8. Faecal Pathogens: Summary of Issues

Problem
Microbiological contamination of surface and ground waters together with general contamination of arable/grassland.

Impact
Health impacts
Drinking water quality, amenity value of freshwaters, estuaries and coastal waters, public access to countryside. Specific concern with *E. coli* O157.

Areas at Risk
Here the presence of livestock waste material is considered synonymous with faecal indicator organisms. Proximity of a 'source of microbiological contaminants' allowing direct contamination of ground/surface waters, presence of field drainage system can increase the risk of contamination after slurry/FYM (Farm Yard Manure) applications. Other sources include direct runoff from livestock housing, hard standing areas, leakage/failure from waste storage units, runoff from unconfined middens, direct dunging in streams, buried livestock.

- shallow groundwater source are especially at risk from contamination by faecal coliforms (e.g. Aberdeenshire private water supplies ~ 40% of samples failed).
- rivers and coastal bathing water/beaches (recent example of Ayrshire SW Scotland).
- direct ingestion of contaminated soil/plant material.

Practical Actions
Agricultural livestock represent only one possible source of faecal indicator organisms and it would be beneficial to be able to separate out other contributors such as septic tanks. We divide sources into three physically distinct 'sources' or mechanisms of contamination.

1. loss via runoff from farm buildings/hard standing areas, from surface runoff after waste spreading
2. direct losses from failure of storage facilities, or direct dunging into surface waters where access for drinking allowed and
3. deep percolation and transport through soils via drainage waters.

The characteristics and nature of contamination from these three broad groups differ. In many cases the sources implicated in the first group are highly responsive to rainfall intensity/duration and will display a high degree of temporal variability related to waste spreading. Runoff of livestock waste is especially likely to occur during the period directly after application. The last group probably provides a 'background' signature, and factors such as soil texture and depth become important with respect to attenuation of pathogen numbers.

- practical mechanisms for reducing microbiological contamination are included in the PEPFAA code farm waste management:

- recent guidelines for the microbial protection of groundwater include items such as source protection through fencing off the well, maintaining lid and concrete skirting, providing a locked cover and enclosure in a shed.
- minimise risk of direct runoff of livestock wastes by following the PEPFAA code for livestock waste spreading.
- it is possible that reed beds/wetland areas could have a beneficial role in reducing pathogen numbers.
- specific management of sediment 'hot spots', achieved through stabilisation or stream bank, fencing of stock, providing drinking troughs, moving feeding rings regularly, management of clean and dirty water in farm yard.

Linkages

Sediment loss – many faecal pathogens are associated with suspended solids.

Research Gaps

Separation of the contribution from faecal indicator organisms derived from human and livestock sources

Prioritising contributions from different farm practices

Evaluation of the impact that changes in the timing of waste spreading (as part of legislation – closed winter periods) will have on potential for contamination.

Improved estimation of decay (death) rates under different environmental conditions (during transport and storage).

8. Faecal Pathogens Critical Commentary

8.1. Background

Livestock represent one significant source of faecal pathogens to the wider environment resulting in the potential contamination of surface and ground waters. The potential of particular management practices to cause pollution events varies considerably with the farming system and local climatic and physical conditions. Apportioning the particular contribution that individual farms make can be difficult and must be judged against a background pathogenic load from other sources such as sewage treatment works and smaller septic tank outflows.

Here, the presence of livestock waste material is considered synonymous with faecal indicator organisms. Proximity of a ‘source of microbiological contaminants’ allowing direct contamination of ground/surface waters, and presence of field drainage systems can increase the risk of contamination after slurry/FYM (Farm Yard Manure) applications. Recent work at SAC has modelled the surface runoff livestock wastes following spreading (Lewis and McGechan, 1999; McGechan and Lewis, 2000) and via tile drains (Hooda *et al*., 1999). Other sources include direct runoff from livestock housing, hard standing areas, leakage/failure from waste storage units, runoff from unconfined middens, direct dunging in streams, and buried livestock. The self-sealing of unlined slurry stores is seen as a crucial step in minimising leakage (Gooddy *et al*., 2001). Shallow groundwater sources are especially at risk from contamination by faecal coliforms (e.g. Aberdeenshire private water supplies ~ 40% of samples failed). A clear seasonality to the microbial contamination of PWS has been noted in the UK (Shepherd *et al*., 1997) and recently NE Scotland (Reid *et al*., 2002).

8.2. Environmental and health consequences of faecal contamination

There are a range of health issues related to microbiological contamination that arise from contaminated drinking water quality (Fewtrell *et al*., 2001; Reid *et al*., 2002), amenity value of freshwaters, estuaries and coastal waters (Kay *et al*., 1999; Crowther *et al*., 2001), public access to countryside. There are specific health impacts related to *E. coli* O157 a virulent human pathogen which currently contaminates between 1 – 15 % of UK cattle herds (Jones, 1999). *E. coli* O157 can remain viable in soil for greater than 4 months and potential human infection can occur through drinking contaminated water or direct ingestion of contaminated soil. Strachan *et al*. (2001) recently modelled the pathogen loading onto a field by sheep immediately prior to a scout camp where 18 scouts and 2 adults were infected.

