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# Optimising the application of livestock farmyard manures and slurries

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## Summary


- **Livestock manures should be viewed as valuable resources rather than as waste products. They can bring significant benefits to soils and crops when used appropriately, and their use can result in considerable savings on purchased fertilisers.**
- **The principles of nutrient supply and losses, and the need for livestock manure management planning are explained.**
- **Owing to farm specific feeding and manure handling practices, manures produced at a livestock unit may have a nutrient content that is consistently different from the values given in the tables. It is therefore worthwhile having the nutrient content of representative manure samples determined by analysis.**
- **This note explains how to use the livestock manures and slurries to best effect, whilst ensuring compliance with the relevant legislation.**
- **Worked examples to help in understanding the financial value of FYM and slurry applications.**


## 1. Introduction

Livestock manures applied to agricultural land are valuable sources of organic matter, major and secondary plant nutrients, and many also contain useful quantities of trace elements and may have a small liming value. When appropriately done, the recycling to land of organic materials allows their nutrient value to be used for the benefit of crops and soils and can provide significant savings on the cost of manufactured fertilisers. Regular applications of livestock manures can improve water-holding capacity, drought resistance and structural stability, as well as the biological activity of soils. The greatest benefits are likely to be observed on soils where organic matter levels are low. Livestock manures should be spread in rotation on all suitable land throughout the farm where agricultural benefit is likely, rather than on land which is conveniently situated in relation to steadings or roads. Care should be taken not to cause soil compaction, which will have a detrimental effect on crop growth and health and may increase the risk of surface run-off. To fully realise the financial value of livestock manures and to comply with legislation, it is essential that their nutrient value is included in your fertiliser management plan.

There is a continuing need to ensure that the figures for the nutrient content of livestock manures are up to date and representative of current practice at the farm gate. It is always advisable to request an analysis report on a regular basis when receiving any type of livestock manures for farm use.

This technical note can be used along with MANNER-NPK, a software tool that provides an estimate of crop available NPK supply from livestock manures (including imported, non-farm organic waste) applications and PLANET Scotland, a software tool designed for routine use by Scottish farmers and advisers to plan and manage nutrient use on individual fields (both programmes are available on (www.planet4farmers.co.uk). The software provides:

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- Field-level nutrient planning and record keeping.
- An Organic Manures Inventory and Storage Requirements module which calculates monthly quantities and the nutrient content of farm manures, and the minimum slurry storage requirement as required for compliance with Nitrate Vulnerable Zone Action Programme (NVZ AP) rules.
- An Organic Manure Storage Capacity module which calculates the storage capacity of existing slurry and solid manure stores based on store dimensions.
- A Livestock Manure N Farm Limit module which calculates the whole-farm manure N capacity, and the current N loading for compliance with this NVZ AP rule.
- A function that calculates the farm maximum N (Nmax) for individual crop types for compliance with this NVZ AP rule.
- A Farmgate Nutrient Balance that calculates the balance of nitrogen, phosphate and potash coming onto the farm (e.g. in feeds, manufactured and organic fertilisers) and those exported off the farm (e.g. in farm produce).

## 2. Legislation and guidance

### 2.1 Storage and handling

Livestock manures can present a considerable environmental risk if not stored and applied carefully. The Water Environment (Controlled Activities) (Scotland) Regulations 2005, make it an offence to allow or cause slurry, manure or effluent to directly enter a watercourse or field drain. Guidance for farmers on the storage, handling and application of organic fertilisers is provided in the PEPFAA Code (www.scotland.gov.uk/Resource/Doc/37428/0014235.pdf).

### 2.2 Nitrate vulnerable zones (NVZs)

In NVZs the total quantity of nitrogen (N) applied in organic manures (other than compost) must not exceed 250 kg N/ha in any 12-month period. In some situations, lower application rates may be appropriate. For example, where the amount of crop available N would exceed the crop requirement. Further guidance on NVZ regulations is provided in this Technical Note and in Scottish Government guidance on NVZs (www.scotland.gov.uk/Topics/farmingrural/Agriculture/Environment/NVZintro). In some fields, particularly on intensive livestock farms, it may be necessary (or advisable) to limit organic manure applications to avoid excessive enrichment of soil phosphorus (P) levels.

### 2.3 General Binding Rules

The Controlled Activity Regulations (CAR) regulations stipulate a set of General Binding Rules (GBRs) that regulate the storage and land spreading of organic and manufactured fertilisers. The regulations apply to all forms of nutrients applied for agricultural purposes including wastes, composts and digestate.

Further guidance on GBR's and diffuse pollution regulations are available from the Scottish Environmental Protection Agency (SEPA) (www.sepa.org.uk/water/water_regulation/regimes/pollution_control/diffuse_pollution.aspx). The GAEC (Good Agricultural and Environmental Condition) measures relating to the land application of livestock manures are outlined in the Scottish Government website (www.scotland.gov.uk/Publications/2005/12/0990918/09207).

GBR 18: The storage and application of fertiliser stipulates that organic fertiliser must not be applied to land that:

- is within 10 m of any river, burn, ditch, wetland, loch, transitional water or coastal water.
- is within 50 m of any spring that supplies water for human consumption or any well or borehole that is not capped to prevent water ingress.
- has an average soil depth of less than 40 cm and overlies gravel or fissured rock, except where the application is for forestry operations.
- is frozen (except where the fertiliser is farmyard manure), waterlogged, or covered with snow; or
- is sloping, unless it is ensured that any run-off of fertiliser is intercepted (by means of a sufficient buffer zone or otherwise) to prevent it from entering any river, burn, ditch, wetland, loch, transitional water or coastal water towards which the land slopes.

The rules also state that fertiliser of any type should not be applied more than crop requirements and that equipment used for spreading must be maintained in a good state of repair.

There are additional requirements within GBR 18 that have not been covered and further information is available from the links provided below.

It is recommended that a Risk Assessment for Manure and Slurry (RAMS) map is drawn up for the farm and made available to spreading contractors, as this is a simple way of helping to ensure compliance with these rules. Information on creating a RAMS map, other good practice guidance and regulations are available in the PEPFAA code and from the Farming and Water Scotland website (www.sruc.ac.uk/info/120603/farming_and_water_scotland).

