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Cattle Manure and the Spread of Bovine Tuberculosis

T. Hahesy, M. Scanlon¹, O.T. Carton², P.J. Quinn¹, and J.J. Lenehan²

The Tuberculosis Investigation Unit has carried out a project (1) to establish if manure/slurry from restricted herds could be implicated in the occurrence of Tb in cattle and (2) to examine methods of reducing any risks involved. A preliminary report on the project was presented in the Tuberculosis Investigation Unit’s Selected Papers 1990 - 1991. This paper provides an update along with a description of further related work conducted in 1992.

The presence of Mycobacterium bovis in cattle manure has been reported by a number of authors including Schroeder and Cotton (1907), Maddock (1936), and Reuss (1955).

Traditional solid manure was regarded as being free of disease causing organisms after 3 weeks composting (Strauch 1980). However, modern winter feeding practice may result in less composting and so solid manure requires longer storage before spreading on farmland (Strauch 1988).

Dokoupil (1964) has indicated that the organism can survive for 176 days in liquid manure in climatic conditions similar to those in Ireland.

Liquid manure appears to constitute a risk since (1) the Tb organism can survive in it for a considerable length of time (2) slurry is generally spread on farmland after a very short storage period and (3) the land application of slurry in Ireland is normally carried out by the high trajectory splash plate method which results in the formation of an aerosol which can drift significant distances to adjoining cattle and grassland. Evenden (1972) reported the recovery of bacteria at least 300 yards downwind from a cattle slurry sprinkler system.

It has been demonstrated that cattle contracted Tb after grazing grassland which had been recently experimentally contaminated with the Tb organism (Maddock, 1934; Schellner, 1956).

While solid manure on Tb restricted farms may constitute a disease risk, it does not appear to be as serious as in the case of liquid slurry. This observation is made since (1) some composting occurs in solid manure which results in the destruction of some microorganisms. This effect may be less significant in recent times since solid manure tends to have a higher moisture content due to increased use of silage feeding and the use of smaller amounts of straw bedding; (2) solid manure is normally stored from spring to autumn i.e. at least seven months before land application, and (3) the spreading of solid manure does not create an aerosol which could drift to adjoining cattle and grassland.

Research Projects

Two initial projects were carried out at Johnstown Castle, Co. Wexford in conjunction with Teagasc and the Faculty of Veterinary Medicine, U.C.D. These were (1) a study of the dispersal of bacteria while landspreading slurry and (2) an evaluation of the effects of dressing grassland with chemically treated slurry. More recently the chemical treatment of slurry at farm level was investigated.

Project No. 1. A study of the dispersal of bacteria while land spreading slurry.

(A) The survival and dispersal of bacteria when spreading slurry. A marker organism Serratia rubidaea, was seeded into slurry in a slurry spreader. Agar plates were placed on the ground at various distances downwind from the slurry spreader. After the slurry was spread the plates were collected, incubated and colony counts taken.

¹ Faculty of Veterinary Medicine ² Teagasc
(B) The effect of slurry spreader type on the dispersal of bacteria. Five different slurry application methods were assessed:

1. Shallow injection spreader.
2. Band spreader.
3. Low trajectory splash plate spreader.
4. High trajectory splash plate spreader.
5. Raingun spreader.

Slurry seeded with the marker organism was used to measure the extent of bacterial dispersal. Six replications were conducted in a range of weather conditions.

(C) The effect of windspeed on bacterial dispersal. This was assessed by conducting the slurry spreading at a number of different maximum windspeeds ranging from 1.0 to 13.8 metres/second.

Results

1. The survival and dispersal of bacteria in slurry was demonstrated by the recovery of the marker bacteria in the agar plates.
2. Marker bacteria were dispersed by and recovered from all five spreaders in windy conditions. In calm weather no dispersal was recorded for the shallow injection and hand spreaders.
3. The shallow injection and band spreaders reduced bacterial dispersal to a significant extent compared with the two splash plate methods and the raingun (Fig. 1).
4. There was no significant difference between the low trajectory splash plate and the high trajectory splash plate methods.
5. The raingun resulted in significantly greater drift than the two splash plate methods.
6. In windy conditions, marker bacteria were recovered at the maximum distances at which agar plates were located i.e.

| Low splash plate | 200 metres |
| High splash plate | 300 metres |
| Raingun          | 800 metres |

7. In windy conditions, marker bacteria were recovered from the injection and band spreaders at 50 metres downwind but not at 100 metres, the maximum distance measured.

8. In general, marker bacteria were recovered in greater numbers and at greater distances from the slurry spreaders in windy conditions (Fig. 2).

9. Windspeed had a statistically significant effect on the distance at which marker bacteria were recovered from both the raingun and the injection spreaders.

10. The recovery of higher numbers of bacteria at greater distances in windy conditions did not translate into a statistically significant effect in the case of the other three slurry spreaders. This may be due to the trial being confined to six replications and the variation in windspeeds within replications at which the different spreaders were tested.

Project No. 2. An evaluation of the effects of dressing grassland with chemically treated slurry.

The chemical treatment consisted of adding lime to slurry before spreading it on grass plots. In Germany it is mandatory to treat slurry on TB restricted farms with thick lime milk before land application Strauch (1980). The purpose is to raise the pH of slurry from approximately 7.0 to at least 11.5 and maintain it for four days. This process results in the inactivation of microorganisms.

