

#### Inside This Sheet

- 1** Introduction
  - What is organic matter?
- 2** How is organic matter lost?
  - How to increase soil organic matter
- 3** Conclusions
  - Definitions
- 4** Important references
  - Acknowledgements

#### Introduction

The most serious land use issue affecting the state of the environment in New South Wales is land degradation (EPA, 1997).

Arable land which is suitable for crops, sown pastures and grasses totals 104241 km<sup>2</sup>, or 13% of New South Wales (ABS, 1996). This is a very small and non-renewable resource compared with other countries. Yet, more than 70% of the state is affected by at least one form of land degradation. Of this area, 29% is "severely to very severely" affected (EPA, 1997).

Land degradation is responsible for at least \$700 million a year in lost production in New South Wales.

It is widely recognised that if steps are not taken to reverse the degradation of these finite soil reserves, the long-term viability of many primary production industries will be severely threatened, as will many areas of aesthetic and biodiversity value in the state (EPA,

1997).

Maintaining or increasing soil organic matter levels is one method of addressing land degradation. This Information Sheet briefly discusses some methods of increasing soil organic matter levels.

#### What is organic matter?

Organic matter is derived from plants and animals. The decomposition and interaction of organic matter with other soil constituents' influences soil physical and chemical fertility (Charman and Roper, 1991).

The Australian climate is generally not conducive to the production of high levels of organic matter in soils. This is related to the dryness and unreliability of climate and low fertility of many of our soils (Charman and Roper, 1991). Consequently, Australian soils are often low in organic matter by world standards (Spain *et al.* 1983).

Conventional land management practices have contributed to

**Plate 1.** Application of composted fine mulch to a road cutting with an Express Blower<sup>®</sup> in the United States of America. The composted fine mulch assists in plant establishment and protects the exposed soil from erosion.



**Plate 2.** Incorporating compost into soil is one method of increasing organic matter levels.



- Retention of plant residues;
- Incorporation of plant residues;
- Crop rotations and fallowing;
- Altering tillage regimes;
- Fertilising surface vegetation to increase biomass levels;
- Applying green manures to soil, and
- Applying composted materials to soil.

In general, these approaches will only have significant effects on soil properties and organic matter in the long term (over many years).

significant decreases in soil organic matter levels (Anon., 1986).

generally range from 1.6 to 4.6% (Hamblin, 1980).

Reductions in soil organic matter may lead to soil structural problems (see Information Sheet 6-2 for more details) such as:

Existing management practices and associated erosional processes contribute to reductions in organic matter levels in soils.

- The formation of a surface soil *crust*;
- Reductions in soil aeration and infiltration, and
- Reduced root penetration, plant establishment and growth.

Research has shown that over a 20 to 30 year period, conventional cropping practices have resulted in significant declines in soil organic matter (Harte, 1982), degrading soil structure and stability (Charman and Murphy, 1991).

Improved soil management practices can help stabilise or increase organic matter levels in soil. Such practices include retention or incorporation of plant residues, green manuring, and the application of imported organic matter (e.g. *recycled organics*).

Excessive cultivation/tillage of soil can dramatically increase the rate at which 'fertile' surface soil is stripped away by erosion (wind and water), exposing less stable, nutrient poor subsoils to the elements. Increased erosion has contributed to reduced yields and increased costs of production (Charman and Murphy, 1991).

Detailed information on the benefits of organic matter to soil is presented in Information Sheet 6-2 of this series.

Similarly, excessive grazing of land may result in a decline in vegetation cover, surface soil compaction and a related deterioration in soil structural properties and organic matter.

### How is organic matter lost?

Organic matter levels in Australia range from <1% in dry inland areas to extreme highs of 50% in cold, alpine, well-watered regions (Charman and Roper, 1991). In most soils, however, organic matter levels

### How to increase soil organic matter

Organic matter levels can be increased using a number of approaches including:

Short-term increases in organic matter may be achieved following the application of large quantities of organic matter to soil.

Each approach is discussed in greater detail below.

