Managing **Livestock Manures**

Managing Manure on Organic Farms

Booklet **4**

ADAS

Funded by the Department for Environment, Food and Rural Affairs (DEFRA)

2002

What is this booklet about?

Livestock manures are a valuable source of nutrients in many organic rotations. Making best use of these nutrients:

- contributes towards economic sustainability
- minimises pollution of the wider environment.

Booklet 4

This booklet draws on scientific research undertaken in the last 10 years, much of it in the UK, and most of it funded by DEFRA (formerly MAFF).

This booklet:

- provides information on typical nutrient contents of livestock manures – from organic and 'conventional' sources
- describes the availability of manure nutrients to the growing crop
- outlines best management practices to optimise manure nutrient supply
- discusses environmental protection and other manure-related issues.

Summary: effective manure management entails:

1 Valuing all manure nutrients.

2 Taking steps to reduce losses of nutrients from animal housing and during manure storage, e.g.

- collect dirty water
- ensure adequate straw is used for bedding
- cover manure heaps.

3 Knowing the nutrient content of your manures:

- use published standard values for general planning
- consider periodic analysis of manures.

4 Calculating a nutrient balance to compare manure nutrient supply with crop removals.

5 Applying evenly and at known application rates.

6 Adopting methods to reduce nitrate leaching and ammonia volatilisation, e.g.

- wherever practical, avoid late summer or early autumn manure applications
- wherever practical, incorporate the manure rapidly into the soil surface.

Contents

Convention used in the booklet:

Manure – all animal manures, no matter how treated (FYM, slurries and composted manures)

Solid manure – FYM and poultry manures that have not received active composting

Slurry – a mixture of faeces, urine and water, with no significant quantities of bedding (<10% dry matter)

Composted manure – manures that have been actively composted to produce a dark, friable, stabilised, high dry matter final product

N=nitrogen, P=phosphorus, K=potassium. P and K nutrient values are normally expressed as their oxides: phosphate, P_2O_5 or potash, K_2O (Appendix III has conversion factors)

Important forms of N include: ammonia (NH_3), a gas; ammonium (NH_4^+), the ionic form found in soil, but rapidly converted to nitrate (NO_3^-); nitrous oxide (N_2O), a gas.

Although guidance in this booklet is considered best practice, if considering any significant change in manure management, always consult your Sector Body.

1 The nutrient value of manures

Factors affecting composition

Animal manures are an important source of organic matter and plant nutrients. Knowledge of manure composition is an important part of good management, either when importing manure onto the farm or transferring nutrients around the farm. Many factors affect the nutrient content of animal manure:

- the livestock diet – affects the amount of nutrients excreted
- feed quality – influences the partitioning of excreted nutrients between faeces and urine
- bedding material type and quantity
- losses during livestock housing
- manure storage – both length and management.

Animal manures can therefore vary greatly in composition. It is important to know the nutrient content of manure before land application.

You should measure or estimate manure nutrients, not rely on 'experience' or guess work. You can:

- Refer to 'standard values' – these are useful for general planning purposes. These are based on the analysis of large numbers of samples. Values for conventional manure are given in **Table 1**. Values for manure produced on organic systems are given in **Table 2**, though the latter are based on much less information.
- Sample manures for analysis – as the nutrient content of manures can depend on the individual circumstances of production, it is good practice to periodically sample manure. Careful sampling and analysis can establish typical nutrient values on a farm.

Manure sampling

Sampling must be carried out carefully so that the sample is a true 'average' of the whole store. Particular care must be taken when sampling slurry stores due to the risk from lethal gases and the need to obtain a safe access point in order to take the samples.

Further guidance on sampling can be found in *Managing Livestock Manures*: Booklet 3, *Spreading systems for slurries and solid manures*, (Appendix II).

Laboratory analysis should include: dry matter (DM), total N, P, K, S, Mg and ammonium-N. For well-composted FYM, nitrate-N should also be measured and for poultry manures, uric-acid N.

Table 1 Typical total nutrient content of livestock manures, from conventional systems (fresh weight basis)

	Dry matter (%)	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)	Sulphur (SO_3)	Magnesium (MgO)
Solid manures				kg/t		
Cattle farmyard manure [1]	25	6.0	3.5	8.0	1.8	0.7
Pig farmyard manure [1]	25	7.0	7.0	5.0	1.8	0.7
Sheep farmyard manure	25	6.0	2.0	3.0	ND	ND
Layer manure	30	16	13	9.0	3.8	2.2
Poultry litter	60	30	25	18	8.3	4.2
Duck manure	25	6.5	5.5	7.5	2.7	1.2
Slurries/liquids				kg/m³		
Dairy [2]	6.0	3.0	1.2	3.5	0.8	0.7
Beef [2]	6.0	2.3	1.2	2.7	0.8	0.7
Pig [2]	4.0	4.0	2.0	2.5	0.7	0.4
Dirty water	<1.0	0.3	Trace	0.3	ND	ND

