Using Compost in Agriculture and Field Horticulture

Compost Information Package 1

PUTTING COMPOST TO WORK!
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WRAP (the Waste & Resources Action Programme) is a national Government programme established to promote sustainable waste management by tackling the barriers to waste minimisation and increased recycling.

For more information go to www.wrap.org.uk or phone 0808 100 2040.
Summary of the benefits of compost and its use in agriculture and in field horticulture

Compost is a product that is made through the process of composting. It is most commonly made from gardeners’ and landscapers’ plant trimmings and prunings, but may also include small amounts of other source-separated biodegradable materials such as manure, untreated wood or paper and card. Kitchen food materials may also be included, but the product literature must contain information regarding restrictions on its use and record keeping where animals graze or crops are cut for fodder.

These materials are processed under carefully controlled conditions to produce a high quality product, as defined by the British Standards Institution’s Publicly Available Specification for Composted Materials– BSI PAS 100 (2002). Compost conformity should be independently assessed and verified through a certification scheme such as that managed by The Composting Association.

These composts are very different from wholly manure based composts and sludges – and must be used differently.

Compost should be screened through a maximum screen size of 40 mm for general use in arable agriculture and grassland establishment. Crops that require a finer seedbed should be treated with compost that has been screened to less than 25 mm or even 15 mm, depending on the crop and the seedbed soil conditions required. Fruit crops benefit from a surface application in the rows of 25 mm screened compost. For grassland top dressing, less than 25 mm screened compost should be used.
Compost contains plant nutrients and organic matter. These ingredients have beneficial effects on the following crop when applied to the soil.

Compost contains slow release nitrogen, phosphate and sulphur. It contains readily available potash that can provide all the crop’s needs plus smaller but useful amounts of magnesium, calcium and trace elements. Compost has a small neutralising value and is about 10% as effective as limestone, tonne for tonne of dry matter. Compost can therefore stabilise soil pH and reduce the acidifying effects of inorganic nitrogen fertilizers.

The organic matter in compost is able to confer many benefits including:

- improved soil aggregation and structure;
- improved water infiltration and water holding capacity;
- increased soil cation exchange capacity in light soils;
- reduced leaching of nutrients.

Compost also contains beneficial microorganisms. These are able to contribute to a healthy soil in terms of improved nutrient cycling and disease suppression.

Compost may be used at rates of up to 30 to 35 tonnes per hectare which will provide approximately 250 kg/ha of total nitrogen – the maximum allowed in Nitrate Vulnerable Zones. This rate will also provide approximately 100 kg/ha phosphate, 200 kg/ha potash, 60 kg/ha magnesium and 33 kg/ha sulphur as S, based on typical compost analysis.

Lower compost application rates may be applied according to crop needs, or as required for the full crop rotation. Recent compost analysis results from the supplier should be used in order to apply and utilise the compost correctly. Compost may be applied at any time of the year as the nitrogen it contains will not be readily leached, even when applied in the autumn.

Crop nutrient requirements are detailed in ‘Fertilizer Recommendations for Agriculture and Horticulture’ (RB209, MAFF 2002).
Introduction

Compost is a natural product made by composting biodegradable materials under managed conditions. In the United Kingdom, plant materials from households, parks and gardens are the main raw materials and, when not composted at home, may be composted at community sites or large scale composting facilities. They are processed under carefully controlled conditions to produce a high quality product, as defined by the British Standards Institution’s Publicly Available Specification for Composted Materials – BSI PAS 100 (2002). Compost conformity to PAS 100 should be independently assessed and verified through a certification scheme such as that managed by the Composting Association. These composts are very different from wholly farmyard manure based composts and sludges – and must be used differently.

What is compost?

Compost is a different product to manures and slurries that are used on land and is defined in the BSI’s PAS 100. It is a product in its own right that is safe to use in the environment with beneficial properties that can be used to advantage in agriculture.

Although compost is mainly made from domestic garden or landscaper’s tree and shrub prunings and grass cuttings, it may also contain some small amounts of paper or card, untreated wood or animal manures. Properly treated kitchen food wastes may also be included at approved composting sites. The compost supplier will have records of the types of materials used to make the compost. The product literature must contain information regarding restrictions on its use and record keeping where animals graze or crops are cut for fodder.

