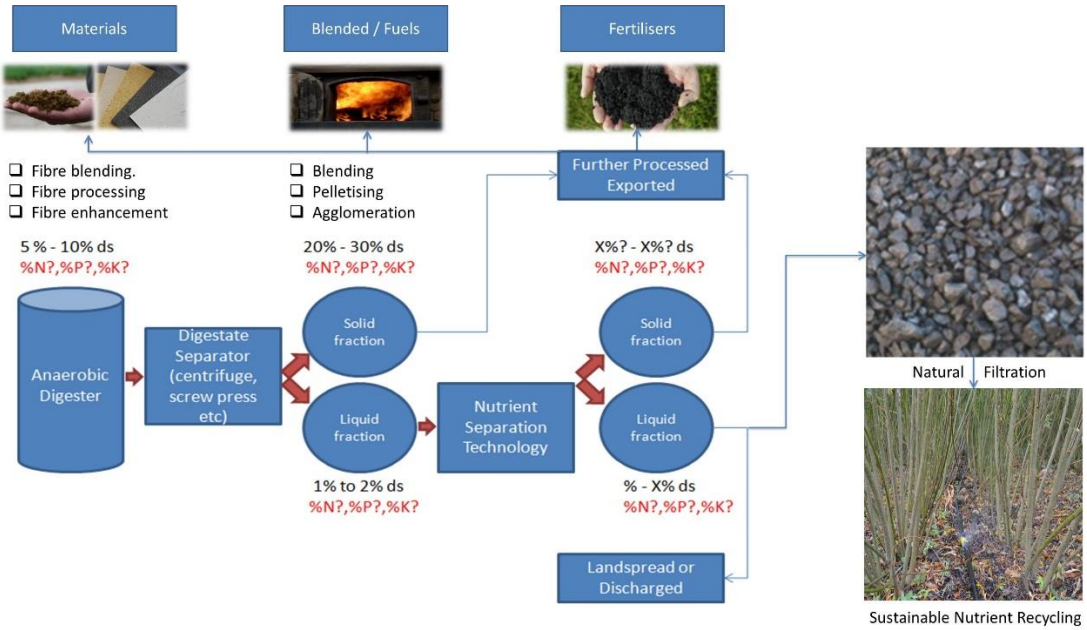
QUB-Mechanical and Aerospace Engineering PhD Project 2018-2019

Title: Nutrient Management of Digestate and Slurry combined with Energy Recovery

Project description:

In N Ireland, 63% of water bodies are not achieving the "Good or Better" status required by the Water Framework Directive, a performance well below the EU average (47%). This is caused by both wastewater treatment and agricultural pollution, where runoff from intensive slurry and dirty water land application, as well as legacy soil P, are major contributors. Slurries and dirty water are commonly used as fertiliser in bioenergy plantations. In addition, an expanding anaerobic digestion industry will result in increased production of digestate, which is typically land-spread and associated with similar environmental problems to slurry.

New management practices are being driven by the DAERA commissioned report, "Delivering Our Future, Valuing Our Soils: A Sustainable Agricultural Land Management Strategy for Northern Ireland" (SALMS), which made recommendations for reducing risks to water quality, including appropriate redistribution of slurries/derivatives and on-farm phosphorous separation. The use of mechanical separation technologies to separate digestate/slurries into solid and liquid fractions is an option to partition nutrient, water and fibre, and as result facilitate higher value utilisation of these materials in order to meet the farmer's and the environment's needs. This project will investigate (1) Separation, (2) Fraction characterisation, and (3) Solids reuse focusing on combustion.



In line with SALMS, the negative effects on water quality of large amounts of organic waste must be addressed. The agricultural sector therefore requires solutions to sustainably manage increasing quantities of organic wastes, a growing proportion of which is processed through anaerobic digestion. If these residues can be processed for fertilisers, fuels or via some other valorisation route, the economics for their sustainable reuse should be significantly improved. As well as these direct market benefits, there would be many non-market co-benefits to society, such as less water and air pollution and less fossil fuel use. From a N Ireland perspective, novelty arises from the use of nutrient separation for specific N Ireland organic residues. In the wider context, the development of the separated fibre fraction of these materials into a biomass fuel for use in dedicated heat or combined heat and power generation represents a novel area of research.

