



COMPOST PRODUCTION AND USE IN HORTICULTURE

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Compost, What is it?

Compost is an aerobically decomposed biologically active material of largely organic origin. While it can vary in texture it is typically dark brown colour with an earthy appearance and smell.

Compost is the result of a managed decomposition process in which successions of aerobic micro-organisms break down and transform organic material into a range of increasingly complex organic substances, many of which are loosely referred to as humus.

Some of the products such as humins are very stable with a half-life in the soil of greater than 100 years, whilst others have a much shorter life span.

Compost is made from a mixture of organic materials. Regardless of the method used, the composting process is managed to maintain temperature, oxygen and moisture levels within acceptable ranges.

Compost can be produced using a range of equipment from basic turning to sophisticated in-vessel processing; however it is the use of appropriate process management rather than equipment that determines compost quality.

Potential benefits of using compost

The benefits of using compost largely result from its effects on both the quality and level of soil organic matter.

The regular use of compost can be expected to improve most, if not all, aspects of crop production. It is however important to appreciate that these changes will increase with its continued use and that the full benefits, especially in terms of disease and pest control may take several years to develop. Using compost can be expected to:

Reduced production costs and improve crop performance by:

- Improved crop yields, quality and storage life.
- More efficient and reduced use of fertilisers, pesticides, including soil fumigants, and irrigation.
- Increased crop ability to resist pests and diseases.

Improved soil quality and hence crop growth by:

- Improved soil organic matter levels and organic cycles.
- Increased plant available water.
- Increased nutrient availability and nutrient holding capacity.
- Improved soil structure.
- Reduced levels of soil borne plant pathogens and pests.

Improved prospects for future industry growth and development because of:

- Increased ability to match and exceed requirements for safe “clean/green” horticultural produce.
- Reduced potential for environment damage to soil and water resources, including increased ability to manage nitrate nitrogen losses to ground water.
- Increased opportunity for securing access to additional soil and water resources
- Increased potential for large-scale organic food production.

Compost production

High quality compost is made from a wide range of organic materials or feed stocks. They include all plant and animal products including crop, food, manure, timber and paper wastes. Inorganic materials such as clay, fly ash (from power generation) and potentially Bauxite residue or ‘Alkaloam’ can also be included and these non-organic materials can improve compost quality and its nutritional characteristics.

Feed stocks for compost production are best delivered to the compost facility in a source-separated state. This ensures that their nutrient levels as well as contaminants, including heavy metals, are both known and reasonably constant, and it allows blending to achieve desirable levels in the final compost product. Feed stocks need to be well mixed either prior to or at the commencement of the composting process.

Compost can be made using different equipment ranging from various physical turning and aeration devices to forced aeration static pile systems. Depending on the nature of the materials, composting may be carried out within enclosed sheds and or within enclosed vessels. These systems are most expensive to establish, but provide maximum control over the composting process as well as odours and enable highly putrescible organic materials to be composted.

To make compost, these raw ingredients or feed stocks, are mixed to provide carbon to nitrogen ratios in the range of 25 to 40:1. There are a number of composting methods including open windrow, static pile and in-vessel processes. Regardless of method, composting requires process control to ensure that within the composting mass:

- adequate oxygen levels (above 14%) are maintained;
- moisture levels are maintained between 40 and 60%; and
- temperatures are maintained below 70°C and preferably in the range, 55 to 65°C.

Composting requires oxygen. This is achieved by either pumping air through the compost or by physical turning of the compost at regular intervals.

Moisture levels are equally important for microbial growth and their activity will decline when moisture levels drop below 40%. As moisture contents increase beyond 60%, the risk of low oxygen conditions developing increases rapidly. Under these conditions there is an increasing likelihood that anaerobic conditions will occur, resulting in longer composting time and reduce compost quality.

The composting process is process and feedstock dependant and it involves two critical stages that are characterised by the temperatures achieved within the composting pile or window. The process outlined below is diagrammatically summarised in Figure 1. Figure 1

represents in-vessel or static pile composting where continuous management of composting conditions make it possible to maintain the steady temperature conditions illustrated. In more conventional processes such as windrow composting, regular turning result in rapid temperature decline followed by slower recovery as the composting process re-establishes itself.

1st Stage Thermophilic - hot phase. Temperature readily exceeds 55°C and need to be maintained below 70°C by turning and aeration. In conventional outdoor composting, this period will typically lasts 6 to 8 weeks, however it is generally accepted to be greater than 3 weeks, regardless of the method of processing (Figure 1). It is the period of greatest volume reduction and culminates in a stable product that can be safely stored.

Providing temperatures above 50-55°C are maintained for 4 to 5 days, effective sanitisation occurs during this period. These temperatures destroy weed seeds and pathogenic microorganisms while the beneficial microbes, responsible for organic matter breakdown, survive temperatures up to 60-70°C.

2nd Stage Mesophilic phase. Temperatures are less than 50°C and fall over time, eventually stabilising at 20 to 25°C. This period is usually referred to as the maturation phase and its duration is determined by the end use of the compost. Compost must be stable and if it has not been further composted, it will be too immature for most crop application. As maturity progresses, composts that are still relatively immature will provide greatest nutritional benefits and are likely to have the most impact of pests and disease management. Highly matured compost will deliver good outcomes in terms of soil quality, but will have increasingly less impact on immediate crop performance.

Continued management of the composting process is vitally important throughout the maturation phase, however at this time, measuring compost maturity and therefore its potential value is not well developed.

