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Agricultural Waste Minimisation

BDB Associates

R&D Project Record P2/i668/7

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Statement of use
This report contains a copy of the waste minimisation guide used in the pilot farm studies.

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1. INTRODUCTION

This project record includes information collected during the research which is not intended for wider dissemination. It is complimentary to the R&D Technical Report P 20 but ,with few exceptions, does not duplicate information recorded there.

The information is provided in three appendices which should be considered in conjunction with R&D Technical Report P 20 (Davies and Parkinson, 1996).

APPENDIX A.

DRAFT FARM WASTE MINIMISATION GUIDANCE MANUAL

INTRODUCTORY NOTE

Waste minimisation has been successfully used in other industries and has resulted in lower costs and improved environmental performance for a wide range of companies.

This is a pilot stage of a project to examine the potential to reduce the amount of waste in the agricultural industry.

The work is sponsored by the Environment Agency and supported by the National Farmers Union.

This manual was developed to help review, step by step, the potential for reduction of farm wastes and the associated costs of handling and disposal.

All information will be kept confidential unless otherwise agreed.

Note. In the event a "targeting" questionnaire was used to identify the most important waste issues on the pilot farms. This approach superseded all but the guidance notes in the manual.

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Section 3. Guidance note on developing an action plan

Section 4. Reviewing progress

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1. Typical costs, manure values wastes, storage, roofing, land application etc. etc.
2. Typical Animal waste production units
3. Soil nutrient Index N P K
4. Typical nutrient values and N availability for cattle and pig manure and slurries
5. The process of reviewing organic waste production
6. Targeting questionnaire

INTRODUCTION TO WASTE MINIMISATION IN AGRICULTURE

Did you know that you could reduce the amount of waste you have to handle and save money at the same time ?

Industry has shown how this can be done and you could benefit from the experience of others.

For example did you know that each tonne (cubic metre) of animal manure, slurry and brown water you produce typically costs from £2.50 to £7 to store and spread on land ? So, for example, by ensuring roof water does not enter your dirty water system you could save £100s each year.

By using your organic wastes wisely you could save a lot on your fertiliser bill as well. For example, in a 100 tonnes of pig manure the value of the N would be some £75, the P would be £90 and the K £65, with a potential reduction in mineral fertiliser costs, allowing for normal losses, of some £200.

Minimising waste when using pesticides also pays ! For example one application of Mecoprop to 10 ha of cereal with an average cost of pesticide of £29 / ha and a 15% mis / over application would cost some £43. For a 300 ha unit the potential saving could be £1,290 which is certainly something to aim for !

The manual will help you identify the sources of waste and ways to minimise them by helping to reduce by-products and maximise reuse and recycling.. The process also helps to review the costs of some key practices by examining the effectiveness of any options.

Using this manual requires two types of information. General information about the farm and more detailed information about the specific farming operations which produce waste.

If you have some ideas for reducing your wastes and costs or you would like to know more please answer the questions on the following pages which will help identify the potential on your farm.

HOW TO USE THE MANUAL

The guidelines in this manual are divided into 4 sections :

SECTION 1. (Blue) General information about the farm

This includes basic information about the location, size and nature of the business with a map(s) of the farming operations such as crop rotations and waste disposal sites and drainage systems.

It also provides a tick sheet to identify the main wastes on your farm.

Action - To provide this information please complete relevant parts of the General Information Sheet and the table of wastes produced on the farm by ticking relevant parts of Table 1. giving details of the waste produced where available.

Once you have completed section 1. please turn to section 2

SECTION 2. (Green) Reviewing waste production

Action - Once you have identified your wastes in Table 1. refer to all guidance notes relevant to your farming operation. For example :

If you produce **animal slurry** refer to relevant guidance notes in **SECTION 2.1 ORGANIC WASTES**

If you use **mineral fertilisers** refer to guidance notes in **SECTION 2.2 FERTILISERS**

If you use **pesticides** complete guidance notes in **SECTION 2.3 PESTICIDES**

If you use **plastics** refer to guidance notes in the **SECTION 2.4 INORGANIC WASTES**

Action - Once you have completed section 2 turn to section 3.

SECTION 3. (Red) Developing an action plan to begin tackling priorities

This will help you select the most important areas to tackle first.

Action - Once you have identified your potential to minimise waste use section 3 to help set out the action plan.

SECTION 4. (White) Reviewing progress

This will help you set a programme to review progress with your action plan and monitor the benefits.

Action - Use this section to decide how and with what frequency to review progress.

SECTION 1. GENERAL INFORMATION SHEET - THE FARM AND ITS OPERATION - BLUE

Please provide information and answer the following questions :

Name of farmer .....Telephone .....Fax .....

Address

.....

.....

.....Post code.....

Nature of farm business .....

Size of farm .....

Stock numbers / types .....

.....

.....**[Options for these sections include tick boxes or detailed interviews]**

.....

.....

Outline of any crops grown and rotation practised

.....

.....

[Options for these sections include tick boxes or detailed interviews]

.....

.....

Do you have a soil map of the farm ?	Yes	No
Do you have a map of the farm showing fields, woodland and features such as streams etc.?	Yes	No
Do you have a map/ plan of the farm showing yard and field drainage systems ?	Yes	No
Do you have a plan showing number / size and position / layout of buildings and stores ?	Yes	No
Do you have a waste management plan ?	Yes	No
Do you have a fertiliser plan ?	Yes	No
Do you have a conservation plan ?	Yes	No

Please have these plans /maps available.

TABLE 1. Please tick below the wastes and other substances that you produce or store BLUE

ORGANIC MATERIAL	PRODUCED	STORED	VOLUME
Cattle - slurry			
Cattle - manure			
Pig - slurry			
Pig - manure			
Poultry - manure			
Compost			
Washings - parlour / other			
Brown water - yards / store			
Clean water runoff			
Silage liquor			
Co-disposal			
Sewage / sludge			
Vegetable wastes			
FERTILISERS			
Mineral fertilisers			
Liquid fertilisers			
PESTICIDES			
Dips / spray washings			
Fuel / lubricants			
INORGANIC WASTES			
Plastic sheets/bags etc.			
Metal, rubble,, glass etc.			
OTHER -specify			

SECTION 2. REVIEWING WASTE PRODUCTION

This section of the manual uses your tick sheet of wastes (Table 1.) to help you to target the potential for reducing wastes and maximising the reuse or recycling of them. This is called waste minimisation.

Please refer to your "tick list" in Table 1. which shows what waste you produce on the farm and then read the relevant **guidance notes** to help you decide if there is potential to minimise waste. This explained below :

Explanation of Guidance Notes

What follows are a series of simple guidance notes to help you reduce specific wastes and estimate any reduction in costs.

In each guidance note the potential ways of reducing the quantity of specific wastes are explored.

An example is given to illustrate typical cost-benefits. This will show if a more accurate assessment would be worthwhile in a specific case. For example, in the case of organic wastes, the more you can reduce your overall storage and disposal needs by reduction of by-products, the more the costs of storage and spreading to land will be reduced. For example reduction of costs and other benefit will follow if clean rainwater is kept separate from animal wastes.

In fact the volume of organic materials to be managed may be increased by by-products, liquid arising from other areas and those which are stored or disposed of together, including :

Wash water and waste milk
Dirty water runoff from yards and feeding areas and onto stores etc.[The farm yard catchment]
Silage liquor
Dilute pesticide washings
Water from roofs and clean yards
Leaking water appliances

These are considered in turn on separate guidance notes below :

Action - By reference to Table 1. and then to the guidance notes, decide what are the most important waste problems on your farm.

2.1 ORGANIC WASTES

GUIDANCE NOTE 1. Managing Organic Wastes

Potential Sources of pollution

By-products from livestock units such as slurry and silage liquor are potentially some of the most polluting of all organic material.

The safe storage and reuse or disposal of such by-products requires careful management and should be part of the routine of the farm. It can be a real cause of worry. The risk of pollution of water includes spillages, storage failure, runoff or leakage from land and percolation into groundwater.

Impact of losses

Even small quantities can cause serious water pollution and damage legitimate uses of natural waters such as drinking or agricultural water supplies and plants and animals, including fish. If pollution is caused prosecution may result in fines up to £20,000 and civil damages far in excess of this.

Methods of leakage control

Often there is potential to reduce the volume of such by-products and protect the content of nutrients or other chemicals to maximise their value. Indeed many farm organic by-products have value as fertiliser, soil conditioner or mulch and this can be of considerable benefit providing it is managed as a useful resource. Thus organic material can be reused as fertiliser or recycled as energy and organic matter in a form which is valuable but which has much less potential to cause pollution. Examples of good practice are :

Reduction of by-product production

Clean and dirty water separation

Careful management of the time, nature and site of application to land (See MAFF COGAP)

Reusing by-products as part of the fertiliser plan

Reusing by-products for energy production

Recycling wastes e.g. by composting

Action Now turn to the guidance notes which relate to the organic waste from your farm

GUIDANCE NOTE 2. Cattle Manure / Slurry (Dairy and beef)

Introduction The Volume and nature of manure / slurry produced will depend upon factors which include :

Stock numbers
Stock species (These examples are for dairy animals. The process is similar with other stock)
Housing system and hence amount of bedding
Duration of inhousing
Diet

By careful management of these variables there may be potential to reduce the volume of by-products and / or the cost of disposal on your farm. The volume of slurry produced may have been identified as part of a farm waste management plan or simply to size storage needs. This section of the waste minimisation audit critically reviews any reductions in by-products which are possible without affecting your production targets or animal welfare requirements.