Notes

1) Values of N and K_2O will be lower for FYM stored for long periods in the open

2) Values for typical diluted slurries, pro rata adjustment for nutrient content can be made based on slurry DM

ND = no data: composting can reduce the N content of manures

Source: DEFRA RB 209

Table 2 Typical total nutrient content of livestock manures, organic systems (fresh weight basis)

	Dry matter (%)	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)	Sulphur (SO_3)	Magnesium (MgO)
Solid manures				kg/t		
Cattle farmyard manure (1)	25	5.9	3.1	6.6*	2.3	1.6
Pig farmyard manure (1)	25	6.5	6.1	6.5*	ND	1.7
Slurries/liquids				kg/m³		
Cattle (2)	6.0	2.0	0.8	2.3	0.6	0.4

Notes
1) Values of N and K_2O will be lower for FYM stored for long periods in the open
2) Values for typical diluted slurries, pro-rata adjustment for nutrient content can be made based on slurry dry DM
* Based on English data, European data suggest a K_2O content of 8 kg/t
ND = no data: composting can reduce the N content of manures

Table 3 Speed of manure incorporation required by ploughing to conserve readily available nitrogen

Manure type	Conservation target for available N	
	90%	50%
Slurry	Immediate	6 hours
FYM	1 hour	24 hours
Poultry	6 hours	48 hours

For slurries, laboratory results can be supplemented by **on-farm 'rapid'** N meter measurements of ammonium-N. **A slurry hydrometer** can also be used to estimate DM, total N and P contents.

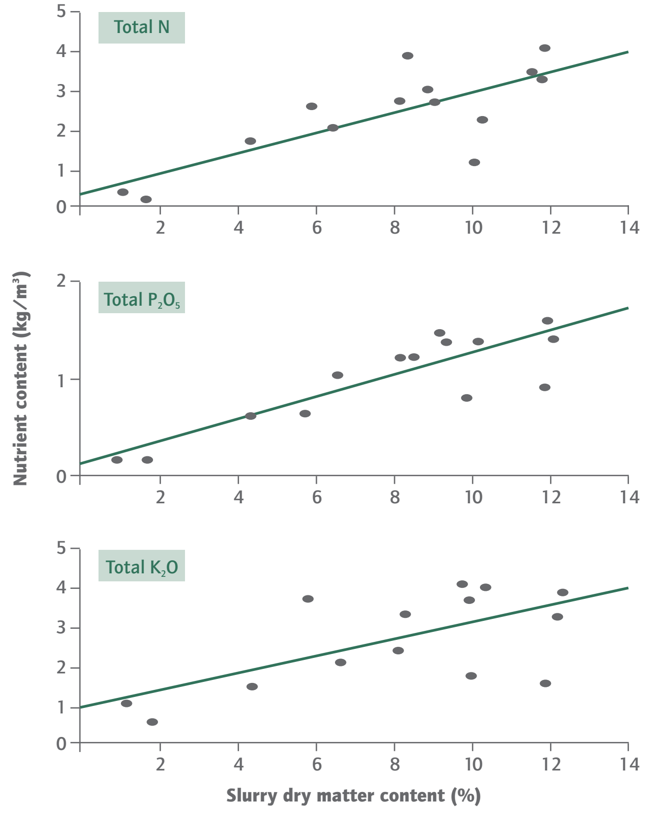
Table 2 indicates that cattle slurry from an organic holding, on average, has a slightly lower nutrient concentration than conventionally produced slurry. On average, there is little difference in FYM from the different systems. However, many factors affect manure nutrient contents on individual holdings. Two key issues to establish are the dry matter content of slurry and the length of storage for solid manures.

The more dilute the **slurry**, the lower its nutrient concentration (e.g. **Figure 1**). Dry matter is not as good a guide for K_2O concentration because this is excreted mainly in urine.

Solid manures lose carbon (as CO_2 and methane) during storage, which can lead to a higher concentration of nutrients over time. Losses will be more rapid if the manure is actively composted. However, concentration may not occur if nutrients are also lost during storage/composting. **Figure 2** shows changes based on manure samples collected from organic farms in England.

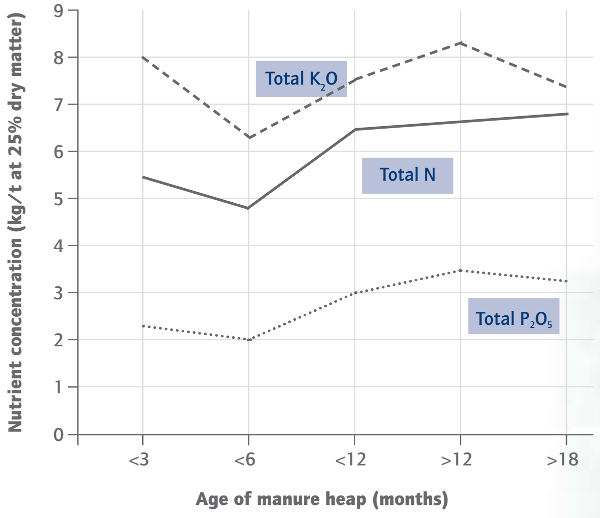
There is little information on the nutrient content of manures from **organic poultry production**. What there is, suggests there

Figure 1 The effect of dry matter content on the nutrient content of cattle slurry



may be little difference to conventionally produced poultry, but it would be advisable to confirm this with analysis. The largest difference may be in the dry matter content of the manure – if it is lower than the standards quoted in **Table 1**, then the nutrient content will be proportionally lower when expressed on a fresh weight basis.

