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MANURE MANAGEMENT IN EUROPE: RESULTS OF A RECENT SURVEY

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INTRODUCTION

Any investigation on potential improvements of manure management must be based on an understanding of the present manure management situation. Information about the types and composition of manure produced, about current storage treatment and spreading techniques, about legislation concerning manure etc. is therefore needed with at least national resolution. Hardly any countries have regular surveys on such topics. The information therefore has to be gathered from national manure experts. Even for them, it often proves difficult to procure "hard data" and they have to rely on qualified estimates. Nevertheless, such information does fully suit the purpose of gaining an understanding of manure management and assessing the potential for improvements.

The information for the present overview on manure management in Europe was primarily gathered through a survey using a questionnaire on the most important aspects of manure management which was distributed to all participants of MATRESA and additional manure experts (especially in non-member countries of MATRESA). Replies were received from the following 27 countries: Austria, Belgium (Flanders), Belorussia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Portugal, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK, Ukraine. Thus the survey practically covers all of Europe except the Balkan states. In the maps presented below, Russia is omitted because it is unknown, how far the data national data received is representative for different regions.

Some additional information could be taken from a survey on solid manure carried out by the working group on solid manure of RAMIRAN in 1997/98 (Menzi et al. 1998). The survey covered the following 16 countries: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Italy, Netherlands, Northern Ireland, Norway, Portugal, Sweden, Switzerland and the United Kingdom.

For both surveys we are deeply indebted to the numerous colleagues who invested a lot of time to provide the requested information.

TERMINOLOGY

In both surveys, the lack of a standardised terminology, especially for manure types, proved to be a major complication. In many countries, depending on housing systems and management, the liquid and solid manure produced contain variable proportions of dung and urine and therefore have a different composition. Under such circumstances, different types of liquid and solid manure should be differentiated. This is common practice in most

countries with existing manure management recommendations and standard value tables. Nevertheless, it proved impossible in the framework of this survey to define and use a standardised definition of manure types across Europe and to assign the information gathered through the questionnaire to such differentiated manure type categories. In the questionnaire, manure types were grouped according to three housing types:

1. Housing systems collecting all excreta in liquid form.
2. Housing systems producing solid and liquid manure.
3. Housing types producing only solid manure (e.g. deep litter systems).

In the presentation of the results below, the information gathered was mostly grouped into "slurry" or liquid manure and solid manure, irrespective of the housing type from which it originated.

TYPE OF MANURE PRODUCED

On a fresh matter basis, the proportion of the total manure produced in the form of liquid manure/slurry and solid manure varies considerably between countries (figure 1). It is highest in the Netherlands with around 95% and lowest, with below 20%, in some Eastern European countries like Ukraine, Estonia or Latvia. In general, the proportion of liquid manure/slurry is high (>65%) in most Central European countries and low in Eastern Europe as well as the UK and France.

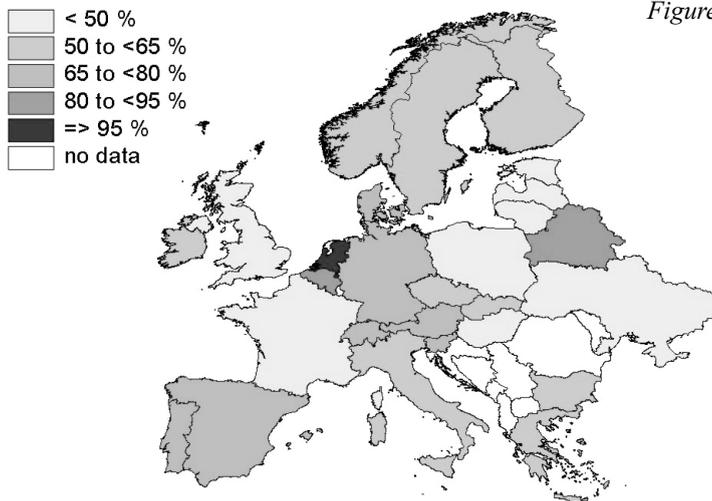


Figure 1: Proportion liquid manure/slurry of the total manure production on a fresh matter basis.

