Potential of recycling dairy processing organic residues

Researchers at TEAGASC are examining residues from dairy processing for use as organic fertiliser.

Wastewater created during the production of butter, cheese, milk powders, cream, and whey powders at milk processing facilities must be treated. This results in the generation of dairy processing organic residues (DPOR), which must be managed; approximately 128,636 tonnes were generated in Ireland in 2015. Due to the abolition of European milk quotas in 2015, milk production in the Irish dairy sector is expected to increase by 50% by 2020. This will create an added challenge of tackling more DPOR generation. Recycling of DPOR to land provides for a circular economy and should also provide farmers with an organic fertiliser. However, there is as yet no systematic study of the recycling of DPOR from an Irish perspective in terms of nutrient recovery, agronomic benefit, and associated environmental impacts. Current research in this area within the Teagasc Environment Research Centre is focusing on the recovery and recycling of agri-nutrients (nitrogen (N), phosphorus (P), and potassium (K)) from DPOR. In particular, this project aims to investigate and develop the comprehensive physicochemical characteristics of DPOR from the Irish dairy processing industry and, subsequently, to identify fertiliser (N/P/K) replacement value and associated agri-environmental impacts from recycling of DPOR through controlled laboratory, micro-plot rainfall simulation and field-scale agronomic trials.

Research method

Seasonal DPOR samples (n=16) (predominantly two types: mixed sludge after biochemical treatment and lime-treated sludge after dissolved air flotation (DAF)) were collected from five dairy processing plants across Ireland. Samples were analysed for physicochemical parameters (e.g., solid and organic matter, nutrients, heavy metals and other elemental composition) following standard sample preparation (homogenisation, freeze drying and grinding in mixer mill). The analytical methods used were inductively coupled plasma optical emission spectrometry (ICP-OES), spectrophotometric measurements by Aquakem 600 discrete analyser, and LECO TruSpec CN analyser.

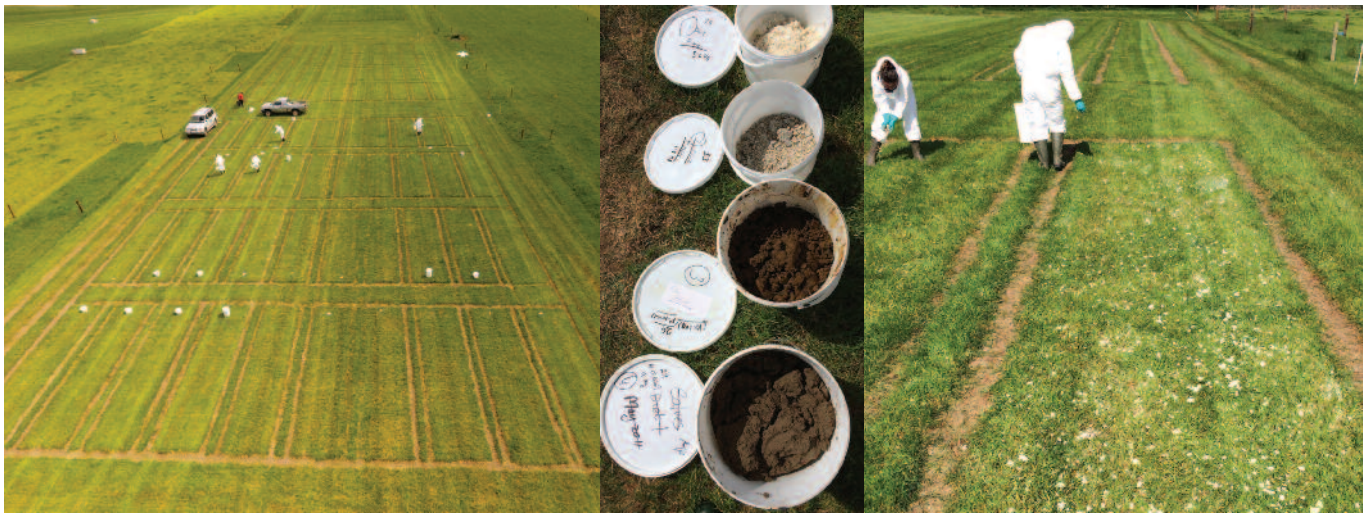

FIGURE 1: Agronomic grassland plots for assessing nitrogen and phosphorus fertiliser replacement value of dairy processing organic residues through land application.

