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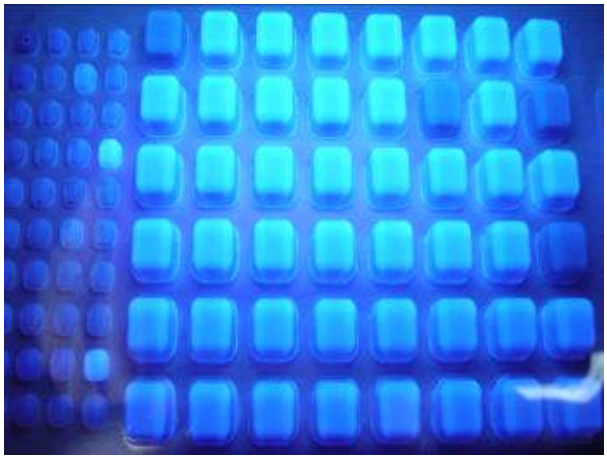
Landspread Pathogen Survival and Transport in Irish Soils



Key external stakeholders:

Farmers
Environmental Protection Agency
Local Authorities
Policy makers
Scientific community
General public

Practical implications for stakeholders:

This research provides important data on the survival and transport of landspread enteric microorganisms in Ireland under a range of soil types and conditions.

- This research highlights the importance of soil structure (macropore flow) as the dominant mechanism for pathogen leaching.
- This research will help to identify areas with soils that are more prone to pathogen loss to groundwater from slurry application.
- The data from this project can be used in quantitative microbial risk assessment to help farmers and water managers protect the microbial quality of drinking water.

Main results:

- Soil type has a significant impact on risk of pathogen transport with poorly drained (well structured) soils representing the greatest risk due both to their inherent capacity to support pathogen survival and their pronounced network of macropores, which facilitate transport.

Opportunity / Benefit:

- *E.coli* can become naturalised and survive long-term in Irish soils. As such, its presence in soils and waters may not be indicative of recent landspreading or other activities. This has implications for its use as an indicator of water quality.

Collaborating Institutions:

Dept. of Microbiology, NUI Galway
Cranfield University, UK
Bioresources Research Centre/Biosystems Engineering, University College Dublin

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External collaborators: Dept. of Microbiology, NUI Galway (Prof. V. O'Flaherty & Dr F. Abram)
Cranfield University, UK (Dr F. Chinalia)
Bioresources Research Centre/Biosystems Engineering, University College Dublin (Prof. NM Holden)

1. Project background:

Microbial contamination of groundwater, including sources of drinking water, continues to be of worldwide concern due to the human and animal health implications which can result as a consequence. Reports by the Environmental protection Agency (EPA) indicate that nationally, a high proportion of groundwater sources are contaminated with faecal coliforms. The high numbers of groundwater sources found to be contaminated with faecal bacteria, and thus considered to be unfit for human consumption, presents a worrying statistic, particularly as the majority of private groundwater supplies in Ireland are untreated or inadequately treated prior to consumption, thereby increasing the risk of gastroenteric and other waterborne diseases. The sources of contamination are varied, but international evidence suggests that the landspreading of animal slurries, manures, and soiled waters is a significant contributor. These organic fertilisers can contain a large range of pathogenic microorganisms including *Campylobacter, Cryptosporidium and Salmonella* spp., which are released into the environment during landspreading. Some of the pathogenic microorganisms in organic amendments applied to soil have been observed to leach through the soil into groundwater thus affecting drinking water quality and posing a risk to public health. As such, understanding how these organisms survive and move in soil has become critical in the assessment and mitigation of the risk to groundwater posed by agricultural activities.

2. Questions addressed by the project:

These projects had two main goals. These were to investigate:

- The effect of soil type and condition on the transport of microbial pathogens through soil, and the risk posed to underlying groundwater from landspreading practices
- The effect of soil type and condition on the capacity of soil to act as a reservoir for enteric microorganisms, which can subsequently be leached to groundwater

3. The experimental studies:

The research questions were addressed using a combination of field, intact soil columns (lysimeters) and laboratory studies. In field trials, the transport of model organism *Escherichia coli* was investigated *in-situ*, under artificial rainfall conditions, on different soil types and under different soil moisture regimes. Transport pathways were identified using a tracer dye. Under natural rainfall conditions the movement of *E. coli* from landspread dairy slurries was investigated in 1 m deep intact soil columns of different soil types. Environmentally persistent *E. coli* isolates were then characterized using molecular and physiological approaches to investigate their capacity for long term survival

4. Main results:

- Landspread microbial pathogens can travel rapidly through soil to depth in macropores which are large soil pores (Figure 1).
- Soil type has a significant impact on risk of pathogen transport with poorly drained (well structured) soils representing the greatest risk due both to their inherent capacity to support pathogen survival and their pronounced network of macropores, which facilitate transport.
- *E.coli* can become naturalised and survive long-term in Irish soils.
- Brilliant blue dye and Bromide were good predictors of *E. coli* transport pathways and distribution under certain conditions. *E. coli* was observed to leach deeper than both tracers in numerous profiles indicating that caution should be used in extrapolating tracer test results to pathogen movement in soil, as this could result in an underestimation of the depth of transport and risk to underlying water bodies.