### 2.4 Animal By-Products (Scotland) Regulations

Organic fertilisers which have been derived (or partly derived) from animal by-products must have been appropriately processed and must be applied to agricultural land in accordance with the Animal By-Products (Enforcement) (Scotland) Regulations 2013 (www.legislation.gov.uk/ssi/2013/307/pdfs/ssi_20130307_en.pdf) and the Animal By-Products (Miscellaneous Amendments) (Scotland) Regulations 2015 (www.legislation.gov.uk/ssi/2015/393/pdfs/ssi_20150393_en.pdf). In particular, pastureland cannot be used for grazing within 2 months (for pigs) and 3 weeks (for other farmed animals) of applying materials derived from animal by-products. Farmers who use animal by-products must keep records of the date, quantity and description of the materials applied, and the date on which pigs and other farmed animals first have access to the land after application.

### 2.5 Farm assurance schemes

Some of the farm assurance schemes have developed their own rules governing where and when organic materials can be used on their scheme members' land.

## 3. Management planning and characteristics of livestock manures

### 3.1 Standard figures of N, $P_2O_5$ and $K_2O$ outputs (ex-housing and storage)

When planning livestock manure management systems, information is needed on the quantity and nutrient content of manures produced on a farm. Standard figures of N, $P_2O_5$ and $K_2O$ outputs (ex-housing and storage) by different categories of grazing livestock are given in Table A and non-grazing livestock in Table B. In NVZs, you should continue to calculate the N produced by livestock on your farm in accordance with the steps outlined in the Scottish Government Guidance for Farmers in Nitrate Vulnerable Zones (2008) (www.scotland.gov.uk/Topics/farmingrural/Agriculture/Environment/NVZintro).

**Table A. Standard figures of N, $P_2O_5$ and $K_2O$ produced by different categories of grazing livestock**

| Livestock type | Total N produced by 1 livestock type (kg/year)[1] | Total $P_2O_5$ produced by 1 livestock type (kg/year) | Total $K_2O$ produced by 1 livestock type (kg/year) |
|---|---|---|---|
| 1 Dairy cow (over 9000 litre milk yield) | 115 | 52 | 92 |
| 1 Dairy cow (6000 to 9000 litre milk yield) | 101 | 44 | 77 |
| 1 Dairy cow (up to 6000 litre milk yield) | 77 | 34 | 61 |
| 1 Dairy heifer replacement, 13 months to first calf | 61 | 25 | 58 |
| 1 Dairy heifer replacement, 3 to 13 months | 29 | 10.3 | 24 |
| 1 Beef suckler cow[2] (over 500 kg) | 83 | 31 | 66 |
| 1 Beef suckler cow[2] (up to 500 kg) | 61 | 24 | 47 |
| 1 Steer / Heifer for slaughter, over 25 months | 50 | 22 | 47 |
| 1 Steer / Heifer, 13 to 25 months | 50 | 15.7 | 38 |
| 1 Steer / Heifer, 3 to 13 months | 28 | 10 | 24 |
| 1 Bull beef, 3 months and over | 54 | 8.8 | 38 |
| 1 Bull for breeding, over 25 months | 48 | 22 | 38 |
| 1 Bull for breeding, 3 to 25 months | 50 | 15.7 | 38 |
| 1 Calf, up to 3 months | 1.4 | 0.77 | 2.6 |
| 1 Lamb (from 6 months up to 9 months) | 0.5 | 0.07 | 1.3 |
| 1 Sheep (from 9 months old to first lambing, tupping or slaughter)[3] | 0.7 | 0.38 | 2.6 |
| 1 Sheep up to 60 kg (inc. lamb to 6 months) | 7.6 | 3.2 | 9.6 |
| 1 Sheep over 60 kg (inc. lamb to 6 months) | 11.9 | 3.7 | 14.4 |
| 1 Goat | 15 | 6.9 | 10.2 |
| 1 Breeding deer | 15.2 | 6.4 | 12.4 |
| 1 Deer (other) | 12 | 4.3 | 9.1 |
| 1 Horse | 21 | 20 | 54 |

[1] Includes an allowance for N losses from livestock housing and manure storage

[2] Suckler cow includes calf up to weaning age

[3] Assumes 6 months in this category

**Table B. Standard figures of N, $P_2O_5$ and $K_2O$ produced by different categories of non-grazing livestock (% occupancy in brackets)**

| Livestock type | % | Total N produced by 1 livestock type (kg/year)[1] | Total $P_2O_5$ produced by 1 livestock type (kg/year) | Total $K_2O$ produced by 1 livestock type (kg/year) |
|---|---|---|---|---|
| 1000 Laying Hens (caged) over 17 weeks | (97) | 400 | 350 | 390 |
| 1000 Laying Hens (free range)[2] over 17 weeks | (97) | 530 | 390 | 390 |
| 1000 Broiler Chickens (table) | (85) | 330 | 220 | 340 |
| 1000 Laying Hens up to 17 weeks | (89) | 210 | 150 | 120 |
| 1000 Broiler Chickens (breeder) up to 25 weeks | (92) | 290 | 260 | 270 |
| 1000 Broiler Chickens (breeder) 25 weeks & over | (95) | 700 | 520 | 720 |
| 1000 Turkeys (male) | (90) | 1230 | 1020 | 950 |
| 1000 Turkeys (female) | (88) | 910 | 740 | 690 |
| 1000 Ducks | (83) | 750 | 730 | 230 |
| 1 Ostrich | | 1.4 | 6.8 | 10 |
| 1 Sow place (including litter up to 7 kg) fed on a diet supplemented with synthetic amino acids | | 16 | 13.5 | 14 |
| 1 Sow place (including litter up to 7 kg) fed on a diet without synthetic amino acids | | 18 | 13.5 | 14 |
| 1 Maiden gilt place 66kg and over | (80) | 11.1 | 5.8 | 5.9 |
| 1 Breeding boar 66 kg to 150 kg | | 12 | 6.5 | 6.6 |
| 1 Breeding boar over 150 kg | | 17.5 | 10.2 | 11.4 |
| 1 Weaner place (7 to 13 kg) | (71) | 1.0 | 0.34 | 1.2 |
| 1 Weaner place (13 to 31 kg) | (82) | 4.2 | 1.8 | 2.1 |
| 1 Grower place (31 to 66 kg) (dry & liquid fed) | (88) | 7.7 | 3.9 | 4.2 |
| 1 Finisher place (66 kg and over) (dry & liquid fed) | (88) | 10.6 | 5.6 | 5.6 |

[1] Includes an allowance for N losses from livestock housing and manure storage

[2] Free range: 80% of excreta is deposited in the building (assumed)

### 3.2 Nutrient content of livestock manures

The nutrient content of manures applied to land depends on a few factors, including the number and type of livestock, the diet and feeding system, the volume of dirty water andrainwater entering storage facilities, and the amount of bedding used. Typical livestock manure dry matter and total nutrient contents are given in Table C.