Data needs

Reduction in livestock waste production units.....
Reduction in period in-housed .....
Reduction in bedding used - number of animals x volume .....
Typical unit cost of storage .....
Typical unit cost of disposal .....

The calculation

To identify the potential for reduction in animal slurry and costs carry out the simple sum below :

An example is given in Box 1.

Reduction in number of waste production units..... x number of days inhousing reduced.....x cost of storage and or disposal per unit..... = £.....and this is your potential **annual** saving
If you do not have details of actual storage and transfer costs use those in Box 1, which are typical industry average figures used **for illustration purpose only (Appendix 1.)**.

Appendix 2. sets out the units of waste for different stock animals for use in the calculation. It will allow you to calculate the volume and nominal savings by any reductions in stock numbers/ duration of inhousing

Box 1. Slurry production

. Each cubic metre [m^3] of slurry produced will cost some £1.50 [earth bank] - £3.5 [tin tank]to store [capital, financing and running costs] and £3 - £3.5 spreading to land. Thus the cost of slurry management can be reduced by some £4.5 - £7 / m^3, or £3-£3.50 / m^3 if existing storage is adequate.

For example if you are able to reduce the housing of 100 dairy animals for 2 days you will reduce the amount of slurry to be handled by some 9.4 m^3 [47 litres / day] saving around £25-30.

e.g. $\frac{100 \text{ waste units} \times 47 \text{ litres/day} \times 2 \text{ days} \times \text{cost in £3 per } m^3 \text{ disposed}}{1000}$ = £ 25-30 in spreading costs.

GUIDANCE NOTE 3. Pig manure / slurry

Introduction The volume and nature of manure / slurry produced will depend upon factors which include :

Stock numbers
Housing system and hence amount of bedding
Duration of inhousing
Diet

By careful management of these variables there may be potential to reduce the volume of by-products and / or the cost of disposal on your farm. The volume of slurry produced may have been identified as part of a farm waste management plan or simply to size storage needs. This section of the waste minimisation audit critically reviews any reductions in by-products which are possible without affecting your production targets or animal welfare requirements.

Data needs

Reduction in number of livestock.....
Reduction in period inhousing .....
Reduction in bedding used - number of animals x volume .....
Typical unit cost of storage .....
Typical unit cost of disposal .....

The calculation

To identify the potential for reduction in animal slurry and costs carry out the simple sum below :

An example is given in Box 2.

Reduction in number of waste production units..... x number of days inhousing reduced.....x cost of storage and or disposal per unit..... = £.....and this is your potential **annual** saving
If you do not have details of actual storage and transfer costs use those in Box 2. Which are typical industry average figures used **for illustration purpose only (Appendix 1.)**.

Appendix 2. sets out the units of waste for different stock animals for use in the calculation. It will allow you to calculate the volume and nominal savings by any reductions in stock numbers/ duration of inhousing.

Box 2. Manure / slurry production

. Each cubic metre [m^3] of slurry produced will typically cost some £1.50 (earth bank) - £3.5 (tin tank)to store (capital, financing and running costs) and £3 - £3.5 spread to land. Thus the cost of slurry management can be reduced by some £4.5 - £7 / m^3, or £3-£3.50 / m^3 if existing storage is adequate.

For example if you are able to reduce the drinking water loss by 0.25 l / pig / day for 12 months you will reduce the amount of slurry to be handled from 1000 pigs by some 91m^3, saving around £275 each year.

$$\frac{\text{e.g. 1000 units x 0.25 l /day x 365 days x cost in £3 per } m^3 \text{ disposed}}{1000} = £\ 273.75 \text{ in spreading costs.}$$

NB In this example the water saved with 10% reduction in leakage would reduce mains water costs by some £65 per year. In fact the water losses can be up to 50%

GUIDANCE NOTE 4. Poultry manure

Introduction The Volume and nature of manure produced will depend upon factors which include :

Stock numbers
Species / nature of stock
Housing system and hence amount of bedding
Duration of inhousing
Diet

By careful management of these variables there may be potential to reduce the volume of by-products and / or the cost of disposal. The volume of manure produced may have been identified as part of a farm waste management plan or simply to size storage needs. This section of the waste minimisation audit critically reviews any reductions in by-products which are possible without affecting your production targets or animal welfare requirements.

Data needs.

Reduction in number of livestock.....
Reduction in period inhousing .....
Reduction in bedding used - number of animals x volume .....
Typical unit cost of storage .....
Typical unit cost of disposal .....

The calculation

To identify the potential for reduction in poultry manure and costs carry out the simple sum below:

An example is given in Box 3.

Reduction in number of manure production units..... x number of days inhousing reduced.....x cost of storage and or disposal per unit..... = £.....and this is your potential **annual** saving
If you do not have details of actual storage and spreading costs use those in Box 3. Which are typical industry average figures used **for illustration purpose only (Appendix 1.)**.

Appendix 1. sets out the units of waste for different stock animals for use in the calculation. It will allow you to calculate the volume and nominal savings by any reductions in bedding, stock numbers/ duration of inhousing.

Box 3. Manure production

Each tonne of manure produced will typically cost £3 - £3.5 spread to land. Thus the cost of manure management can be reduced by some £3 - £3.50 for every tonne less manure produced.

For example if you are able to reduce the housing of 100 poultry unit (100,000 birds) by two weeks by improved growth you will reduce the amount of manure to be handled by some 42 m^3 [115 kg / day], saving around £ each year.

$$\text{e.g. } \frac{100 \text{ waste units} \times 115 \text{ kg/day} \times 14 \text{ days} \times \text{cost £3 per tonne disposed}}{1000} = £483 \text{ in spreading costs.}$$

GUIDANCE NOTE 5. Farm Yard Manure - Composting

Introduction

Composting organic manures can reduce the volume of by-products at the same time as preventing nutrient losses during storage and spreading to land. This adds value and flexibility to its use.

Site requirements

For agricultural purposes a level, preferably concreted area is needed. Existing concrete areas, stores or even silage clamps are suitable for part of the year; preferably roofed. A system to collect leachate which can be use to wet the compost as needed and a tractor with a front end loader or similar. Simple facilities for monitoring temperature and moisture content of the compost are also desirable but not essential.

Potential benefits

The process is based on the microbial breakdown of organic materials under aerobic conditions. Composting often occurs unintentionally on farm, resulted in semi-composted material with a more friable texture than raw manure. Careful management of manure heaps, with periodic turning to ensure adequate aeration, with lead to a significant reduction in manure volume. During the process nutrients are converted from soluble or volatile forms making them stable and hence more useful for plant nutrition. As a consequence atmospheric and leaching losses during and after spreading are reduced. Time spent turning the compost will be compensated for by a reduced labour requirement for spreading.
Composting can have a wide range of benefits for agriculture including :

* Reduction in volume of FYM up to 50%, which reduces spreading costs
* May reduce liquid wastes if they are used to maintain moisturise levels in the compost
* Destruction of pathogens, weed seeds, soil borne plant diseases and elimination of odour
* Increases window for application of manures to crops and reduces stock avoidance period
* No need to incorporate in the soil which facilitates reduced tillage systems
* Stabilisation of nitrogen which allows applications on otherwise unsuitable land
* Composting can include use of excess plant materials
* Low start up capital and nominal maintenance costs
* Greater efficiency may reduce need for inorganic fertilisers and pesticides
* Improves soil structure and can reduce topsoil losses from erosion
* Potential for commercial compost production

Typical cost benefits are illustrated in Box 4.

Box 4. Composting manure

The calculation of cost benefit is site specific and the most important reductions would include :

* **Reduction in mineral fertilisers needs.** For example with a 100 tonnes of pig manure, the initial value of the N would be 200 kg. At 36 p / kg this has a nominal value of some £75. On the same basis the 310 kg of P would be worth some £ 90 and the 310 kg of K some £65 a total fertiliser value of some £230. Some losses of nutrients are inevitable but composting will minimise these.

* **Reduction in quantity FYM and liquid waste**. Using 100 tonnes of pig manure, there is a potential reduction of some 25 -50% in overall volumes giving 25-50 cubic metres less waste with a typical unit cost of £4.5 - £7 per cubic metre to store and spread to land, saving some £100 to £350.

* Reduction in costs of **disposal of other wastes** e.g. vegetable outgrades

GUIDANCE NOTE 6. Wash water and waste milk

Introduction

A typical volume of washwater for a dairy unit will be 18 litres / cow /day [35 litres / day with high pressure system] with milk being negligible in volume, although it will be of considerable pollution potential. This adds significantly to the volume of dirty water to be managed or slurry if it is co-disposed.

Data needs

Actual volume of washwater per animal per day .....
Number of animals .....
Number of days per animal .....
Typical unit cost of treatment and / or storage .....
Typical unit cost of transfer to disposal site .....