#### 1. Retention of plant residues on soil surfaces

Burning plant residues is a practice that is still carried out in many cropping systems. While this practice can be important in assisting with normal tillage operations, it reduces or removes vegetation at the soil surface (Valzano *et al.*, 1997). The removal of this material exposes soils to possible erosion hazards and wastes valuable organic matter.

Management regimes that maintain plant residues (e.g. stubble retention): protect soil surfaces from erosion; increase biomass levels at the soil surface, and encourage soil biological activity. These outcomes will, in time, help increase total soil organic matter levels.

#### 2. Incorporation of plant residues into soil

Management practices that involve the incorporation of crop/plant materials into soil may also help increase soil organic matter levels in

the long term (Charman and Roper, 1991).

However, the incorporation of residues is a less favourable option to retaining plant material at soil surfaces, due to: possible *phytotoxic* effects of the decomposing organic matter; carryover of plant pathogens from one crop unto another, and additional tillage related soil disturbances.

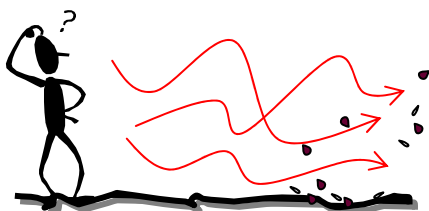
### 3. Crop rotations and fallowing practices

Management practices that include long (several years) fallow periods (with surface vegetation) between cropping cycles may help increase organic matter in soil.

Surface vegetation protects soil surfaces from erosion, improving conditions for soil organisms (Littler and Marley, 1978).

### 4. Altering tillage regimes

Limiting tillage operations in agricultural systems may help reduce the speed at which organic matter breaks down in soil, while at the same time reducing the physical stresses a soil sustains during cropping phases.



*Wind on bare soil surfaces contributes to the loss of fertile top soil and organic matter.*

Management regimes with reduced tillage or no tillage have been shown to help maintain or increase organic matter levels in the long term (years) (Holland *et al.*, 1987). Such practices directly and indirectly help improve soil structure and stability.

### 5. Fertilising surface vegetation to increase biomass levels

The fertilisation (inorganic or organic) of soil may promote better plant growth and health. Increased plant biomass may, in time, help maintain or increase soil organic matter levels (Charman and Roper, 1991).

### 6. Green manure

Green manure is a crop-based material that is grown to be incorporated into soil or retained on soil surfaces as an organic mulch (e.g. lupins). The plant material is used to alter soil characteristics (e.g. pH, nutrient availability), and may in time increase nutrient and organic matter levels in soils.

### 7. Applying composted materials to soil

Repeated applications of recycled organics products (e.g. composts) increases soil organic matter levels in the long term. The level of increase depends upon the type and quantity of material added, soil type, climate, and other management practices used.

Recycled organics products can be used to correct surface and internal soil problems. Different composted or pasteurised product types are available for a range of applications. See Information Sheet 6-5 for product details.

## Conclusions

Land degradation in Australia is becoming an issue of increasing concern. Altering conventional management regimes to increase levels of organic matter in and on soil helps address part of this problem.

Organic matter levels in soil take significant time to increase, especially in larger scale agricultural situations. Therefore, approaches to

## Definitions\*

### Crust

A thin continuous layer of clay sized particles at a soil surface, which impedes the movement of water into soil (Charman and Murphy, 1991).

### Recycled organics

The term Recycled Organics has been adopted by Resource NSW as a generic term for a range of products manufactured from compostable organic materials (garden organics, food organics, residual wood and timber, biosolids and agricultural organics).

### Phytotoxic

Toxic to plants. Partially decomposed organic materials or immature composts are often phytotoxic, but this usually decreases with time. Such products may be phytotoxic due to a number of factors, including: low nutrient content; high oxygen consumption; presence of fatty acid or alcohol metabolites formed by microorganisms under anaerobic conditions; or due to excessive concentrations of salts, heavy metals and other organic compounds.

\* Recycled Organics Unit (2002).

correcting or countering land degradation in the short term should form a part of longer term strategies for sustainable development.

