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Understanding soil organic amendments and their application in sandy soils.

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Key messages:

- Soil organic amendments can improve soil health through improvements to physical, chemical, and biological soil properties.
- An understanding of the soil constraints, and management objectives will ensure the most appropriate soil organic amendment for use is selected.
- Suppliers can develop custom blends to address multiple constraints common in sandy soils.

1. Introduction

There are over 1.2 million hectares of sandy soils across the Limestone Coast with low water and nutrient retention capacity, often resulting in poor plant health and soil function. Thankfully, these constraints can be treated with a range of soil management techniques to improve their productivity and resilience. These include practices such as clay spreading and targeted nutrient applications to treat chemical constraints, and deep ripping and soil mixing to treat soil physical constraints. Recent research on sandy soils across the southern cropping zone has explored the use of organic soil amendments such as animal manure, legume hays and compost to improve soil and crop health, generating interest in the broadacre application of these products.



Figure 1. Compost piles being turned to promote microbial activity and stimulating decomposition processes (courtesy Mulbarton Compost).

Organic amendments can improve many soil properties and as their use increases in popularity it is essential that the potential benefits of each amendment type and how they work is well understood. This factsheet provides a basic understanding of a range of products currently available in the Limestone Coast, and a brief overview of how they may contribute to a healthy soil.

2. What are soil organic amendments?

While there are multiple definitions for the term 'organic', for the purpose of this document, 'organic' refers to a product derived from living matter (plants and animals) and is non-synthetic. Unlike fertilisers, which are used to directly supply plants with nutrients, organic amendments can improve the physical and chemical properties of a soil, in turn improving biological function, and can be used to address single or multiple soil constraints. Additionally, amendments can improve

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Soil Health

Soil health is the capacity of a soil to function as a vital living system that sustains plants, animals and humans.



plant health, enhance crop productivity, and increase water use efficiency, thereby leading to an increase in soil organic matter and carbon storage in soils.

2.1 A quick rundown on soil organic matter and soil organic carbon

Soil organic matter is comprised of living and non-living plant and animal matter and is critical to the function of a healthy soil (*Table 1*). Modifying physical, chemical, and biological soil properties, organic matter improves soil structure, increases water holding capacity and the retention and supply of nutrients, and increases resilience to changing environmental conditions.

Soil organic matter is composed of approximately 58% organic carbon (OC), which is particularly important for soil health¹. Carbon from organic matter is consumed and utilised by soil microorganisms, stimulating decomposition of organic matter, increasing nutrient cycling, suppressing pathogens, and increasing aggregate stability. There are four main pools of organic carbon in soil: crop residues, particulate, humus and recalcitrant, each with increasing degrees of stability (*Table 2*). A soil's ability to retain and protect OC is determined primarily by its texture and the climate, hence there is no 'ideal' amount of carbon that any one type of soil should contain, however soils with less than 1% OC are often regarded as functionally impaired².

Table 1. Key functions of a healthy soil³

Productivity outcomes	Environmental outcomes
Physical support for plants	Filters and purifies water
Structure suitable for root growth	Detoxifies pollutants
Capacity for water infiltration	Provision of habitat
Supply of water and nutrients	Prevention of nutrient and sediment loss
Suppression of pests and diseases	Carbon sequestration

Table 2. Types of soil organic carbon⁴

Organic carbon pool	Sources	Size (mm)	Stability	Turnover time	Key functions
Crop residues	Plant roots and shoots, both in and on the soil	> 2	Readily available (labile)	Days	A source of energy for soil microor- ganisms; encouraging biological activity, biomass and enhancing biological processes.
Particulate organic matter	Plant and animal matter	0.05 – 2	Readily available (labile)	Years	A source of energy for soil microor- ganisms; encouraging biological activity, biomass and enhancing biological processes. Important for soil structure.
Humus	Decomposed organic material	<0.05	Resistant	Decades	All key functions, particularly nutri- ent retention.
Recalcitrant or- ganic matter	Primarily charcoal	Variable	Very stable (inert)	Centuries	Can contribute to cation exchange capacity.

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3. What sort of organic amendments are available in SA?

Below is an overview of several organic amendments currently available in South Australia, with a breakdown of the main benefits to physical, biological, and chemical soil properties.

