

# Selecting Organic Soil Amendments

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*The Organic Force*



# Organic Soil Amendments - plenty to choose from...

- **Animal Manures**
- **Slurries & pond sludges**
- **Grease trap waste (in Victoria?)**
- **Commercial / industrial residues  
(food & fibre processing, retail)**
- **Composts**
- **Biosolids**
- **Biochar**

**All originating from  
organic 'waste' materials**

# Raw or Processed

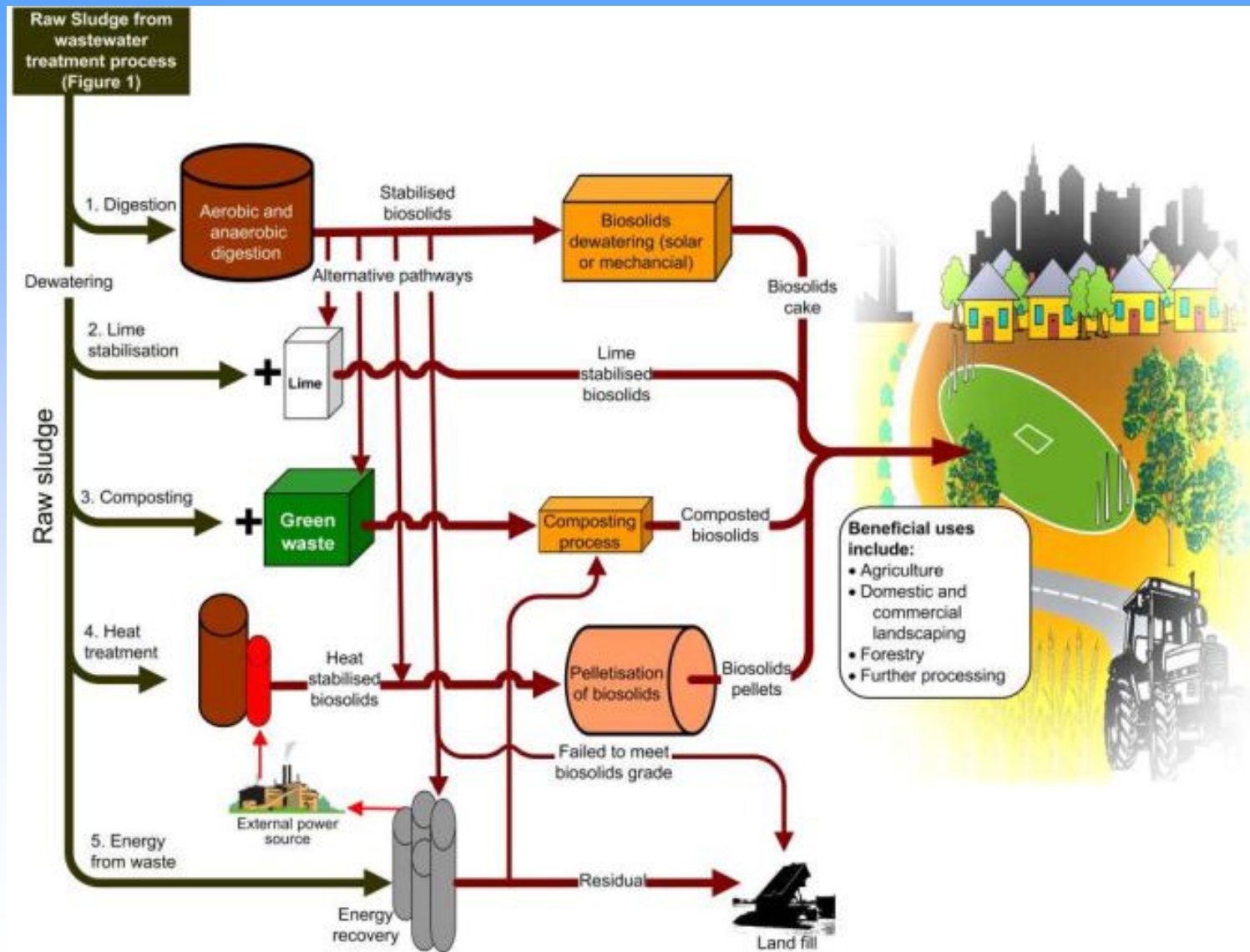
- Raw – no refinement (e.g manure, slurry)
- Processed
  - screened
  - stabilised (dried, composted)
  - pasteurised
  - pelletised
  - additives(for processing or value adding)

