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# PRACTICAL ASPECTS OF ABATING AMMONIA ON UK FARMS

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**ABSTRACT**

The practicalities of adopting techniques to abate ammonia ($NH_3$) emissions (narrow band slurry applicators, slurry store covers and rapid incorporation of solid manure (FYM)) were examined on commercial livestock farms in England, UK. Four contracting companies also used the novel slurry applicators on three of their customers' farms. The abatement techniques were used successfully on all the farms. In addition to $NH_3$ abatement, these practices impacted on the overall farm business with notable benefits in reduced odour (and public nuisance), fertiliser inputs and crop contamination. Store covers were effective in excluding rain which resulted in a reduced volume of slurry for storage and spreading, reduced spreading costs and more timely application to growing crops in spring. The main disadvantage with both slurry applicators and store covers was the additional purchase cost, and, for the applicators only, increased repair and maintenance costs. Additional costs were incurred on some farms for FYM incorporation.

## INTRODUCTION

Each year about 240 kt of ammonia ($NH_3$) nitrogen are lost from farms in the UK (Misselbrook, pers. comm.) causing acidification of the soil, eutrophication of surface waters and damage to naturally infertile ecosystems such as heathlands. Livestock farming is well recognised as the major source of gaseous $NH_3$. International pressures, through the United Nations Economic Commission for Europe (UNECE) and the EU Integrated Pollution Prevention and Control Directive (IPPC) (EC, 1996), may result in national regulations in the UK within the next few years. Radical changes to the way in which animal manures, particularly slurries, are managed will be required. This paper reports the provisional findings of a three-year contract funded by the UK Department of Environment, Food and Rural Affairs (DEFRA) to examine the practical implications of adopting ammonia abatement measures on commercial farms and their impact on $NH_3$ emissions and the farm economy.

## METHODOLOGY

Three techniques, considered to be appropriate for reducing ammonia emissions on a wide range of farms in the UK, were evaluated:
*Covering slurry stores.* Tensioned, reinforced, vented, polyethylene covers (Wiefferink bv, The Netherlands) were erected on 3 above-ground circular slurry stores and on one earth-banked lagoon.
*Slurry application to land.* Open-slot shallow injectors, and trailing hose spreaders (with shoe attachments for grassland application) were purchased from different manufacturers in Belgium (Joskin), the Netherlands (Duport, Veenhuis) and France (Pichon) since no suitable machines were made by UK companies.

*Rapid incorporation of solid manure (FYM).* Solid manures applied to arable land were incorporated by ploughing on the same day as spreading.

Eleven commercial farms were selected to represent the main types of livestock enterprise (dairy, beef, pig, poultry) and the main types of manure management practice. The farms were situated in various geographical locations throughout England and included high and lower rainfall and heavy and light soil types. Each farmer changed from slurry spreading by conventional surface broadcasting (via a vacuum tanker and splash plate) to one of the new slurry applicators tailored to the specific requirements of the farm. Four above-ground, circular slurry stores were covered, three on dairy farms and one on a pig farm. An earth-banked slurry lagoon was covered on another pig farm. Also, FYM was incorporated within 24 hours when spread on arable land. Detailed records were made each time slurry and FYM were applied to land, information concerning the practical and physical aspects of adopting the abatement methods was collected and the impact of the abatement techniques on farm and manure management, $NH_3$ emissions (using the empirical model 'MAST' with estimates of emission factors for each source provided by the current ammonia emissions inventory) and the farm economy were assessed. On farms with more than one livestock enterprise, $NH_3$ emissions and abatement were calculated for each enterprise and for the whole farm. In addition, four agricultural contracting companies were selected using the same criteria as for the farms. The contractors evaluated slurry applicators only and collected data and opinion from three of their regular customers on each occasion that they were called on to spread slurry.

## PRELIMINARY RESULTS AND DISCUSSION

### Practical evaluation

The new slurry applicators and store covers were used successfully on all the farms and by the contractors. The main benefits and problems in adopting these abatement techniques are summarised in Table 1.

*Table 1. Some benefits and problems associated with the use of narrow-band slurry spreaders and slurry store covers.*

| BENEFITS | PROBLEMS |
|---|---|
| Slurry applicators: | |
| ▪ Reduced odour and public nuisance | ▪ Reduced crop contamination |
| ▪ Reduced fertiliser inputs | ▪ High purchase and maintenance costs |
| ▪ Uniformity of application | ▪ Higher repair costs |
| ▪ Reduced crop contamination | ▪ Greater expertise required |
| ▪ Increased farm fertility | ▪ Field accessibility |
| ▪ More flexible manure management | ▪ Soil damage in summer on heavy soils |
| Store covers: | |
| ▪ Exclusion of rain | ▪ High purchase cost |
| ▪ Less slurry to store and spread | ▪ Greater $NH_3$ emissions from slurries with higher DM content |
| ▪ Reduced spreading costs | |
| ▪ More timely application | |
| ▪ Increased nutrient value | |