Your calculation

To identify the potential for reduction in washings and disposal costs carry out the simple sum below :

In this case you can reduce waste by per capita reduction in washing water.

Reduction in washwater in litres.....x stock numbers..... x number of days..... x cost of storage and disposal.....= £.....

Plus

Reduced rate of washwater.....x stock numbers..... x unit cost of water = £.... and together this is your potential **annual** saving.

An example is given in Box 5.

Box 5 . Washwater

Considerable savings may be possible if the use of wash water is carefully controlled to ensure that it is at or less than the typical rate of use of 18 to 35 litres/cow /day. Using a 100 cow herd as an example the reduction of only 1 litre / cow / day of washwater would reduce the volume by $\frac{1 \times 100 \times 365}{1000} = 36.5\ m^3$

This would reduce the cost of storage by £55-128 and spreading to land of £110-128 plus the cost of the mains water [SW 77p / m^3] of £59 a total of £224-315 per year.

See guidance note 8. For the additional cost of rainfall caught in the storage.

Note. This has considerable potential for cost saving. The way to improve the washwater use is to monitor existing use and develop site specific ways to reduce the need for water. This would include evaluating the cost / benefits of washing equipment including high pressure systems or better surfaces for cleaning , subject to ensuring that hygiene is not compromised.

GUIDANCE NOTE 7. Dirty water runoff from yards and feeding areas (The farm yard catchment])

Introduction

The area of yard open to the elements is site specific, depending on the scale of the operation, the areas roofed and the drainage pattern of the farmyard. The volume of dirty water will also depend on the precipitation and whether clean areas in the farmyard catchment are drained separately.

Clearly reducing the farmyard catchment, roofing all or part of the yards, subject to cost benefit, minimising the dirty areas and keeping clean water separate could provide a considerable reduction in costs, help manage the peaks of rainfall and overall reduce the risks of pollution significantly.
Once again the calculation of the volume of runoff must be based on historic information and will reflect the average position which will vary from year to year.

Similar savings can be made by redirecting land runoff or streams which would otherwise flood dirty yards by constructing bunds or diversion ditches.

Data needs

Area of unroofed yard .....**Note - refer to your map of the buildings**
Annual precipitation .....
Typical unit cost of treatment/ storage .....
Typical unit cost of disposal .....

The calculation

To identify the potential for reduction in runoff and disposal costs carry out the simple sum below :

An example is given in Box 6.

Reduction in area of yard m^2 .....x annual precipitation m .....x typical unit cost of storage, treatment and disposal .....=£..... and this is your potential **annual** saving

Box 6. Dirty water runoff.

If we consider $1m^2$ of yard with an impermeable surface and with an annual precipitation of 1200mm, a typical annual value for the South West of the country ,the volume of runoff would be :

$\frac{1 \times 1200}{1000} = 1.2\ m^3$ which would cost some £2-4 to store and £3.5-4 to transfer to land. The runoff from a yard /feeding area of $500m^3$ would cost £750-1750 a year to store and £1500-1750 to transfer to land.

In the Midlands, with a typical rainfall of 900 mm, the same example would give costs of £675- 1575 a year to store and £1350- 1575 to transfer to land.

GUIDANCE NOTE 8. Rainfall onto and runoff from slurry and waste water stores.

Introduction

On a similar basis the area of storage which is open to the elements will add to the costs of storage and transfer to land .

Data needs

Area of storage to be covered .....
Annual precipitation .....
Typical costs of storage .....
Typical costs of transfer .....

Your calculation

To identify the potential for reduction in storage and disposal costs carry out the simple sum below:

An example is given in Box 7.

Reduction in area of store m^2 .....x annual precipitation m .....x typical unit cost of storage, treatment and disposal .....=£..... and this is your potential **annual** saving

Box 7. Stores

In the example above each m^2 of store open to the elements would add £1.5 - 3.5 a year to the costs of storage and £3 - 3.5 per m^3 for transfer to land. An earth store of capacity of $1500m^3$ and 3m deep would have an area of some $495m^2$ and rainfall would add 594 m^3 to the storage. Disposal to land of this would cost some £1782 - £2079 each year on average with the storage an additional £890, if not already available.

Note. In some high rainfall areas it may be cost-effective to roof stores. In the example above a roof would save some £35 - £40, 000 in waste management costs over 20 years.

Runoff from stores e.g. farm yard manure, siloes, composting etc.

Introduction

The potential reduction in waste by, for example , covering such stores and keeping clean water separate are similar to the example in Box 6 above, although less runoff may occur.

To identify the potential for reduction in runoff and disposal costs carry out the simple sum below :

An example is given in Box 6.

Reduction in area of store m^2 .....x annual precipitation m .....x typical unit cost of storage, treatment and disposal .....=£..... and this is your potential **annual** saving

GUIDANCE NOTE 9. Water from roofs and clean yards

Introduction

In the same way that water from yards can increase the volume of waste to be disposed, roof and clean yard water which is not kept separate may add considerably to the storage and disposal costs.
The task here is to identify the areas currently contributing to waste volumes by draining clean water which could be kept separate.

Data needs

Potential area of roof / yard to be drained separately from dirty water .....
Annual precipitation .....
Typical unit cost of storage.....
Typical unit cost of transfer to disposal .....

Your calculation

To identify the potential for reduction in storage and disposal costs carry out the simple sum below:

An example is given in Box 8.

Reduction in roof area draining to dirty water system..... x annual precipitation m..... x unit cost of storage and transfer to disposal ..... = £..... and this is your potential **annual** saving.

Box 8 . Roof water separation

In an example of an existing buildings with an area of 20 x 30m =600m^2, which currently has defective guttering and an annual precipitation of 1200mm, without the cost of storage and disposal costs of £3 / 3.5 m^3, the cost benefit of improvements would be :

600 x 1.2 x £3 - £3.5= £2160-2520 per annum less the cost of repairing the gutters which would be relatively low. This could save some [20 x £2160 or £2520] £ £45-50,000 less the cost of gutter repairs over 20 years. At a rate of some £75 per m^2 of roof drained, over 20 years even much smaller savings would be very cost-effective in the long term.

The costs of completing repairs is subject to a number of site specific factors. So the key to the success of this review is how much guttering repairs, of re-roofing would cost using actual, (not typical) costs on your farm.

GUIDANCE NOTE 10. Water leakage and reuse

Introduction On most farms there are a number of automatic or manual mains water systems and often a long spine main from the supply to service them. The farmer is responsible for all consumption after the stopcock on the service main at a tariff rate that varies between suppliers. In the South West this rate is currently 77p per m^3. It is in the interest of the user to monitor the use and losses from the system on a regular basis or to ensure that a reliable contractor does so.

Data needs

Leakage from internal service systems, taps, and equipment in m^3 .....
Tariff for mains water, pence / m^3.....

Your calculation

To identify the potential for reduction in leakage storage and disposal costs where the leakage passes to storage carry out the simple sums below:

An example is given in Box 10.

Reduction in leakage..... x cost per unit volume..... =£..... **plus**

Volume of leakage water to dirty water system ....x cost to store and transfer.....= £ ..... and this is your potential **annual** saving.

Box 9. Water leakage.

A tap, for example, with a leaking washer or a badly maintained drinking trough can easily waste 10 litres per hour. If not corrected this will cost some £67 a year.

$\frac{10l/hr \times 24\ hrs \times 365\ days \times 77p / m^3}{1000}$ = £67.45 a year plus disposal costs if it adds to the waste.

Leakage from the service main would cause a much more substantial cost. It is worth ensuring the farm house water supply system is secure on the same basis.

Rain water / wastewater reuse

Introduction

There is considerable potential for using non-main water supplies for non critical tasks such as yard cleaning if the cost of this is less than the tariff for mains water [currently 77p / m^3 in the SW]. Potential sources include stored roof water, ponds, springs rivers and boreholes and recycled waste water from yard runoff.

Data needs

Cost per m^3 of water **including abstraction licence**, storage and pumping .....
Tariff for mains water .....**The calculation** is number of m^3 of mains water .....x tariff / per m^3 £..... = £ .....

GUIDANCE NOTE 11. Silage liquor

Introduction

The quantity of silage liquor produced will depend on the means of making the silage, including the use *of* additives, the maturity and nature of the crop being used and, critically, its moisture content the weather conditions and whether absorbents are being used to retain the liquor. Wilted silage produces less liquor than unwilted and this could lead to less waste to manage. The peak flows occur in the first 2-3 days with 50% of the total volume arising within 10 days.

Data needs

The typical quantity of silage produced in clamp(s) .....
The normal dry matter content.....
Nature and quantity of additives / absorbants .....
Typical unit cost of storage of silage liquor.....
Typical unit cost of transfer to disposal .....

Your calculation

To identify the potential for reduction in storage and disposal costs carry out the simple sum below:

An example is given in Box 10.

Using your assessment of crop dry matter and the typical quantity of silage produced you can estimate the reduction in waste liquor :

Reduction in effluent... x 100s of tonnes produced... x 2 dilutions.... x unit cost of storage and/or disposal .....= £..... and this is your potential **annual** saving

Box 10. Silage liquor.