# Animal Manures & Slurries

## (Examples)

| Manure Type          | Dry Matter | Ammonium-N | Total N | P    | K    |
|----------------------|------------|------------|---------|------|------|
|                      | %          | kg/tonne   |         |      |      |
| Swine, no bedding    | 18         | 3          | 5       | 2.0  | 3.3  |
| Swine, with bedding  | 18         | 2.5        | 3       | 1.5  | 2.9  |
| Beef, no bedding     | 52         | 3.5        | 10.5    | 3.1  | 9.5  |
| Beef, with bedding   | 50         | 4          | 10.5    | 3.9  | 10.8 |
| Dairy, no bedding    | 18         | 2          | 4.5     | 0.9  | 4.2  |
| Dairy, with bedding  | 21         | 2.5        | 4.5     | 0.9  | 4.2  |
| Poultry, no litter   | 45         | 13         | 16.5    | 10.5 | 14.1 |
| Poultry, with litter | 75         | 18         | 28      | 9.8  | 14.1 |

# Biosolids



# Biosolids (cont.)

Biosolids Cake = regulated waste

- Use is regulated according to classification (contaminants / vector attraction)
- Not stabilised
- High moisture content (around 80%)
- High nutrient (N,P,K) and good micronutrient supply
- Heavy metals / contaminants
- Biosecurity risk

# Biochar

- Charcoal
- Characteristics & effects depend on
  - feedstock material
  - processing (temperature, duration,...)
- No biosecurity risk
- Largely stable carbon → C sequestration
- Little nutrient contribution
- Soil improvement agent

# Compost

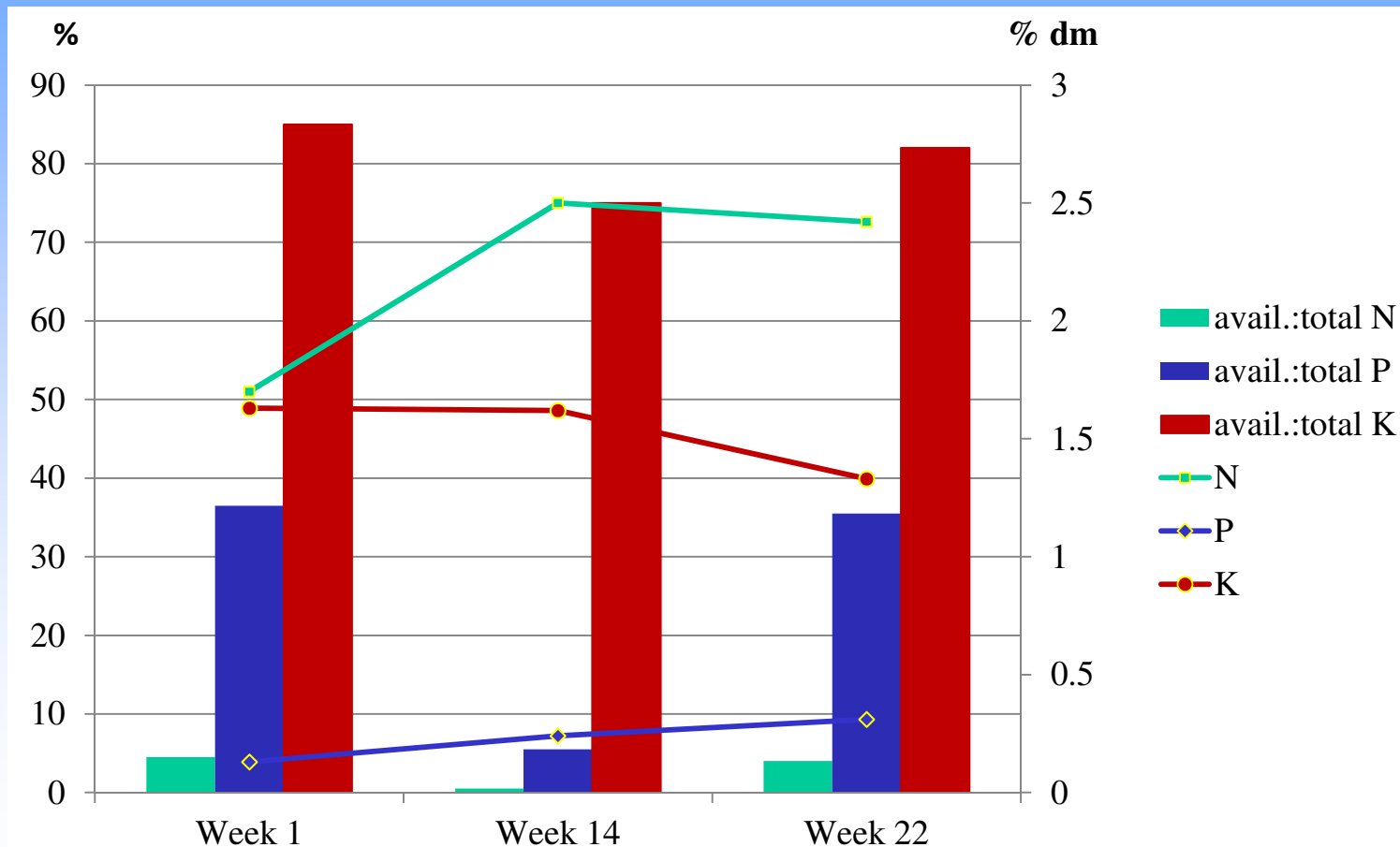
- An organic product that has undergone **controlled aerobic** and **thermophilic biological transformation** to **achieve pasteurisation** and a specified **level of maturity**. (ROU Library)
- Australian Standard for Composts, Soil Conditioners and Mulches (AS 4454)  
(raw – pasteurised – composted – mature)