Owing to farm specific feeding and manure handling practices, manures produced at a livestock unit may have a nutrient content that is consistently different from the values given in the tables. It is therefore worthwhile having the nutrient content of representative manure samples determined by analysis (see Section 4).

**Table C. Typical dry matter (DM%) and nutrient contents of livestock manures as kg/t (solids) or kg/m³ (slurries)**

| Livestock manures | DM% | Total N | Total $P_2O_5$ | Total $K_2O$ | Total $SO_3$ | Total MgO |
|---|---|---|---|---|---|---|
| Cattle FYM – fresh | 25 | 6 | 3.2 | 8 | 2.4 | 1.8 |
| Cattle FYM – old | 25 | 6 | 3.2 | 8 | 2.4 | 1.8 |
| Pig FYM – fresh | 25 | 7 | 6 | 8 | 3.4 | 1.8 |
| Pig FYM – old | 25 | 7 | 6 | 8 | 3.4 | 1.8 |
| Sheep FYM – fresh | 25 | 7 | 3.2 | 8 | 3 | 1.6 |
| Sheep FYM – old | 25 | 7 | 3.2 | 8 | 3 | 1.6 |
| Duck FYM – fresh | 25 | 6.5 | 5.5 | 7.5 | 2.6 | 1.2 |
| Duck FYM – old | 25 | 6.5 | 5.5 | 7.5 | 2.6 | 1.2 |
| Layer manure | 35 | 19 | 14 | 9.5 | 4 | 2.6 |
| Broiler / Turkey litter | 60 | 30 | 25 | 18 | 8 | 4.4 |
| Horse FYM | 30 | 7 | 5 | 6 | * | * |
| Goat FYM | 25 | 6 | 3.2 | 8 | 2.4 | 1.8 |
| Cattle slurry | 6 | 2.6 | 1.2 | 3.2 | 0.7 | 0.6 |
| Pig slurry | 4 | 3.6 | 1.8 | 2.4 | 1 | 0.7 |
| Cattle slurry, strainer box liquid | 1.5 | 1.5 | 0.3 | 2.2 | * | * |
| Cattle slurry, weeping wall liquid | 2 | 3 | 0.5 | 3 | * | * |
| Cattle slurry, mechanically separated liquid | 3 | 4 | 1.2 | 3.5 | * | * |
| Cattle slurry, separated solids | 20 | 4 | 2 | 4 | * | * |
| Pig slurry, separated liquid | 3 | 3.6 | 1.6 | 2.4 | * | * |
| Pig slurry, separated solids | 20 | 5 | 4.6 | 2.2 | * | * |
| Dirty water | 0.5 | 0.5 | 0.1 | 1 | 0.1 | 0.1 |

*data not available

### 3.3 Different forms of N present in livestock manures

Whether using typical values for the nutrient content of organic fertilisers or the results of analysis, the availability of the nutrients for crop uptake must be assessed before the fertiliser replacement value of an application can be calculated. An understanding of the characteristics of the major plant nutrients in organic fertilisers will also help in planning applications that minimise diffuse pollution.

Nitrogen is present in farmyard manures in different forms:

- Readily available nitrogen (RAN) i.e. ammonium-N as measured by N meters, nitrate-N and uric acid-N is the nitrogen that is potentially available for rapid crop uptake and is measured on the fresh manure as received in the laboratory.
- Organic-N is the nitrogen contained in organic forms which are broken down slowly to become potentially available for crop uptake over a period of months to years.
- Crop available nitrogen is the readily available-N that remains available for the next crop following application. This also includes nitrogen released from organic forms.

In NVZs, there are mandatory closed spreading periods for high RAN manures (e.g. slurries and poultry manures) and default minimum N efficiency values (www.scotland.gov.uk/Topics/farmingrural/Agriculture/Environment/NVZintro). Data in Table D show total N, RAN, and RAN in livestock manures expressed as percent of total N.

**Table D. Typical total N and RAN contents of livestock manures as kg/t (solids) or kg/m$^3$ (slurries) and RAN expressed as % total N**

| Manure type | Total N | RAN | RAN as % total N |
|---|---|---|---|
| Cattle FYM – fresh | 6 | 1.2 | 20 |
| Cattle FYM – old | 6 | 0.6 | 10 |
| Pig FYM – fresh | 7 | 1.8 | 25.7 |
| Pig FYM – old | 7 | 1 | 14.3 |
| Sheep FYM – fresh | 7 | 1.4 | 20 |
| Sheep FYM – old | 7 | 0.7 | 10 |
| Duck FYM – fresh | 6.5 | 1.6 | 24.6 |
| Duck FYM – old | 6.5 | 1 | 15.4 |
| Layer manure | 19 | 9.5 | 50 |
| Broiler / Turkey litter | 30 | 10.5 | 35 |
| Horse FYM | 7 | 0.7 | 10 |
| Goat FYM | 6 | 0.6 | 10 |
| Cattle slurry | 2.6 | 1.2 | 46.2 |
| Pig slurry | 3.6 | 2.5 | 69.4 |
| Cattle slurry, strainer box liquid | 1.5 | 0.8 | 53.3 |
| Cattle slurry, weeping wall liquid | 3 | 1 | 33.3 |
| Cattle slurry, mechanically separated liquid | 4 | 1.5 | 37.5 |
| Cattle slurry, separated solids | 4 | 1 | 25 |
| Pig slurry, separated liquid | 3.6 | 2.2 | 61.1 |
| Pig slurry, separated solids | 5 | 1.3 | 26 |

Slurries and poultry manures are ‘high’ in RAN (typically, in the range of 35-70% of total N, and more than 30% in NVZs) compared with FYM which is ‘low’ in RAN (10-25% of total N). Nitrogen losses can occur following the land application of bulky organic fertiliser through ammonia volatilisation, nitrate leaching and denitrification. Ammonium-N can be volatilised to the atmosphere as ammonia gas following the land application of manures. Following conversion to nitrate-N, further losses may occur through nitrate leaching and de-nitrification (gaseous loss as nitrous oxide and nitrogen under warm and wet soil conditions). To make optimum use of the N content, organic fertilisers should be applied at times of maximum crop growth, generally during the late winter to summer period.