The volume of liquor produced is directly dependant on the moisture content of the crop being ensiled. For example ensiled grass at 15% dry matter will produce some 33 m^3 / 100 tonnes ensiled

20%	22 m^3 / 100t
25%	11 m^3 / 100t

The cost of providing extra storage for silage liquor, which is very corrosive and polluting, would be £10-20 / m^3.

Spreading after 1:1 dilution, by low rate irrigation or spreader application at a maximum rate of 50m^3 / ha (4500 galls / acre) of diluted liquor would cost £1-3.5 / m^3 giving a potential saving which is based on the volume of silage liquor not produced, stored or reused.

NB Although silage liquor has a relatively low nutritional value (18 litres = kilogram of wheat in nutritional energy) it can be used to feed livestock thus providing a short term cost benefit in both nutrition and reduced disposal costs.

GUIDANCE NOTE 12. Co-disposal

Dilute pesticide washings

Introduction

The volume of washings from pesticide application equipment and containers should be kept to a minimum. Whilst disposal of washings to an untreated section of the crop being treated, or other suitable land, is generally the optimum environmental solution, in some cases co-disposal with slurry is used. In such cases the costs for dirty water above (also see guidance note 7.) would apply and savings would result from reduction in volumes at a rate of some £3 per m^3 .

Low rate wash systems also reduce volumes for disposal.

Milk

Introduction

Milk has a very high water pollution potential based on its high food value for micro-organism which remove oxygen from the water in this metabolic process. The volumes involved as waste are generally small and it is often co-disposed with slurry although there are dangers with gas formation which require careful health and safety precautions.

Because of its high food value there is benefit in recycling waste milk to feed other stock, although a vet's advice on the transfer of any disease should be sought beforehand.

GUIDANCE NOTE 13. Sewage and sewage sludge

Introduction

Sewage may be a by-product of domestic accommodation or of sewage treatment more generally and available for soil and nutrient enhancement from the local Water Utility.

Domestic sewage

In many cases it is possible to treat and dispose of domestic sewage through simple settlement and biological treatment in a septic tank. The supernatant liquid is then soaked a way through a herring bone system. Provided clean water is kept separate from the system, use of chemicals such as bleach is minimised, and there is an adequate soakaway, the process will operate for years with little maintenance except desludging every 1-5 years, which can often be done on farm.

This can be an environmentally sound and cost effective system which avoids Water Utility sewerage charges typically more than £100 per annum.

Sewage sludge

The use of land for disposal of sewage sludge has potential benefits for the farmer and the Water Utilities. Some 500,000 tonnes (dry weight) are currently disposed to land in the UK. However the potential for sludge to contain materials such as heavy metals which can build up in the soil, has resulted in development of EU law which is enacted in the UK by regulations. With careful adherence to the regulations there is little chance of long term soil damage and some benefits from nutrients, irrigation and improved soil structure, particularly in arable regions where organic levels in soils can be low. There seems little chance that the Water Utilities will pay for the use of land but the operation is generally at no cost to the farmer.

To make full benefit from this operation the nutrients in the sludge should be credited to the nutrient budget and hence deducted from the fertiliser costs.

Data needs

Number of units of fertiliser credited.....
Value of benefit of each unit.....

Your calculation

To identify the potential for reduction in fertiliser costs with benefit of sewage sludge carry out the simple sums below:

Number of units of nutrients credited .....x value of each unit..... = £..... and this will be the benefit **per application** provided it is used as part of the crop nutrient budget.

GUIDANCE NOTE 14. Vegetable wastes

Introduction - washings

As with all washing processes there are a number of potential savings to be made which include reductions in unit volume, recycling of used water (some use closed systems) and the use of settled material as a soil improver although care needs to be taken to avoid the spread of disease or weeds.

Data needs

Volume of water used per unit of vegetables washed #.....
Cost of raw washing water.....

This will vary according to the source for example mains water will be 77p / m^3 (South West) and rather less if it is a local source e.g. borehole which will have to be costed separately.

Your calculation

To identify the potential for reduction in washing costs carry out the simple sums below:

Reduction in number of units of washwater per unit of vegetables....x cost of each unit..... = £..... and this will be the benefit **per operation.**

Recycling of used water, for initial washing would also reduce the costs pro rata.

Disposal of settled solids is not likely to provide net income but use for gardens or highway landscaping may well cover transport costs and reduce the overall cost of the washing operation.

Management of waste vegetables

Introduction - waste vegetables

The process of preparing vegetables for market identifies large volumes of damaged or otherwise unsuitable vegetables which need to be recycled of disposed of to land.

The options are :

Minimise machine and pest damaged vegetables

Identify outlets for less than perfect vegetables

Reuse as animal feed

Recycle by composting and use as organic mulch (See composting under guidance note 5.)

Dispose of to suitable land fill on or off farm.

The potential savings in reuse / recycling arise from reduction in disposal costs and the value as feed and for organic material / nutrients.

2.2 FERTILISERS

GUIDANCE NOTE 15. Introduction to nutrient management

Potential sources of leakage

The main objective of waste minimisation in arable crops is to avoid leakage of nutrients from land to water and air. Leakage can arise from a wide range of sources including organic wastes, fertilisers and pesticides from stores or from land applications.
Leakage from land results from runoff and erosion of soils which carries nutrients, biological material and particulate matter to surface and groundwaters. Very often this natural process of transfer is made more damaging to the water environment and its uses by inappropriate land use practices.
Leakage to the air results from the loss of nitrogen as ammonia and denitrification, which results if livestock wastes are not rapidly incorporated in the soil.

Impact of losses

Such losses may result in pollution incidents which cause immediate damage or more subtle changes such as eutrophication over a longer period. The water quality change brought about by this pollution may cause serious impact on water uses such as potable supplies and be costly to remedy.

Methods of leakage control

By considering factors such as climate, soil type and topography it is possible to plan farming operations to minimise the waste of materials which result from land use practices.

Techniques include ;

Planning crop production and rotations compatible with the farm environment

Ensuring careful budgeting of all inputs and soil reserves of nutrients i.e. analyse your soil

Identifying areas where no applications should be made e.g. adjacent to wells (Farm waste plan)

Controlling the time, rate, method and accuracy of applications

Minimising soil erosion runoff by appropriate land management practices, crop cover and buffer strips

Managing inputs to balance profit and yield

Value of losses

Losses are also a significant problem for farming profits since they add to crop management costs and may reduce yields. For example each kilogram kg of mineral nitrogen applied which is lost or ineffective in crop production costs [£122-147 per tonne] some 36p, plus application costs of. 1-5 p per kg applied per ha (£7 at rate of 125 kg/ha - £11 at rate of 1250 kg/ha) i.e. a total of say 40p.

Ineffective application resulting a 10% reduction of plant uptake would cost £5 (40p x 12.5 kg) - £50 (40p x 125 kg) per ha. Plus the consequent loss of yield.

Similar costs are incurred with over application resulting from poor input budgeting or lack of calibration of equipment, and losses from organic nutrients in storage. The following guidance notes sets out how to reduce these costs by careful management of fertilisers, manures and application machinery.

GUIDANCE NOTE 16. Developing a nutrient budget

STEP 1. Produce a cropping plan.

If you have not already done so review your cropping plan, including grass and any bio-fuels etc. taking into account the suitability and characteristics of the farm environment for specific crops, and identify the crop rotation, nutrient and crop protection needs.

STEP 2. Understand your soil

Soil is a key feature of any farm. Understanding the basic characteristics of your soil will help identify limitations and potential to enhance production and reduce costs by better targeting of resources.
If you have not already done so you should develop a soil map of your land and summarise any features which will influence crop management for example how the soil type will influence access and the timing or rates of applications.
It will also help in wider management since the structure of the soil will reflect historic inputs and land use practices. (Map source Soil Survey Silsoe)

STEP 3. Establish the soil pH and nutrient status

Tests of the soil chemistry every 3-5 years (pH more frequently) will allow you to gain full value from the reserve of nutrients and elements in the soil. This is an important step in identifying the additional requirements of subsequent crops. During intervening years assumptions about nutrient status may be based on the cropping regime. Current costs of soil sampling are £1-2 per ha . A saving of only 3-6 kg of N per ha would pay for the cost of this work.

STEP 4. Review potential nutrient value of farm by-products

The volume, nutrient value and availability of any farm by-products or imported wastes needs to be established to identify how they may best be used to meet crop nutrient requirements over and above soil reserves. Where waste will make a significant contribution to the nutrient requirements, for example on a dairy farm, it is advisable to test the slurry and any separated liquid to build up a more accurate picture of its value.

In the absence of this information Appendix 4 sets out the basic nutrient value of the most common wastes and this can be used to calculate the availability and value of deploying them to meet the needs of the crops. Allowances will need to be made for losses of nutrients from storage or application to land when crops are not actively growing.

The nutrient value and any potential contaminants of other wastes e.g. sewage sludge should be confirmed before application.

STEP 5. Identify the need and specification of mineral fertilisers

Using the cropping plan it is possible to identify the quantity and timing of nutrients to ensure optimum conditions for plant nutrition. Allowances can then made for existing soil reserves and the nutrients available in by-products. Any balance will require input of the appropriate formulation of mineral fertiliser.