# Compost Characteristics

- Characteristics & effects depend on
  - feedstock material
  - processing (duration, temperature, moisture, aeration, **management**)
- Small biosecurity risk
- Both labile and stable carbon
- Limited N, large P and K contribution
- Soil improver  Fertilising compost

# Changes in Nutrient Status during Composting of Cotton Trash

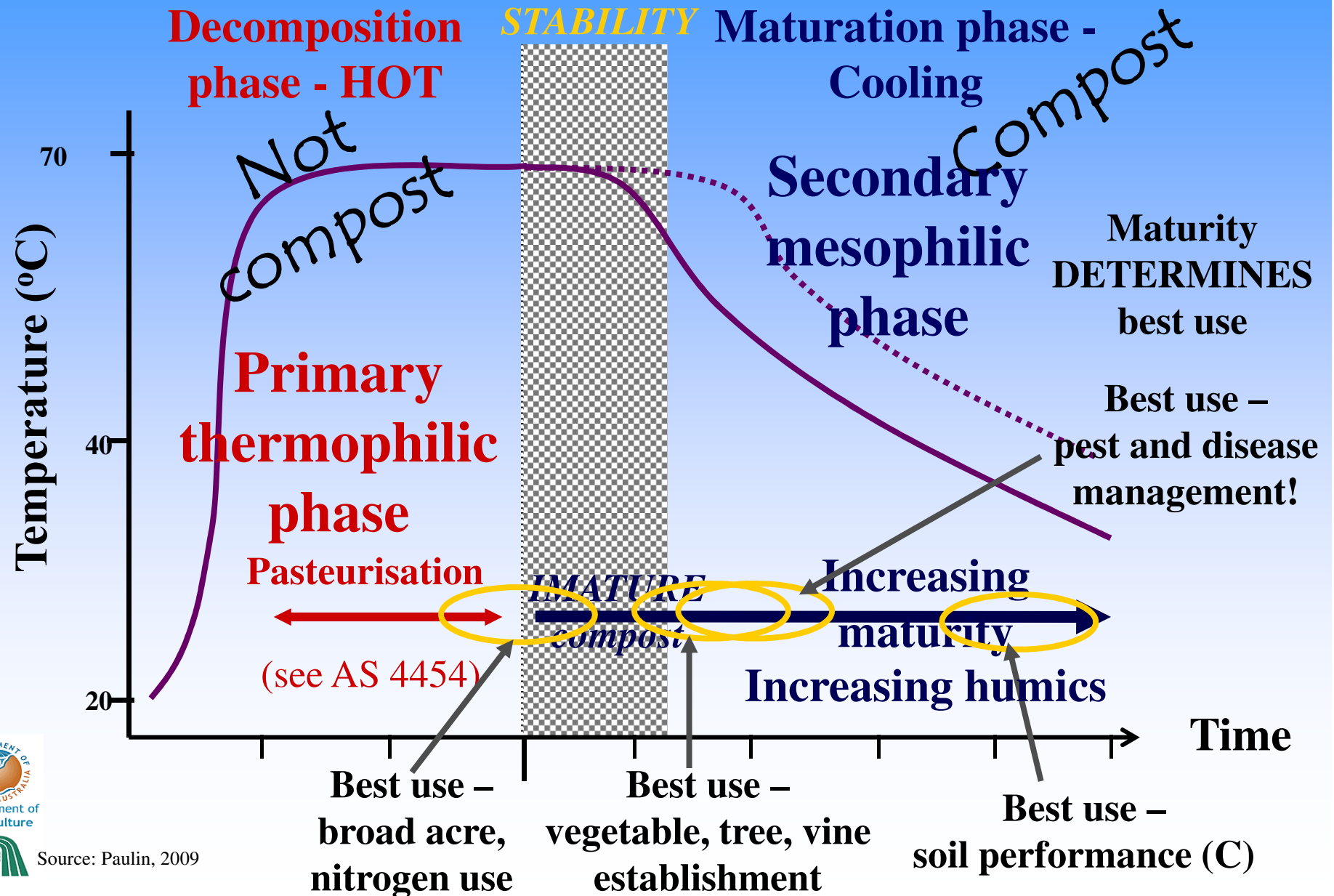


Lines represent nutrient content (% dm)