Figure 2 The effect of FYM age on nutrient content, based on a survey of organic holdings in England



2 Nutrient supply to soils and crops

Soil biological activity and soil conditioning benefits

The soil environment is the habitat of a diverse array of bacteria, fungi, protozoa and invertebrate animals (including earthworms), which contribute to the maintenance and productivity of soil-crop systems. These organisms are responsible for the cycling of nutrients through the soil. The majority of this cycling is undertaken by the soil microbial biomass (bacteria and fungi). Organic matter additions, as manure or compost, are a source of energy (carbon) for the soil organisms, helping to sustain their populations and their activity.

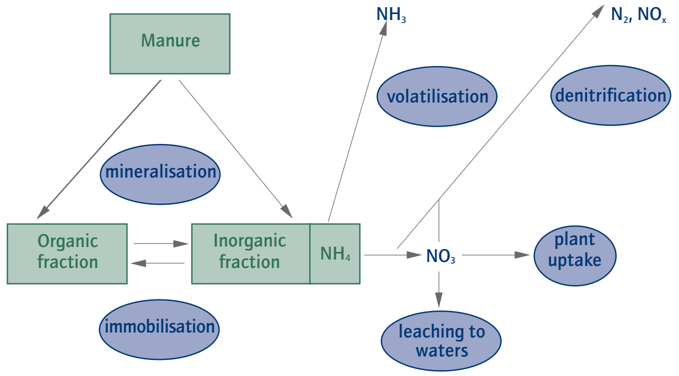
The organic matter added in solid livestock manures and composts also acts as a soil conditioner and improves soil structure, partly because of improved biological activity and partly because of its interaction with soil minerals.

Improvements in biological activity and soil condition are most likely to be achieved in soils receiving regular applications of solid animal manure or compost.

Nitrogen availability

Analysis of manure for the total nutrient content does not necessarily indicate the amounts of nutrients that may be available during the subsequent growing season. In organic systems, a better understanding of manure nitrogen availability will help develop an environmentally sound and sustainable system.

Figure 3 Transformations of manure N after land application



The total N content reflects two N pools within the manure (**Figure 3**):

- 'readily available' (primarily the ammonium-N content and, for composted manures, the nitrate-N content plus, for poultry manures, uric acid-N)
- 'slowly available' (organic N), relying on breakdown and recycling by soil biological activity.

Slurries and poultry manures have a large readily available N content (40–60% of the total N), compared with FYM (10–25% of total N). The rest of the total N contained in manures is organic-N, which will be released (mineralised) slowly (months to years) following manure application. Composted manures tend to have lower available N contents compared with the fresh, source manure.

Readily available nitrogen allows a rapid crop response, whereas the organically bound N is a 'slow release' form. The availability to the growing crop will also be affected by losses via ammonia volatilisation and nitrate leaching. Thus, the amount of crop-available N is affected by many factors including:

- manure type
- duration of storage
- method of application
- slurry DM content
- application timing
- soil type.

Good manure management can increase the potential for N supply from applied manures. This may be important for organic systems where nitrogen shortage is limiting crop production.

Phosphate and potash

Short-term availability of P and K from animal manures is greater than from rock sources. Over a rotation, all of the P and K in manures should become available. On soils with a high reserve of P, the phosphorus from manures should not exceed that removed by crops to reduce the risk of P loss to the environment.

Sulphur and magnesium

Manure also provides a useful source of sulphur and magnesium, which may be deficient in some soils. For cattle slurry, 50% sulphur availability has been measured in the season following application. The remaining organically bound sulphur will become slowly available as the manure is mineralised. Magnesium inputs from manures provide maintenance of soil reserves.

3 Good manure management practices – minimising pollution and using the nutrients

All farmers should follow a Farm Waste Management Plan to help reduce the risk of pollution of water. The plan helps identify areas of land where spreading of slurry or manure should not take place, due to factors such as proximity to water, soil type, slope and drainage. No additional guidelines exist in Organic Standards, but registered holdings are required to avoid pollution from both diffuse and point sources. Following Good Farm Practice is a requirement of the Organic Farming Scheme.

Complaints of smells emitted from manure during housing, storage, treatment, transport and spreading, has become an acute public relations problem. Emissions of odour are highest during manure spreading, but odours may persist for up to 12 hours following application. Organic farms that maintain aerobic conditions (e.g. by composting) should have fewer problems than those using slurry systems.