Compost: Produced from a variety of organic materials, such as plant matter and/or animal manures, composts typically feature a high organic matter content. The addition of organic matter to a soil provides a myriad of physical, chemical, and biological benefits. The main benefits include increased organic matter content, cation exchange capacity (CEC), improved soil structure, nutrient supply and increased water holding capacity.

The basic composting process involves incorporating a mixture of nitrogen and carbon sources into a variety of other organic materials to stimulate microorganism activity and decomposition processes. Any product that is composted has been allowed to decompose for a period longer than 6 months, and often up to two years. The time the product has been left to decompose is referred to as the 'maturity'. The maturity of a compost tells a consumer that the product is essentially safe for use. Compost is considered 'mature' when the main decomposition processes have ceased. A good indicator of this is a product with a consistent texture and no large pieces of organic material remaining. Immature products, often referred to as 'hot', commonly contain decomposing microorganisms and very high concentrations and forms of nutrients which can be detrimental to plant health. The burning of plant roots and low germination rates are common upon application of 'hot' amendments.

The Australia Standard (AS 4454) outlines the requirements of a quality compost product. As this certification is on a voluntary basis, not all compost products have undergone this rigorous process, which guarantees a safe and controlled product. More information on quality assurance is listed below in the Quality Assurance section.

A variety of composted products are available in the Limestone Coast that are commonly used in viticultural and horticultural production (Table 3).

Chicken litter: Composed of chicken manure and bedding (roughly a 55:45 mix), chicken litter is rich in organic matter. The addition of organic matter encourages soil microbial activity, improves soil structure and aggregate stability, potentially reducing carbon turnover in soils. Improvements in soil structure can increase water holding capacity, however, there have been limited studies undertaken in Australia that demonstrate its effects other than its efficacy as a fertiliser. With no large local suppliers in the Limestone Coast, chicken litter may be cost prohibitive due to transport costs (Table 3).

Pig manure (composted): Commonly used for its fertilising effect, the high organic matter content of this product provides similar benefits to that of other composts. This includes improving soil structure, increasing nutrient retention, and providing resources for beneficial soil microorganisms. Composted pig manure undergoes the same treatment process as other composts, however, can slightly differ between suppliers. Although pig manure can be sold as a raw product (not composted), due to its high nutrient concentration its application can severely impact plant health. Additionally, raw pig manure has the potential to introduce pathogens (e.g. salmonella) and weeds to the soil. For these reasons, most pig manures sold commercially in Australia are composted. Composted pig manure is available from Bio Gro at their Wandilo site near Mount Gambier, and can be added to any other of their composted products if required.

Biochar: A carbon rich material produced by pyrolysis, biochar can improve soil structure, increase water holding capacity, increase CEC and improve soil fertility. Biochar has also been shown to improve nutrient retention, improve nitrogen cycling, reduce greenhouse gas emissions, and increase the potential for carbon sequestration. The actual benefits will depend on the type of material the biochar is produced from, and the soil type. For example, a plant/manure-based biochar will likely have greater nutrient content compared to a wood-based biochar which generally demonstrates a higher carbon sequestration capacity.

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Table 3. Indicative pricing schedule (excluding delivery) as of May 2021. Please use this as a guide only; contact the supplier for a quote.

Drieine	Bio Gro					١	/arious
Pricing	Horticultural Compost	Composted Manure	Organic Fines	Viticultural Mulch	Compost	Biochar	Chicken Litter (composted)
\$/m³	13	38	16	13	42	600	N/A
\$/tonne	20	72	30	27	80	1500	75

4. Key considerations when selecting an amendment

How you use organic amendments will be determined by your soil type and land use, your current management practices and objectives and the range of constraints present.

Consideration of the following will assist in selecting the most appropriate amendment for your soil:

- What soil constraints are present?
- What are your objectives e.g. do you aim to improve general soil health, treat a single soil constraint, or overcome a combination of constraints?
- What is the composition of the products available?
- What application rate will you need, and will the cost be prohibitive?
- Was the amendment made in accordance with a quality assurance program?
- Is there information available that demonstrates the efficacy of the product? Have local trials been undertaken?