Bars represent the proportion of available to total nutrients in compost (%)

Source: Pittaway, 2006 (modified)

# Composting Process & Product Quality



# Organic Soil Amendment Characteristics

- Macro Nutrients
- Micro Nutrients
- Neutral pH / Liming Effect
- Organic Carbon (labile/stable)
- High Cation Exchange Capacity
- High Water Holding Capacity
- Low bulk density (not biosolids)

## Active Ingredients

| Product characteristic                  | Unit               |              |
|-----------------------------------------|--------------------|--------------|
| Bulk density                            | g / lt             | 0.5          |
| Moisture                                | %                  | 34.4         |
| Organic carbon                          | % dm               | 25.926       |
| Organic matter                          | % dm               | 44.70        |
| C/N Ratio                               |                    | 21.6         |
| pH                                      | -                  | 7.1          |
| Conductivity                            | dS/m               | 3.8          |
| Total phosphorus                        | % dm               | 0.31         |
| Phosphorus - Colwell extr.              | mg / kg            | Not tested   |
| Orthophosphate                          | mg / kg            | 4.746 ug/L   |
| Total nitrogen                          | % dm               | 1.2          |
| Ammonium - N                            | mg / kg            | 2.59 mg/L    |
| Nitrate - N                             | mg / kg            | 169 mg/L     |
| Ammonium + Nitrate - N                  | mg / kg            | 172 mg/L     |
| Potassium (soluble)                     | mg / kg            | 1900         |
| Potassium                               | % dm               | 0.36         |
| Boron                                   | mg / kg            | 26           |
| Calcium (soluble)                       | mg / kg            | 5800         |
| Calcium                                 | % dm               | 2.76         |
| Molybdenum                              | mg / kg            | 6.9          |
| Manganese                               | mg / kg            | 240          |
| Magnesium (soluble)                     | mg / kg            | 1,500        |
| Magnesium                               | % dm               | 0.44         |
| Sodium (soluble)                        | mg / kg            | 1500         |
| Sodium                                  | % dm               | 0.23         |
| Chloride                                | mg/L               |              |
| Sulphur                                 | % dm               | 0.25         |
| Iron                                    | mg / kg            | 44,000       |
| Exchangable Calcium                     | mequival/100g      | 28.8         |
| Exchangeable Sodium                     | mequival/100g      | 6.6          |
| Exchangable Potassium                   | mequival/100g      | 4.81         |
| Exchangable Magnesium                   | mequival/100g      | 12.61        |
| Ca/Mg Ratio                             |                    | 2.3          |
| Cation Exchange Capacity                | mequival/100g      | 52.82        |
| Water holding capacity                  | %                  | 56.9         |
| Toxicity                                | cm                 | 6.4          |
| Maturity (self heating)                 | °C                 | 22.2         |
| Nitrogen Drawdown Index                 |                    | 0.4          |
| Viable seeds and plant propagules       | No. / lt (21 days) | 0            |
| <b>Impurities</b>                       |                    |              |
| Glass, metal and rigid plastic > 2mm    | % dm               | Trace        |
| Plastic – light, flexible or film > 5mm | % dm               | 0.03         |
| Stones and lumps of clay ≥ 5mm          | % dm               | 6.6          |
| <b>Pathogens<sup>#</sup></b>            |                    |              |
| E. coli                                 | MPN/g              | < 3          |
| Faecal coliforms                        | MPN/g              | 150          |
| Salmonella                              | in 25 g            | Not detected |
| <b>Heavy Metals<sup>#</sup></b>         |                    |              |
| Arsenic (Total)                         | mg / kg            | 8.6          |
| Cadmium (Total)                         | mg / kg            | 0.4          |
| Cadmium (Total) - second sample         | mg / kg            | 0.16         |