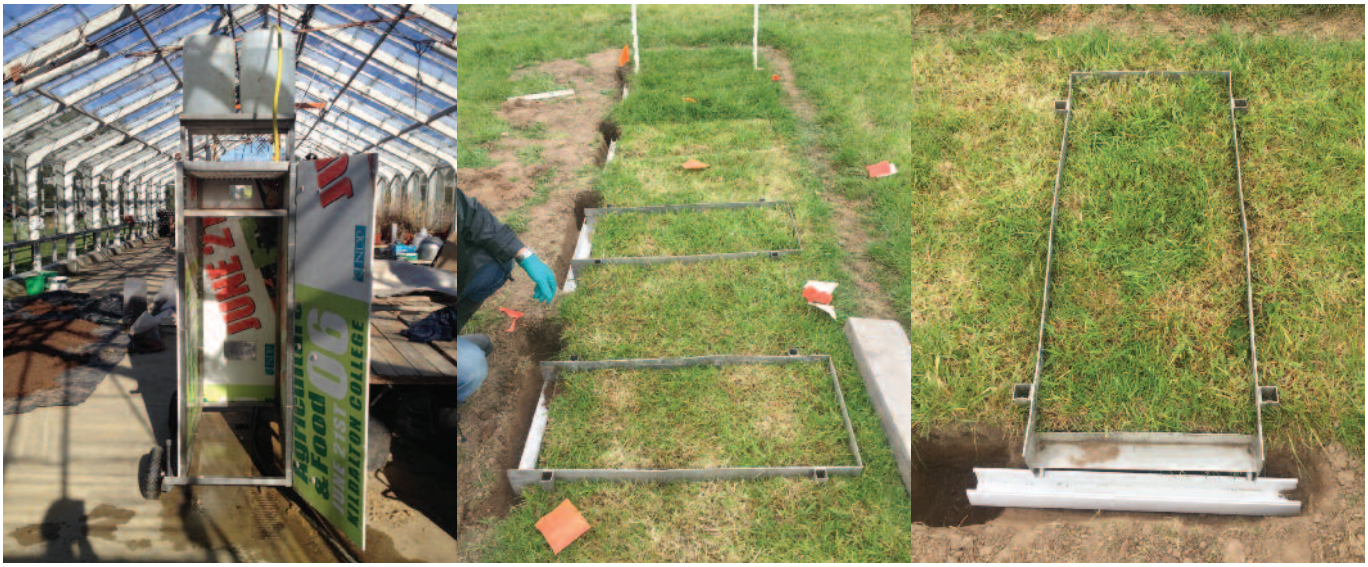

FIGURE 2: Micro-plot rainfall simulation study site. Left: Amsterdam drip-type rainfall simulator. Middle: Series of isolated grassland micro-plots. Right: Individual plot isolated by steel frame of dimension 0.9m in length and 0.4m in width with runoff collection channel.

Results

Preliminary results of the analysis of DPOR samples showed that the values of dry matter (DM, in %wt) and total nutrient content (kg/tonne DM) were in the range of: DM=9.4-19.7, N=37-65, P=18-61, and K=3.5-13.6 for mixed DPOR (n=11); and, DM=19-30, N=9.1-48.7, P=15-82, and K=1.2-6.1 for DAF DPOR (n=5).

The levels of N, P and K in DPOR are generally higher than those typically observed with other commonly used organic fertilisers (e.g., cattle slurry, biosolids), with DPOR also showing lower heavy metal levels (Wall and Plunkett, 2016). Heavy metal levels in DPOR are significantly lower than those regulated by the European Union in agricultural land due to sludge recycling (EC, 2001). An estimated evaluation reflected a higher financial value of DPOR (€13-22/tonne) than cattle slurry (approximately €5.4/tonne) considering total nutrient content. But, it is important to evaluate the realistic fertiliser replacement value (FRV) through agronomic investigation in order to realise the actual commercial value of DPOR. Overall, the results indicate that DPOR are enriched in nutrients. There is significant variation in major nutrient content and other physicochemical composition across different milk processing plants and DPOR types. There are also some indications of seasonal variability in nutrient content and other compositions, which will be statistically analysed when the seasonal sampling is complete.

The next stage

Future work will elucidate the fertiliser (N/P/K) replacement value of DPOR and assess potential agri-environmental impacts through runoff losses, and uptake in soil and grass from the recycling of DPOR to grassland. These experiments have begun in Johnstown Castle with the creation of a new field site (**Figures 1** and **2**).

References

Wall, D.P. and Plunkett, M. (eds.). (2016). 'Major and micro nutrient advice for productive agricultural crops.' Johnstown Castle, Wexford: Teagasc, Environment Research Centre.

EC. (2001). 'Disposal and recycling routes for sewage sludge.' Part 2 – Regulatory Report, European Commission.

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