Using manures on grassland

Cutting grass for silage or hay can remove large amounts of phosphate and potash. Manures are an effective way of replacing these removals – apply solid manures in autumn/winter or slurries in spring.

Most of the nutrients from grass consumed by a grazing animal are excreted back on to the soil, so that the net removal from the field is small. In addition, using manures on grazed swards can lead to problems (disease risk, reduced intake, nutrient imbalances), and is best avoided.

Large applications of N will reduce the clover content of grass/clover swards.

Using manures on arable crops

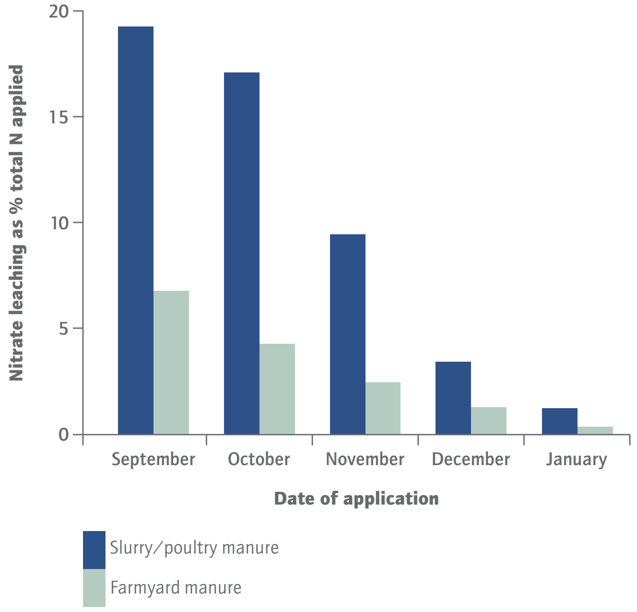
Arable crops will benefit from manure applications. Solid manures could be applied before cultivating the soil – either in the autumn before winter cereals, or in the spring before spring cereals or potatoes, sugar beet etc. Rapid incorporation after application decreases losses of nitrogen as ammonia.

Slurry and poultry manure applications will ensure best use of the nitrogen if they are made in spring before spring crops (again, incorporating rapidly). It is also possible to top-dress growing cereal crops with slurry in the spring.

Application to land

To make best use of the nutrients in manure, in particular N, it should be applied when potential crop uptake is at its maximum and risk of losses are at their lowest.

Figure 4 Nitrate leaching in winter and spring following manure application



Ammonia losses, which are also associated with odour nuisance, can be greatly reduced by incorporating all manures as soon as possible into soil (see **Table 3**) whereas for slurry application to grass, the use of injectors, trailing shoe spreaders and band spreaders should be considered.

The dry matter (DM) content of surface-applied slurry affects ammonia losses – 20% more N is lost from a slurry with a DM of 6% compared to a 2% DM slurry. The lower losses are the result of more rapid infiltration into the soil.

Livestock manures are frequently the greatest source of avoidable nitrate leaching. Where possible, avoid applications during the autumn or early winter period. Delaying applications (in particular those with a high proportion of readily available N) until late winter or spring will increase N utilisation by the crop. **Figure 4** shows the potential nitrate leaching risk associated with manures applied at different times over the autumn/winter period.

Reducing losses of nutrients from manures is a challenge, made more difficult by the interactions between loss pathways and, often, conflicts in best management practices to meet different environmental objectives. There is no simple, single answer. Best manure management to optimise nutrient supply to the soil will generally have the added benefit of reducing environmental impact.

In certain areas, there are restrictions regarding manure application timing and rates. In Nitrate Vulnerable Zones (NVZs), slurries and poultry manures must not be applied to sandy or shallow soils between 1 August – 1 November (arable fields) or 1 September – 1 November (grassland fields). All farmers affected by NVZ conditions will have been notified by the Environment Agency. Other schemes may have different restrictions. Check with Sector Bodies for any specific conditions.

Application rate

Standards laid down by the Sector Bodies will govern maximum application rates of manure. They will not be greater than the maximum annual N loading (averaged over all the agricultural land on a farm) of 170 kg/ha set by the EU Regulation. However, other schemes may have more stringent restrictions: for example, the Soil Association limits the application of manure N on unimproved meadows to 75 kg N/ha/yr.

It is important that slurry or manure is spread as accurately and as evenly as possible. See DEFRA *Managing Livestock Manures:* Booklet 3, (Appendix II) for further information on spreading systems for slurries and solid manures.

Solid manure composting

Composting is actively encouraged on organic farms because it:

- reduces substrate mass
- improves friability and handling characteristics
- destroys weed seeds and potentially harmful pathogens by generating high (60–70°C) temperatures during the process
- provides phyto-sanitary effects on incorporation into the soil
- incorporates inorganic N into the organic fraction, thus protecting from immediate loss after application
- reduces odour and ammonia emissions during land spreading
- concentrates plant nutrients, enabling application rates to be lower and the risk of crop smothering to be reduced.

