Poultry waste characterization for easier management

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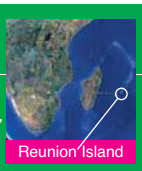
AGRICULTURAL RESEARCH FOR DEVELOPMENT



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Reunion Island (a French overseas department, 700 km east of Madagascar) produces ¾ of the poultry meat eaten locally, thus huge quantities of poultry litter (PL). Burning or composting PL represent interesting alternatives in term of substitution of non-renewable energy sources, volume- and possible pollution reductions in a fragile environment / limited area.

Is NIRS a good candidate to asses the PL characteristics that are to be considered for their recycling as a fuel and/or composted fertilizer?

Is NIRS useful to represent basic characteristics in compost windrows for subsequent use in gas emission models?

Typical situation of intensive land use and occupation in Reunion Island: poultry farms, agricultural land (here market gardening), houses in a UNESCO World Heritage Site.

Poultry litters, NIRS and laboratory analyses

- Whole set "ALL" (n=494) = CAL (n= 433) + VAL (n= 58) Calibration, CAL = broiler litters from 20 chicken farms. Validation, VAL = breeder hen litters, + windrow fronts (compost of breeder hen litters). VAL samples are fully independent.
- Homogenized fresh PL samples scanned (rep=3) on a XDS (Foss) spectrometer.
- Spectra transformed (SNVD, 2/5/5) and calibrations performed using the mPLS procedure (Win-ISI).
- Dry matter (DM), total nitrogen (N) and ammonium (NH_4-N) quantified according to French standard methods.
- Standard errors of laboratory (SEL) estimated with repeated measures on intern standards.

Origin of the samples: broiler,breeder litters, compost of breeder litters.

Results

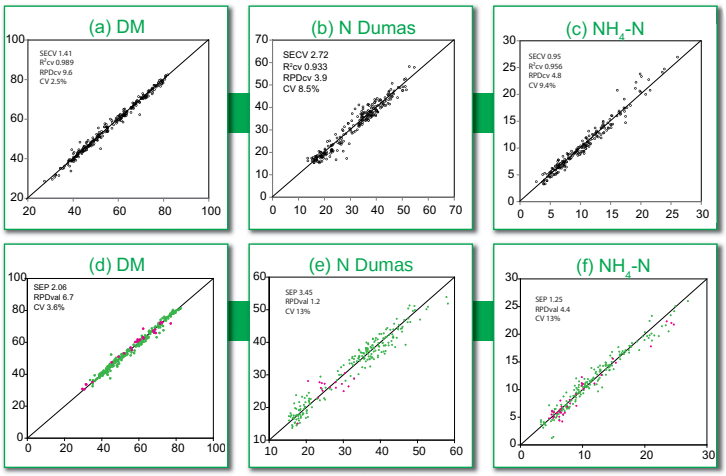

Fig. 1. Reference and predicted (a, d) Dry Matter (g 100g^{-1} BW), (b, e) N Dumas and (c, f) NH_4-N (g kg^{-1} DM) contents for the ALL (black), CAL (green) and VAL (pink) datasets of PL (sampled in farm or during composting).

- Global feasibility of NIR models was tested on ALL (Fig.1a, 1b, 1c).
- Models showed good performances (R^2 > 0.9, RPDcv > 3, and CV < 10%).
- N Dumas and NH_4-N being not highly correlated with DM (0.24 <R^2< 0.30), and NH_4-N not correlated with N Dumas (R= -0.028), the performance of NIRS models for N Dumas and NH_4-N contents in g kg^{-1} dry matter from fresh sample spectra were particularly interesting.
- Performances of CAL models were close to those of ALL (CAL samples predominantly represented in ALL).
- Models developed for CAL were successfully applied to VAL for DM and NH_4-N, (Fig. 1d, 1f; R^2>0.95, RPDval>3) even if VAL samples were different (origin, PL set size).
- It was not the case for N Dumas (slope ≠ 1, R^2<0.4). = Distribution of the N Dumas values in VAL was too narrow?

- NIRS models for DM and even NH_4-N can be transferred in the laboratory (alternatives to reference analyses, see Fig.2).

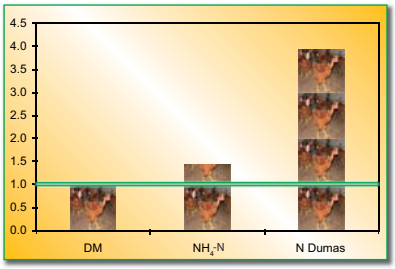

Fig. 2. Ratios SENIRS/SEL.

- Using these models, DM or NH_4-N contents were repre-sented on cross-sections of PL windrows (Fig. 3). It is a valuable help for providing localized data for the gas emission model developed in our team for a better management of PL.

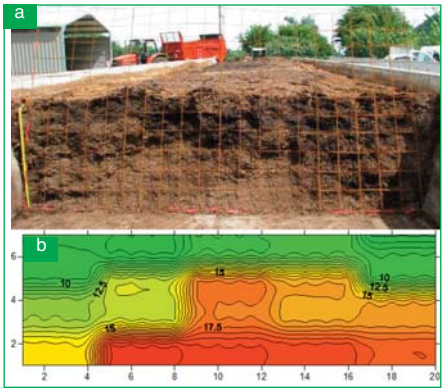

Fig. 3. Cross sections of a poultry litter windrow; (a) actual, (b) representation of the NH_4-N contents (g kg^{-1} DM).

Conclusions

- Well performing NIR models for DM, N and NH_4-N contents (expressed on a DM basis) were elaborated on 494 poultry litters (broiler, breeder hen), sampled on a fresh state in farm or during composting. Models were successfully applied to a validation set. The DM model can be transferred to the laboratory.
- NIRS is a good candidate to asses the PL characteristics that are to be considered for their recycling as a fuel and/or composted fertilizer.
- NIRS is useful to represent analytical characteristics in compost windrows for subsequent use in gas emission models calibrated for Reunion Island.