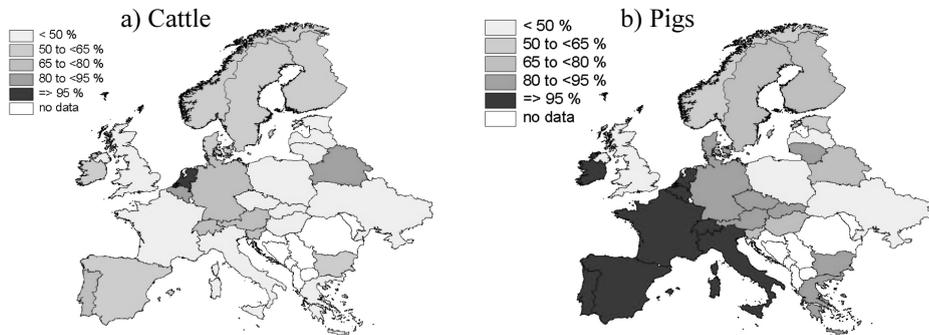
In countries such as the Netherlands, Germany, Denmark, Norway, Italy and Spain the liquid manure mostly contains all the faeces and urine produced by the livestock, whereas a high proportion of liquid manure/slurry is produced together with solid manure in traditional housing systems (mainly tied housing systems for cattle) in Alpine countries (Switzerland, Austria), Northern countries (Finland, Sweden, Lithuania) and Ireland.

For cattle, liquid manure/slurry is the predominant manure type in the Netherlands, Belgium, Portugal, Germany, Switzerland, Austria, Slovenia, Belorussia and Russia, while a high proportion is solid manure in Northern Europe, Italy, France, Spain, the UK and many Eastern European countries (figure 2a). In the UK and Spain, the high

proportion of solid manure is especially due to the higher importance of beef cattle compared to other countries.

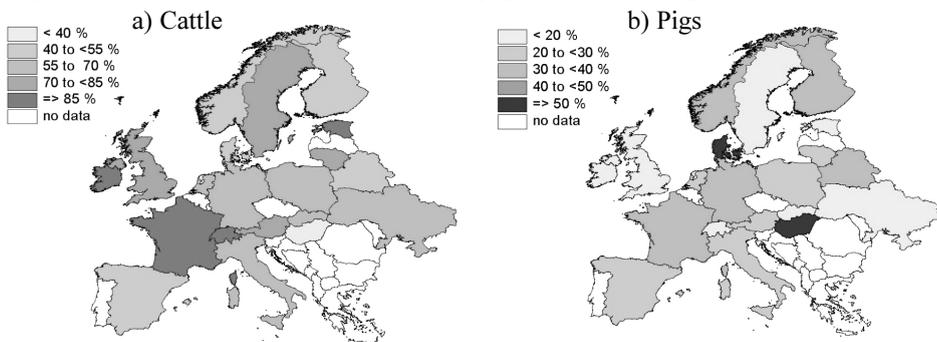
For pigs, liquid manure systems are more common than for cattle in most countries. In Southern and Western Europe (except UK) such systems are responsible for over 80% of the pig manure produced (figure 2b). Only in the UK, Norway and some Eastern European countries the proportion of solid manure is higher than 40%. There appears to be a gradient of high to lower proportion of liquid manure in pig production from the South-West to the North-East.

Figure 2: Proportion of liquid manure and slurry of the total manure production of cattle (a) and pigs (b).



Apart from Denmark and Hungary, cattle produce the largest proportion of the total, national manure production (figure 3). In most countries it is 40-70% of the total production but in Switzerland, Ireland and France it is more than 85%. While dairy cattle is clearly more important than beef cattle in most countries, it is the other way round in Spain and the UK. Pigs contribute more than half of the total manure produced in Denmark and Hungary. In most other countries their contribution is 20-40%.

Figure 3: Contribution (%) of cattle (a) and pigs (b) to the total production of manure.



Looking only at liquid manure/slurry, pigs contribute more than 50% in Denmark and Hungary and less than 10% in Ireland, UK, Switzerland and Ukraine (figure 4). Correspondingly, cattle, especially dairy cattle, are the predominant liquid manure/slurry producers in Switzerland and Ireland, two countries with a high importance of natural grassland. Beef cattle are a major category only in Spain and Italy. Looking only at solid manure, the contribution of cattle ranges from over or around 90% in Ireland, France,

Italy, Switzerland, Austria and Estonia down to below 10% in Spain (figure 5).

