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Agricultural Development and Advisory Service (A.D.A.S.) recommendations to farmers on manure disposal and recycling

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Farm animal excreta may fall directly on grazed crops or be collected from housed animals as semi-liquid slurry or more solid manure. Estimates are given of the total amounts of N in animal excreta in the U.K. and in the various forms in which it may be collected from housed animals. The factors affecting the losses of N from stored manures and the availability to crops of the N content of manures are reviewed. The optimum use of the N content of manures as a crop nutrient is discussed in relation to practical farming problems including the costs to farmers of storing manures and slurries, the difficulties of applying these materials to land at particular times of the year, and the risks of causing pollution of water.

Introduction

Farm animal faeces and urine, which together are commonly referred to as excreta, may be collected in semi-liquid form known as slurry or mixed with straw or similar bedding to form farmyard manure (f.y.m.). Most poultry excreta is now removed from the housing in fairly dry form as a result of in-house drying of the initially produced slurry or because the excreta is mixed with litter such as sawdust.

Slurries and manures applied to land can have a number of beneficial effects including providing nutrients to crops, improving soil structure and improving the moisture-holding capacity of the soil. Bulky manures generally have greater physical effects on soils than slurries. The use of manures and slurries can also cause pollution problems especially with surface water and in relation to odours. This paper is concerned only with the relevance of the management of slurries and manures to the nitrogen cycle considered in the context of the total amounts of N in excreta, including those dropped by animals while grazing.

Quantities of nitrogen in animal excreta

Table 1 shows the numbers of animals on farms in the U.K. during the period 1950–80. While the numbers of cattle, sheep, pigs and poultry all increased over the 30 year period, only the number of sheep increased considerably between 1970 and 1980.

The total amount of N in excreta produced by farm animals represents a considerable proportion of the total N cycling in the environment. The N content of slurries and manures can vary widely, both between species and within species depending upon the circumstances of the excreta production and storage (Ministry of Agriculture, Fisheries and Food (M.A.F.F.) 1976). However, some average N contents are given in table 2.

The total amount of N in animal excreta in the U.K. can be estimated from data on the N content of the droppings from individual animals of various types and the total numbers of farm animals. It may be calculated that in 1980 about 975 kt of N were produced in farm animal excreta. Of this 600 kt came from cattle, 220 kt from sheep, 70 kt from pigs and 85 kt from poultry.

TABLE 1. TOTAL LIVESTOCK ON AGRICULTURAL HOLDINGS IN THE U.K. (MILLIONS)

year...	1950	1960	1970	1980
cattle	10.6	11.8	12.6	13.5
sheep	20.4	27.9	26.1	31.4
pigs	3.0	5.7	8.1	7.9
poultry	96.1	103.0	143.4	137.9

TABLE 2. AVERAGE TOTAL NITROGEN CONTENT OF MANURES AND SLURRIES

	nitrogen (%)	dry matter (%)
cattle f.y.m.	0.6	25
pig f.y.m.	0.6	25
poultry broiler litter	2.4	70
battery hen droppings (in-house air dried)	4.2	70
cattle slurry	0.5	10
pig slurry	0.6	10

EXCRETA PRODUCTION BY HOUSED ANIMALS

Virtually all excreta from sheep and about half of that from cattle is dropped on to grass while the animals are grazing. The remaining excreta is collected in stock housing and yards. Thus the latter accounts for about half the cattle droppings (mostly from animals housed over winter and cows during visits to dairies for milking). Nearly all pigs and poultry are also housed. The total quantities of N potentially available for spreading in manures and slurries are therefore: cattle 300 kt, pigs 70 kt, poultry 85 kt. Droppings can be collected in semi-liquid slurry form or in relatively dry manures as described earlier. Estimates of the amounts in liquid or dry form are not readily available for the whole U.K., but in England and Wales it has been estimated that about 70% of housed cattle droppings are collected as slurry, while the remaining 30% are collected as f.y.m. With pigs in England and Wales roughly equal proportions of droppings are believed to go to slurry and f.y.m., while 90% of poultry droppings are now collected in dry form. In terms of the total tonnage of N in droppings from housed animals, roughly half is collected as slurry and the rest is eventually collected in dry form, i.e. approximately 165 kt in each case. Of the slurry N, 140 kt, 85%, comes from cattle.