Around 40% of the RAN content of livestock manures is commonly lost via ammonia volatilisation following surface application to land. Ammonia loss and odour nuisance can be reduced by ensuring that manures are rapidly incorporated into soils (within 6 hours of application for slurries and 24 hours for solid manures). For livestock slurries, the use of precision spreading techniques such as trailing shoes and trailing hoses are effective application methods that reduce ammonia emission (typically by 30-70%) compared with broadcast application. These application techniques also increase the number of spreading days and cause less crop contamination than surface broadcast applications. The practices mentioned above will also increase the amount of N available for crop uptake. Ammonia losses are generally smaller from low dry matter slurries due to more rapid infiltration into the soil, compared with higher dry matter slurries, which remain on the soil/crop surface for longer leading to greater losses. Losses are also higher when slurries are applied to dry soils under warm weather conditions.

### 3.4 N available to next crop following manure applications

The amount of manure N leached as nitrate following land application is mainly related to the application rate, application method, the RAN content, and the amount of rainfall after application. As ammonium-N is rapidly converted in the soil to nitrate-N, manure applications during the autumn or early winter period should be avoided, as over-winter rainfall is likely to be sufficient to wash a large proportion of this nitrate out of the soil before the crop can use it. Delaying applications until late winter or spring will reduce nitrate leaching and increase the efficiency of utilisation of manure N. This is particularly important for manures with a high content of readily available-N. Values for the crop availability of N from different application timings and methods are given in Tables E to H.

**Table E. Cattle and pig FYM with 25% DM – Percentage of total nitrogen available to next crop following manure applications**

| FYM type | Plough down | Total N kg/t | % of total N taken up by the following crop | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | August-October | | November-January | | Feb-April | Summer |
| | | | Sands, sandy loams, shallow | All other soils | Sands, sandy loams, shallow | All other soils | All soils | Grassland |
| Cattle (fresh[1] & old[2]) | Over 24h | 6 | 5 | 10 | 10 | 10 | 10 | 10 |
| Cattle (fresh) | Within 24h | 6 | 5 | 10 | 10 | 10 | 15 | N/A |
| Cattle (old) | Within 24h | 6 | 5 | 10 | 10 | 10 | 10 | N/A |
| Pig (fresh & old) | Over 24h | 7 | 5 | 10 | 10 | 10 | 10 | 10 |
| Pig (fresh) | Within 24h | 7 | 5 | 10 | 10 | 10 | 15 | N/A |
| Pig (old) | Within 24h | 7 | 5 | 5 | 10 | 10 | 10 | N/A |

[1] Fresh FYM is manure that has been spread straight from the building.

[2] Old FYM is manure that has been stored for 3 months or more.

N/A Not appropriate

**Table F. Poultry manure – Percentage of total nitrogen available to next crop following manure applications (use the value in brackets for grassland and winter oilseed rape cropping)**

| Manure type | Plough down | Total N kg/t | % of total N taken up by the following crop | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | August-October | | November-January | | Feb-April | Summer |
| | | | Sands, sandy loams, shallow[1] | All other soils | Sands, sandy loams, shallow | All other soils | All soils | Grassland |
| Layer manure (35% DM) | Over 24h | 19 | 10 (15) | 25 (30) | 25 | 25 | 35 | 35 |
| Layer manure (35% DM) | Within 24h | 19 | 10 (15) | 35 (40) | 25 | 40 | 50 | N/A |
| Broiler/Turkey litter (60% DM) | Over 24h | 30 | 10 (15) | 25 (30) | 20 | 25 | 30 | 30 |
| Broiler/Turkey litter (60% DM) | Within 24h | 30 | 10 (15) | 30 (35) | 20 | 30 | 40 | N/A |

[1] In NVZs a minimum of 30% must be used (www.scotland.gov.uk/Topics/farmingrural/Agriculture/Environment/NVZintro).

N/A Not appropriate

**Table G. Percentage of total nitrogen available to next crop following the application of cattle slurry (use the value in brackets for grassland and winter oilseed rape cropping)**

| Cattle slurry method | Ploughed down[1] | Total N kg/t | DM % | % of total N taken up by the following crop: August-October: Sands, sandy loams, shallow[2] | August-October: All other soils | November-January: Sands, sand loams, shallow | November-January: All other soils | Feb-April: All soils | Summer grassland: All soils |
|---|---|---|---|---|---|---|---|---|---|
| Surface applied | N/A | 1.6 | 2 | 5 (10) | 30 (35) | 30 | 30 | 45 | 30 |
| Surface applied | N/A | 2.6 | 6 | 5 (10) | 25 (30) | 25 | 25 | 35 | 25 |
| Surface applied | N/A | 3.6 | 10 | 5 (10) | 20 (25) | 20 | 20 | 25 | 20 |
| Ploughed | Within 6h | 1.6 | 2 | 5 (10) | 35 (40) | 25 | 35 | 50 | N/A |
| Ploughed | Within 6h | 2.6 | 6 | 5 (10) | 30 (35) | 20 | 30 | 40 | N/A |
| Ploughed | Within 6h | 3.6 | 10 | 5 (10) | 25 (30) | 15 | 25 | 30 | N/A |
| Precision spread[3] | NA | 1.6 | 2 | 5 (10) | 30 (35) | 30 | 30 | 50 | 40 |
| Precision spread | NA | 2.6 | 6 | 5 (10) | 25 (30) | 25 | 25 | 40 | 30 |
| Precision spread | NA | 3.6 | 10 | 5 (10) | 20 (25) | 20 | 20 | 30 | 25 |
| Shallow injected | Injected | 1.6 | 2 | 5 (10) | 30 (35) | 35 | 35 | 55 | 45 |
| Shallow injected | Injected | 2.6 | 6 | 5 (10) | 25 (30) | 30 | 30 | 45 | 35 |
| Shallow injected | Injected | 3.6 | 10 | 5 (10) | 20 (25) | 25 | 25 | 35 | 30 |

[1] These values assume incorporation by ploughing. Cultivation using discs or tines is likely to be less effective in minimising ammonia losses and intermediate values of N availability.

[2] In NVZs nitrogen availability values in Scottish Government guidance must be used (www.scotland.gov.uk/Topics/farmingrural/Agriculture/Environment/NVZintro).

[3] Precision spreading techniques include trailing shoes and dribble bars.

