SURVEY ON MANURE MANAGEMENT: A VALUABLE TOOL TO ASSESS AND OPTIMISE FARM NUTRIENT CYCLING AND MINIMISE EMISSIONS

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ABSTRACT

The assessment of the impact of farm manures on ammonia and other environmental emissions is severely limited by the lack of reliable data on current manure management practice. To provide such data, representative surveys on farm and manure management were recently conducted in Switzerland and the UK. Thanks to the stratified structure of the representative survey it was possible to make detailed differentiated assessments (either geographical or farm type basis) of the impact of a wide variety of farm management practices. This is valuable for the assessment of ammonia emissions and other environmental risks and for predicting the potential benefits of legislative action or incentives. Moreover, if the survey can be repeated at regular intervals, the development of farm management practices can be studied over time. Regular surveys on farm and manure management can be a valuable tool for informing research, extension and policy. To guarantee a full use of the potential of such activities it would be important to initiate them in a coordinated approach across Europe and to repeat them at regular intervals.
Keywords: *Manure management, farming practice, representative survey.*

INTRODUCTION

Agriculture is a major source of emissions to water and atmosphere. To assess the relevance of these emissions as well as the need for, and potential of, abatement measures it is important that agricultural nutrient fluxes and the different forms of emissions can be quantified. For this, it is essential to have reliable information on farm management practice, especially with respect to manure management. Unfortunately, such aspects are not part of the regular official farm census in most countries and such statistical information is therefore generally not available. In absence of such data, nutrient flux calculations and emission estimates are mostly based on expert opinion and experience. Inevitably, such views are relatively crude and subject to personal perception. They can hardly be used to study the development of emissions over time and comparisons based on calculations made with varying underlying assumptions are problematic (Menzi et al. 2004). To overcome this, it is necessary to perform representative surveys. Such surveys were recently conducted in Switzerland and England.

MATERIAL AND METHODS

Swiss survey

The Swiss survey was performed at the end of 2002 in the framework of a project for a new ammonia emission survey (Reidy and Menzi 2003). A twelve-page questionnaire covering management aspects relevant to ammonia emissions (feeding, grazing, livestock housing, manure storage and application) was posted to a representative sample of about 4000 farms. The sample was stratified into three geographical regions (eastern, central and western/southern part of

Switzerland); three altitude zones (valley, hill and mountain zone as defined by the Federal Office of Agriculture); four farm types (cattle farms, crop farms, pig and poultry farms, mixed farms - the latter categories defined by the Federal Research Station for rural economy FAT). The sample size of 6% of all farms or at least 50 farms per class was determined together with statistics experts in such a way that a return of 40% would be sufficient for results to be statistically meaningful. Thanks to a wide-ranging campaign involving promotional activity, several reminders and a lottery for participants, a return of 50% was achieved, and a total of 1950 farms were included in the analysis. Following complementation with livestock numbers and farm area by the Federal Office of Statistics, the survey data was transformed to an anonymous database. Extensive plausibility and integrity checks were used to identify conflicting or wrong information. Nevertheless, the quality of the information proved to be surprisingly good. Statistical analysis was done for individual sample classes as well as for the whole data. Results are usually expressed as weighted averages.

Survey in England

The postal survey conducted in 2001 (Scott et al., 2002) was carried out to provide the agricultural and environmental authorities with evidential data on those aspects of farm practices considered relevant to sustainability. The stratified sample of just over 10,000 farms was grouped into eight main farm types (cropping, cattle plus arable crops, cattle with no significant crops, pigs plus arable crops, pigs with no significant crops, poultry, sheep, mixed livestock). Within the farm type groups, four different farm sizes were differentiated according to Standard Gross Margin (SGM) criteria. From a set of 43 main questions and > 500 subset options, an individual questionnaire was designed for each farm type. The sample size of 1500 randomly selected farms per farm type was chosen to allow an expected satisfactory minimum return of around 27%. However, a return of only 20% was achieved from the initial mailing and, due to the outbreak of foot and mouth disease at the start of the survey, it was agreed that no reminder mailings should be sent out. This return resulted in an effective sample of only 2110 farms, for analysis. An extensive technical review of the data (33% of farms at data entry stage) also proved necessary before any statistical analysis could be attempted.

SELECTED RESULTS

Swiss survey

The results obtained from the survey can be illustrated by the following three examples.

Example 1: While experts for 1995 had assumed 20% of the cattle slurry and 30% of the pig slurry to be stored in open tanks (overall ca. 23%; Menzi et al. 1997), the survey showed this percentage to be about 14% in 2000 (Table 1). The proportion of open stores is highest in the central region and lowest in the eastern region. There also is a gradient between altitude zones (valley zone highest). The high values for the valley and hill zone of the central region can be explained with the fact that diversification with pigs in the sixties and seventies was strongest in these regions. Correspondingly, these farms also had the highest deficit of slurry storage capacity when this became an important issue in the eighties and nineties. For financial reasons they invested in open tanks rather than in the traditional closed pits. Nevertheless, there appears to be hardly any systematic relation between farm type and slurry store cover.