Using the results of soil testing, the cropping plan and assumptions about the quantity and value of wastes produced on the farm or available from elsewhere it is possible to plan the likely fertiliser needs well in advance. This will assist with ordering, costing and monitoring use and outputs.

STEP 6. Calibration of equipment

Managing the method and accuracy of fertiliser applications will also help avoid wasteful applications and leakage to watercourses. To do this farm or contractor's equipment should be calibrated to deliver the correct volume per unit area and avoid collateral impact.

Action - calibrate equipment to ensure accurate delivery of fertilisers and organic material

STEP 7. Storage

Waste and hence costs can be reduced by careful management or supervision of contractors to ensure that spillages do not occur and residues are disposed of safely and cost effectively. This can be achieved by careful planning of how the work will be organised. For example the costs of storage and carrying stocks can be avoided if the requirements are accurately predicted and fertilisers are brought onto the farm for immediate use with the contractor taking responsibility for agreed precautions.

Action - develop a plan to minimise the risk of waste and pollution from storage and use of fertilisers

STEP 8. Record keeping

Information on application rates, yield and soil test results will be valuable for improving future decisions. For this reason it is important to keep a simple record of the steps taken for future reference. This might, for example, be on a farm map which shows the cropping and the nutrient plan for each year.

Action - As a first step keep records which will allow you to reduce waste and costs

STEP 9. Reviewing progress

It is important to use the experience of setting targets to reduce waste and costs for the benefit of future performance. This is best done by monitoring performance against the targets and periodic assessment of progress and lessons learned. Often the whole process benefits from co-operation between local farmers and technical advisers working together.

Action - review your progress against the plans and alter them with the experience gained.

GUIDANCE NOTE 17. Nutrient budgets

Introduction

The development of a nutrient plan is central to crop yield, crop health, cost effective use of by-products and ensuring profits, since diminishing returns follow over or under use of nutrients.

To simplify the development of a nutrient budget it has been assumed that basic requirements such as a cropping plan and soil data are available for the farm. If these are needed it is suggested that the steps in guidance note 16. are followed.

Data needs

Crop
Soil type
Soil nutrient and element status
History of cropping
Specific crop nutrient needs
Nutrients available in farm by-products **Note - these can only be used effectively with adequate storage**

Calculation of additional crop nutrient needs

Crop nutrient needs -minus - allowance for soil nutrient status -minus - allowance for nutrients in organic by-products to be applied = balance of inorganic fertiliser to be applied kg / ha .

Crop nutrient budget example 1.

CROP Grass for silage

	NUTRIENTS kg/ha					COMMENTS
	N	**P**	**K**	**OTHER**	**pH**	
Soil nutrient index	1-2	1	1			See appendix 3
Crop nutrient needs	120	60	100			MAFF recommendation allowing for soil reserves
Minus organic nutrients	30	30	160			Dairy slurry 50m^3 / ha DM 6% applied December
Balance	90	30	0			Additional nutrients to sustain crop
Mineral fertiliser application regime e.g.	40	30	0			Feb - early March
	50	0	0			March -early April
Savings £ per ha from organic nutrients	11	9	21			Total savings based on average prices are £41/ha

Crop nutrient budget example 2.

CROP **Maincrop potatoes**

SOIL **Loamy sand**

	NUTRIENTS kg/ha					COMMENTS
	N	**P**	**K**	**OTHER**	**pH**	
Soil nutrient index	1-2	4	1			See appendix 3
Crop nutrient needs	240	100	300			MAFF recommendation allowing for soil reserves
Minus organic nutrients *	93	120	112			Broiler manure 8t/ ha immediate incorporation
Balance	147	0	188			Additional nutrients to sustain crop
Mineral fertiliser application regime	75	0	95			In seedbed
	75	0	95			Tuber initiation
Savings £ per ha from use of organic nutrients	53	0	40			Total savings based on average prices of nutrients are £93/ha

* The organic nutrient allowance is for year 1 only. There will also be some smaller benefits in subsequent years.
Using these examples for guidance identify the crops in your cropping plan on which organic by-products from the farm will be used.

Identify the quantities and the timing of applications for these crops which will allow calculation of the residual nutrients and subsequently the mineral fertiliser needs.

Action -complete a blank crop nutrient sheet for each crop and refer to appendices for further information .

Where you have data on the nutrient value of your by-products use it, otherwise use typical national average data as supplied by MAFF.

CROP NUTRIENT BUDGET PROFROMA

CROP

SOIL

	NUTRIENTS kg/ha					COMMENTS
	N	**P**	**K**	**OTHER**	**pH**	
Soil nutrient index						See appendix ....
Crop nutrient needs						MAFF recommendation allowing for soil reserves
Minus organic nutrients						
Balance						Additional nutrients to sustain crop
Mineral fertiliser application regime						
Savings £ per ha from use of organic nutrients						Total savings based on average prices of nutrients are £ /ha

NOTES

2.3 AGROCHEMICAL WASTES

GUIDANCE NOTE 18. Avoiding wastage of pesticides

Potential sources of leakage

Leakage can arise from a range of sources including spillages, inappropriate disposal, inaccurate application, and transport mechanisms including runoff, leaching or erosion of land. Some pesticides or their breakdown products are relatively soluble in water and follow land drainage to natural waters. Others adhere to soil particles and travel with them when erosion takes place. This natural transport process can become excessive, for example, if soils are at or over field water capacity.

Impact of losses

Such losses may result in pollution incidents which cause immediate damage or more subtle changes resulting from diffuse runoff and accumulation in sediment, biota or natural waters over a longer period. The water quality change brought about by this pollution may cause serious impact on water uses such as potable supplies and, as in the case of contamination of groundwater, will be costly to remedy.

Methods of leakage control

By considering factors such as climate, soil type and topography it is possible to plan farming operations to minimise the waste of pesticides which result from inappropriate storage and land use practices.

Techniques include ;

Planning crop production and rotations compatible with the farm environment

Identifying areas where no applications should be made e.g. adjacent to wells

Controlling the time, rate, method and accuracy of applications

Minimising soil erosion by appropriate land management practices, crop cover and buffer strips

Reusing washings on part of the crop identified for that purpose

Minimising inputs of chemicals

Potential options include :

Crop rotation to break pest life cycles

Using resistant crop varieties or combinations of them

Ensuring optimum conditions for crop health and vigour

Managing pest predator habitats

Reducing inputs to improve profit not just production +

+ For example in some cases tilling to control weeds in combination with band and / or low concentration spraying will reduce inputs and costs without materially affecting yields.

Value of losses

Losses are also a significant problem for farming profits since they add to crop management costs and may reduce yields. For example each ha of crop to which a pesticide is unnecessarily applied, wrongly targeted or is ineffective in crop protection costs from £3-90 depending on the formulation, and £5.50 - £11.60 in application costs. This is a total of some £8.50 - £100 per ha plus the cost of the loss of yield which would result.

The following worksheets set out how to reduce costs by careful management.

GUIDANCE NOTE 19. Managing Crop Protection

STEP 1. Producing a crop protection plan.

If you have not already done so review your cropping plan, including grass and any bio-fuels etc. taking into account the suitability and characteristics of the farm environment for specific crops, the local history of pest problems and identify the potential crop protection needs.

Action - review your cropping plan to identify potential crop protection needs

STEP 2. Consider the options for crop protection

Consider the physical, biological and chemical options which would help control pests and identify a balanced approach which minimises costs and chemical inputs. This in turn will minimise the waste of resources.

Potential options for use individually or in combination include :

Crop rotation to break pest life cycles

Using resistant crop varieties or combinations of them

Ensuring optimum conditions for crop health and vigour

Managing pest predator habitats

Using tillage and other techniques in combination with chemical control of pests

Reducing inputs to improve profit not just production

Action - identify the potential pest control strategies which suit your farm environment

STEP 3. Collecting information on target pest species

To reduce costs, protect the environment and minimise waste it is necessary to obtain information on the status of target pests to update the planned crop protection . This information is needed to establish the need for a particular pesticide which will be effective in achieving satisfactory levels of control, has least potential to damage the environment and is cost effective.

Information on specific target pests will also allow accurate decisions on the timing, rate and area of application which can reduce costs by reducing unnecessary applications. For example in some cases lower concentrations of active ingredient and zone or band spraying will reduce inputs and hence costs

Action - collect information to allow accurate selection of pest control remedies

STEP 4. Managing chemical applications

Pesticide application is a complex and potentially dangerous activity if it is not carefully managed. For this reason it can be worthwhile to compare the difference in costs of equipment, storage, application, disposal of washings, training and insurance between the farm and a reputable contractor. Use of a contractor could allow more attention to be given to accurate targeting of pests which is where waste and hence costs can be reduced.

Use of the farm map which shows particular features where care is needed will help avoid losses and pollution of natural waters or spray drift to protected areas, for example habitats for predator species.

Action - Manage the application of pesticides by targeting of pests and avoiding vulnerable areas

STEP 5. Calibration of equipment

Managing the method and accuracy of pesticide applications will also help to target pests and avoid wasteful applications and leakage to watercourses. To do this farm or contractor's equipment should be calibrated to deliver the correct volume per unit area with appropriate droplet size and avoiding collateral impact.