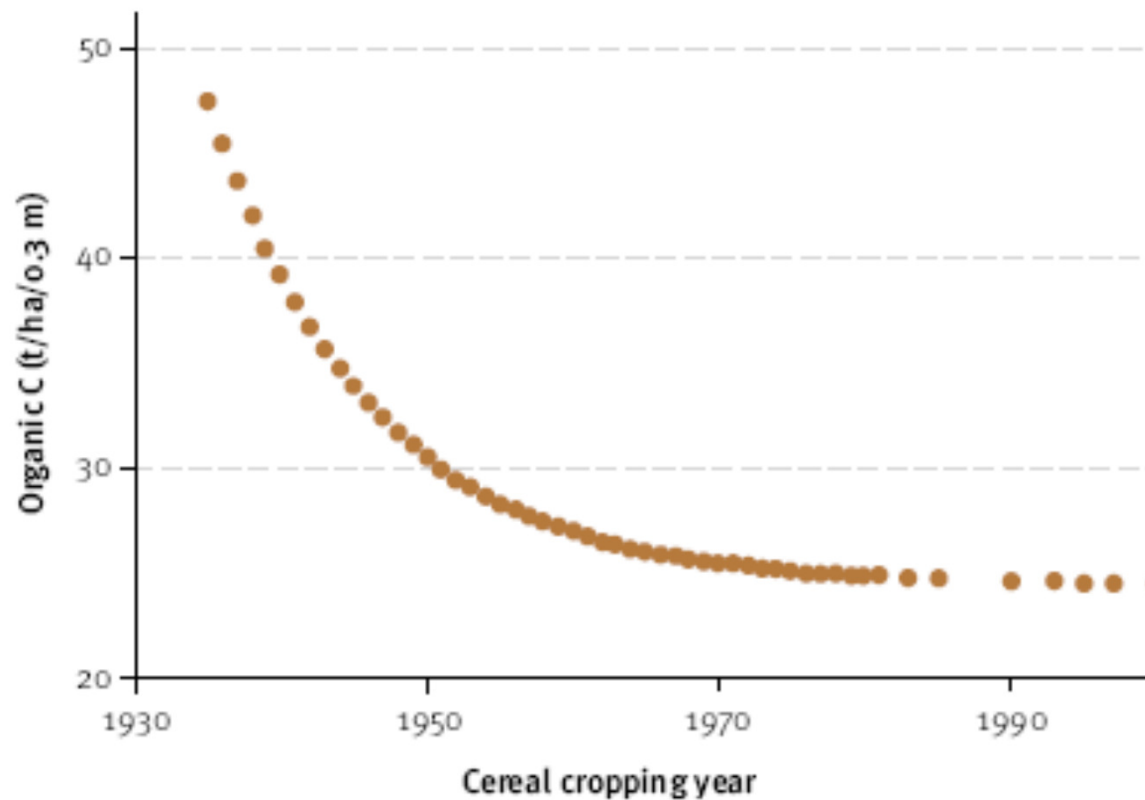
Organic Soil Amendments are  
Multi-purpose Products  
and Can Improve

Chemical  
Physical &  
Biological  
Soil Properties

# Improving Chemical Soil Properties

- Supply of macro and micro nutrients
  - soluble and immediately available
  - organically bound and released over time  
(Compost: N 0-15%, P 20-40%, K 80-100%)
- **Caution:** Possible imbalance of nutrient supply
- Supply of labile & stable carbon compounds
- Supply of humic / fulvic acid
- Adjustment / buffering of pH towards neutral
- Improved cation exchange capacity

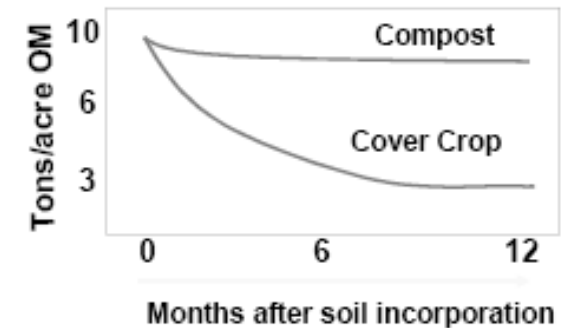
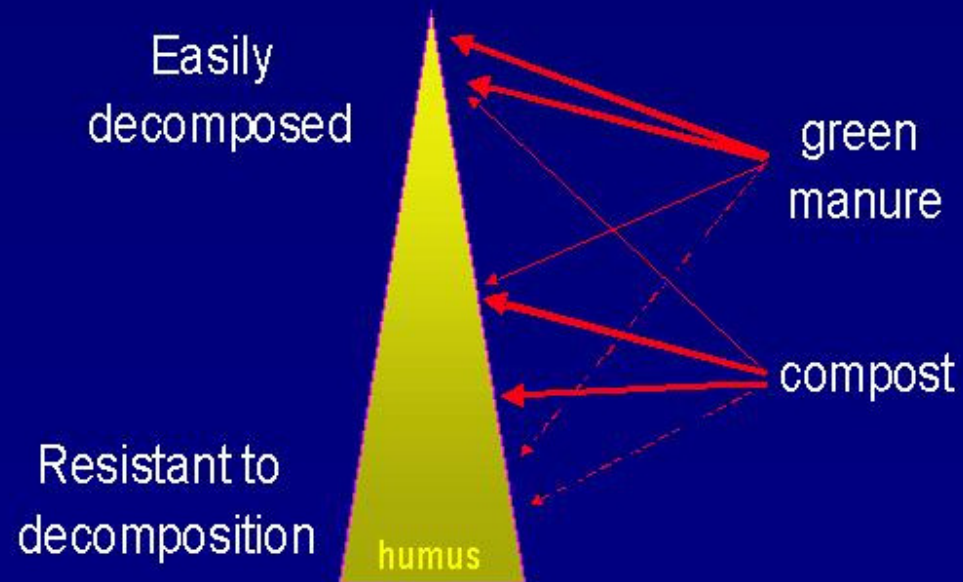
# Declining Soil Carbon Levels



