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Rural Economy and Land Use Programme

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Safe recycling of livestock manures

A Rural Economy and Land Use Programme research project that investigates the impact of livestock farming on microbial water quality and develops new ways of assessing and managing risks at the farm and field levels.

Policy and Practice Notes

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The Rural Economy and Land Use Programme is a UK-wide research programme carrying out interdisciplinary research on the multiple challenges facing rural areas. It is funded by the Economic and Social Research Council, the Biotechnology and Biological Sciences Research Council and the Natural Environment Research Council, with additional funding from the Scottish Government and the Department for Environment, Food and Rural Affairs.

Ensuring that livestock farming does not compromise water quality is an important objective for environmental protection. Livestock manures contain pathogenic micro-organisms. Human exposure to these can adversely affect public health and the viability of regional industries dependent on clean water. Policy makers and environmental managers working to new standards for water quality need to understand better how and why farm management practices contribute to these risks, and what can reasonably be done to reduce their impact.

How do manures and slurries pollute watercourses?

Detailed monitoring of watercourses for evidence of pathogenic micro-organisms is a developing area of science. One important approach is to monitor watercourses for Faecal Indicator Organisms (FIOs). FIOs indicate the presence of faecal material and this means that there may be pathogenic micro-organisms in the water. Currently FIOs are defined by international legislation as Escherichia coli and intestinal enterococci and are investigated using standard microbiological techniques.

- The research established a link between elevated FIO concentrations and stock grazing in close proximity to unfenced streams and rivers.
- Monitoring of FIOs showed seasonal variability in concentrations, with elevated levels through the spring and summer, coincidental with the grazing season.
- FIO burdens derived from human sources can be important too. In 40% of the farms that were monitored, these played a significant role either as direct sewage from the farmhouse or as the result of a discharge from a nearby sewage treatment works.

What factors affect the level of risk?

Past attempts to reduce risk from pathogenic organisms in manures and slurries have tended to concentrate on a limited number of management issues, such as the timing of slurry applications. This research has highlighted the need to develop broader and more integrated approaches incorporating a range of factors.

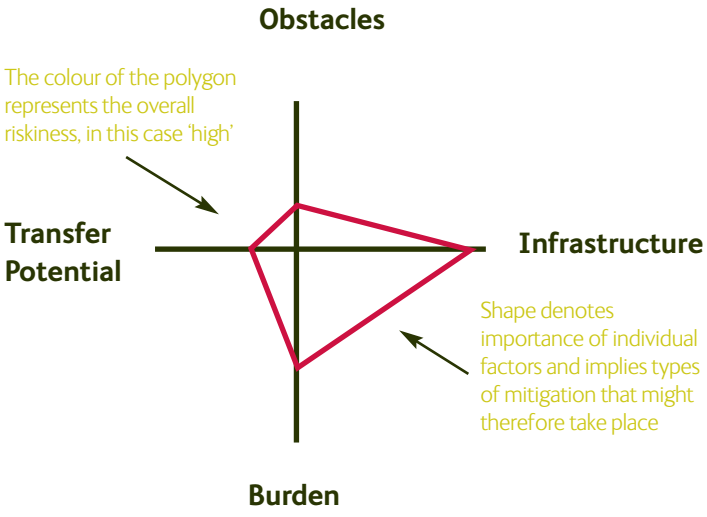
The research has identified four salient issues as the basis for developing targeted risk assessment:

- **Accumulating microbial burden to land**: risks associated with how manures are applied and deposited during farming activities (e.g. stocking density).
- **Landscape transfer potential**: incorporating risks associated with the topographical characteristics of land (e.g. slope shape).
- **Infrastructural characteristics of the enterprise**: risks associated with human interventions and constructions in the farm landscape (e.g. manure storage capacity).
- **Social and economic obstacles to taking action**: structural and attitudinal factors that limit a farmer's ability and inclination to manage for risk (e.g. levels of training).

How can farm advisers measure and demonstrate risk?

Understanding how the four components interact to influence risk is key to effective microbial risk assessment on the farm. This enables the farmer or other land manager to analyse where the most serious and difficult risks lie, and to mitigate these more effectively and efficiently.

- Although the understanding or attitude of the farmer may be a significant factor, they may be outweighed by more intractable factors such as the topography of the land.
- One of the research challenges arising is how to convey clear messages about the management of microbial related risks at the farm enterprise level, whilst recognising underlying complexities. To do this, the study has devised an approach to assessment that represents each risk component on an axis and plots its relative influence on overall risk using a normalised sliding scale of 0 (minimal risk) through to 10 (worst-case risk). The colour (red, amber, green) of the resulting polygon illustrates this overall farm riskiness, while the shape indicates where key controls on risk lie.