Different degrees of 'composting' are achieved on-farm during manure storage, ranging from actively managed frequently turned piles, through to simple stockpiles. The degree of composting will impact on nutrient and water losses during storage, and the composition of the end product.

For effective composting, the manure must remain aerobic throughout. This is normally achieved by regular turning or mechanical aeration. As a result of microbial activity, substantial rises in temperatures occur. Temperatures in excess of 60˚C destroy weed seeds, pathogens, chemical residues and antibiotics, and the composting process should aim to achieve this. Sector Bodies may have requirements for manure storage and composting.

The potential benefits of composting may be lost, and harmful environmental impacts caused by poor practice. Increased rates of ammonia volatilisation have been measured, with losses up to 70% of total N. Ammonia emission is dependent upon temperature, initial ammonium-N content, turning frequency, moisture content and the composition of the manure. Ammonia emissions can be reduced by composting manure with an initial carbon:nitrogen ratio >35:1 and by carefully balancing the frequency of turning to meet the conflicting requirements of sufficient aeration and minimum disturbance.

Typically, the final composted product has 85–95% of the total N in organic forms, 5–15% as ammonium-N and 1–5% as nitrate-N.

Slurry aeration

The aim of on-farm aerobic treatment of slurry is to produce a better product for spreading. Slurry aeration is frequently recommended for use in organic systems, but it may be difficult to achieve cost-effectively. Adequate aeration involves dissolving sufficient oxygen in the slurry to convert the anaerobic microbial activity to aerobic (much as composting does for solid manures). The expected benefits are:

- a reduction in ammonium-N content (through nitrification), which results in more positive effects on soils and crops
- removal of pathogens with temperatures between 50 and 60˚C
- an improvement in slurry homogeneity
- a reduction in offensive odours and methane emission during storage and land application.

However, incorrect operation of aeration can lead to increased losses of N (and odours). Some of the potential drawbacks are:

- removal of the surface crust, thereby increasing the risk of ammonia emission
- movement of ammonium-N to the surface, increasing the potential emission of ammonia
- encouragement of nitrous oxide emission through intermittent aerobic and anaerobic conditions.

Although aeration may theoretically be the best approach to slurry management, it is expensive and the potential problems are high.

4 Nutrient planning

Maintaining soil fertility depends on the balance between nutrient inputs (from all sources) and removals in crops and as losses. In many organic systems, manures are valued for their phosphate, potash and organic matter contents, but the nitrogen component should not be forgotten – especially where it is the limiting nutrient on the farm.

Planning at the farm level

- Estimate the nutrients in manures produced on-farm (and in any imported manures) or permitted fertilisers.
- Use standard figures, animal types and numbers to calculate nutrient production on the farm (e.g. Appendix IV). Where possible use actual estimates based on store size and analysis of manures – reliable estimates may require measurements over a couple of years.
- Calculate imported nutrients from manure nutrient content (**Tables 1 or 2**) and weight/volume imported.
- Use these data to plan where the manures would best be used in the rotation, in terms of their nutrient supply.
- Divide total manure N (in kg) by 170 (the application limit in the EU Livestock Directive) to check that your organic unit is large enough to accept the manure.

Planning at the field level

- Know the weight or volume of the manure to be applied.
- Know the nutrients applied to a field by using standard values for nutrient content (**Tables 1 or 2**) or analysing the manure and multiplying by the weight to be applied.
- Decide on the best application time, depending on the type of manure and the crop to be grown.
- Wherever practical, try to minimise losses of ammonia and nitrate, thus conserving nitrogen for use by the crop.

The use of farm balances

Organic systems aim to ensure that soil fertility is at least maintained, without damage to the wider environment. The farm nutrient balance is an important tool to check this. There are several calculation methods, either at the farm or field level. All calculate nutrient inputs (feed, fertilisers, atmospheric deposition, N fixed by legumes, etc.) and outputs (crop and animal produce, nutrient losses etc.). Balances are useful to test if a farming system is viable; a large negative value (removal of nutrients far in excess of inputs) would suggest only short-term sustainability. A small positive value in the balance of N, P and K is probably the ideal.

Ask your Sector Body or consultant for more information about how to calculate nutrient balances.

5 Other materials for use on organic farms

At the time of writing, the import of animal manures from conventional farms is still permitted, provided that these are not highly intensive production units, and that there is adequate land on which to spread the manures. Certifying Bodies require some pretreatment of these manures (e.g. composting or long-term stockpiling), so check the precise requirements.

A number of alternatives to animal manures, as a source of plant nutrients and organic matter, can also be used. A number of organic materials are restricted and some prohibited.

The permitted materials include:

- plant waste materials and by-products from organic food processing
- sawdust, shavings and bark – from untreated wood
- compost activators – microbial and plant extracts
- seaweed.