5. Identifying constraints

Table 4 outlines common sandy soil constraints that amendments may treat. Each of these constraints warrant careful diagnosis in the paddock, particularly when several different soil types are present. For further information on diagnosing and treating sandy soil constraints, a guide can be accessed <u>here</u>.

Table 4. Common constraints in sandy soils.

Physical	Chemical
Low organic matter	Low organic matter
Low water holding capacity	Acidity
Compaction	Low nutrient retention
Water repellence	Naturally low P & K
Poor aggregate stability	Aluminium toxicity

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Figure 2. A sandy soil profile affected by four constraints that contribute to poor crop water use.



6. Product composition

Table 5 outlines important chemical characteristics of a variety of organic amendments available in the Limestone Coast. It's important to understand what is in your amendments to ensure that you are not exacerbating existing soil constraints or oversupplying nutrients that could be lost to the environment.

Many suppliers can provide laboratory analyses of their products, enabling you to select the most suitable amendment for your requirements. If an analysis cannot be provided, it is recommended that the amendment first be trialled prior to broad scale application.

Chemical Characteristic		Mulbarton		
	Horticultural Compost	Composted Manure	Organic Fines	Compost
рН	7.6	7.9	8.3	8.5
EC1:5 (dS/m)	2.6	9.82	3.77	5.3
Moisture (%)	30.3	49	53.3	47.3
Carbon (%)	24.7	34.1	38.2	30.48
Organic matter (%)	42	58	65	-
Nitrogen (%dw)	1.28	1.83	1.2	1.44
Phosphorus (%dw)	0.26	0.72	0.28	0.29
Cu (mg/kg)	79	97.5	36.4	21.4
Zn (mg/kg)	169	388	129	90

Table 5. Selected chemical characteristics of readily available organic soil amendments in the Limestone Coast.

Organic amendments can be used in isolation or as a blend in conjunction with suitable management practices to improve overall soil health. Suppliers can develop blends that address specific requirements (e.g. correcting a phosphorus

deficiency), while keeping financial and management objectives in mind. Common additions include mineral powders, phosphorus, lime and gypsum.

To receive the maximum benefit from an applied organic amendment, it is recommended that when engaging with a supplier you provide as much detail as possible to ensure:

- the ideal soil amendments are incorporated into the finished product at the correct dosage;
- the best advice on application rate, method and timing is given.



Figure 3. Compost row being turned at Bio Gro Wandilo site with a Windrow Turner (courtesy Bio Gro).

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7. Application rates

Application rates depend on soil characteristics, constraints, management practices and your objectives. Common application rates are provided in Table 6, however, these are only a guide. Please consult with your supplier to ensure you are applying amendments at the right rate, time, and place.

Table 6. Common application rates of organic amendments.

Organic Amendment	Application Rate (t/ha)					
	Broadacre Pasture	Viticulture	Horticultural Crops			
Compost	1-1.5	8-15	5-10			
Biochar	5-10	1-1.5	0.5-4.5			

8. Quality assurance

For composted products, the Australian Standard for Soil Conditioners and Mulches (AS 4454) outlines the requirements of what constitutes a quality product. Products which are certified will feature the Australian Standard badge, and the manufacturers licence number. To gain this certification, a product must undergo pasteurisation, removing pathogens, weed seeds, herbicides, pesticides, and heavy metals. This certification ensures consistency of the product, and reliability that compliance to these standards is maintained.

9. Soil amendments in practice

A recent trial conducted on a highly compacted sandy soil with poor nutrient supply assessed the impact of rippingbased approaches (ripping, ripping + inclusion plates, spading, unmodified control) and amendments (chicken litter, clay, fertiliser, and hay) on the yield of various grain crops.

Yield responses ranged from nil to 1.1 t/ha compared to the unmodified control. Deep ripping and chicken litter observed the most consistent yield improvements, with an average gain of 0.6 t/ha. Responses were variable and were highly dependent on the soil constraints, management practice and annual rainfall. This underscores the fact that there is no 'one size fits all' approach to the use of organic amendments.

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Useful links

Bio Gro: http://www.biogro.com.au/

Mulbarton Compost: https://www.mulbartoncompost.com/

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