What is composting?

Composting is a process of controlled biological decomposition of biodegradable materials under managed conditions. Conditions within the composting heaps are controlled by various means to ensure there is sufficient air, moisture and high temperatures within each heap such that, over time, this results in compost that will have beneficial effects when added to soil or container-mixes that support plants. Vermicomposting, which relies on specific worm species, can also produce high quality vermicomposts although they are not covered by PAS 100, which only deals with high temperature composting.

High temperatures and moist conditions sustained during managed composting processes ensure that weed seeds and plant, human and animal pathogens are destroyed. The compost will be stable such that plant pathogens cannot become re-established again after mixing with the soil. This is because the readily biodegradable materials will have been transformed into the building blocks that become soil humus and also because a multitude of beneficial microorganisms are present that can out-compete the plant pathogens.

These guidelines help you to obtain the correct product grade for your requirements and help you to use compost wisely and profitably.

CASE STUDY 01

Pete Richardson
Horticulturalist, Coleshill Organics

We specialise in high quality organic hot crops and mixed leaf salad crops, delivering our produce to 250 private customers in and around the Vale of Whitehorse.

Five years ago, seeking to improve our soil structure and fertility, we switched from farmyard manure to organic waste derived compost supplied by Worton Farm, who are working towards TCA Certification. The results have been amazing. Certified compost acts as a wonderful disease suppressant, is much more complex than manure and is rich in microbial goodness. The soil gets a great fertility boost, while we get healthier plants and better quality vegetables.

We have also found that certified compost is much easier to apply, particularly across our eight poly-tunnels. It shovels well and handles better than any other conditioner.

KEY FACTS ABOUT COLESHILL ORGANICS

• Coleshill Organics is a 16-acre organic nursery in Oxfordshire
• They supply organic produce, including mixed leaf salad crops, hot crops and fruit, to approx 250 private customers in the local area
• 40 cubic metres of organic waste derived compost from Worton Farm are used at the nursery each year
What are the standards for compost?

Biodegradable, source separated materials are processed under carefully controlled conditions to produce a high quality product, as defined by the British Standards Institution’s Publicly Available Specification for Composted Material – BSI PAS 100 (2002). Compost conformity to PAS 100 should be independently assessed and verified through a certification scheme such as that managed by the Composting Association – look for the certification mark.

Full details of the PAS 100 are available from the British Standards Institution (BSI). Information is also available from The Composting Association at www.compost.org.uk or from the Waste and Resources Action Programme (WRAP) at www.wrap.org.uk.

There are limitations depending on the composting feedstocks for use in organic agriculture. Where kitchen or catering wastes have been composted, the Animal By-Products Regulations 2003 must be followed - see the regulations section (see page 12).

How is compost analysed?

Compost samples should be tested by laboratories that use the methods specified in BSI PAS 100. Most of the methods are for soil improvers and growing media, such as those made from or including composts. These methods are different from those used for soils. The Composting Association maintains a list of suitable laboratories.

What are the characteristics of compost for use in agriculture and field horticulture?

These are some recommended properties of a good compost for use in agriculture and horticulture.

<table>
<thead>
<tr>
<th>Compost Parameters</th>
<th>Reported as (units of measure)</th>
<th>Recommended Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>pH units (1:5 water extract)</td>
<td>7.0 – 8.7</td>
</tr>
<tr>
<td>Moisture Content</td>
<td>% m/m of fresh weight</td>
<td>35 – 55</td>
</tr>
<tr>
<td>Organic Matter Content</td>
<td>%, dry weight basis</td>
<td>&gt;25</td>
</tr>
</tbody>
</table>
| Screen aperture size          | mm                                                  | 40 maximum for soil improvement  
25 maximum for top dressing grassland  
25 maximum for root crops and vegetables  
25 maximum for surface dressings in fruit crop rows  
15 maximum for finer seedbeds       |
| C:N Ratio                     |                                                     | 20:1 maximum                                                                      |
What are the potential benefits of using compost?