Action - calibrate equipment to ensure accurate delivery of active ingredients

STEP 6. Pesticide storage, mixing and disposal of washings

Waste and hence costs can be reduced by careful management or supervision of contractors to ensure that spillages do not occur and residues and washings are disposed of safely and cost effectively. This can be achieved by careful planning of how the work will be organised. For example the costs of storage and carrying stocks can be avoided if the requirements are accurately predicted and pesticides are brought onto the farm for immediate use with the contractor taking responsibility for agreed precautions and disposal routes.

Action - develop a plan to minimise the risk of waste and pollution from storage and use of pesticides

STEP 8. Record keeping

Information on incidence of pest and implementation of control strategies and the results will be valuable for improving future decisions. For this reason it is important to keep a simple record of the steps taken for future reference. This might, for example, be on a farm map which shows the cropping, nutrient and crop protection plan for the year. Computerised systems are available which guide you through the process of record keeping.

Action - keep records which will allow you to reduce waste and costs

STEP 9. Reviewing progress

It is important to use the experience of setting targets to reduce waste and costs for the benefit of future performance. This is best done by monitoring performance against the targets and periodic assessment of progress and lessons learned. Often the whole process benefits from co-operation between local farmers and technical advisers working together.

Action - review your progress against the plans and alter them with the experience gained .

GUIDANCE NOTE 20. Calibration of pesticide spray equipment

Introduction

Managing the method and accuracy of pesticide applications will also help to target pests and avoid wasteful applications and leakage to watercourses. To do this the farm or the contractor's equipment should be calibrated to deliver the correct volume per unit area with appropriate droplet size to avoid impact outside target areas.

Data needs

Cost per ha of pesticide to be used
Area to have application (ha)
Estimate of % waste by over application due to poor calibration of equipment

Your calculation

Cost £/ha of pesticide x number of ha to be sprayed x percentage loss = potential savings per application

Examples

1. Calibration of spray equipment

One application of Mecoprop to 20 ha of cereal with a 15% wastage (over-application) rate and an average cost of pesticide of £29/ha i.e.

$$£29 \times 20 \times \frac{15}{100} = £87 \text{ per application}$$

Action - calibrate equipment annually to ensure accurate delivery of active ingredients.

2. Reducing pesticide drift

In the this case the losses are caused by drift which wastes the pesticide and may cause collateral damage.

One application of MCPA to 20 ha of grassland with a drift loss / mis-application of 15% and an average cost of £9 per ha i.e.

$$£9 \times 20 \times \frac{15}{100} = £27$$ per application. Savings on the first application would pay for appropriate spray nozzles : 6 tilt jets at an average cost of £23.50 or 6 lo-drift nozzles at an average cost of £15.

Action - reduce spray drift by using appropriate equipment.

GUIDANCE NOTE 21. Targeting the pest species for control

Introduction

The amount of pesticide wasted can be reduced by accurate targeting to areas where a pest is known to exist. In the case of weeds general applications can be wasteful if the distribution of the pest is limited or control in the immediate area of the crop is sufficient to ensure a satisfactory yield.

In such cases zone, band or low dose spraying may be sufficient. Choice of such options will depend on accurate scouting of the target pest species and then delivery of sufficient of the active ingredient for control, not necessarily eradication which may not be cost-effective.

Data needs

Cost per ha of pesticide to be used
Area to have application (ha)
Estimate of savings in application per ha by targeting pests.

Your calculation

Cost £/ha of pesticide x number of ha to be sprayed minus savings per ha = potential savings per application

Example

Use of the pre-emergence herbicide Chloridazon would cost £25- 75 per ha for sugar beet. Band spraying would cost £9- 25 per ha with considerable potential savings. For this reason time and money spent targeting pests and ensuring accurate application could be very worthwhile.

Action Ensure you are targeting pests accurately

GUIDANCE NOTE 22. Pesticide management on the farm.

Introduction

Waste and hence costs can be reduced by careful planning of how the work will be organised. For example the costs of storage and carrying stocks can be avoided if the requirements are accurately predicted and pesticides are brought onto the farm for immediate use with the contractor taking responsibility for agreed precautions and disposal routes.

Data needs

The costs of on farm management of pesticide compared with contractors costs would include :

Secure storage
Investment in stored pesticides
Equipment provision, calibration and maintenance
Training of staff
Insurance
Disposal of containers etc.

There is also the peace of mind from knowing the management of the applications is a contractor's hands.

Example

No clear example of cost savings can be given because of the considerable range in costs for safe storage of pesticides etc. Each must be done on a site specific basis. However the average additional costs of using a contractor will be approx. £4.50 - £5.65 per ha.

Action - develop a plan to minimise the risk of waste and pollution from storage and use of pesticides and compare costs with that of contractors.

GUIDANCE NOTE 23. Mixing and disposal of washings

Introduction

Waste and hence costs can be reduced by careful management to ensure that spillages do not occur, and residues and washings are disposed of safely and effectively. Savings can also be made with accurate mixing and calculation of the volumes needed. If a contractor is used the costs of miscalculations or clearing up spillages are his but selection of mixing and disposal sites, if on farm, and supervision of contractors is an important part of the farmer's role.

Careful calculation of the volume needed will reduce the amount of spay in excess to requirements and thus the costs of active ingredient, waste disposal and environmental risk.

Data needs

Cost of pesticide per ha
Area to be sprayed
Estimated over use of active ingredient

Your calculation

Cost of pesticide per ha x area to be sprayed x % waste by overuse of active ingredient = £ per application

Example

Over use of active ingredients

10% overuse of Chlortoluron active ingredient in mixing spray for blackgrass in 10 ha of cereals at average price of £23.50 per ha i.e.

$$£23.50 \times 10 \times \frac{10}{100} = £23.50 \text{ saving per application.}$$

Note Also see Guidance note 12 about co-disposal of dilute pesticide washings

2.4 INORGANIC WASTES

GUIDANCE NOTE 24. Managing inorganic wastes

A whole range of inorganic materials can be accumulated as by-products of farming. Whilst their impact on the environment is not so dramatic as other by-products they can cause pollution and aesthetic problems. Further, they may be a danger to livestock and farmer workers or visitors if not properly managed.
Materials include metals including containers, glass, rubble, bale twine, pallets general litter and plastics.

Management of inorganic wastes

Often the by-products can be reused or recycled to reduce costs and the risks of aesthetic or water quality pollution. However it is also sensible to review the production of such wastes and decide if the quantity can be reduced in the first place. Action should be taken to :

Review the way such by-products arise and minimise production

Separate by-products and store them until needed or they represent a suitable amount for disposal.

Identify ways to reuse or recycle such by-products

Value of the inorganic by-products

There is little financial value in most inorganic by-products. However, the disposal of such materials incurs a cost which can be reduced by deciding the most cost-effective and environmentally sound disposal route.

Some by-products can be reused around the farm, for example rubble to stabilise gateways, others such as plastic film can be collected free of charge as part of a national service.

GUIDANCE NOTE 25. Plastics / polythene [sheeting, wraps, bags, containers etc.

Introduction

A wide range of plastics have become an indispensable aid to modern farming as packaging of inputs such as fertilisers and products such as silage. For example farming has become one of the largest users of plastic film in the country and disposal of this and other plastics is now a major concern.

Action plan

The cost of disposal of plastics to land fill would be prohibitively expensive and on farm disposal unrealistic in the long term. For this reason it is important to develop a strategy for disposal of plastic by-products in as cost-effective manner as possible.

This should include :

Reduction of by-products by seeking action on minimising packaging

Reuse of plastic for covering stores, equipment and machinery

Reuse of plastic for horticultural purposes

Reuse of containers

Recycling of plastics through regional centres

Recycling of plastic film through the National Farm Film Recovery Scheme

Many of these options are cost neutral if the appropriate plastics are stored separately and clean without extraneous matter, until suitable volumes are available for collection.

SECTION 3. ACTION PLANS

GUIDANCE NOTE 26. DEVELOPING AN ACTION PLAN

When you have completed the questions look through your notes and identify where you have found potential to reduce wastes.

If there are a number of options identify the most important by considering :

the potential savings (Guidance notes based on typical costs are available)

the benefits to the environment by reduced pollution risk

the benefit in reduction in management time

how easily the changes may be made

Set out the results of your thoughts on the following table which identifies where further help is needed and the top priorities for action.

		PRIORITY		
ACTION PROPOSED	IMMEDIATE	URGENT	THIS YEAR	5 YEAR PLAN
EXAMPLE				
Seek advice on cost benefit of roofing stock feed area.	Brown water storage under pressure - pollution risk			
PRIORITY 1.				
PRIORITY 2.				
PRIORITY 3.				

SECTION 4. REVIEWING PROGRESS

The importance of monitoring

Once achievable Action Plan targets have been set it is advisable to review progress and ensure windows of time in the farming calender are available to carry out any necessary planning and remedial work.

If a opportunity is lost for repairs to equipment or infrastructure it may be a year before another opportunity arises. Further, the motivation to continue the process of waste minimisation will depend on achieving tangible results. Only with regular reviews will the opportunity be available to decide how problems in the process can be overcome.