N/A Not appropriate

**Table H. Percentage of total nitrogen available to next crop following the application of pig slurry (use the value in brackets for grassland and winter oilseed rape cropping)**

| Pig slurry method | Ploughed down[1] | Total N kg/t | DM % | % of total N taken up by the following crop: August-October: Sands, sandy loams, shallow[2] | August-October: All other soils | November-January: Sands, sandy loams, shallow | November-January: All other soils | Feb-April: All soils | Summer grassland: All soils |
|---|---|---|---|---|---|---|---|---|---|
| Surface applied | N/A | 3.0 | 2 | 10 (15) | 35 (40) | 40 | 40 | 55 | 55 |
| Surface applied | N/A | 3.6 | 4 | 10 (15) | 30 (35) | 35 | 35 | 50 | 50 |
| Surface applied | N/A | 4.4 | 6 | 10 (15) | 25 (30) | 30 | 30 | 45 | 45 |
| Ploughed | Within 6h | 3.0 | 2 | 10 (15) | 45 (50) | 35 | 50 | 65 | N/A |
| Ploughed | Within 6h | 3.6 | 4 | 10 (15) | 40 (45) | 30 | 45 | 60 | N/A |
| Ploughed | Within 6h | 4.4 | 6 | 10 (15) | 40 (45) | 25 | 40 | 55 | N/A |
| Precision spread[3] | NA | 3.0 | 2 | 10 (15) | 35 (40) | 40 | 30 | 60 | 60 |
| Precision spread | NA | 3.6 | 4 | 10 (15) | 35 (40) | 35 | 35 | 55 | 55 |
| Precision spread | NA | 4.4 | 6 | 10 (15) | 30 (35) | 35 | 35 | 50 | 50 |
| Shallow injected | Injected | 3.0 | 2 | 10 (15) | 40 (45) | 45 | 45 | 65 | 65 |
| Shallow injected | Injected | 3.6 | 4 | 10 (15) | 35 (40) | 40 | 40 | 60 | 60 |
| Shallow injected | Injected | 4.4 | 6 | 10 (15) | 35 (40) | 40 | 40 | 55 | 55 |

[1] These values assume incorporation by ploughing. Cultivation using discs or tines is likely to be less effective in minimising ammonia losses and intermediate values of N availability.

[2] In NVZs nitrogen availability values in Scottish Government guidance must be used (www.scotland.gov.uk/Topics/farmingrural/Agriculture/Environment/NVZintro).

[3] Precision spreading techniques include trailing shoes and dribble bars. N/A Not appropriate

### 3.5 P, K, and S available to next crop following manure applications

Livestock manures are valuable sources of other nutrients as well as nitrogen, although not all the total nutrient content will be available for the next crop. Nutrients which are not immediately available will mostly become available over a period of years and will usually be accounted for when soil analysis is carried out. The availability of manure phosphate to the next crop grown is lower than from water-soluble phosphate fertilisers. Generally, around 50% of the phosphate in pig and cattle slurries will become available to the crop in the year of application and around 60% of the phosphate in solid animal manures. However, the amount of phosphate that is taken up from the available P form is dependent on several other factors. The uptake of phosphate is low in acid soils especially with pH values below 5.5 and is reduced at low temperatures such as when growth is beginning in early spring. Soil P supply to the plant is dependent on soil reserves, which must be converted to a soluble form before being absorbed by plant roots. Soil P levels may decline over the rotation in some soils, due to gradual sorption, when only maintenance applications are made. A soil specific approach to P management considers the relationship between differing soils capacity to regulate P availability for plant uptake with PSC 1, 2 and 3 Indices. This soil information has been made available at the farm level jointly by SRUC and The James Hutton Institute as P technical notes for 4 Regions of Scotland (www.fas.scot/publications/technical-notes/).

The percentage of total P applied in the livestock manures that is recommended to use in planning the balance of P crop requirement is given in Table I. Where crop responses to phosphate are expected (e.g. where soils have very low or low P status); or where responsive crops are grown on moderate P status (e.g. potatoes or vegetables), 50% of the total P content of the organic fertiliser should be used when calculating the P contribution. Where soil P status is at the target level (M-, M+ or H, depending on the crops grown in the rotation) or above (e.g. H or VH), 100% of the total P content of the organic fertiliser should be used in planning the balance that should be applied as manufactured P. Where crops are sown in cold soil conditions and slow crop establishment is expected, ensure that soluble, manufactured P fertiliser is applied at sowing.  Where soil P status is above target, take care to ensure that total P inputs do not exceed the amounts removed in crops during the rotation by checking the concentration of extractable P in soil test results are not increasing over time. This will avoid the soil P status reaching an unnecessarily high level and will reduce the risk of P pollution to surface water.

**Table I.  Percentage of total P applied in the livestock manure that should be used in planning the balance of P crop requirement.**

| | Soil P status | | | |
|---|---|---|---|---|
| **Crop type** | **Very low and low** | **Moderate (M-)** | **Moderate (M+)** | **High** |
| Low responsive | 50 | 100 | 100 | 100 |
| High responsive | 50 | 50 | 50 | 100 |

In some fields, particularly on intensive livestock farms, it may be necessary (or advisable) to limit organic manure applications to avoid excessive enrichment of soil P levels. Phosphorus is important with regards to water quality, because small increases in concentration can cause eutrophication (nutrient enrichment) of fresh waters. The effects of eutrophication include algal blooms, fish death, excessive weed growth, poor water clarity and loss of species diversity. The EU Water Framework Directive is focussing attention on the need to control eutrophication due to phosphorus movement from soils by requiring all surface waters to have good ecological and chemical status. Phosphorus moves from soil to water by:

- Surface run-off following recently spread organic fertilisers
- Erosion of soil particles containing phosphorus
- Particulate and soluble phosphorus in drain outflo

The risk of surface run-off of phosphorus, and also potassium, is reduced by avoiding surface applications of all organic fertilisers (solid or liquid) when soils are frozen, snow covered, waterlogged, or on steeply sloping ground adjacent to watercourses, or when there is a risk of heavy rainfall following application. Drawing up a risk assessment map is an important starting point for planning the application of organic fertilisers and is mandatory in NVZs. Similar guidance is provided in "The 4 Point Plan, Straightforward Guidance for Livestock Farmers to Minimise Pollution and Benefit Your Business".

Most of the potash present in FYM and slurry will become quickly available for crop uptake, estimated around 90% available to the crop in the year of application, although potash availability from dirty water is estimated to be around 100%.