Two different forms of lime were used in this study:

1. Hydrated lime powder
2. Thick lime milk (1 part hydrated lime : 3 parts water).
Experimental grass plots were dressed with one of the following (1) untreated slurry (2) slurry treated with hydrated lime powder and (3) slurry treated with thick lime milk.

Each slurry treatment was applied by three different slurry spreaders:—

(a) splash plate;
(b) shallow injection; and
(c) band spreader.

The grass plots were harvested approximately nine weeks after slurry application and the following were measured:—

1. Grass dry matter yield.
2. Silage quality. This was assessed by packing grass into laboratory silos and analysing the silage subsequently.

Results

1. Silage quality was not significantly effected by the application of slurry which has been treated with either thick lime milk or hydrated lime.
2. The dry matter yield of grass was not adversely affected by the application of slurry treated with hydrated lime.
3. The dry matter yield of grass was not affected by the application of slurry which had been treated with thick lime milk and applied with a shallow injection or a band spreader. However, when this treatment was spread on grass with a splash plate spreader, the dry matter grass yield was depressed by 8%. It is difficult to explain this finding, since the thick lime milk treatment contained the same quantity of hydrated lime as the hydrated lime treatment itself which had no significant effect on yield.

Project No. 3. The treatment of cattle slurry with lime at farm level

(A) Hydrated lime powder trial at Kildalton College, Co. Kilkenny.

A tank containing 20,000 gallons of slurry in a cattle shed was used for this project. The lime which was packed in 25kg bags was emptied through the slatted floor into the slurry tank. The slurry was agitated for a short period before the addition of the lime and for a period each day for four days after the addition of lime. The initial pH of the slurry was 7.2 and this increased to a maximum of 12.2 after the addition of the lime. The quantity of lime required, i.e. 1.8 tonnes, formed a 2.5% solution in 20,000 gallons of slurry. The quantity required was higher than expected, since the equivalent of 2% in the form of thick lime milk is stipulated in the German regulations. Perhaps a higher standard of agitation than that attained at Kildalton might have resulted in a more thorough mixing of lime and slurry and a higher pH at the 2% concentration. However the standard of agitation used was typical of that on many Irish farms. A 2% solution increased the pH to 10.5 while a 2.25% concentration resulted in pH of 11.4.

(B) Thick lime milk treatment trial at Johnstown Castle.

A tank in a cattle shed containing 83,000 gallons of cattle slurry was treated with thick lime milk. Thick lime milk is not normally available commercially in Ireland. However, a lime company in Co. Carlow agreed to supply the requirements for this project by blending 7.1 tonnes of hydrated lime in 4700 gallons of water. This quantity resulted in an 8% solution when mixed with 83,000 gallons of slurry.

The slurry was well agitated before the addition of lime and then for a period each day for 4 days afterwards. The pH of the slurry was increased from 7.4 to a maximum of 12.4 after the addition of the lime. The pH dropped to 12.2 on the fourth day which was well above the 11.5 target figure.

The thick lime milk liquid mixed more quickly with the slurry than in the case of the hydrated lime powder in the other project at Kildalton College. This was possibly due to its more liquid form and also to the use of

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a powerful slurry agitator in Johnstown. Thick lime milk, however, is expensive to transport due to the high water content. Hydrated lime powder may be a more practical proposition but requires very good agitation and may involve the use of a higher concentration of lime as instanced in the study at Kildalton.

The slurry from both locations was spread on farmland one week after treatment without difficulty. It is advisable to avoid undue delay between lime treatment and land application so as to prevent the lime setting in the bottom of the tank and becoming difficult to pump (Thungeard, 1975).

Conclusions

1. The published evidence suggests that cattle manure and especially liquid slurry from Tb restricted herds should be regarded as a potential source of Tb.

2. The risk associated with manure from restricted herds can be minimised as follows:-

   (A) Store solid manure from the spring to the following autumn at least before land application.

   (B) Liquid slurry should be subject to one of the following measures:-

      (i) store for at least 6 months, before spreading or

      (ii) Treat with lime before spreading despite the possibility of a relatively small reduction in grass yield or

      (iii) Spread on tillage land or fields closed for a cut of silage using a low drift spreader only, i.e. shallow injection or band spreaders.

In all farm situations it is advisable to confine slurry spreading to calm days.

3. The treatment of slurry in cattle sheds with (i) thick lime milk liquid and (ii) hydrated lime powder demonstrated that lime treatment can be implemented at farm level if it is regarded as being necessary in the future.

4. The recovery of marker bacteria significant distances from slurry spreaders indicates a potential risk of farm stock contracting other diseases in addition to Tb. The use of the splash plate methods on windy days and the raingun in any weather conditions is a cause of concern from the general environmental viewpoint.

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On the persistance of bacteria in manure.  
Figure 1. The effect of spreader type on dispersal of bacteria

![Graph showing dispersal of bacteria based on spreader type.](image)

Figure 2. The effect of wind speed on the maximum distance at which *Serratia rubidaea* were found

![Graph showing the effect of wind speed on the maximum distance.](image)