*Slurry application*

Although there were additional costs, all the participants were unanimous in wanting to continue with the new spreading methods beyond the end of the project. Improved

efficiency of utilization of slurry nutrients was demonstrated, particularly on dairy farms, with reduced nitrogen fertiliser inputs and/or increased stock carrying capacity. Slurry was successfully applied to grassland prior to dairy cow grazing with no apparent effects on intake or milk yield, with trailing shoe application being most beneficial on taller swards. The novel application methods did not take longer than conventional surface broadcasting. A greater level of expertise was required to operate and maintain the slurry spreaders. Insufficient storage capacity was the main reason why slurry was spread during late autumn/winter, at times when the land was too wet for the slurry tankers to travel and the applicators (particularly injectors) to operate efficiently. Consequently, over all farms, 50% - 100% of slurry was applied with the new applicators.

*Store covers*

Covering slurry stores had a major impact on manure management. The main benefit was a significant increase in the available storage capacity (up to 33% in the highest rainfall area) with the exclusion of rain from the store. Consequently, spreading costs were reduced and more timely application to crops during the growing season was possible. The farmers were able to benefit from the higher nutrient value of a higher dry matter product and made allowances for this with reduced inorganic fertiliser inputs.

*Rapid incorporation*

Rapid incorporation of FYM was already practised on some of the farms. Commonly, the manure was transported from animal houses and stored in heaps in the field subsequent to spreading, ploughing and sowing, with these operations being carried out on the same day. Small amounts of semi-liquid and solid manure were collected daily on some farms and spread throughout the winter period (particularly on maize land on dairy farms). Rapid incorporation was not always carried out in this scenario. Consequently, the proportion of FYM incorporated on the same day as spreading varied from 50% to 100% between farms.

**Ammonia abatement**

Preliminary results were variable between farms with the same stock and between farms with different stock classes. On dairy farms, emissions were reduced over the range 10-48% for grass fertilizer application, 5-77% for slurry storage, 44-74% for slurry spreading and 3-55% for FYM spreading. Corresponding reductions for pig farms were 67-69% for slurry storage, 21-77% for spreading and 24-55% for FYM spreading. Reductions for FYM incorporation on poultry farms were 65% for laying hens and 90% for broilers and on beef farms over the range 25-55%. Mean whole-farm emissions for each of the main stock enterprises (Table 2) show overall reductions of 45%, 16%, 25% and 10% for dairy, pig, poultry and beef farms, respectively. Corresponding reductions per livestock unit were 13 kg, 7 kg, 12 kg, and 1 kg.

*Table 2. Preliminary estimates of overall mean $NH_3$ emissions before and after abatement. The results are reported on a 'per farm' and 'per livestock unit (LU)' basis for each stock class.*

| Stock class | Per farm (kg) | | Per LU (kg) | | Reduction (%) |
|---|---|---|---|---|---|
| | Before | After | Before | After | |
| Dairy (5) | 6805 | 3761 | 31 | 18 | 45 |
| Pig (4) | 34356 | 28745 | 30 | 23 | 16 |
| Poultry (2) | 66635 | 50271 | 26 | 14 | 25 |
| Beef (3) | 2059 | 1843 | 12 | 11 | 10 |

Number of farm units in parentheses.

**Economic evaluation**

Preliminary results show that the estimated additional annual cost of adopting the new slurry applicators and store covers was Ł3835 for dairy farms and Ł4559 for pig farms, an overall average increase of 128% compared with the previous costs of slurry broadcasting. The average cost of abating ammonia was higher for dairy (Ł1.90/kg $NH_3$) than pig (Ł1.00/kg $NH_3$) farms (range: Ł0.50-Ł5.30/kg $NH_3$ for dairy farms; Ł0.30-Ł1.50/kg $NH_3$ for pig farms). Additional costs for contractor support were incurred for the rapid incorporation of FYM on a farm where beef was the main enterprise and a poultry (broiler) farm.

## CONCLUSIONS

- The $NH_3$ abatement methods have significant potential to reduce ammonia emissions.
- The new slurry applicators were used successfully on all the farms.
- Benefits in more flexible manure management, reduced fertiliser inputs, greater stock carrying capacity, increased farm fertility, uniformity of application and significantly reduced odour and public nuisance were identified.
- Purchase, repair and maintenance costs were all significantly greater than for conventional slurry application methods.
- Insufficient storage capacity was a main reason for continued dependence on slurry broadcasting during winter.
- Rapid incorporation of solid manure was weather-dependent.
- Covering slurry stores significantly reduced the volume requiring storage and generated savings in spreading costs and a greater efficiency of utilization of a more valuable (higher DM) product.
- Increased farmer awareness of the basics of good manure management is essential.

## REFERENCES

EC (1996). Council Directive 96/61/EEC on Integrated Pollution Prevention and Control. Official Journal of the European Communities, No L257, Vol. 39, Brussels