Organic matter in soil is essential for soil structure, water holding properties, microbial activity and soil health.

Composts can be used to add organic matter to soils and increase the production of soils through many benefits:

- reduced need for inorganic fertilizers
- reduced nutrient leaching
- increased yielding potential
- better soil structure leading to
  - greater workability of soil and
  - increased traffic tolerance
- improved water holding in light soils
- reduced erosion risk
- beneficial soil microorganisms aid
  - soil aggregation
  - nutrient recycling
  - plant disease suppression

Compost supplies nutrients and reduces the need for inorganic fertilizers. Ref [1]

The composition of compost will vary according to the materials included and the composting process itself. However, as a general rule compost provides the following nutrient benefits (approximate figures as total nutrient kilogrammes per tonne of moist compost based on typical analysis):

<table>
<thead>
<tr>
<th>Nutrient as N</th>
<th>Phosphate as P₂O₅</th>
<th>Potash as K₂O</th>
<th>Magnesium as Mg</th>
<th>Sulphur as S</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.1</td>
<td>3.3</td>
<td>6.6</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Composts not only provide valuable organic matter to soils, but also act as slow-release fertilizers for nitrogen and phosphate, and provide a readily available source of potash. Other nutrients are also provided by composts such as magnesium, sulphur and trace elements. The efficiency of inorganic nitrogen fertilizer use by plants has been shown to be improved by the application of compost because of better overall nutrient supply and improved rooting environment.

Compost can also provide a valuable source of calcium with a small liming effect (it has up to 10% of the neutralising value of limestone on a dry matter basis).

Typical application of 31.5 tonnes of compost (20 tonnes dry weight basis) will provide (approximate figures):

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>Total amount (kg/ha)</th>
<th>Available year 1 (kg/ha)</th>
<th>Available year 2 (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen as N</td>
<td>250</td>
<td>25 (10%)</td>
<td>12 (5%)</td>
</tr>
<tr>
<td>Phosphate as P₂O₅</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potash as K₂O</td>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium as Mg</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulphur as S</td>
<td>33</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The total nitrogen in compost should be applied according to the needs of the next crop in conjunction with inorganic nitrogen fertilizer. The needs of the soil for the full crop rotation should be considered when assessing the other major nutrients. Fertilizer recommendations for agricultural and horticultural crops are provided in the MAFF publication RB209 (2000).

CASE STUDY 02

Tristan Squier, a farmer in Essex, has been testing different rates of compost on his heavy clay land. “In the field where compost was applied, the combine yield map showed that the wheat responded well to the compost with higher yields. A trial was also funded by Remade Essex (see www.remadeessex.org.uk) where oilseed rape was grown with various combinations of compost and fertilizer. There were big differences in plant establishment, early growth and yield where compost was applied. The improvement in soil structure will take a few years to take effect but we are taking a long-term view and feel it is a worthwhile investment.”
The organic matter in compost can increase the yielding potential of soils. Ref [3]

The organic matter level in a soil of given texture is normally greatest under permanent grassland. When this is ploughed out, some of the organic matter is oxidised over the following years until a new equilibrium is reached at a lower level.

It has been shown in long-term experiments such as those in the Rothamsted ‘Classicals’ that modern varieties only reach their full potential when organic matter levels are high enough. It was found that additional nitrogen fertilizer could not compensate when the organic matter was low. This may be because modern crops need to establish rapidly and this requires good physical conditions for rapid root growth to explore the soil for nutrients and water.

Compost is able to provide organic matter in a relatively stable form that can raise the soil organic matter levels and provide benefits described below, resulting in improved yields and cost savings.

Compost improves soil structure for better workability and traffic tolerance. Ref [4]

Many experiments have shown that organic matter improves the aggregate strength of soils. This means that the soil is more resistant to compaction and that roots can penetrate more easily to find nutrients and water. The workability and traffic tolerance of the soil is also improved so that the use of large, modern machinery results in less soil compaction and the soil can tolerate the use of vehicles and equipment on more days per year.

