Cattle slurry contains valuable plant nutrients, in particular nitrogen (N), phosphorus (P), potassium (K) and sulphur (S). When used efficiently as a substitute for bagged fertiliser, slurry has the potential to make substantial savings; the over-winter slurry production from 100 cows is worth over £2,000 as fertiliser. However, pollution of the air and surface waters is a major problem when slurry is mismanaged and nutrients are allowed to leak to the wider environment. Much of the nitrogen consumed in livestock diets is excreted in manure as urea (uric acid for poultry) which is readily broken down to ammonia. With the predominance of livestock farms in the UK, large amounts of ammonia are released from buildings, stores, land-spreading, and from stock kept outside, e.g., cattle at pasture. Indeed, agriculture is the major source of ammonia gas in the UK (accounting for about 80% of the total annual emission) with an emission of about 245,000 tonnes of ammonia-N each year.

Deposition of ammonia-N results in soil acidification of weakly buffered soils resulting in damage of forests, lakes and rivers. This added N also leads to changes in plant community structures on nutrient poor soils with invasion of competitive grasses. There is increasing European pressure to reduce ammonia emissions because of the effects ammonia deposition has on natural and semi-natural ecosystems. International agreements to reduce gaseous emissions within the EU are likely to lead to national regulations in the UK. It may be that the UK will be required to reduce its emissions of ammonia by 15-30% by the year 2010. Already, large pig and poultry farms are regulated by the Integrated Pollution Prevention and Control Directive (IPPC).

**UK Ammonia emissions inventory**

IGER has been responsible for the construction and updating of the UK Ammonia Emissions Inventory in collaboration with ADAS, Silsoe Research Institute and the Centre for Ecology and Hydrology. The Inventory shows that the cattle sector is the most important in UK agriculture in terms of annual ammonia emissions, accounting for 134 kt (54% of the total). Land spreading of manure is the single largest source, followed by animal housing (Table 7.1). Dairy production accounts for a slightly greater proportion of the emission than the beef sector (55

### Table 7.1 Total ammonia emission (kt per annum) from UK dairy and beef cattle

<table>
<thead>
<tr>
<th>Sector</th>
<th>Animal housing</th>
<th>Hard- standings</th>
<th>Manure storage</th>
<th>Land spreading</th>
<th>Grazing</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>19.8</td>
<td>13.0</td>
<td>7.9</td>
<td>26.6</td>
<td>6.8</td>
<td>74.1</td>
</tr>
<tr>
<td>Beef</td>
<td>19.6</td>
<td>6.1</td>
<td>2.8</td>
<td>28.2</td>
<td>3.2</td>
<td>59.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>TOTAL 134.0</td>
</tr>
</tbody>
</table>
and 45% of the total, respectively). Emissions from slurry-based systems tend to be greater than from straw-based systems, particularly from housing.

The focus of this article is the impact of alternative slurry spreading techniques on ammonia emissions, silage quality and acceptance of the sward by grazing cattle. However, options for reducing ammonia emissions from animal houses, hard-standings and manure stores are also being assessed in current research projects at IGER.

**Application of slurry to land**

At the moment, slurry is applied to land using splash-plate spreaders which results in large losses of N to the environment (up to 80% of that applied) and contamination of forage, which grazing animals find unacceptable. Our research at IGER has been exploring options to reduce these problems. In collaboration with ADAS, we have been evaluating narrow-band slurry applicators that have been developed (in a number of European countries), primarily to reduce ammonia emissions after land-spreading (Figures 7.1 and 7.2). Slurry is placed in bands (3-5 cm wide and 20-30 cm apart) either in the soil, via shallow injection, or on the soil surface and below the grass canopy via trailing shoes (trailing shoes are specifically developed for use on grassland).

Ammonia emissions from the reduced surface area of slurry may be 30-70% less (see Figure 7.3) than when slurry is broadcast by conventional methods (i.e., vacuum tanker and splash-plate).

![Image of shallow disc injectors](Image)
Aversion of grazing animals to contaminated silage and pasture

An important additional benefit of these novel slurry application methods is a significant reduction in contamination of the grass with slurry solids. Joint IGER-ADAS research has shown that slurry can be spread at later dates, i.e., closer to cutting without affecting silage quality. Good quality grass silage was made even under extreme conditions, when slurry was applied, by shallow injection or trailing shoe, just two weeks before harvesting (Figure 7.4). As expected, silage made after surface broadcasting at the same time was badly contaminated with slurry and fermentation was poor, indicated by low acidity (i.e., high pH) and low lactic acid.

Contamination of grass may also have a major impact on cattle grazing, following slurry spreading. When beef steers were offered a choice between grazing uncontaminated grass or grass that had been spread with slurry after cutting five weeks earlier, preference was measured as the proportion of time spent grazing either untreated or treated pasture. Results were 48:52 for shallow injection, 51:49 for

![Graph showing reduction in ammonia emissions compared to conventional surface spreading by splash-plate.](image-url)
trailing shoe application, but 61:39 for conventional surface broadcasting for untreated and treated swards, respectively. Thus, slurry application by shallow injection and trailing shoe had little impact on grazing, while there was significant aversion to treated swards in the surface broadcasting treatment. Consequently, it was possible to replace nitrogen fertiliser with slurry in the grazing rotation and make significant savings.

The practicalities of using the new slurry applicators are presently being examined on commercial dairy farms. The benefits identified in the experimental programme have also been confirmed at the farm level. Advantages of the new slurry applicators identified by the farmers and contractors taking part in the project include:

- Conserved nutrients
- Reduced fertiliser inputs
- Reduced odour and associated public nuisance
- Reduced contamination of grass, allowing slurry use on pasture before grazing and at later dates before cutting
- Increased flexibility in rate and timing of slurry application.
- Better uniformity of application

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Figure 7.4 Lactic acid content and acidity (pH) were used as indicators of silage quality when slurry was applied to grassland before cutting.