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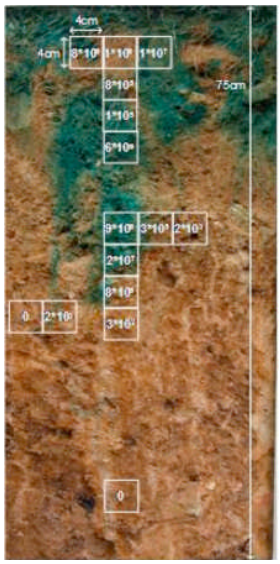

Figure 1 Soil flow paths stained blue with *E. Coli* concentrations superimposed in white.

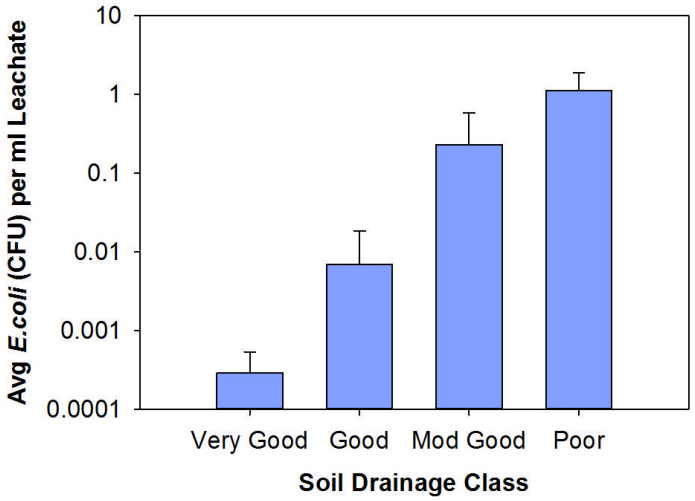

Figure 2 Average E. coli leaching on 4 soils with drainage from very good to poor. E. coli leaching was inversely related to soil drainage (adapted from Brenan et al. 2010b).

5. Opportunity/Benefit:

The presence of *E. coli* in soils and waters may not be indicative of recent landspreading or other activities. This has implications for its use as an indicator of water quality.

6. Dissemination:

The findings of this research has been disseminated to stake holders by means of international peer reviewed papers, national and international conferences, popular and technical outputs, open days and radio interviews.

Main publications:

Brennan, F.P., Kramers, G, Grant, J., O'Flaherty, V., Holden, N.M. & Richards, K.G. (2012) Evaluating E. coli transport risk in soil using dye and bromide tracers, *Soil Science Society of America Journal*, 76, 663-673.

Brennan, F.P., Abram, F., Chinalia, F. A., Richards, K. G. & O'Flaherty, V. (2010a) Characterization of Environmentally Persistent Escherichia coli Isolates Leached from an Irish Soil. *Applied and Environmental Microbiology*, 76**,** 2175-2180.

Brennan, F.P., O'Flaherty, V., Kramers, G., Grant, J. & Richards, K.G. (2010b) Long-Term Persistence and Leaching of Escherichia coli in Temperate Maritime Soils. *Applied and Environmental Microbiology*, 76**,** 1449-1455.

Brennan, F.P. (2010c) The Role of Soil Type and Condition in the Fate and Transport of Landspread Microbial Enteropathogens in Soil. *PhD Thesis Microbiology.* National University of Ireland, Galway.

Popular publications:

Brennan, F. P., Richards, K., O'Flaherty, V., Bhreathnach, N., Moynihan, E., Ritz, K., Tyrrel, S., Jordan, P., Murphy, S. & Wuertz, S. (2010d) Protecting Environmental Water Quality from microbial pathogens. *TResearch,* 5**,** 26-27. http://www.teagasc.ie/publications/view_publication.aspx?publicationID=6

Brennan, F. P. (2010a) Fate and transport of landspread microbial pathogens in Irish soils. *Teagasc Environment Advisory Newsletter,* May**,** 4.

Radio interviews by Fiona Brennan on Galway Bay FM and Dublin City FM

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