STORAGE LOSSES

Losses of N occur when slurry or manures are stored. With over-winter storage, 10–20% of the N may be lost from slurry to the atmosphere as ammonia or other compounds. More is lost if the slurry is agitated to discourage the formation of a surface crust or if the material is aerated to decrease odour problems. N can also be lost by leakage and leaching from poor storage conditions. In relation to losses to the atmosphere, the maintenance of the material in

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a pumpable state or the reduction of odours will often be of more importance than the saving of a limited amount of N. Losses will also occur from stored f.y.m. Losses to the atmosphere can be reduced by keeping the manure compacted. Leaching can be avoided by keeping the manure on an impervious base and providing cover.

Availability to crops

Not all of the N in excreta returned to land is available to crops in the season of application. It can be lost back to the atmosphere as ammonia or other gaseous forms of N, or leached away or incorporated into soil organic matter. This applies just as much to droppings from grazing animals as to returned manures.

With grazing animals, when droppings are produced in cool wet weather this can result in much of the ammonium-N being washed into the soil where it will be held available to crops at least for a time. Hot dry weather can result in much of the NH_4-N being lost to the atmosphere. Faeces remaining on the soil surface decompose, releasing ammonia as well as oxides of N and N_2. Also, the uneven distribution of droppings detracts from optimum crop response. Hence, the response of grass to the N in droppings is often very small.

Table 3. Relative effectiveness of manure N compared with inorganic fertilizer N

	effectiveness (%)
cattle f.y.m.	25
pig f.y.m.	25
poultry broiler litter	60
battery hen droppings	60
cattle slurry	50
pig slurry	65

With manures and slurries, optimum crop response to the N content is obtained with application in the spring. Table 3 gives the relative effectiveness of manure or slurry N compared with inorganic fertilizer N, when application is made at the optimum time in spring and under optimum conditions.

When slurry is applied in autumn or early winter, there is virtually no effect from the slurry N on crops in the succeeding year. Most of the effect of manure N is also lost after autumn applications. Applications in mid to late winter result in intermediate effectiveness. The lack of complete effectiveness even in spring is in part due to some N remaining in organic form and unavailable to plants. Some of this N may benefit crops in succeeding years. Other N may be lost to the atmosphere, as has been mentioned with droppings of grazing animals. Evidence has accumulated over the years and especially recently in a current and as yet uncompleted series of A.D.A.S. trials that N effectiveness with cow slurry applied in spring is often below the 'optimum' figure of 50%. There is some evidence that in some circumstances dilute slurry applied to grass may be less liable to N loss than more concentrated slurry, possibly because nutrients from the former are carried more readily into the soil. Clearly this only applies where appreciable leaching or run-off does not occur. Much of the loss of N from autumn and early winter applications of slurry probably results from leaching by rain water.

Summer applications of slurry to grass give very variable results in terms of the effectiveness of the N content. A high proportion of the N is often lost to the atmosphere, especially in dry weather conditions.

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Practical farming problems

Among the many A.D.A.S. publications for farmers are booklets on the profitable utilization of manures (M.A.F.F. 1980*a*) and advice on avoiding pollution (M.A.F.F. 1980*b*). There can be conflicts between different considerations in giving advice to farmers.

As has been indicated, much of the slurry is produced from cattle enterprises and hence is potentially available for spreading on grass. Storage of slurry over winter is often desirable to avoid pollution of water, but the cost of providing the storage can normally only be covered in part by the value to the farmer of the N which would be leached away after regular spreading during winter. Moreover, there may be a very short period of time in spring when slurry can be applied for the maximum effectiveness of the N content, after the risk of run-off from wet soil has diminished and before the risk of excessive losses to the atmosphere increases. The K content of the slurry can also give rise to problems. If the farmer attempts to spread the whole winter's production of slurry in a short time in spring, the resulting high K content of the herbage can lead to the disease hypomagnesaemia, a disorder of magnesium intake, in cattle consuming the crop. Heavy applications of slurry to grass in spring will therefore often not be in the farmer's best interest. If he avoids this period for spreading the bulk of his slurry, from his point of view the difference in crop response may not be great when comparing spreading in winter and storage and spreading in summer, although the fate of much of the slurry N will differ in the two cases.

Application of slurries or manures to arable land is often only practicable in autumn, especially when the crops are autumn sown. Because of the sensitiveness of cereal yields to the amount of N applied and the unreliability of organic manures as sources of N, A.D.A.S. does not encourage the use of slurry or manure as the primary source N for spring top dressing of cereal crops.

Almost all of the droppings produced by housed farm animals in the U.K. are recycled to crops. However, as the foregoing discussion shows, optimization of the beneficial use of the N content of manures and consequent savings in inorganic fertilizer usage is not a simple matter. Frequently the deciding factor in decisions on the recycling of slurries and manures to land will be the need to avoid pollution of water or odour problems.

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