Figure 4: Contribution (%) of cattle (a) and pigs (b) to the production of liquid manure/slurry.

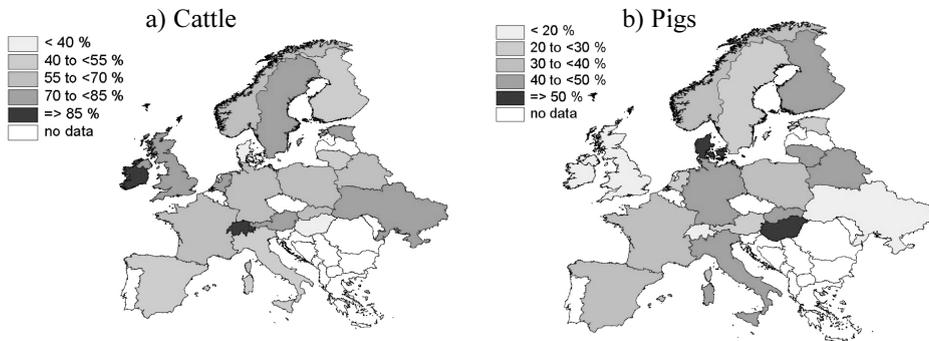
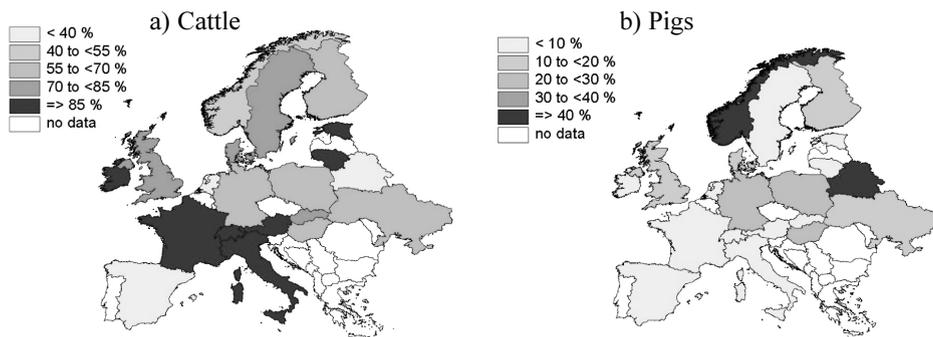


Figure 5: Contribution (%) of cattle (a) and pigs to the production of solid manure.



For laying hens, liquid manure systems are practically non-existent in the UK, Germany, Switzerland, Denmark, Sweden and Lithuania and dominant in France, Spain, Ireland and Austria. For broilers and turkeys only solid manure is produced.

MANURE STORAGE

Liquid cattle and pig manure/slurry is mostly stored in concrete tanks. In the UK tin tanks are most common. In the Netherlands, Ireland and Norway the storage is mostly below the slatted floor of the animal houses. The tanks are mostly uncovered, except in Finland, Netherlands and Switzerland. In Denmark a natural crust is mandatory. Lagoons and lined ponds are especially reported from Greece, Italy (60% of the pig slurry), Spain, Portugal, the UK, East Germany, Hungary and Lithuania. Solid cattle and pig manure is usually stored in heaps on concrete ground, which in most countries and cases has a drainage to the slurry. In the UK weeping walls stores, which allow the seeping-out of the liquid, are also common. Deep litter solid manure is mostly stored in the animal houses until it can be spread. A storage of solid manure in the field is reported from Italy and some Eastern European countries.

Liquid poultry manure is stored below the animals (Norway, Netherlands, Ireland), in tanks or in lined ponds (Spain). Solid manure from laying hen manure belt systems is mostly stored on concrete ground which is reported to be mostly covered in France, Italy, Belgium and Hungary. In the Netherlands the belt drying of the laying hen manure is common and the resulting product is stored in special transport containers. Poultry manure from deep litter systems is mostly applied directly. Poultry manure storage on non-lined surfaces is only reported from Portugal and the Czech Republic.

The average storage capacity for liquid/manure/slurry is around 6 months in many countries (table 1), longer especially in Scandinavian countries and shorter in some Southern and Eastern European countries. For solid manure the storage capacity varies from 2 to 12 months. For most countries it is less or equal to that of liquid manure/slurry.