- This enables environmental managers and advisers working with farmers to collect data on the variables defining each risk factor. It provides a simple means of informing the farmer about where to take action to reduce the risk. In the example shown risks arise principally from deficiencies of infrastructure (e.g. the direct drainage of contaminated water to watercourse from an impervious yard area) and burden (e.g. relatively high livestock numbers). Transfer potential is low (e.g. because fields are flat and on well drained soil) as are human obstacles (e.g. the farmer understands and recognises potential risks).

How can farmers reduce risk more effectively?

Standard "good practice" guidance explains how farmers can work to reduce risks. This includes measures such as fencing off watercourses to restrict livestock access and creating buffer strips, to more ambitious interventions, such as the use of constructed wetlands.

- This study shows us that farmers need to target their efforts more effectively according to individual circumstances. Fundamental changes in infrastructure may be necessary under some management and landscape conditions; in other instances appropriate advice or training may be what the farmer needs in order to be equipped to manage the risk effectively.
- The research also highlights the need to assess environmental trade-offs from different land management practices. For instance, the project asked farmers how they use their slurry and looked at whether injecting it into the soil, as is required in several European countries, rather than spreading, reduces risk. They found that although injection achieved its objective of reducing ammonia emissions it favoured survival of faecal indicator organisms. On the other hand, it may reduce run-off compared with surface slurry applications and lower the risk of animal to animal contamination, which means that animals could be let onto grazing areas earlier.

- Different land management practices may bring different environmental trade-offs and these all need to be considered when land managers are taking decisions.
- Simple forms of risk assessment allow farmers to tailor the "mitigation mix" more effectively.
- Some management practices adopted to reduce transfer of organisms can also have additional positive benefits.

What does the public think about these risks?

While science can tell us many things about the character of these risks, it is policy makers working in the interests of the public who must ultimately come to terms with the wider social and economic issues that microbial pollution raises.

- As part of the research a citizens' jury considered different aspects of this issue. This is a technique that has been widely recommended as a means of engaging the public in contentious areas of policy development. The citizens' jury reached the following judgements:
  - Microbial risks are, overall, less significant than other potential risks such as biological, chemical, radiological and nuclear threats
  - Farmers should take primary responsibility for risks associated with livestock farming, and if they fail to do so they should be penalised
  - Tackling risks where there is a significant commercial interest might call for a cross industry response eg shell fisheries could subsidise mitigation measures put in place by livestock farmers
  - More low cost, low-tech and localised solutions in step with existing patterns of farming activity, such as fencing off watercourses are needed
  - Agri-environment measures should be strengthened to include actions that mitigate the risks
  - More routine monitoring of watercourses for FIOs all year round would be helpful. At the moment the Environment Agency only monitors bathing waters, and this is only carried out from May to September.

What more do we need to know?

A number of avenues could take the project's insights forward including:

- improving understanding of how FIOs behave on the farm under field relevant conditions
- further testing of different mitigation measures in experimental research areas and the real world and exploration of how these measures can impact on FIO 'hot-spots' at the field, farm and, ultimately, at catchment level
- monitoring of watercourses over an extended number of field seasons. The research offers a snapshot picture of the risk of farms contributing FIOs to watercourses, but there is a need for longitudinal research to establish a more robust picture of what these risks might be over an extended period of time, both annually and seasonally
- evaluation and validation of risk assessment tools in relation to microbial water quality data to help ensure they serve their intended purposes, both in the short term for framing research needs and in the long term through development for use on farms
- testing and refinement of mitigation measures through farmer and adviser outreach
- relating risk assessment to the cost of mitigation at the farm scale. If we want to foster a culture of mitigation among farmers we need to understand better the relationship between costs and outcomes.

Further information

The research has been carried out by researchers at North Wyke Research, the Centre of Sustainable Water Management at Lancaster University and the Centre for Rural Policy Research at the University of Exeter

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Useful resources:

Chadwick, D. R., Fish, R. D., Oliver, D. M. Heathwaite, A. L. , Hodgson, C. J. and Winter M. (2008). Management of livestock and their manure to reduce the risk of microbial transfers to water - the case for an interdisciplinary approach. Trends in Food Science & Technology.19, 240-247

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Project website:
www.lec.lancs.ac.uk/cswm/foodchains.htm

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