The available water holding capacity of soil is raised. Ref [5]

As part of the benefit of improved soil structure, the infiltration of rainfall and irrigation water is improved and the soil water holding capacity is increased especially on light textured soils. Thus the frequency and duration of irrigations can be reduced leading to lower water consumption and labour requirements, saving money.

<table>
<thead>
<tr>
<th>Time compost applications so that increased nutrient availability helps meet the nutrient requirements of your crop rotation programme.</th>
<th>Include available nutrients supplied by compost applications in your inorganic fertilizer programme using information from RB209.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulations regarding Nitrate Vulnerable Zones must be followed and the Soil Code practiced in other areas. If catering wastes or animal by-products have been included in the composting feedstocks, the Animal By-Products Regulations (2003) must be followed (see regulations section, page 12).</td>
<td>As compost works differently to manures and slurries, it can have added benefits: Spring application is possible due to the slow-release nutrients in composts, not adversely affecting crop establishment and quality. Autumn application results in less nutrient leaching due to the slow-release forms of many of the nutrients in composts.</td>
</tr>
</tbody>
</table>

Compost reduces the risk of nutrient leaching. Ref [2]

Light textured soils have low cation exchange capacities (CEC) and the addition of compost will raise the CEC of these soils. This enables the soil to hold onto nutrients such as potassium and nitrogen, which would otherwise leach beyond rooting depth.

The available water holding capacity of soil is raised.

As part of the benefit of improved soil structure, the infiltration of rainfall and irrigation water is improved and the soil water holding capacity is increased especially on light textured soils. Thus the frequency and duration of irrigations can be reduced leading to lower water consumption and labour requirements, saving money.
Erosion risk is reduced by using compost. Ref [6]
On light soils in the UK, erosion risk from wind and water is high. This is especially so where organic matter levels are low and soil aggregation poor. Compost can rectify the situation and spot applications can be used to reduce erosion in susceptible areas of a field.

The microorganisms in compost increase soil aggregation. Ref [6]
The organic matter in compost is populated by microorganisms which supplement those already present in the soil. The microorganisms utilise organic matter as an energy source and release polysaccharides and humic substances that help form soil aggregates and improve the structure of soil.

The microorganisms in compost recycle nutrients from organic matter. Ref [7]
Microorganisms cycle nutrients in the soil and release nutrients to plants from organic matter. Annual applications of compost can lead to a significant increase in soil enzyme activity. This activity of the enzymes is related to the nutrient turnover cycles.

The microorganisms in compost help to suppress soil borne diseases. Ref [8]
Soil borne plant pathogens may be suppressed in soil when suitable microorganism species are introduced into the soil in appropriately prepared composts. This suppression may be caused by a combination of factors such as competition, antibiosis, parasitism or induced systemic resistance.

Cost benefits

The inorganic fertilizer replacement value of compost is up to £5 per tonne of compost. Although not all of the nutrients are immediately available, compost applications improve the value of the land as an asset.

Organic matter greatly improves the quality of the soil, its value and its ability to grow better crops. Improved soil organic matter can lead to savings in fuel during cultivations, reduce the frequency of irrigations saving labour and water, and allow machinery onto the land on more days (especially valuable during busy periods) without damaging the soil structure. These benefits are difficult to quantify but farmers notice them where compost has been used.

Spreading costs are generally £1-3 per tonne depending on whether farm machinery is used or contractors employed. The relatively high cost of transporting compost by road means that fields close to the composting site should be utilised whenever possible. Crops further away on land where specific soil problems have been found should be targeted as well as crops with higher gross margins on responsive soils.
How to use compost

Compost is most easily applied with a spreader that has a moving floor and rear discharge.

It is important to mix the compost into the soil and not to invert the compost into a buried layer with the plough. This will maximise the effects of the organic matter on soil structure.

For crops with sensitive seeds, as with manures or NPK fertilizers, it is advisable to mix the compost with the soil at least two weeks prior to sowing in case the germination is affected by any temporary raised salt content of the soil.