There have been numerous well-documented cases of faecal contamination of coastal bathing water/beaches (recent example of Ayrshire SW Scotland) and failures under EU bathing water directives. The primary source of this contamination was considered to be direct discharges of effluent from sewage treatment works (STWs) to coastal waters or via rivers. Continued failure has meant that secondary sources of contamination are now being investigated by SEERAD which focus on diffuse and point inputs from agriculture (See project report by Aitken *et al*., 2001). The timing of delivery and longevity of pathogens are especially important as in the context of bathing waters as it is a seasonal issue (May - September). This aspect is currently an active area of research within the UK.

Agricultural livestock represent only one possible source of faecal contamination and it would be beneficial to be able to separate out indicator organisms of livestock pollution from other contributors such as septic tanks. A number of physically distinct 'sources' or mechanisms of livestock contamination can be identified:

a) loss via runoff from farm buildings/hard standing areas and from surface runoff after waste spreading;
b) direct losses from failure of storage facilities, or direct dunging into surface waters where livestock access for drinking is allowed;
c) deep percolation and transport through soils via drainage waters.

The characteristics and nature of contamination from these three broad groups differ. In many cases the sources implicated in the first group are highly responsive to rainfall intensity/duration and will display a high degree of temporal variability related to waste spreading. Runoff of livestock waste is especially likely to occur during the period directly after application. The last group probably provides a 'background' signature, and factors such as soil texture and depth become important with respect to attenuation of pathogen numbers.

8.3. Practical remedies for reducing faecal contamination

Practical mechanisms for reducing microbiological contamination are included in the PEPFAA code and addressed through farm waste management plans. The importance of practical measures to improve microbial quality have been recently highlighted in a comprehensive study of farms within the Irvine and Girvin catchments (Aitken *et al*., 2001).

8.3.1. Construction and maintenance of adequate livestock waste storage facilities

Well designed, constructed and maintained livestock waste collection and storage facilities are essential if contaminated runoff from farm buildings/hard standing areas and from the failure of storage facilities is to be avoided. Adequate storage facilities to avoid application of slurry to land during high risk or closed periods will also reduce the level of contamination from surface runoff after waste spreading. There is evidence to suggest tremendous variability in livestock waste storage, handling and management systems throughout Scotland (for example see Aitken *et al*., 2001). Consequently, the capital and operating costs to individual farms of compliance with recommended waste management practice guidelines can be highly variable according to the farm sector and individual circumstances and practices on each farm. A recent study of the Ythan Nitrate Vulnerable Zone (SEERAD, 2001) provides an example of the estimated costs that might be incurred by different farm types to comply with different management options. Whilst construction and maintenance of waste collection and storage facilities is an effective way of minimising faecal contamination, it may not be a low cost option for a significant proportion of the agricultural community. The farms that are likely to incur the highest costs are those farm types that produce and dispose of large quantities of slurry.

8.3.2. Following codes of good agricultural practice for livestock waste spreading

Following the codes of good agricultural practice for livestock waste spreading is likely to be a low cost way of minimising the risk of direct runoff of livestock wastes, although this may not be the case if additional collection and storage facilities are required. The codes of good agricultural practice are generally specified to reduce all negative impacts of livestock waste spreading, including nutrient losses and faecal contamination. In this respect, there may be multiple potential benefits from avoiding pollution from livestock waste. However, there is little apparent information of the relative effectiveness of these measures to achieve the different objectives.

Other waste management practices might include the specific management of sediment 'hot spots' through stabilisation of stream banks, fencing of stock, providing drinking troughs, moving feeding rings regularly and management of clean and dirty water in farm yard.

8.3.3. Protection of drinking water wells and boreholes

Recent guidelines for the microbial protection of groundwater include items such as source protection through fencing off wells/boreholes, maintenenance of lid and concrete skirting, and locked and enclosed covers. The effectiveness of these measures has been explored by Reid *et al*. (2001), whilst the costs are likely to be farm specific.

8.3.4. Waste water treatment systems

The cost of treatment of livestock waste before disposal is generally considered to prohibitive. However, reed beds/wetland areas have been used effectively in some European countries (Switzerland and Italy) to reduce pathogen numbers in waste water. As with many of the other waste management options, the cost to individual farms is likely to be highly variable.

8.4. Policy issues

Despite the fact that many of the practical measures available to farmers to reduce faecal contamination are widely documented in codes of good agricultural practice and in other management guidelines, a very significant proportion of farmers have yet to voluntarily comply (see for example Aitken *et a*l., 2001). This suggests that there may be a need for policy intervention if these types of environmental impacts of agriculture are to be reduced. Government has a range of policy mechanisms available to it for encouraging change in agricultural management practices, including regulation, economic instruments and education. The adoption of many of the remedial measure and practical actions set out in this commentary can be encouraged through any one of the policy options outlined above. An examination of the relative advantages and disadvantages of alternative policy mechanisms for achieving reductions in microbial contamination is beyond the scope of this commentary. However, the full costs, the distribution of the costs and the effectiveness of the different policy interventions can vary considerably, and are important considerations in any discussion of achieving practical action at the farm level.

8.5. References

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Please see Appendix 3 for selected bibliography on nutrients and faecal pathogens