Table 1: Average storage capacity (months) for liquid manure/slurry and solid manure in different countries.

	slurry/liquid manure	solid manure
	months	Months
Austria	4-6	4-6
Denmark	9	7
Estonia	10	8
Finland	8-12	8-12
France	4-6	4
Germany	cattle 5, pigs 7	4
Greece	3-6	6-12
Hungary	3	5-6
Ireland	4	5
Italy	cattle 4, pigs 6	3
Latvia	6	4-6
Lithuania	6	8
Luxemburg	5	3
Netherlands	6	2-3
Norway	8	8
Poland	3	4
Portugal	1-3	no data
Slovenia	6	5
Spain	4-6	2-3
Sweden	6-10	6-10

MANURE TREATMENT

Special treatment (except storage) of liquid manure/slurry is not practiced widely, except of mixing before application. Spain (10% of slurry), Italy (15% of cattle and 40% of pig slurry), Netherlands and the UK report that some slurry/liquid manure is separated. Nitrification/denitrification processes are sometimes used in the Netherlands. Some aeration of pig slurry was reported from France, the Netherlands and Finland. Anaerobic digestion with biogas production is not a major system anywhere, but some plants exist in many countries. In general, treatment is more common for pig slurry than for cattle slurry.

For solid manure no special treatment is practiced in most countries. Some composting is reported from France, some Southern and Eastern European countries and Finland (mainly organic farms), but it is not always clear if an active treatment or just a natural degradation process during storage is meant.

MANURE UTILISATION

The proportion of liquid manure/slurry used on arable crops varies considerably between countries and farms, depending mainly on the proportion of arable land. While 70% or more are used on arable crops in a majority of the countries, the major part is used on grassland in Switzerland, Ireland, the UK, Norway, Lithuania, the Czech Republic, Russia, Greece and on cattle farms in the Netherlands (table 2). For solid manure from cattle and pigs, the proportion applied to arable crops is higher than for liquid manure/slurry. Again a high proportion is used on grassland in Norway, Switzerland, Ireland, the UK, Greece, Russia and on cattle farms in the Netherlands and Sweden. Poultry manure is predominately used on arable crops, except in Ireland, the UK and Greece. In some countries (especially Ireland, Belgium, Italy, Switzerland) up to 40% of it is exported from agriculture (for mushroom growing, combustion etc.). A notable discharge of manure was only reported from Hungary, Poland, Portugal and the UK.

Table 2: Proportion (%) of different types of manure used on arable crops (AC) and grassland (GL) exported (E) from agriculture or discharged (D).

	Slurry/liquid manure				Solid manure cattle pigs				poultry manure			
	AC	GL	E	D	AC	GL	E	D	AC	GL	E	D
Austria	40	60			60	40			95	5		
Belgium (Flanders)	80	20			100				80		20	
Czech Rep	20	80			80	20			90	10		
Denmark	75	25			75	25			95	3	2	
Finland	80	20			90	10			95		5	
France	80	20			95	5			98	2		
Germany	85	15			85	15			100			
Greece	20	80			20	80			50	50		
Hungary	50	30		20	90	5	5		60	20	10	10
Ireland	5	95				100				60	40	
Italy	70	25		5	90	10			80		20	
Lithuania	10	90			90	10			100			
Luxemburg	30	70			90	10						
Netherlands ¹⁾	35	65			35	35						
Norway	22	78			30	70						
Poland	80	20			90	10			80	10		10
Portugal	20			80	100				100			
Russia	30	70			40	60			100	0		
Slovak Republic ²⁾	80	20			100				100			
Spain	75	25			100				90-100		5	
Sweden ³⁾	na	na			30	70			na	na		
Switzerland	10	90			50	50			50	30	20	
UK ⁴⁾	25	75	<1	<1	50	50	<1	<1	50	40	<1	10

1) Cattle, liquid and solid: 10% on AC, 90% on GL; pigs: 90% on AC, 10% on GL

2) On AC 100% of liquid manure and 60% of slurry

3) Cattle 10% AC, 90% GL; pigs 90% AC, 10% GL

3) Cattle, liquid: 20% on AC, 80% on GL; solid: 40% on AC, 60% on GL;
pigs: 55% on AC, 45% on GL; solid: 80% on AC, 20% on GL

Typical application rates for slurry/liquid manure are in the range of 20-40 m³/ha in most countries (table 3). Higher rates are especially reported from Italy and France, which also have the highest application rates for solid manure. In most countries there appears to be little correlation between the application rate and the dilution of the liquid manure/slurry.