Information on the sulphur availability from organic fertilisers can be found in FAS/SRUC Technical Note TN685 (2017) (www.fas.scot/publications/technical-notes/). For autumn application the % total $SO_3$ available for the following crop may be 5-10% from livestock manures. For spring applications S availability is expected to be higher and generally around 15% of the $SO_3$ in cattle FYM and 35% of the $SO_3$ in cattle/pig slurry will be available to the crop in the year of application.

Magnesium behaves in soil more like K than P but moves less freely in soil solution than K, being reduced in colder soil temperatures. Manures can supply useful quantities of 20 to 30 kg/ha MgO (Table C) that replaces the Mg taken off by the crop.

# 4. Practical aspects of using livestock manures

### 4.1 Using organic and manufactured fertilisers together

If you apply livestock manures, you should use the N efficiency values in Tables D to G to determine the percentage of the total N content that will become available to the crop. This available N value must be deducted from the N crop requirement to calculate the balance that needs be applied as manufactured N fertiliser.

Where crop responses to phosphate or potash are expected (e.g. where soils have very low or low P or K status for combinable crops and grassland) or where responsive crops are grown (e.g. potatoes or vegetables), the available phosphate and potash content of the manure should be used when calculating the nutrient contribution. Where soil status is at the target level or above (usually moderate), the total phosphate and potash content of the organic fertiliser should be used in planning the balance that should be applied as manufactured P and K. At high soil P status, take care to ensure that total phosphate inputs do not exceed the amounts removed in crops during the rotation. This will avoid the soil P status reaching an unnecessarily high level. It is important to manage manure phosphate and potash supply over the crop rotation. Sulphur and magnesium inputs from manures should largely be regarded as contributing to the maintenance of soil reserves.

### 4.2 Spreading of livestock manures

The risk of causing water pollution by spreading solid manures is lower than for slurries. Surface run-off can still occur if heavy rain falls shortly after an application. Surface application rates for solid manures should never exceed 50 t/ha, and liquids including slurries should never exceed 50 m3/ha. Lower rates should be used where soil and weather conditions are likely to increase the risks of pollution. Poultry manures should not be spread at rates exceeding 15 t/ha. Repeat applications should not be made for a period of at least 3 weeks. This is necessary to allow the crop to utilise the available nutrients. More frequentapplications would smother herbage and saturate the soil, increasing the chances of leaching and run-off. All applications should take account of the soil conditions and the amount of rain forecast. Careful planning will help to minimise the risk of run off and entry into field drains.

Slurries are often applied using tankers with splash plate applicators but that there are restrictions on the use of high trajectory splash plates in NVZs. This is acceptable, providing weather and soil conditions are suitable, and providing the sensitivities of nearby communities are considered, but elevated N losses can occur through ammonia volatilisation. Newer precision application techniques such as band spreading (e.g. trailing hoses and shoes) will result in less N losses and reduced crop contamination following treatment (compared with crops which have been treated with surface-broadcast slurries). The application of odorous liquid materials, such as slurries, tends to cause fewer complaints where the newer application methods are used. Slurry spreaders can also be fitted with flow metres and control systems that accurately manage the application rate.

Solid manures are usually applied through side or rear discharge spreaders. The more expensive models can achieve an even spread of material within each pass. Spreading machinery should be calibrated to gain a clear idea of how much bulky organic fertiliser is applied. The physical characteristics of the material (e.g. dry matter content, straw content, fresh or old) will affect spreader performance. Only by knowing the weight of material in the spreader, the nutrient content (per tonne of fresh material), and the number of spreader loads applied per hectare will it be possible to gain an accurate understanding of the nutrients applied. Where solid manures are surface applied, nutrient losses (primarily ammonia) can be minimised by ploughing the material down as quickly as possible after spreading. Care must be taken when applying solid manures to avoid compaction or damage to soil structure; incorporation should be restricted to the top 30 cm of soil, and it should not take place when soil conditions are poor.

### 4.3 Sampling for analysis

The nutrient content of slurry can vary considerably within a store due to settlement and crusting. Similarly, the composition of solid manure in a heap can vary depending on the amount of bedding and losses of nutrients during storage. Only by knowing the nutrient content can the amount of nutrients applied be optimised, fertiliser costs reduced and the potential for losses to the environment minimised.

The optimum sampling frequency for solid manures and slurries will vary depending on how manures are managed on the farm, but at least two samples per year are recommended, coinciding with the main spreading periods. It is important that sampling is carried out carefully and that representative samples are provided for analysis. The sample submitted should be made up of around ten sub-samples of around 1 kg each (at least five samples of 1 litre each in the case of liquid materials). These sub-samples should be taken from a range of positions within the tank, store, or heap. Solid manure sub-samples should be spread out together on a clean dry tray or sheet (not used fertiliser sacks!), the lumps broken up and the whole sample well mixed. In the case of slurries, the subsamples should be well mixed in a bucket or similar container. A representative subsample of the mixed material should be sent to the laboratory and a duplicate sample kept in a cool dry place until the results are received. Usually about 2 litres of slurry or about 2 kg of solid manure is required for testing, but farmers are advised to check the quantities required with their intended laboratory.

In NVZs, a specific protocol must be followed when sampling solid manures and slurries for determination of total N (see Booklet 9, Scottish Government Guidance for Farmers in Nitrate Vulnerable Zones, 2008, (www.scotland.gov.uk/Publications/2008/12/12134339/11).

Samples of slurry sent to a laboratory for analysis should be dispatched in clean screw topped 2 litre plastic containers. Leave at least 5 cm of air space to allow the sample to be shaken in the laboratory. For solid manures, use 500-gauge polythene bags and expel excess air from the bag before sealing. Clearly label the samples on the outside of the container or bag and dispatch them immediately or within a maximum of 7 days if kept in a refrigerator.

Rapid on-farm kits (e.g. Agros, Quantofix) can reliably assess the ammonium-N content of slurries and hydrometers can be used to assess dry matter content, but laboratory analysis is necessary for other determinations. Laboratory analyses should include dry matter (DM), total N, total $P_2O_5$, total $K_2O$, total $SO_3$, total MgO and ammonium-N ($NH_4$-N). Additionally, nitrate-N ($NO_3$-N) should be measured for well composted FYM and poultry manures and slurry that has been treated aerobically, and uric acid-N for poultry manures.

### 4.4 Interpretation of analyses

Care must be taken when interpreting the results of laboratory analyses, as the results are often expressed in units that are not immediately useful. To determine how much to apply, total nutrients must be expressed as the kilograms per fresh tonne for solids or kilograms per cubic metre for slurries. In practice, laboratories often express results as mg/kg of nutrient in the dry matter (mg/kg DM) or percentage dry matter (% DM). In these cases, the % dry matter in the fresh material tested must be known to calculate the amount of each nutrient in the fresh material (as kg/t or kg/$m^3$).