The successful PhD candidate will undertake laboratory work in the new Nutrient Management Centre (NMC) at the Agri-Food and Biosciences Institute (AFBI) farm in Hillsborough. The centre will provide a research and demonstration platform for mechanical separation of farm slurries and anaerobic digestate using either a screw press separator or a decanting centrifuge separator. The NMC will also enable research on the treatment of the separated solids for further processing. AFBI's Environment and Renewable Energy Centre (EREC) contains

combustion technologies (Biokompkat 120kW, Froling 320kW and a KWB 50kW) capable of combusting biomass for heat recovery coupled with on-line gas analysing equipment (Horiba) and a particulate impactor (Dekati) for assessment of combustion emissions quality.

The successful PhD candidate will be based between AFBI, Queen's University Belfast (QUB) and Letterkenny Institute of Technology (LYIT), but the majority of time will be spent on the AFBI site in Hillsborough.

Key skills required for the post:

- A minimum of a 2:1 or first degree in a relevant discipline/subject area (Agriculture, Chemistry, Biological/Environmental Science, or Civil/Environmental/Mechanical/Chemical Engineering) or
- A masters degree in a relevant subject area (Agriculture, Chemistry, Biological/Environmental Science, or Civil/Environmental/Mechanical/Chemical Engineering). The masters must have been attained with overall marks at merit level (60%). In addition, the dissertation or equivalent element in the masters must also have been attained with a mark at merit level (60%). Students with a postgraduate masters degree should preferably also hold a minimum of a 2:1 in their first degree.
- Experience or knowledge of bioenergy and agri-environmental issues is preferable.
- Analytical skills along with high self-motivation and preparation for laboratory/field work are required.
- Students should demonstrate the potential to engage in innovative research and to complete the PhD within a prescribed period of study.
- English language proficiency is essential (please refer to http://www.qub.ac.uk/International/International-students/Applying/English-language-requirements/).

Key transferable skills that will be developed during the PhD:
At the end of the doctorate the candidate is expected to have developed generic and transferable skills in time management, problem solving, report writing and oral presentations. The student is also expected to develop a considerable skillset in bioenergy and agri-environmental area. The project will also benefit from the collaborations with the project partners and the wider group within the Bryden Centre. Collaboration with industrial partners is also expected, and this should enhance both professional standing and competency.

The successful candidate will also have access to supplementary professional training, allowing him/her to develop skills in analytical and interdisciplinary thinking; improved oral and written communication skills through dissemination of research findings; contacts for future projects, employment and funding opportunities; and project management skills in preparation for future challenges in both industrial and academic settings.

AFBI supervisors **First/Lead academic supervisor**	Mr Chris Johnston, Agri-Food and Biosciences Institute, Large Park, Hillsborough, chris.johnston@afbini.gov.uk, +44 (0)28 9268 2484 Dr Gary Lyons, Agri-Food and Biosciences Institute, Large Park, Hillsborough, gary.lyons@afbini.gov.uk, +44 (0)28 9268 2484 Dr Beatrice Smyth, School of Mechanical & Aerospace Engineering, Queen's University Belfast, beatrice.smyth@qub.ac.uk, +44 (0)28 9097 4318
Second supervisors	Dr Simon Murray/Professor David Rooney, School Chemistry and Chemical Engineering, Queen's University Belfast, s.murray@qub.ac.uk, +44 (0)28 9097 5614 Dr Christina Forbes, Department of Science, Letterkenny Institute of Technology, Co Donegal, Ireland, christina.forbes@lyit.ie, +353 (0)74 918 6316
Funding	Funding is for 39 months and covers full university tuition fees for UK/EU students and a stipend of £14,553 per annum. There is also the opportunity to undertake teaching and demonstration duties to earn a further £1,500 per annum. International students would be required to pay the balance in tuition fees, currently in the region of £15,500 per annum; details of international fees are available on the QUB website: http://www.qub.ac.uk/International/International-students/International-tuition-fees/
Project links	This project is part of the Bryden Centre, which has been funded under the European Union's INTERREG VA Programme. The Bryden Centre will create a 'virtual centre of competence' that will support industry-led applied/pre-commercial collaborative research on a cross-border, interregional basis that is focused on two specific forms of renewable energy: bioenergy and marine renewable energy. Please see the website for more information: https://www.brydencentre.com/