Table 3: Typical application rates of manure in different countries (na: not applicable or no data).

	Slurry/liquid manure		Solid manure	
	arable crops m ³ /ha	grassland m ³ /ha	arable crops t/ha	grassland t/ha
Austria	depending on N-demand	15 (undiluted)	depending N-demand	15-20
Bulgaria	na	na	20-60	na
Czech Rep	30-90	70	20-40	30
Denmark	30-40	40	30	30
Estonia	20-30	20	30-40	20
Finland	20-30	20-40	15-20	15-20
France	40-80	30	40-80	na
Germany	10-40	10-40	15-30	15-30
Hungary (GB)	30-200	30-200	30-40	na
Ireland	22	33	na	30
Italy	100-120	80-100	40-60	na
Latvia	20-35	20-40	na	na
Lithuania	30-40	15-40	30-50	na
Luxemburg	25	20	30	na
Netherlands	30-40	30-40	20	30
Norway	35	35	35	35
Poland	55	55	30	30
Russia	20	30	20-30	20-30
Spain	30-50	na	25-35	0
Sweden	na	na	20-30	15-25
Switzerland	50-60	20-40	20-40	20-30
UK	40-60	40	50	30

For liquid manure/slurry, surface spreading with splash plate equipment is most common. Low emission spreading techniques (band application with trailing hose or trailing shoes, injection etc.) are increasingly used in Central and Northern Europe. Nevertheless, it is the predominant equipment only in countries demanding it by legislation (mainly Netherlands, Denmark, Southern Sweden). In Southern countries, strongly diluted slurry (especially pig slurry) is sometimes spread in combination with irrigation.

Solid manure is spread with different rear and side discharge equipment.

Most countries report that manure nutrients are at least partly accounted for in fertilisation. Nevertheless, the actual reduction of mineral fertiliser use when manure is also applied appears to be quite low in practice. This was especially reported from the UK and Ireland but is probably similar in many countries, unless legal restrictions exist and are enforced. Such legislation exists in various countries (e.g. Netherlands, Denmark, Germany, Switzerland). The strictest rules are probably applied in Denmark and Switzerland where in the mandatory (for most farms) nutrient balance up to 70% of the nitrogen in liquid manure/slurry and up to 40% of the total nitrogen in solid manure is counted as plant available within the year of application and the following year.

MANURE COMPOSITION

While guide values for the composition of different types of manure exist in most Central and Northern European countries, they do not in most of Southern and Eastern Europe. The method to derive such guide values varies from country to country. While some are based on average values of analysed samples, others are derived from or verified with data on the nutrient excretion of different livestock categories and quantities of manure produced. In Sweden a model for calculating the fertiliser value of manure and nutrient balances is offered to farmers instead of standard values.

The values on the composition of manure vary considerably between countries (table 4). A part of this variability is due to differences in the production technique (animal feeding, housing and storage systems, dilution of liquid manure/slurry etc.). Nevertheless, unclear definitions for manure types and a lack of differentiated guide values are also responsible for a part of the variability. For example, many countries give the same composition values for liquid manure containing all excreta and slurry which is produced besides solid

Table 4: Average and range of composition values for different types of manure reported from different countries.