Solids may have bulk densities ranging from 400 to 800 grams/litre. Standard nutrient values are provided for each solid organic material, based on its typical fresh bulk density. Where standard values (rather than analysis of your own materials) are used, you should estimate whether the bulk density of your material is typical of its type. If it is heavier (wetter) it is likely to have lower nutrient concentrations (and more water) per fresh tonne of material. If it is lighter (drier), it is likely to have higher nutrient concentrations (and less water) per fresh tonne of material.

In laboratory analysis reports, phosphorus (P) and potassium (K) are usually expressed in terms of mg/kg DM or % DM. It is important to note that fertiliser recommendations are expressed on a phosphate ($P_2O_5$) and potash ($K_2O$) basis rather than for phosphorus and potassium. The amount of phosphorus P (in kg/fresh tonne) should be multiplied by 2.29 to calculate the amount of phosphate ($P_2O_5$) present. Similarly, the amount of potassium K (in kg/fresh tonne) present should be multiplied by 1.2 to calculate the amount of potash ($K_2O$) present. If in doubt about how to interpret the results of laboratory analysis, farmers are advised to seek help from advisors with experience in the use of manures.

## 5 Worked examples

### 5.1. Understanding the value of FYM application

Table J shows fertiliser recommendations and potential and actual savings in fertiliser costs where 30 t/ha old cattle FYM with 25% DM was applied in autumn prior to growing a winter barley crop in an NVZ area. The FYM was ploughed down more than 24 hours after application (Table E). The NPK analytical values used were from Table C. The NPK recommendations for winter barley were based on information from SRUC technical notes TN731 and TN715-8 for an expected yield of 8.5 t/ha winter barley grown for feed following a crop of winter oilseed rape. The soil was a sandy loam and the straw was removed. The Nitrogen Residue Group following the winter rape crop was 2. The soil P and K status were at the target of lower moderate (M-). The actual financial saving from the application of the FYM was £121/ha. In this example there was residual N and K remaining for subsequent crops.

**Table J. Savings in fertiliser costs where 30 t/ha old cattle FYM was applied in autumn prior to growing a winter barley crop**

| | Nitrogen (N) | Phosphate ($P_2O_5$) | Potash ($K_2O$) | Financial (£/ha) |
|---|---|---|---|---|
| 1. Total NPK in old cattle FYM (kg/t) | 6.0 | 3.2 | 8.0 | |
| 2. Total NPK applied in 30 t/ha (kg/ha) | 180 | 96 | 240 | |
| 3. Availability of NPK from FYM used in planning the balance of NPK crop requirement (%) | 5% | 100% | 100% | |
| 4. Estimated NPK contribution from FYM (kg/ha) | 9 | 96 | 240 | |
| 5. Total NPK requirement for winter barley (kg/ha) | 200[1] | 102 | 89 | |
| *Cost of total NPK required (£)[2]* | *152.00* | *72.42* | *41.83* | *266.25* |
| 6. Manufactured NPK fertiliser required in addition to FYM (i.e. item 5 minus item 4) | 191 | 6 | 0 | |
| *Cost of manufactured NPK required (£)* | *145.16* | *0.0* | *0.0* | *145.16* |
| *7. Actual savings in year 1 (i.e. items 5 minus 6)* | *6.84* | *72.42* | *41.83* | *121.09* |

[1] Including adjustments for expected yield of 8.5 t/ha.

[2] Based on prices for N, phosphate, and potash of 76, 71 and 47p/kg respectively (The Farm Management Handbook, 2019/20).

### 5.2. Understanding the value of cattle slurry application

Table K shows fertiliser recommendations and potential and actual savings in fertiliser costs where 30 $m^3$/ha cattle slurry (6% DM) was applied in spring and ploughed in within 6hrs of application. The crop was spring barley which followed a winter barley crop grown in a non-NVZ area on a soil with a PSC index of 2. The NPK analytical values used were taken from Table C. The percentage of total N and P from the cattle slurry that should be used in planning the balance of N and P for crop requirement is given in Tables G and I. The NPK recommendations for spring barley were based on information from SRUC technical notes TN731 and TN715-8 for an expected yield of 6.5 t/ha spring barley grown for feed. The soil was a sandy silt loam and the straw was removed. The Nitrogen Residue Group following the winter barley crop was 1. The soil P status was low (L) and below target and soil K status was lower moderate and on target. The actual financial saving from the application of the cattle slurry was £72/ha. Any P not used by the crop in the year of slurry application will be available for crops in subsequent years.

**Table K. Savings in fertiliser costs where 30 $m^3$/ha cattle slurry (6% DM) was applied in spring prior to growing a spring barley crop.**

| | Nitrogen (N) | Phosphate ($P_2O_5$) | Potash ($K_2O$) | Financial (£/ha) |
|---|---|---|---|---|
| 1. Total NPK in cattle slurry (6% DM) (kg/$m^3$) | 2.6 | 1.2 | 3.2 | |
| 2. Total NPK applied in 30 $m^3$/ha (kg/ha) | 78 | 36 | 96 | |
| 3. Availability of NPK from cattle slurry used in planning the balance of NPK crop requirement (%) | 40% | 50% | 100% | |
| 4. Estimated NPK contribution from slurry (kg/ha) | 31 | 18 | 96 | |
| 5. Total NPK requirement for spring barley (kg/ha) | 145[1] | 86 | 77 | |
| *Cost of total NPK required (£)[2]* | *110.20* | *61.06* | *36.19* | *207.45* |
| 6. Manufactured NPK fertiliser required in addition to cattle slurry (i.e. item 5 minus item 4) | 114 | 68 | 0 | |
| *Cost of manufactured NPK required (£)* | *86.64* | *48.28* | *0* | *134.92* |
| *7. Actual savings in year 1 (i.e. items 5 minus 6)* | *23.56* | *12.78* | *36.19* | *72.53* |

[1] Including adjustments for expected yield of 6.5 t/ha.

[2] Based on prices for N, phosphate, and potash of 76, 71 and 47p/kg respectively (The Farm Management Handbook, 2019/20).

### 5.3 Understanding the value of N, P&K in cattle slurry in a dairy enterprise

Slurry samples were taken for analysis from a dairy cow enterprise (Slurry 1) and compared to the standard values in Technical Note TN736 (Slurry 2). Results are shown in Table L.