*Modelled decline in soil organic carbon since 1935 after land under brigalow was cleared for cereal cropping on the Darling Downs (Dalal et al. 2003)*

# Improving Soil Carbon Levels

## Soil Organic Matter Continuum



# Improving Physical Soil Properties

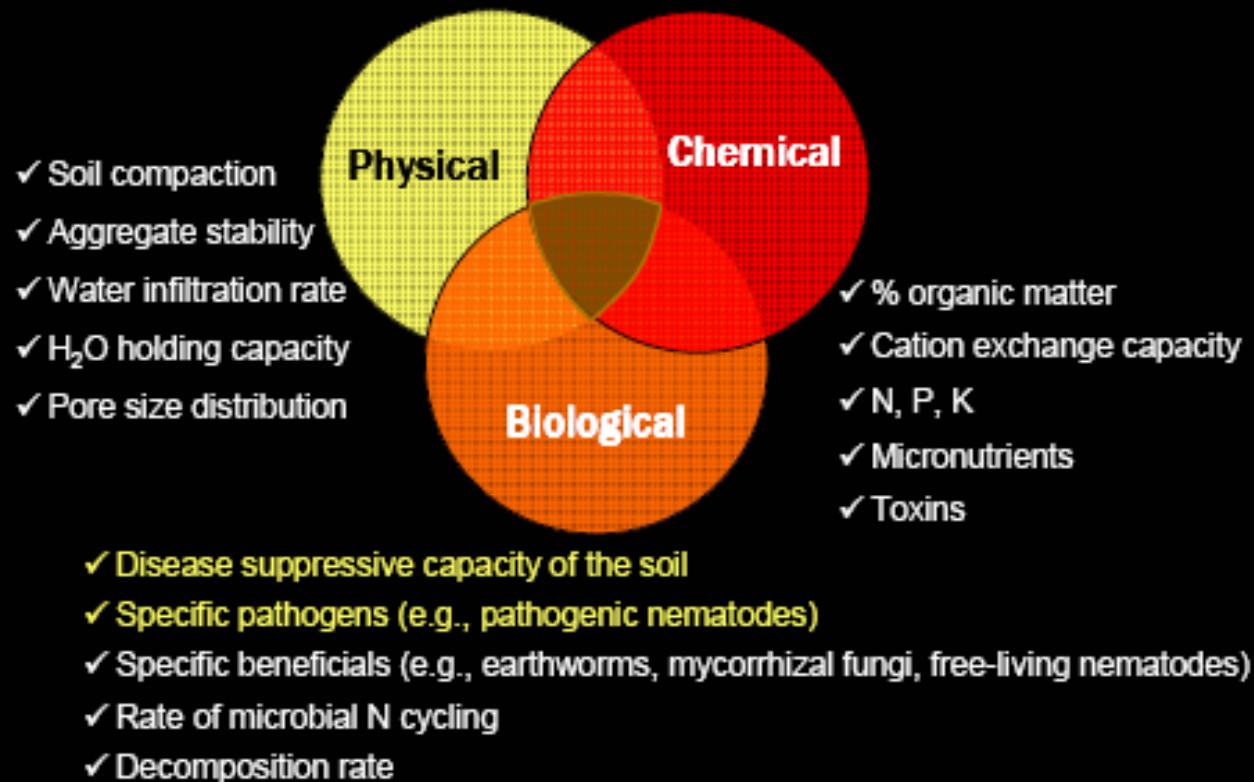
- Reduced bulk density
- Improved aeration of heavy soil
- Improved water holding capacity of sandy soils
- Improved water infiltration and drainage
- Improved aggregation
- Improved tilth
- Ease of tillage (reduced fuel consumption)

# Improving Biological Soil Properties

- Increases
  - soil biomass
  - biological activity
  - soil microbial biodiversity
- Enhances the soil food web
- Aides the suppression of plant pathogens

# Organic Soil Amendments deliver Multiple Benefits

## How Do We Measure Soil Health?



# Organic Soil Amendments - the choice is yours...

- What is your reason for using organic soil amendments?
- What are the desired effects and benefits of using such products?
- What are your circumstances and needs?
- Availability, costs, risks, product limitations