		DM	OM	N	NH ₄ -N*	P ₂ O ₅	K ₂ O	Mg
		g/kg or kg/t or kg/m ³						
Liquid manure/slurry								
Cattle	Average	67	57	4.0	2.3	1.4	5.1	0.5
	Range	15-123	10-75	2.0-7.0	1.0-4.9	0.2-6.0	2.6-9.5	0.2-1.3
pigs	Average	52	38	4.8	3.4	2.1	3.2	0.6
	Range	15-92	5-64	1.2-8.2	1.9-6.1	0.3-5.0	0.6-8.0	0.1-1.8
poultry	Average	170	122	11.2	5.3	8.6	5.3	1.5
	Range	10-300	20-198	2-18	1.9-7.8	0.9-15	2.5-9.0	0.2-3.6
Solid manure								
Cattle	Average	207	165	5.2	1.4	2.4	6.1	1.1
	Range	140-300	140-200	2.9-8.1	0.3-3.2	1.1-4.8	3.6-12	0.7-2.1
pigs	Average	238	161	6.8	2.2	5.4	6.3	1.5
	Range	150-330	130-245	3.5-11	0.5-6.0	1.7-15	2.8-16	0.9-2.5
poultry	Average	455	347	22.5	6.2	16.7	13.3	3.3
	Range	220-700	180-560	10-58	2.4-18	6.2-39	5.0-52	1.5-6.5
Results of solid manure survey RAMIRAN								
Cattle	Average	22.3		4.8	1.3	3.0	5.7	1.1
	range	16-43		2.0-7.7	0.5-2.5	1.0-3.9	1.4-8.8	0.7-2.1
Pigs	Average	23.8		6.8	2.4	6.2	4.9	1.4
	range	20-30		4.0-9.0	0.7-6.0	1.9-9.2	2.5-7.2	0.5-2.5
Laying hens	Average	40.6		23.6	10.9	16.6	10.7	3.1
	range	22-55		5.1-25	37-60	8-27	6-15	1.2-6.0
Broilers	Average	60.3		24.5	8.0	18.5	17.1	4.2
	range	45-85		218-40	2.0-15	6.9-25	6.7-23	2.5-6.5

manure or for dairy and beef cattle. As the variability is about the same for the composition on a fresh matter basis as on a dry matter basis, differences in the solid matter content can not be made responsible for the great general variability. For solid manure, but not for liquid manure/slurry, the variability is greater for pig and poultry than for cattle.

The average as well as the range of the composition values for solid manure derived from this survey and of the one performed in the framework of RAMIRAN some years back are well comparable.

Analysing only the data from countries where different composition values are given for dairy and beef cattle as well as for laying hens and broilers (table 5), shows that:

- manure from beef cattle tends to have a slightly higher nutrient content than that of dairy cattle. For liquid manure/slurry this differences is mainly due to the higher dry matter content of the beef cattle liquid manure.
- Broiler manure has a higher dry matter and thus nutrient content than laying hen manure. On a dry matter basis, only the N and K₂O content is greater for broilers.

Table 5: Average composition of dairy and beef as well as broiler and laying hens manure.

		DM	OM	N	NH ₄ -N*)	P ₂ O ₅	K ₂ O	Mg
		g/kg or kg/t or kg/m ³						
Liquid manure/slurry								
dairy cattle	Average	61	38	3.7	2.2	1.3	5.1	0.4
beef cattle	Average	76	52	4.6	2.6	1.6	5.3	0.6
Solid manure								
dairy cattle	Average	201	165	5.1	1.2	2.4	5.8	1.0
beef cattle	Average	206	157	5.4	1.7	2.3	6.0	1.1
Laying hens	Average	402	299	26	4.8	15	9.8	2.6
Broilers	Average	539	426	50	7.6	19	18	4.2

A dilution of the liquid manure/slurry is reported from most countries. In many cases it is at an average around 1:1 (part water : parts undiluted slurry). This dilution is not usually due to an intentional adding of water, but by collecting waste water in the slurry pit. Only from the Netherlands it was reported that liquid manure/slurry is usually not diluted.

SUMMARISED CONCLUSIONS

Manure management is highly variable across Europe due to different housing, feeding and manure handling systems, climatic and structural conditions, tradition etc. A standardised comparison across the whole of Europe is encumbered by the lack of a standardised terminology.

With few exceptions, manure is fully used on crops. Its nutrient content is only partly accounted for in fertilisation (corresponding reduction of mineral fertiliser use) unless this is legally required, which is the case in some Central European and Scandinavian countries (especially Denmark, Netherlands, Switzerland). Liquid manure/slurry is mainly stored in tanks which are mostly not covered. Lagoons are common in Southern and Eastern Europe, but never the major storage system. The storage capacity is higher in Northern than in Southern Europe. Manure treatment is rarely practised. It is more common for pig than for cattle slurry.

The biggest potential for improvement lies in taking better account of manure nutrients in fertilisation. Especially in Southern and Eastern Europe this will still need considerable investments in more detailed and reliable recommendations and planning aids. There is a considerable potential of improving manure management through a more intensive exchange of national experiences, especially concerning extension work and aids and policy aspects.

Without doubt, there still is a need of more research concerning manure. Nevertheless, this is of secondary importance compared to the lack of transferring the scientific knowledge into actual farming practice.