**Table L. Slurry analysis.**

| | Dry Matter (%) | Total N (kg/m³) | Total $P_2O_5$ (kg/m³) | Total $K_2O$ (kg/m³) |
|---|---|---|---|---|
| Slurry 1 | 3.8 | 2.7 | 1.9 | 4.2 |
| Slurry 2 | 6 | 2.6 | 1.2 | 3.2 |

The variation in nutrient levels between Slurry 1 and 2 demonstrates the value of sampling organic manures. How would these different slurry results affect fertiliser recommendations? Table M shows fertiliser recommendations and potential and actual savings in fertiliser where 30 m³/ha cattle slurry with was applied by a trailing shoe prior to 1st cut silage crop in April. The NPK recommendations for 1st cut silage were taken from SRUC technical note TN726 for a crop with expected yield of 23t/ha. The soil P and K status were at the target of lower moderate (M-). The Nitrogen Residue Group was Site Class 1.

**Table M. Comparison in fertiliser required where 30 m³/ha of 2 cattle slurries were applied in April to a 1st cut silage crop.**

| | Nitrogen (N) | | Phosphate ($P_2O_5$) | | Potash ($K_2O$) | |
|---|---|---|---|---|---|---|
| | Slurry 1 | Slurry 2 | Slurry 1 | Slurry 2 | Slurry 1 | Slurry 2 |
| 1. Total Nutrient in slurry (kg/m³) | 2.7 | 2.6 | 1.9 | 1.2 | 4.2 | 3.2 |
| 2. Total NPK applied in 30 m³/ha (kg/ha) | 81 | 78 | 57 | 36 | 126 | 96 |
| 3. Availability of NPK from cattle slurry used in planning the balance of NPK crop requirement (%)[1] | 50% | 40% | 100% | 100% | 100% | 100% |
| 4. Estimated NPK contribution from slurry (kg/ha) | 40 | 31.2 | 57 | 18 | 126 | 96 |
| 5. Total NPK requirement for Silage (kg/ha) | 120 | 120 | 39 | 39 | 138 | 138 |
| *Total Cost of NPK required (£)*[2] | *£91.20* | | *£27.69* | | *£64.86* | |
| 6. Manufactured NPK fertiliser required in addition to cattle slurry kg/ha (i.e. item 5 minus item 4) | 80 | 88.8 | 0 | 3[3] | 12 | 42 |
| *Cost of manufactured NPK required (£)* | *£60.80* | *£67.49* | *£0.00* | *£0.00* | *£5.64* | *£19.74* |
| ***Actual savings in year 1*** | *£30.40* | *£23.71* | *£27.69* | *£27.69* | *£59.22* | *£45.12* |

[1] N availability based on Table G, Feb-April, precision spread, using 2% DM for slurry 1, and 6% DM for slurry 2.

[2] Based on prices for N, P & K of 76, 71 and 47p/kg, respectively (The Farm Management Handbook, 2019/20).

[3] Impractical to apply this quantity.

For slurry with a DM lower than 5% a Farm Waste Management Plan can assist with identifying where steading water management can be upgraded to reduce the volume of slurry being spread to land and improve operating efficiency.

### 5.4. Understanding the value of N, P&K in cattle slurry in a beef enterprise

Slurry samples were taken for analysis from a suckler cow enterprise (Slurry 1) and a finishing cattle enterprise (Slurry 2) on the same farm. The results are shown over.

**Table N. Comparison of slurry analysis from a beef enterprise**

| | Dry Matter (%) | Total N (kg/m$^3$) | Total $P_2O_5$ (kg/m$^3$) | Total $K_2O$ (kg/m$^3$) |
|---|---|---|---|---|
| Slurry 1 | 9.1 | 2.0 | 1.2 | 3.3 |
| Slurry 2 | 8.8 | 4.7 | 2.0 | 6.1 |
| "Typical Slurry" | 6.0 | 2.6 | 1.2 | 3.2 |

The variation in nutrient levels between slurry 1 and 2 demonstrates the value of sampling organic manures. How would these different slurry results affect fertiliser recommendations?
Table O shows fertiliser recommendations where 30 m$^3$/ha cattle slurry was applied on a silage crop in May. The soil P status was below target at low (L) with a PSC soil index of 2 and soil K status was lower moderate and on target.

**Table O. Comparison in fertiliser required where 30 m$^3$/ha of 2 cattle slurries were applied in May to a 1$^{st}$ cut silage crop.**

| | Nitrogen (N) | | Phosphate ($P_2O_5$) | | Potash $K_2O$ | |
|---|---|---|---|---|---|---|
| | Slurry 1 | Slurry 2 | Slurry 1 | Slurry 2 | Slurry 1 | Slurry 2 |
| 1.Total Nutrient in slurry (kg/m$^3$) | 2 | 4.7 | 1.2 | 2 | 3.3 | 6.1 |
| 2.Total NPK applied in 30 m$^3$/ha (kg/ha) | 60 | 141 | 36 | 60 | 99 | 183 |
| 3.[1]Availability of NPK from cattle slurry used in planning the balance of NPK crop requirement (%) | 30% | 30% | 50% | 50% | 100% | 100% |
| 4.Estimated NPK contribution from slurry (kg/ha) | 18 | 42.3 | 18 | 30 | 99 | 183 |
| 5.Total NPK requirement for Silage (kg/ha) | 120 | 120 | 64 | 64 | 120 | 120 |
| Total Cost of NPK required (£)[2] | £91.20 | | £45.44 | | £56.40 | |
| 6.Manufactured NPK fertiliser required in addition to cattle slurry kg/ha (i.e. item 5 minus item 4) | 102 | 77.7 | 46 | 34 | 21 | 0 |
| *Cost of manufactured NPK required (£)* | *£77.52* | *£59.05* | *£32.66* | *£24.14* | *£9.87* | *£0.00* |
| *Actual savings in year 1* | *£13.68* | *£32.15* | *£12.78* | *£21.30* | *£46.53* | *£56.40* |

**The cost of fertiliser savings of slurry 1 equate to £72.49 per hectare and slurry 2 savings £109.85 per hectare**

Assumptions

Silage yield is 20t/ha

[1] N availability based on Table G, summer grassland, shallow injected, 10% DM slurry

[2] Based on prices for N, P&K of 76, 71 and 47p/kg, respectively (The Farm Management Handbook, 2019/20)

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