**Know what you want - Know what to get**

# What you should ask for

- Current analytical results
  - presented in a way which farmers can understand
- Product specification sheet and recommendations for use in your cropping situation
- Assurance/evidence of
  - product certification (e.g. AS 4454, organic)
  - quality management system (e.g. HACCP)
  - license , regulatory requirements (biosolids)

# What to watch out for

- Heavy metals
- High soluble salts (EC) Na & Cl  
but, elevated nutrient content = elevated EC
- Biosecurity risks  
(weeds, animal & human pathogens)
- Herbicide residues  
(Clopyralid, Picloram, Aminopyralid)

# What to watch out for (cont.)

- High C/N ratio
- Impurities (e.g. plastic, metal, rocks, twine)
- Immature compost / phytotoxic effects
- Inappropriate particle size
- Moisture content
- Bulk density

| Analytical Results (Example)       |     | Chicken Manure |       | Compost |         |
|------------------------------------|-----|----------------|-------|---------|---------|
|                                    |     | Unit           | Value | Unit    | Value   |
| MOISTURE CONTENT                   | MC  | %              | 28.2  | %       | 25.7    |
| TOTAL ORGANIC CARBON               | OC  | %              | 40.4  | %       | 17.3    |
| TOTAL NITROGEN                     | N   | %              | 5.06  | %       | 1.34    |
| TOTAL PHOSPHORUS                   | P   | %              | 1.17  | %       | 0.26    |
| TOTAL POTASSIUM                    | K   | %              | 2.03  | %       | 0.86    |
| TOTAL SULPHUR                      | S   | %              | 0.55  | %       | 0.22    |
| TOTAL CALCIUM                      | Ca  | %              | 1.65  | %       | 4.85    |
| TOTAL MAGNESIUM                    | Mg  | %              | 0.58  | %       | 0.48    |
| TOTAL SODIUM                       | Na  | %              | 0.37  | %       | 0.33    |
| TOTAL IRON                         | Fe  | ppm            | 721   | mg/kg   | 8,633   |
| TOTAL MANGANESE                    | Mn  | ppm            | 445   | mg/kg   | 158     |
| TOTAL ZINC                         | Zn  | ppm            | 353.9 | mg/kg   | 149     |
| TOTAL COPPER                       | Cu  | ppm            | 103.7 | mg/kg   | 28      |
| TOTAL BORON                        | B   | ppm            | 31.6  | mg/kg   | 91      |
| pH (1:5 Water)                     |     |                | 6.3   |         | 7.9     |
| ELECTRICAL CONDUCTIVITY            |     | µS/cm          | 11870 | dS/m    | 5.5     |
| CARBON / NITROGEN RATIO            | C/N |                | 7.98  |         | 12.9    |
| E.coli / Salmonella                |     |                |       | cfu/g   | <10 / 0 |
| Viable plant parts (after 21 days) |     |                |       |         | 0       |

# Analytical Results

|                            |    |
|----------------------------|----|
| MOISTURE CONTENT           | MC |
| TOTAL ORGANIC CARBON       | OC |
| <b>Soluble N &amp; P ?</b> | N  |
|                            | P  |
| TOTAL POTASSIUM            | K  |
| TOTAL SULPHUR              | S  |
| TOTAL CALCIUM              | Ca |
| TOTAL MAGNESIUM            | Mg |
| TOTAL SODIUM               | Na |
| TOTAL IRON                 | Fe |

Analytical results –  
Not necessarily comparable  
Need uniform methodology  
Need to be user friendly

E.coli / Salmonella

Viable plant parts (after 21 days)

## Chicken Manure

| Unit  | Value |
|-------|-------|
| %     | 28.2  |
| %     | 40.4  |
| %     | 5.06  |
| %     | 1.17  |
| %     | 2.03  |
| %     | 0.55  |
| %     | 1.65  |
| %     | 0.58  |
| %     | 0.37  |
| ppm   | 721   |
| ppm   | units |
| ppm   | 333.9 |
| ppm   | 103.7 |
| ppm   | 31.6  |
|       | 6.3   |
| μS/cm | 11870 |
|       | units |
|       | 7.98  |

Analysis according to soil analysis method?