Materials that are restricted (approval must be obtained from the Organic Sector Body prior to use):

- plant wastes and by-products from non-organic food processing, after being properly composted for 3 months or stacked for 6 months
- mushroom composts made from non-organic animal manure, after being properly composted for 3 months or stacked for 6 months
- worm composts made from non-organic animal manure
- green waste compost, after being properly composted for at least 3 months, and concentrations in the dry matter (mg/kg) not exceeding the following: cadmium 0.7; copper 70; nickel 25; lead 45; zinc 200; mercury 0.4; chromium (VI) 0 (i.e. limit of detection).

Prohibited materials

- sewage sludge, sewage effluents and sludge-based composts.

Further details on materials that can or cannot be applied to land being used for organic farming should be obtained from the relevant Organic Sector Body, details of contacts in Appendix I.

6 Regulations affecting manure management on organic holdings

Organic Certification

The EU Regulation for Organic Production (2092/91) and Livestock (No. 1804/1999) sets down in law that producers must meet standards of production to be classified as 'organic'. UKROFS (The United Kingdom Register of Organic Food Standards) has set production standards in the UK to meet the EU regulations and licenses five 'bodies' that operate primarily in England and Wales to carry out producer inspections and certifications. These bodies are (contact details in Appendix I):

- Demeter Symbol Scheme (Bio-dynamic Agricultural Association, BDAA)
- Soil Association Certification Ltd (SACert)
- Organic Farmers and Growers Ltd (OFG)
- Organic Food Federation (OFF)
- CMi Certification.

SOPA (Scottish Organic Producer Association), IOFGA (Irish Organic Farmers and Growers Association) and the Organic Trust operate in Scotland and Northern Ireland/Eire, respectively. The licensed bodies either adopt the UKROFS Standards unchanged or introduce additional standards. An organic farmer must register with one of these bodies or with UKROFS. The Sector Body is then responsible for inspecting the holding and awarding their organic status if approved.

Organic Livestock Standards

EU Organic Livestock Regulation (No. 1804/1999) came into force in 2000. There is a maximum annual loading of 170 kg N/ha from animal manure (including that from the grazing animal). This limit is an annual average over the whole organic unit. Certifying bodies may also have restrictions on timing of applications, as well as other manure management aspects.

Although guidance in this booklet is considered best practice, if considering any significant change in manure management, always consult your Sector Body.

7 Nutrient losses – a waste of a valuable resource and environmentally damaging

Animal manures (including slurries) are valuable sources of nutrients in organic farming systems. Careful management is required to reduce the potential risk of pollution to the environment:

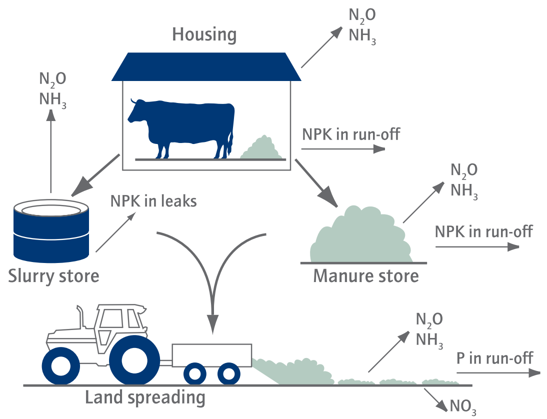
- 'Point source' pollution of water courses can occur as a result of a burst or overflowing slurry store and yard or field run-off during heavy rainfall events. Such incidents can have catastrophic effects on fish and other aquatic life, because of the direct effect of dissolved ammonia (from the manure), or by depletion of oxygen levels in the water as the added organic matter is broken down.
- 'Diffuse' pollution is the pollution that can arise when nutrients are lost from fields, is not easily seen and can affect water and air over a large area.

Nutrients of concern

- Nitrate (NO_3) affects water quality. It can contribute to eutrophication of surface waters (e.g. development of algal blooms) and can exceed legal limits in drinking water. Losses from agriculture are a major source of nitrate in some ground and surface waters, especially in eastern and central England.
- Ammonia (NH_3) loss as gas (volatilisation) can cause a number of environmental problems. NH_3 can be redeposited either locally or transported long distances. This aerial deposition can disturb the balance in natural ecosystems by adding nitrogen. It also causes the acidification of soils and water bodies and so contributes to acid rain. Livestock production is the most important source of ammonia emission in Northern Europe.
- Nitrous oxide (N_2O) is a greenhouse gas, i.e. contributing to global warming. It is also implicated in the destruction of ozone through reactions with chlorinated carbon compounds.
- Phosphorus enrichment is the main factor contributing to algal blooms in freshwater systems. These can be damaging to aquatic life, unsightly and in some cases poisonous to humans and animals. Agriculture contributes significant phosphorus loads to surface waters, due to run-off and leaching.

Potassium is an important plant nutrient; small losses do occur by leaching but have not been associated with a risk to the environment.

Figure 5 The main losses of nutrients around the farm



Losses occur through all stages of manure management (**Figure 5**).