Unlike animal manures and inorganic nitrogen fertilizers, the nitrogen in compost is slow release and less subject to leaching over winter. Compost may therefore be applied in the autumn and most of the nitrogen will remain in the soil to benefit crops in the following years.

Arable agriculture
Up to approximately 30 - 35 tonnes per hectare of compost may be applied to soils on an annual basis. This is especially beneficial to clayey soils that are difficult to work up into a seedbed and for light soils that have low organic matter status and low potassium index.

Root crops and vegetables
Valuable root crops are often grown on land with ‘light’ soil that is responsive to the organic matter and the nutrients contained in compost. Up to approximately 30 - 35 tonnes per hectare of compost may be applied to soils on an annual basis.

Grassland
Compost can be used to add nutrients to established grassland. The source of the feedstocks for the compost should be verified by the compost supplier to ascertain whether any catering wastes or animal by-products have been included. If any such wastes have, the Animal By-Products Regulations (2003) require a two month grazing ban for pigs and a three week grazing ban for other ruminants after the compost has been applied. Application records of composts derived from catering wastes or animal by-products are required.

Using finer grades of composts, screened to less than 25 mm, will allow the compost to fall more readily into the sward towards the roots.

Established fruit crops
The rows of established fruit crops, whether top fruit or soft fruit, can be mulched with a 25 to 75 mm deep layer of compost. Nutrients will be washed down into the soil to feed the crop and the mulch will aid the suppression of weeds. Planting fruit trees and bushes with compost combats Replant Disease.
How to buy compost

The Composting Association Certification Scheme is the only UK scheme that gives third party assessment and verification of conformity with the BSI Publicly Available Specification for Composted Materials (BSI PAS 100). TCA certified composts are quality assured, traceable and safe.

There are a number of composting companies that can supply quality assured compost manufactured to PAS100.

For a list of certified suppliers, visit the WRAP website on www.wrap.org.uk/publications/CertifiedCompostSuppliers.pdf or call the WRAP Freephone Helpline on 0808 100 2040. Alternatively, contact the Composting Association on 01933 227 777.
Nitrate Vulnerable Zones (NVZs)

Sixty six Nitrate Vulnerable Zones (NVZs) were designated in England in 1996 and the NVZ Action Programme came into force in those zones in December 1998. Following further consultation, additional NVZs were designated in 2002 for England, coming into force in December 2002. Compliance with the rules of the Action Programme is a legal requirement. The rules detail the amounts of organic materials, through total nitrogen application, that may be applied to the land - see www.defra.gov.uk/environment/water/quality/nitrate.

Composts have much lower availability of nitrogen compared with most farm manures or slurries but are covered by the same regulations and rules detailed below.

The rules include closed periods for both inorganic fertilizers on all soil types and organic materials with a high available nitrogen content on sandy and shallow soils. The nitrogen limits for organic materials are based on the whole farm at 210 kg total N/ha for arable (reducing to 170 kg/ha after four years) and 250 kg total N/ha for grassland, with individual field limits of 250 kg/ha as long as the available nitrogen does not exceed crop requirements.

In areas not within an NVZ, the Soil (MAFF 1998) and Water (MAFF 1998) Codes should be practiced (the codes are available from DEFRA). The Water Code includes a maximum guide figure for the total nitrogen in organic materials of 250 kg/ha per year. The available nitrogen applied should not exceed the requirements of the next crop. Phosphorus and potassium should also be applied with regards to the crops needs through the rotation. Guidelines for application of organic materials are given in Fertilizer Recommendations (RB209) published by the Stationary Office (MAFF 2000).

Organic agriculture

EU and UKROFS regulations

Both the European Union (EU) and the United Kingdom Register of Organic Food Standards (UKROFS) emphasise that the maintenance of soil fertility and soil biological activity is a fundamental principle of organic farming. A number of treatments that help achieve that principle in practice are listed in the standards, for example: incorporation of organic material (in the form of farmyard manure, composts and slurries) and implementation of appropriate rotations. Organic matter from (non-intensive) non-organic farms, green composting facilities and source separated and composted household waste are acceptable within the EU organic standards although some prescriptions on use may be included depending on the material (see EU 2092/91).