## Compost

| Unit  | Value   |
|-------|---------|
| %     | 25.7    |
| %     | 17.3    |
| %     | 1.34    |
| %     | 0.26    |
| %     | 0.86    |
| %     | 0.22    |
| %     | 4.15    |
| %     | 1.6     |
| %     | 0.33    |
| mg/kg | 8,633   |
| mg/kg | 158     |
| mg/kg | 149     |
| mg/kg | 24      |
| mg/kg | 91      |
|       | 7.9     |
| dS/m  | 5.5     |
|       | 12.9    |
| cfu/g | <10 / 0 |
|       | 0       |

Analysis according to Australian Standards AS 4454

# Analytical Results - User Friendly

| <b>Chicken Manure (Layer)</b>            | <b>Nutrient concentration</b> |        | <b>Nutrient supply / ha</b> |             |
|------------------------------------------|-------------------------------|--------|-----------------------------|-------------|
| <b>Application rate</b> cubic meter / ha |                               |        |                             | <b>5.30</b> |
| tonnes fresh matter / ha                 |                               |        |                             | <b>3.5</b>  |
| tonnes dry matter / ha                   |                               |        |                             | <b>1.37</b> |
| Organic carbon                           | % fm                          | 24.30  | kg / ha                     | 850.50      |
| <b>Total Nutrients</b>                   |                               |        |                             |             |
| Nitrogen (Kjeldahl)                      | % fm                          | 2.93   | kg / ha                     | 102.55      |
| Phosphorus                               | % fm                          | 2.04   | kg / ha                     | 71.40       |
| Potassium                                | % fm                          | 2.60   | kg / ha                     | 91.00       |
| Calcium                                  | % dm                          | 11.60  | kg / ha                     | 159.48      |
| Magnesium                                | % dm                          | 0.51   | kg / ha                     | 7.01        |
| Manganese                                | mg/kg dm                      | 541    | kg / ha                     | 0.74        |
| Sulphur                                  | % dm                          | 0.54   | kg / ha                     | 7.42        |
| Sodium                                   | % dm                          | 0.39   | kg / ha                     | 5.36        |
| Copper                                   | mg/kg dm                      | 77.00  | kg / ha                     | 0.11        |
| Zinc                                     | mg/kg dm                      | 525.00 | kg / ha                     | 0.72        |
| <b>Available Nutrients</b>               |                               |        |                             |             |
| Ammonium - N                             | mg/kg fm                      | 9938   | kg / ha                     | 34.78       |
| Nitrate - N                              | mg/kg fm                      | 38.00  | kg / ha                     | 0.13        |
| Ammonium + Nitrate - N                   | mg/kg fm                      | 9976   | kg / ha                     | 34.92       |
| Available phosphorous                    | mg/kg fm                      | 2466   | kg / ha                     | 8.63        |

# Example: Composted Feedlot Manure

| <b>Composted Feedlot Manure</b> |                          | <b>Nutrient concentration</b> |         | <b>Nutrient supply / ha</b> |              |
|---------------------------------|--------------------------|-------------------------------|---------|-----------------------------|--------------|
| <b>Application rate</b>         | cubic meter / ha         |                               |         |                             | <b>35.21</b> |
|                                 | tonnes fresh matter / ha |                               |         |                             | <b>25</b>    |
|                                 | tonnes dry matter / ha   |                               |         |                             | <b>17.57</b> |
| Organic carbon                  | % fm                     | 16.40                         | kg / ha |                             | 4100.00      |
| <b>Total Nutrients</b>          |                          |                               |         |                             |              |
| Nitrogen (Kjeldahl)             | % fm                     | 1.86                          | kg / ha |                             | 466.00       |
| Phosphorus                      | % fm                     | 0.90                          | kg / ha |                             | 224.75       |
| Potassium                       | % fm                     | 1.99                          | kg / ha |                             | 497.50       |
| Calcium                         | % dm                     | 3.18                          | kg / ha |                             | 558.65       |
| Magnesium                       | % dm                     | 1.19                          | kg / ha |                             | 209.05       |
| Manganese                       | mg/kg dm                 | 559                           | kg / ha |                             | 9.82         |
| Sulphur                         | % dm                     | 0.60                          | kg / ha |                             | 105.41       |
| Sodium                          | % dm                     | 0.46                          | kg / ha |                             | 80.81        |
| Copper                          | mg/kg dm                 | 57.00                         | kg / ha |                             | 1.00         |
| Zinc                            | mg/kg dm                 | 330.00                        | kg / ha |                             | 5.80         |
| <b>Available Nutrients</b>      |                          |                               |         |                             |              |
| Ammonium - N                    | mg/kg fm                 | 1403                          | kg / ha |                             | 35.08        |
| Nitrate - N                     | mg/kg fm                 | 0.00                          | kg / ha |                             | 0.00         |
| Ammonium + Nitrate - N          | mg/kg fm                 | 1403                          | kg / ha |                             | 35.08        |
| Available phosphorous           | mg/kg fm                 | 3,398                         | kg / ha |                             | 84.95        |

# Summary

- Know what your needs and expectations are
- Know the strength and weaknesses of different products and what they can and can't deliver
- Watch out for risks and pitfalls
- Ask potential suppliers (product quality / service)
- Request user-friendly information

Know what you want - Know what to get

# Waiting for Productivity Gains

**Once a land manager begins working towards enhancing soil organic matter, a series of soil changes and environmental benefits follow**