Timescales

Reviews once or twice a year are adequate providing the key time for improvements has been identified and set aside. It is important not to put pressure on the participants by setting targets which are too demanding; " under plan and over achieve" is a good maxim.

Simple actions first

Another useful rule is to ensure that progress which requires easy steps is undertaken first. For example, the repair of a gutter on a large building could provide large benefits for relatively little time or cost. The rule here is "start simple".

Group therapy

A useful way to keep up the momentum and spread ideas rapidly is to develop small local groups of farmers who have common interests, or build waste minimisation groups on existing organisations, where mutual support will help the process. Here the progress with action plans and the way to solve problems can be discussed.

Overall

Set achievable and targets which will bring early benefits with limited costs, monitor progress and amend plans to ensure success.

SOURCES OF FURTHER INFORMATION [Indicative only]

APPENDICES [Indicative only]

1. Typical costs, manure values wastes, storage, roofing, land application etc.

2. Typical Animal waste production units

3. Soil nutrient Index N P K

4. Typical nutrient values and N availability for cattle and pig manure and slurries

		Nutrient content kg / tonne			Nitrogen (N) availability % of total N *			
Fresh		N	P	K	Autumn	Winter	Spring	Summer
FYM	Cattle	6	3.5	8	5	10-15	20	n/a
DM 25%	Pigs	7	7	5	5	10-15	20	n/a
	kg / m3							
Slurries	Cattle	3	1.2	3.5	5-10	10-20	30	20
DM 6%	Pigs	5	3	3	5-10	10-25	35	20

* Nitrogen values for FYM materials should be reduced by up to half where they have been stored in the open for long periods.

This would mean that application in Autumn, of cattle FYM which has been stored outside for long periods, would result in only 2.5% of the N being available for the next crop largely due to losses to the air and runoff or leaching into groundwater.

These circumstances would reduce its potential value as a Nitrogen fertiliser from some £2 to about 5 pence per tonne.

5. The process of reviewing organic waste production

In the case of animal slurry the approach could be as in farm waste management planning :

Unit production of faeces per day x number of stock = check with norm, review need for inhousing etc.

Duration of inhousing x daily faeces production = check with norm. and review.

Add any wash water used - stock x unit volume = check with norm for washwater and review

Add any co-disposed by-products e.g. silage liquor = check with norm for silage liquor production

Add water from roofs, yard runoff and stores etc. = review potential for separation

Less separation and low rate irrigation of liquid faction.

APPENDIX B. TARGETING QUESTIONNAIRE

1. SLURRY / FYM / BROWN WATER

FARM ..... **SITE / ENTERPRISE** ..... **DATE** .....

Please consider each question below and if it is relevent to your enterprise answer Yes or No by ticking the appropriate box and add comments alongside.

WASTE PRODUCTION	**CHECK LIST**		**NOTES**
1. HOUSING OF STOCK			
Are there any options to reduce waste by changing the in-housing arrangements, diet etc.	YES NO	☐ ☐	**Guidance note 12**
Do you import any organic wastes?	YES NO	☐ ☐	**Guidance notes 1, 2, 3, 4.**
2. WASH WATER			
Do you monitor the amount of water used for parlour, yard and vehicle washing ?	YES NO	☐ ☐	
Do you reuse any water e.g. from roofs or elsewhere?	YES NO	☐ ☐	
Do you think that there are any other ways you could reduce the amount of water used ?	YES NO	☐ ☐	**Guidance notes 6, 10.**
3. CLEAN AND DIRTY WATER SEPARATION			
Do you keep clean water from yards and roofs separate from dirty water ?	YES NO	☐ ☐	
During heavy rain does water run from land or streams across your yard and / or into your stores ?	YES NO	☐ ☐	
Do your store(s) collect direct rainwater ?	YES NO	☐ ☐	
Is it be possible to separate or divert clean water and thus reduce the amount of brown water produced on your farm ?	YES NO	☐ ☐	**Guidance notes 7, 8, 9, 12.**

4. STORAGE

Are you able to store your wastes without leakage until you are able to spread on land ? YES ☐ NO ☐

Do you manage the wastes to reduce the loss of beneficial nutrients ? YES ☐ NO ☐

5. DISPOSAL

Do you make timely applications by ensuring the site, rate, crop needs and weather are suitable ? YES ☐ NO ☐

Have you used practices to minimise losses from land ? YES ☐ NO ☐

Is you equipment calibrated to deliver an accurate and even application ? YES ☐ NO ☐

Do you use a contractor to apply your organic wastes ? YES ☐ NO ☐

Do you use composting and / or digestion to gain added value from your organic wastes ? YES ☐ NO ☐ **Guidance note 5.**

Is any of your organic waste disposed of off farm ? YES ☐ NO ☐

Do you make use of any crop residues ? YES ☐ NO ☐

Have you ideas on how to improve the use of your organic wastes or brown water ? YES ☐ NO ☐

5. EMERGENCIES

Do you have an emergency plan to deal with spillages and pollution ? YES ☐ NO ☐

3. SILAGE LIQUOR

Please consider each question below and if it is relevent to your enterprise answer Yes or No by ticking the appropriate box and add comments alongside.

1. SILAGE LIQUOR PRODUCTION

Do you wilt your crop to ensure high dry matter in grass ensiled ?	YES ☐ NO ☐	**Guidance note 11**
Do you use whole grain or other crop silates which produce less liquor ?	YES ☐ NO ☐	
Are crop residues and / or absorbents used to reduce liquor leaching ?	YES ☐ NO ☐	
Do you use any silage additives ?	YES ☐ NO ☐	
Are there any ways for you to reduce the amount of silage liquor produced ?	YES ☐ NO ☐	

2. DISPOSAL

Do you reuse the liquor as stock feed ?	YES ☐ NO ☐	
Do you make timely applications by ensuring the site, rate, crop needs and weather are suitable ?	YES ☐ NO ☐	
Have you used practices to minimise losses from land ?	YES ☐ NO ☐	
Is your equipment calibrated to deliver an accurate and even application ?	YES ☐ NO ☐	
Do you believe there are ways to improve your use / disposal of silage liquor ?	YES ☐ NO ☐	

4. FERTILISERS

Please consider each question below and if it is relevent to your enterprise answer Yes or No by ticking the appropriate box and add comments alongside.

1. CROP NUTRIENTS

Do you have a nutrient (fertiliser) plan ?	YES ☐ NO ☐	**Guidance note 15**
Are your soil nutrient reserves regularly tested ?	YES ☐ NO ☐	
Do you take account of crop residues and green crops in nutrient planning ?	YES ☐ NO ☐	**Guidance notes 16, 17**
Is the nutrient value of organic wastes from livestock part of your nutrient budget ?	YES ☐ NO ☐	**Guidance notes 16, 17**
Do you account for the nutrients in silage liquor and dirty water spread on land ?	YES ☐ NO ☐	
Is your equipment calibrated to ensure accurate and even applications ?	YES ☐ NO ☐	
Do you ensure timely applications ?	YES ☐ NO ☐	
Overall, do you have ideas about how you could improve use of nutrients ?	YES ☐ NO ☐	**Guidance note 15**

2. STORAGE

Do you minimise the storage of fertilisers on farm ?	YES ☐ NO ☐
Do you use a contractor to apply fertilisers to your crops ?	YES ☐ NO ☐
Are there ways you could improve storage or reduce costs?	YES ☐ NO ☐

5. PESTICIDES

Please consider each question below and if it is relevent to your enterprise answer Yes or No by ticking the appropriate box and add your comments alongside.

1. APPLICATIONS

Do you use methods other than chemical control for crop protection ?	YES ☐ NO ☐	**Guidance note 18**
Do you target pest species by field tests or predictions ?	YES ☐ NO ☐	**Guidance note 21**
Is your equipment regularly calibrated to ensure accurate and even applications ?	YES ☐ NO ☐	**Guidance note 20**
Have you identified "no spray" areas to protect wildlife and water sources ?	YES ☐ NO ☐	
Do you minimise pesticide use by low dose, band or row application ?	YES ☐ NO ☐	**Guidance note 21**
Do you use a contractor for part or all of your applications ?	YES ☐ NO ☐	**Guidance note 22**
Do you use animal or plant dips ?	YES ☐ NO ☐	
Do you have ideas on reducing pesticide use	YES ☐ NO ☐	**Guidance note 19**

2. STORAGE

Do you minimise the storage of pesticides on farm ?	YES ☐ NO ☐	**Guidance note 23**
Have you arranged a mixing area designed to avoid / contain spillage of chemicals ?	YES ☐ NO ☐	

3. DISPOSAL

If you use a contractor does he dispose of all containers, excess concentrate and washings ?	YES ☐ NO ☐	
Do you dispose of dip liquid and equipment rinsings to land / crops ?	YES ☐ NO ☐	
Do you have ideas on how to improve the disposal of wastes from pesticides ?	YES ☐ NO ☐	

6. OTHER WASTES

Please consider each question below and if it is relevent to your enterprise answer Yes or No by ticking the appropriate box and add comments alongside.

