographical errors were fixed. Solid manure outliers were removed: (Total Kjeldahl N) >2.0% TKN <0.5%; >5.0% P <0.1%.

Solid manure sources were corral, separator, compost and scraped material solids. Concentrations of N, P and K were recorded in mg/kg. Solids analyzed on an "as-is" (AS) basis (Figure 1) were converted to a "dry-matter" (DM) basis and converted from mg/kg to kg/100kg for comparisons:

Figure 1. Example corral solid manure sample collection.

$$\text{DM Conc.} = \frac{\text{AS Conc.}}{100 - (\%\ \text{Moisture})} * 100$$

$$\text{DM Conc. kg/100kg} = \frac{\text{DM Con. mg/kg}}{10{,}000}$$

Figure 2. Example liquid manure sample collection.

Liquid manure (Figure 2) animal excrement, organic crop materials and flushed water. Liquid manure outliers were removed: >25mg/L TKN <1,000mg/L; >2.75mg/L P <300mg/L; <50mg/L K. Liquid samples are analyzed for TKN, ammoniacal N (NH_4-N), P and K concentrations (mg/L).

RESULTS Nutrient composition variability by manure source.

Cleaned data

Solid manure sample size decreased from 275 to 121 (44% of the original data). Liquid manure sample size decreased from 585 to 381 (66% of the original data) (Table 1). The primary culprit of data size reduction is data outside of TKN standard ranges for both solid (35.6% data removed) and liquid (17.4% data removed) manure.

Comparing average nutrient composition

Nutrient composition by source is presented in Figures 3 and 4. Ranges identified in Figures 3 and 4 are useful for comparison purposes for farmers and consultants to compare individual sample results to reasonable population ranges. When data are outside these ranges, it is important to evaluate sampling methodology to determine if samples represented their source[3].

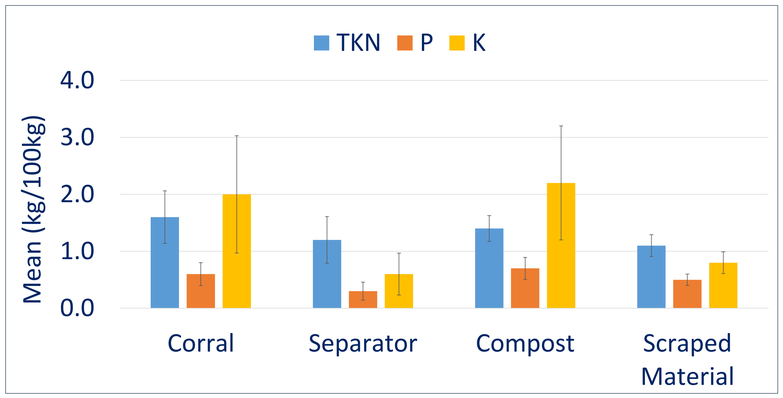

Figure 3. Average nutrient composition of solid manure DM basis by manure source.

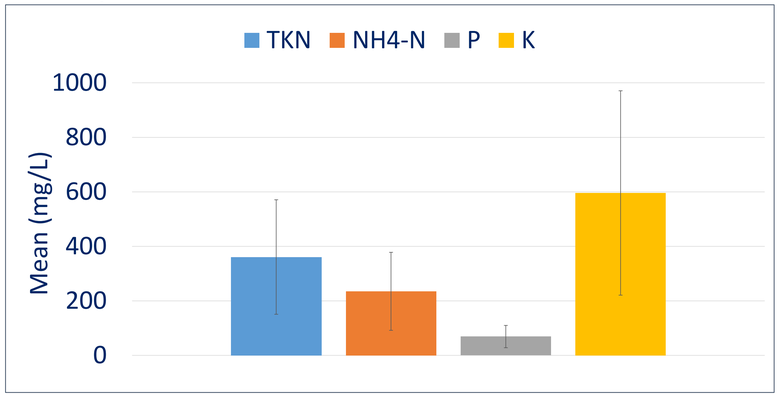

Figure 4. Average nutrient composition of liquid manure samples.

CONCLUSION Reviewing nutrient analysis allows for enhanced agronomic management.

Greater attention to proper sample collection and preservation may improve sample quality. Improved data will facilitate more accurate agronomic nutrient rate prescriptions when applying manure as a fertilizer and soil amendment. Increased accuracy in nutrient application rates may support greater crop yield and reduce risks of groundwater contamination.

REFERENCES

1. California Regional Water Quality Control Board Reissued Waste Discharge Requirements General Order for Existing Milk Cow Dairies – Order R5-2013-0122.
2. Miller, C.M.F., Clark, N.E. & Meyer, D. (2021). Optimizing accuracy of measurement protocols for nitrogen application in dilute dairy manure. *Journal of Environmental Quality*, 51:325-336.
3. Miller, C.M.F, Heguy, J.M., Karle, B.M., Price, P.L., & Meyer, D. (2018). Optimizing accuracy of sampling protocols to measure nutrient content of solid manure. *Elsevier,* Waste Management 85:121-130.

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