Example 2: Trailing hoses are utilised most in the central and least in the eastern part of the country (table 2). They hardly exist in the mountain zone. As such techniques have not so far been demanded and were not supported with public money in most parts of Switzerland, these regional differences can be seen as an indication that the awareness about the importance of

emission abatement measures is highest in regions with high livestock density (central region). The relatively high value in the hill zone of the West/South region may be explained by the fact that contractors are more common than in most other parts of the country.

***Table 1**. Proportion of slurry stored in open pits in Switzerland in the year 2002 for a) regions x altitude zones and b) region x farm type*

a)region altitude zone	East	Central	West/South	average
Valley	11%	21%	11%	17%
Hills	8%	14%	16%	13%
Mountains	2%	9%	10%	8%
Average	9%	17%	13%	14%
b)region farm type	East	Central	West/South	average
Crop farms	(39%)[1]	0%	0%	15%
Cattle farms	6%	19%	8%	13%
Pig/poultry farms	9%	18%	18%	17%
Mixed farms	8%	12%	12%	11%

[1] *Strongly influenced by one big farm with pigs*

Example 3: As loose housing systems have drastically increased in the past 15 years, the questionnaire asked when such systems had been constructed (where relevant). In 2002, 22% of the dairy cows were kept in loose housing systems; in the year 2000 it was 19% and in 1990 7% (Menzi et al. 1997: 5%).

***Table 2**. Proportion of slurry applied with trailing hose technique in Switzerland in the year 2002 for regions x altitude zones*

Region altitude zone	East	Central	West/South
valley	4%	18%	2%
Hills	6%	14%	13%
mountains	1%	0%	1%

Other important variables studied included livestock housing system, distribution of different manures to grassland and different crops, estimated application rates, grazing etc.

Knowledge as gained from these examples is very important when targeted actions to promote ammonia emission abatement measures should be identified. The numerous request received from other research groups for data from the survey show that a more detailed and reliable knowledge of farm management practice is in high demand.

Survey in England

Examples of the data provided by the survey include slurry storage type (table 3) and manure application time (table 4). Storage is important for many aspects of manure management and impacts on the flexibility of recycling to land and emissions to air and surface water. Above ground (steel or concrete) tanks and unlined, earth-banked lagoons represent the most common storage system for slurries, accounting for >50% of total pig and cattle slurry production. On farms with no storage or estimated <1 month slurry storage capacity (13% and 14% for cattle and pig units, respectively), there must be a relatively high risk of surface water pollution arising from storage overflow during wet weather, or of surface runoff following land application under adverse weather conditions.

Manure application timing is of great importance in terms of the efficiency of N utilisation

by crops and emissions to water, e.g. nitrate leaching risk (Smith et al., 2002). Ammonia emissions, too, may be affected by seasonal effects (Smith et al. 2000), tending to increase following application under hot, dry conditions. Application of FYM in the autumn-winter months is acceptable, since they contain only a small proportion of readily available ammoniacal N (NH_4-N). However, the high proportions of layer manure and broiler litter applied (60%+) between August and January (mostly to tillage ground) are a concern, since high rates of nitrate leaching are likely to occur following application to freely draining soils. Data of this nature help to highlight where and how changes in farming and manure management practice can provide benefits to both environment (reduced emissions) and to the farm business (improved nutrient recycling and reduced fertiliser requirement).

Table 3. *Proportion of cattle and pig slurry stored by storage types.*

Storage type	Cattle slurry %[2]	Pig slurry %[2]
Weeping walls [1]	11	-
Above ground tanks	25	25
Earth-banked lagoons - unlined	28	27
Earth-banked lagoons with plastic or butyl lining	2	2
Storage tanks, pits or channels below buildings	6	26
Storage tanks outside buildings	14	6
No storage or farms with < 1 months capacity	13	14

[1] *Concrete/wooden panel wall construction allowing drainage and separation of liquid fraction*
[2] *Weighted data according to estimated, undiluted slurry production on farms*

Table 4. *Seasonality of application of solid manures and land use (%)*[1].

Manure type and land use		Feb–April	May–July	Aug–Oct	Nov-Jan	Overall
FYM:	Grassland	17	4	9	13	43
	Tillage land	18	6	21	9	54
Layer manure:	Grassland	11	7	8	4	30
	Tillage land	24	2	36	11	73
Broiler manure:	Grassland	12	3	2	1	18
	Tillage land	10	9	56	7	82

[1] *Percentages weighted according to cropping areas treated and estimated application rates*

OUTLOOK AND CONCLUSIONS

Surveys on farm management (especially manure management) can be of great help to assess the strength and weaknesses as well as the scope for improvement of the present situation, both with respect to environmental impacts as the optimisation of the production and for predicting the potential benefits of legislative action or incentives. Moreover, if the survey can be repeated at regular intervals, this will allow the development of farm management practices to be studied over time. Interesting aspects, for example, might be changes in housing systems, in the proportion of livestock excreta gathered in liquid and solid form, changes in land application practice (which crops and seasons, rates etc.), in manure spreading technology and changes in the importance of grazing etc. Such survey data would also allow the interaction between key components of manure management practice to be studied, e.g. storage capacity and application strategy. If comparable surveys were to exist across Europe, they would be an invaluable source of information for researchers, consultants and policy advisers.

Regular surveys on farm and manure management can be a valuable tool for informing research, extension and policy. To guarantee a full use of the potential of such activities it would be

important to initiate them in a coordinated approach across Europe and to repeat them at regular intervals.

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