Ammonia is lost to the atmosphere at all stages. Release to the atmosphere can be rapid. **Nitrate** is produced in soil after land application. It is highly mobile and can be washed out with drainage water. Losses of dissolved N (and other nutrients) from housing, manure storage or handling only occur if run-off is not collected. **Nitrous oxide** is derived from the microbial breakdown of nitrate and this emission is encouraged by the presence of manure. **Phosphorus** is normally held firmly in soil, but excessive applications can result in P leaching. Losses also occur by soil erosion and from surface run-off of freshly applied manure. These are the major routes for phosphorus loss.

8 Other issues

Pathogens

Concerns have been raised recently about the risk of potential transmission of human pathogens from manures, via the soil-plant route of e.g. E. Coli O157, Salmonella, Campylobacter and Cryptosporidium. An active research programme is currently investigating the risk. The risk will depend on the amount and type of pathogens excreted, and their viability during storage of the manure. Composting manure is likely to kill a large proportion of pathogens. Long-term storage, as opposed to composting, will also reduce pathogen numbers over time.

A sensible practical measure is to avoid applications, particularly of fresh manure, immediately before or to crops that are likely to be eaten raw (e.g. salad crops). Sector Bodies and the Food Standards Agency are currently considering more detailed guidelines. If in doubt, seek advice from your Sector Body.

Genetically modified organisms

The use of genetically modified organisms (GMOs) is prohibited in organic production standards. This has been extended in the UK so that manure, composts and other organic fertilisers containing GMOs or their derivatives are prohibited for use on organic holdings. This means that imported manures must be from stock that have only received GMO-free foodstuffs.

Appendix I – Organic Certifying Bodies operating in the UK

United Kingdom Register of Organic Food Standards (UKROFS), c/o DEFRA, Nobel House, 17 Smith Square, London, SW1P 3JR
Tel: 020 7238 5633 (Contact: Alex Dasi-Sutton)
Fax: 020 7238 6148 alex.dasi-sutton@defra.gsi.gov.uk

Biodynamic Agricultural Association, The Painswick Inn Project, Gloucester Street, Stroud, Gloucestershire, GL5 1QG
Tel: 01453 759501 Fax: 01453 759501
bdaa@biodynamic.freeserve.co.uk www.anth.org.uk/biodynamic

CMi Certification, Lodge Road, Long Hanborough, Oxford, OX29 8LH
Tel: 0131 3172500 Fax: 0131 3171872
tim.green@cmi-plc.com

Organic Certification Ltd, 106 Abbots Road, Monkmoor, Shrewsbury, SY2 5QX
Tel: 01743 248257 Fax 01743 248259 caroline@ocert.co.uk

Organic Farmers and Growers Ltd, The Elim Centre, Lancaster Road, Shrewsbury, Shropshire, SY1 3LE
Tel: 01743 440512 Fax: 01743 461441
info@organicfarmers.uk.com www.organicfarmers.uk.com

Organic Food Federation, 31 Turbine Way, EcoTech Business Park, Swaffham, Norfolk, PE37 7XD
Tel: 01760 720444 Fax: 01760 720790
info@orgfoodfed.com www.orgfoodfed.com

Soil Association Certification Ltd, Bristol House, 40–56 Victoria Street, Bristol, BS1 6BY
Tel: 0117 9142406 Fax: 0117 9252504
prod.cert@soilassociation.org www.soilassociation.org

Farm Verified Organic, Meadow Vale Offices, Betws Road, Llanrwst, Conwy, LL26 0PP
Tel: 01492 642628 Fax: 01492 642091
ICSGB@ics-intl.com

Scottish Organic Producers Association, Scottish Organic Centre, 10th Avenue, Royal Highland Centre, Ingliston, Edinburgh, EH28 8NF
Tel: 0131 3356606 Fax: 0131 3356607
sopa@sfqc.co.uk www.sopa.org.uk

Irish Organic Farmers and Growers Association, Harbour Building, Harbour Road, Kilbeggan, Co. Westmeath, Ireland
Tel: 00 353 506 32563 Fax: 00 353 506 32063
iofga@eircom.net www.irishorganic.ie

Organic Trust Ltd, Vernon House, 2 Vernon Avenue, Clontarf, Dublin 3, Ireland
Tel: 00 353 185 30271 Fax: 00 353 185 30271
organic@iol.ie www.organic-trust.org

Appendix II – Further reading

Fertiliser Recommendations for Agricultural and Horticultural Crops (DEFRA RB 209)
Comprehensive reference book on soil nutrient status and the use of organic manures. (7th edition, 2000). Available from The Stationery Office (£15) ISBN 0-11-243058-9.

Available free from ADAS Gleadthorpe Research Centre. Tel: 01623 844331

- **Managing Livestock Manures: Booklet 1** – Making better use of livestock manures on arable land. (2nd Edition, 2001) (ADAS, IGER, SRI)
- **Managing Livestock Manures: Booklet 2** – Making better use of livestock manures on grassland. (2nd Edition, 2001) (IGER, ADAS, SRI)
- **Managing Livestock Manures: Booklet 3** – Spreading systems for slurries and solid manures. (2001) (SRI, ADAS, IGER)

Available free from DEFRA Tel: 020 7238 6262

- **DEFRA/NAW – Farm Waste Management Plan:** A step-by-step guide for farmers.