1. WATER LEAKAGE

Do you monitor your use of clean water ?	YES ☐ NO ☐	
Do you check equipment for leaks ?	YES ☐ NO ☐	
Are there ways you could reduce water leaks and hence costs ?	YES ☐ NO ☐	**Guidance note 10**

2. VEGETABLE WASTES

Do you have large quantities of "outgrades" to dispose of ?	YES ☐ NO ☐	
Do you recycle "outgrades" by reusing for stock feed, landfill or composting?	YES ☐ NO ☐	
Do you recycle vegetable washwater and soil ?	YES ☐ NO ☐	
Are there ways you could reduce or recycle your vegetable wastes ?	YES ☐ NO ☐	**Guidance note 14**

3. FUEL AND LUBRICANTS

Do you manage your purchases to minimise storage on the farm ?	YES ☐ NO ☐	
Do you have ideas on how to recycle waste oils ?	YES ☐ NO ☐	

4. INORGANIC WASTES

Do you accumulate and store wastes such as plastics, rubble, glass and metal ?	YES ☐ NO ☐	**Guidance note 24**
Do you reuse or recycle plastics or other materials ?	YES ☐ NO ☐	
Have you ideas on how to reduce wastes such as plastics ?	YES ☐ NO ☐	**Guidance note 25**

APPENDIX C.

Identifying the waste problems and waste minimisation remedies

A summary of the problems and practical remedies for waste management was developed as a basis for the farm audits as follows :

1. Organic Wastes

Potential sources of pollution

By-products from livestock units such as FYM, slurry, "brown water" and silage liquor are potentially some of the most polluting of all organic materials. The safe storage, reuse or disposal of such by-products requires careful management, can be a real cause of worry and should be part of the routine management of the farm. The main risks of pollution result from spillages, storage failure, runoff from yards or land and percolation into groundwater.

Impact of losses

Even small quantities can cause serious water pollution and damage to existing and potential uses of natural waters such as potable drinking or agricultural water supplies and aquatic biota. If pollution is caused prosecution may result in fines up to £20,000 and civil damages far in excess of this.

Practical remedies

Often there is potential to reduce the volume of such by-products and manage the content of nutrients or other chemicals to maximise their value and control leakage. Indeed many organic farm by-products have value as fertiliser, soil conditioner or mulch and this can be of considerable benefit providing it is managed as a useful resource. Thus organic material can be reused as fertiliser or recycled as energy and organic matter in a form which is valuable but which has much less potential to cause pollution. Examples of good practice in waste minimisation of organic materials are :

1. direct reduction of by-product production;
2. indirect reduction by clean and dirty water separation;
3. careful management of the time, nature and site of application to land;
4. reusing by-products as part of the fertiliser plan;
5. reusing by-products for energy production;
6. recycling wastes in a more valuable and flexible form e.g. by composting.

Value of losses

Organic material has value as a soil conditioner, mulch and with good management can help to reduce mineral fertilisers needs by providing some of the nutrients which a crop needs. Reduction of availability of nutrients can occur in a number of ways, some of which result from avoidable, permanent losses :

LOSS OF NUTRIENT AVAILABILITY

In soil	**Off-field**	
Immobilised short term N	Leaching	N K (P)
Immobilised long term P	Runoff	P
	De-nitrification / volatilisation	N

Long term losses from the system can cause unnecessary costs. For example with a 100 tonnes of pig manure, the initial quantity of the N would be 200 kg. At an average value of 36 p / kg (Nix 1996) this has a nominal value of some £75. On a similar basis the 310 kg of P would be worth some £ 90 and the 310 kg of K some £65, with a total fertiliser value of some £230. However, depending on the fate of the nutrients, which could be the subject of short or long term losses, the value of the available nutrients in the organic matter could be considerably less.

2. Agrochemical Wastes

Potential sources of leakage

Leakage can arise from a range of sources including spillages, inappropriate disposal, inaccurate application, and runoff or erosion of land. Some pesticides or their breakdown products are relatively soluble in water and follow drainage from land to natural waters. Others adhere to soil particles and travel with them when erosion takes place. These natural transport processes can become excessive if, for example, soils are vulnerable to the forces of erosion.

Impact of losses

Such losses may result in pollution incidents which cause immediate damage or more subtle changes resulting from diffuse runoff and accumulation of pesticides in sediment, biota or natural waters over a longer period. The water quality change brought about by this pollution may cause serious impact on potable supplies or on biodiversity. In the case of contamination of groundwater, the damage will be difficult and costly to remedy.

Practical remedies

By considering factors such as climate, soil type and topography it is possible to plan farming operations to minimise the leakage of pesticides which result from inappropriate storage and

land use practices. Simple management practices such as accuracy of applications could also be significant. LEAF suggest 50% of spreaders and sprayers are never calibrated (LEAF 1995) Although it is not clear how representative this is, one pilot farmer was convinced that it was important.

Managing applications :

1. planning crop production and rotations compatible with the farm environment;

2. identifying areas where no applications should be made e.g. adjacent to wells;

3. controlling the time, rate, method and accuracy of applications;

4. minimising soil transport by appropriate land practices, crop cover and buffer strips;

5. reusing washings on part of the crop or suitable land identified for that purpose.

6. Using modern sprayers with in-system mixing and washing facilities

Minimising inputs including the following potential options :

1. using a crop rotation to break pest life cycles;

2. using disease / pest resistant crop varieties or combinations of them;

3. ensuring optimum conditions for crop health and vigour;

4. managing pest predator habitats;

5. managing inputs to balance yields and profit. +

+ For example, in some cases, tilling to control weeds in combination with band, area and / or low concentration spraying will reduce herbicide use and overall costs without materially affecting yields and (WDATCP Tech. Bull 1989).

Value of losses

Losses of pesticides can be a significant problem for farming profits since they add to crop management costs and may reduce yields. For example each hectare of crop to which a pesticide application is not accurately targeted or where for other reasons the effectiveness in crop protection is reduced, will typically cost from £3 - £90 depending on the formulation, and £5.50 - £11.60 in application costs. This is a total of some £8.50 - £100 per ha plus the cost of any consequent loss of yield.

3. Fertilisers

Potential sources of leakage

The main objective of waste minimisation in arable crops is to minimise leakage of nutrients from land to water. Leakage can arise from a range of sources including organic wastes,

fertilisers losses from stores or inappropriate land applications. Leakage from land results from runoff and erosion of soils which carry nutrients, biological material and particulate matter to surface and groundwaters. Very often these natural processes of transfer become damaging to the water environment because of the level of contaminants resulting from inappropriate land use practices. Leakage to the air results from the loss of nitrogen as ammonia which is greatest if livestock wastes are not rapidly incorporated in the soil.

Impact of losses

Such losses may result in pollution incidents which cause immediate damage or more subtle changes such as eutrophication over a longer period, often resulting from a large number of small inputs. The water quality change brought about by this pollution may cause serious impact on water uses such as potable supplies or bio-diversity and may be very costly to remedy.

Practical remedies

By considering factors such as cropping plans, climate, soil type and topography it is possible to plan farming operations to minimise the leakage of materials which result from land use practices.

Techniques include:

1. planning crop production and rotations which are compatible with the farm environment;

2. identifying areas where no applications should be made e.g. adjacent to wells;

3. controlling the time, rate, method and accuracy of applications;

4. minimising soil erosion and runoff by good land practices, crop cover and buffer strips;

5. managing inputs to balance yield and profit ;

6. ensuring careful budgeting of crop needs with all inputs and regular testing of soil reserves of nutrients.

Value of losses

The efficiency of utilisation of fertiliser applied is already quite low : Typically N 50%, P 25% and K 50-60%. Further unnecessary losses are a significant problem since they add to crop management costs and may reduce yields. For example each kg of nitrogen (N) which is lost or ineffective in crop production costs some 36p, plus application costs of 1-5 p per kg applied per ha.

A loss of 10% of the application, which is not uncommon, from an application of 100 kg of N (300 kg Ammonium Nitrate) would be 10 kg of N with a value of some £3.60 plus spreading costs a total of some £5 plus any consequent loss of yield. For grass, which receives higher rates of N the losses could be financially significant.

Losses higher than 10% can easily result from over-application, poor input budgeting (20-50%), uneven application resulting from lack of calibration of equipment(20-40%) and losses of nutrients from organic materials in storage (up to 50%) (CEST 1993).

4. Inorganic Wastes

Potential sources of impact

A wide range of inorganic materials can be accumulated as by-products of farming. Whilst their impact on the environment is not so dramatic as other by-products they can cause pollution and aesthetic problems. Further, they may be a danger to livestock and farm workers or visitors if not properly managed. Materials include metal wastes, containers, glass, rubble, general litter and plastics.

Practical remedies

Often the by-products can be reused or recycled to reduce costs and the risks of aesthetic or water quality pollution. However it is also sensible to review the production of such wastes and decide if the quantity can be reduced in the first place. Action should be taken to :

1. review the way such by-products arise and minimise production;

2. separate by-products and store them safely until ready for disposal;

3. identify ways to reuse or recycle such by-products.

Value of the inorganic by-products

There is little financial value in most inorganic by-products. However, the disposal of such materials incurs a cost which can be reduced by deciding the most cost-effective and environmentally sound disposal route.

Some by-products can be reused around the farm, for example rubble to stabilise gateways. Others such as plastic film, can currently be collected free of charge as part of a national service.

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