The total amount of compost or manure (as defined in directive 91/676/EEC) applied on the holding may not exceed 170 kg N ha⁻¹ yr⁻¹ under EC law, although the Biodynamic Agricultural Association (BDAA) stipulates that a maximum of 112 kg N ha⁻¹ yr⁻¹ may be applied under their regulations.

Ten of the twelve UK organic certification bodies (including UKROFS) have similar standards for the preparation and use of composts and manures. The standards of the other two certification bodies (The Soil Association and The Biodynamic Agricultural Association) differ in that they provide greater guidance and in some cases set stricter standards to their licensees.
Soil Association and Demeter (BDAA) Regulations

The Soil Association Standards for Organic Food and farming go into considerably greater detail than the basic EU/UKROFS standards with regards to protection of the soil and preparation and management of manures and composts (Soil Association standards 2002). They recommend that all manure should be composted and slurries should be aerated. The composting process is defined and basic guidance is given as to how to prepare compost. Recommendations are included on the treatment and application of manures and composts in horticultural systems and there are new standards for substrate requirements for ornamentals and pot grown herbs.

The Demeter standards (produced by the BDAA) give more descriptive information than the basic UKROFS standards, but they don’t differ greatly in terms of recommended practice. The importance of composts for market gardens and potting soils is emphasised in the standards, but limited guidance is given as to how to make or use composts.

Animal By-Products Regulations 2003

The EU Animal By-Products Regulation (EC 1774/2002) has been applied since 1 May 2003 and enforced since 1 July 2003. It permits the use of composting and biogas treatments for catering wastes and other low-risk (Category 3) animal by-products through a time temperature regime with a maximum particle size specification. For composting or biogas plants which only treat catering waste and certain animal by-products such as animal manures, the Regulation allows Member States to specify their own process standards at national level. The rules have been introduced in England and Wales by the Animal By-Products Regulations 2003 (SI No. 1482/2003).

The operator of a biogas or composting plant must keep records of animal by-products and catering waste which are received on the premises, and records of the treatment process.

If consignments of compost or digestion residues are for use on agricultural land, the operator must ensure that they are labelled or accompanied by documentation that draws the recipients to the requirements of Regulation 11. The EU ABPR prohibits livestock from grazing pasture or being fed fodder crops from land where compost or digestion residues have been applied. The length of the ban is under discussion. Regulation 11 of the national Regulations specifies that pasture land is land that is intended to be used for grazing or cropping for feedingstuffs following the application of compost or digestion residues within two months for pigs and three weeks for other farmed animals. The land must not be grazed during these periods and cropping is also banned during that period for feeding during that period (but may be used after the period has expired). Regulation 39 requires farmers to keep records of the date, quantity and description of compost or biogas residues brought onto the premises, the land to which it is applied (and the date) and the date on which ruminant, pigs or poultry first have access to the land after application or the date it is first cropped, whichever is sooner.
The full technical report that forms the basis of this technical information package will be available on the WRAP website from March 2004.

The report provides detailed scientific evidence to support the benefits claimed in this information package, further to the references given below.

References

[1] Data sources: TCA and Remade Data
   Compost Use in Agriculture, Enviros Consulting 2002
   Open Windrow GROWS Project Compost – Vegetable Waste & Manure
   Wyvern Compost 1997-2000, HDRA Report


Useful contacts
British Standards Institution
www.bsi-global.com
The Composting Association
www.compost.org.uk
Waste and Resources Action Programme (WRAP)
www.wrap.org.uk

Information sources
www.thestationeryoffice.com
The Water and Soil Codes are available from The Stationery Office
Animal By-Products information
www.defra.gov.uk/animalh/by-prods/default.htm

Web sites
DEFRA www.defra.gov.uk
The Environment Agency
www.environment-agency.gov.uk
SEPA www.sepa.org.uk
The British Potato Council
www.potato.org.uk
The Horticultural Development Council
www.hdc.org.uk
The Home-Grown Cereals Authority
www.hgca.co.uk
The National Farmers Union
www.nfu.org.uk
Horticulture Research International
www.hri.ac.uk