Available free from DEFRA publications. Tel: 08459 556000

- **The Water Code – Code of Good Agricultural Practice for the Protection of Water – PB 0587**
  Information on farm waste management plans and avoiding water pollution.
- **The Air Code – Code of Good Agricultural Practice for the Protection of Air – PB 0618** Information on farm waste treatment, minimising odours and ammonia losses.
- **The Soil Code – Code of Agricultural Practice for the Protection of Soil – PB 0617** Information on soil fertility, erosion and contamination.

National Farm Waste Management Plan Register – a list of local consultants who can provide professional advice on waste management planning. Tel: 01884 234852

MANNER (ADAS MANure Nitrogen Evaluation Routine) is a simple, personal-computer-based decision-support system, supplied on CD-ROM or disk, with full instructions and a User Guide. It can be obtained free of charge from: ADAS Gleadthorpe Research Centre, Meden Vale, Mansfield, Nottingham, NG20 9PF Tel: 01623 844331
Fax: 01623 844472 www.adas.co.uk/manner

Appendix III – Conversion factors

Volumes

1 imperial gallon (gall) = 0.0045 cubic metre (m^3) — 1 m^3 = 220 gall

1 imperial gallon (gall) = 4.55 litres (l) — 1 litre = 0.22 gall

Length

1 foot (ft) = 0.31 metre (m) — 1 m = 3.28 ft

Speed

1 mile per hour (mph) = 1.61 kilometre per hour (km/h) — 1 km/h = 0.62 mph

1 mile per hour (mph) = 0.45 metre per second (m/s) — 1 m/s = 2.24 mph

Application rates

1 imperial gallon per acre (gall/ac) = 0.011 cubic metres per hectare (m^3/ha) — 1 m^3/ha = 90 gall/ac

1 ton per acre (ton/ac) = 2.50 tonne/hectare (t/ha) — 1 t/ha = 0.40 ton/ac

Area

1 acre (ac) = 0.405 hectares (ha) — 1 ha = 2.47 ac

Nutrients

1 unit per acre (unit/ac) = 1.25 kilogram/hectare (kg/ha) — 1 kg/ha = 0.8 units/ac

1 kg P = 2.29 kg P_2O_5 — 1 kg P_2O_5 = 0.44 kg P

1 kg K = 1.20 kg K_2O — 1 kg K_2O = 0.83 kg K

1 kg S = 2.50 kg SO_3 — 1 kg SO_3 = 0.40 kg S

1 kg Mg = 1.66 kg MgO — 1 kg MgO = 0.60 kg Mg

Appendix IV – Stocking rates to supply 170 kg total N/ha from manure on organic farms

Cattle	No./ha[1]	Annual N production per animal (kg)
Dairy cow (500 kg)	2	85
Dairy cow (450 kg)	2.2	77
Dairy heifer replacement >2 years (500 kg)	2.9	59
Beef cow (500 kg)	2.9	59
Males/grower fattener > 2 years (500 kg)	2.9	59
Ditto, 12–24 months (400 kg)	3.8	45
Grower fattener 6–12 months (180 kg)	7	12[2]
Calf (0–6 months) (100 kg)	12	7[2]

Sheep	No./ha[1]	Annual N production per animal (kg)
Ewes (65 kg)	19	9
Lambs – kept for 6 months	140	1.2

Pigs	No./ha[1]	Annual N production per animal (kg)
Pig (baconer 35–105 kg)	16	10.6
Cutter (35–85 kg)	18	9.4
Grower (18–35 kg)	28	6.1
Weaner (7–18 kg), piglets	60	2.8
Sow and litter (to 7 kg)	9.0	18.9

Poultry	No./ha[1]	Annual N production per animal (kg)
Laying hens	260	0.65
Table birds (3.5 crops per year)	580	0.29
Turkeys – male (13.5 kg, 2.1 crops per year)	120	1.42
Turkeys – female (6.5 kg, 2.4 crops per year)	260	0.65

[1]Source: UKROFS Livestock Standards. These are consistent with, but not identical to, values recognised under the Nitrate Directive.
[2]Assumes 6 months' occupancy.

This booklet was written by ADAS (Mark Shepherd & Paul Gibbs) with assistance from
Elm Farm Research Centre (Lois Philipps).

Copies available from:

ADAS Gleadthorpe Research Centre
Meden Vale
Mansfield
Notts
NG20 9PF

Tel: 01623 844331
Fax: 01623 844472
Email: glyn.scrimshire@adas.co.uk

Elm Farm Research Centre
Hamstead Marshall
Newbury
Berks
RG20 0HR

Tel: 01488 658298
Fax: 01488 658503
Email: elmfarm@efrc.com