Nitrogen is required to produce the microbial mass that degrades or breaks down the carbon rich organic materials such as straw, crop waste, food waste and green waste. Nitrogen is usually derived from manure, however a number of fresh, green/leafy organic wastes have adequate carbon nitrogen ratios for them to compost without the addition of extra nitrogen.

When the carbon nitrogen (C/N) ratio is low, nitrogen levels are high relative to carbon levels. This accelerates microbial activity levels and maintaining temperatures below 70°C becomes difficult. This situation also results in nitrogen losses.

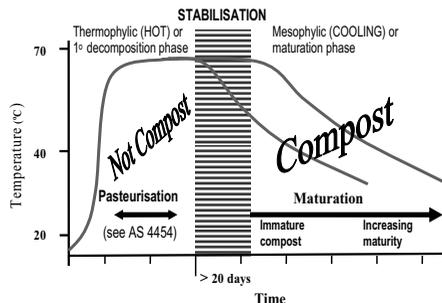


Figure1. Diagrammatic depiction of temperature change during 'in-vessel' or 'static pile' composting process.

If nitrogen levels are too low, the composting process will be slowed and fail to achieve temperatures required to pasteurise feedstock's and effectively deal with disease organisms, pests and weeds.

When determining C/N ratio of the materials to be composted, consideration needs to be given to carbon availability. With woody materials, the total amount of carbon present as determined by analysis is much greater than the amount immediately available to the composting process. The available carbon is the carbon that is available or exposed to microbial attack and depending on the coarseness of the material is probably around 25% of the total carbon.

Compost quality

Compost quality is complex and no single measure is sufficient to describe it. Quality is also related to the intended use of the composted product.

Aspects of quality include consideration of its maturity and stability, type, nutrient content and levels of contaminants. Other useful measures include the C/N ratio, Nitrogen Draw Down index (NDI), and information on available nitrogen. Contaminants include pests, pathogens and weeds or PPW's, inert contaminants such as plastic in all its forms, metal and glass as well as heavy metals. Heavy metals, which can include excessive levels of plant nutrients such as Copper and Zinc, could build to plant and environmentally unacceptable levels with repeated soil application.

The objective of compost manufacture is to either eliminate these risks or to reduce them to acceptable levels. Compost manufacturers should therefore consider having demonstrable and therefore certified quality control processes in place.

Compost maturity and stability

Compost maturity and stability are probably the most important considerations in determining best use for given compost.

Compost stability relates to completion of the thermophillic, first stage of composting. In simplest terms it is the stage at which compost can be stored without further processing. The compost will be free of unpleasant odours and biological activity will have stabilised at relatively low constant rates. This means that following turning and providing other compost requirements are not limiting, the composting temperature will not rise above 45 to 50°C. Compost stability can also be measured in a laboratory using a re-heating test that is carried out with the aid of a vacuum (Dewar) flask.

Maturity reflects the level to which the mesophillic, second stage of composting has proceeded. Arguably, compost maturity is the single most important determinant of compost quality because of its influence on how it will perform when applied to a crop. Ultimately the composting process reaches a stage where the core temperature of the composting pile reaches a relatively cool and stable temperature in the vicinity of 25 to 30°C.

Humification occurs during the maturation process and the time required to reach a particular stage of maturity depends on the feed stocks, woody materials taking the longest time, and the process used.

As indicated, measuring or quantifying maturity is not simple and a consistent conclusion from large volumes of research is that it cannot be defined by a single measurement. The compost maturity index recently developed by a group lead by Dr Marc Buchanan (Buchanan 2000) for the Californian Compost Quality Council (CCQC) has considerable promise.

The CCQC compost maturity index involves three tests that include the Carbon: Nitrogen ratio, one test for potential plant toxicity (germination, Ammonium nitrogen level) and one for compost stability (rate of oxygen uptake, carbon dioxide production, reheat test). Based on critical values from each of the tests, the compost is given a maturity score/rating between 1 (immature) and 5 (highly mature).

This index has been subsequently validated using an extensive range of commercial composts in commercial vegetable trials. This work indicated that composts with a rating of 2 to 3 are most likely to improve crop performance. The potential importance of this maturity rating is to provide a quantitative measure of maturity and enable the production of more consistently performing compost.

Using current analysis used in the Australian Standards, AS 4454 – 2003, any consideration of compost maturity should always include C/N ratio, total and available nitrogen, including Ammonium nitrogen, and arguably a NDI value. Critical values used to evaluate compost maturity and quality in Department of Agriculture trials to evaluate the use of compost in growing vegetables are provided in the Table 1. The nature of the nitrogen present is an indicator of immaturity and is indicated by a nitrate to ammonium nitrogen ratio is less than 0.14. The potential for compost to compete for nitrogen, measured by the nitrogen drawdown index (NDI), is also a useful indicator of compost maturity.

Table 1. Critical analysis values, conducted to Australian Standards AS 4454-1999 and used in conjunction with the Department of Agriculture's compost research and development program

Measurement	Value	Unit	Comment
Carbon Nitrogen (C/N) ration	< 20	none	For crop available nitrogen.
Nitrogen Drawdown Index (NDI)	> 0.5	none	Lower values likely to compete for crop N.
Organic matter	> 35	% DM	Higher the better.
pH (CaCl ₂)	5-7.5		Ideally around 7.0.
Electrical conductivity	< 6.0	dS/m	
Toxicity (potting mix test)	> 60	%	Indicates immaturity and possibly anaerobic composting conditions.
Moisture content	> 25	%	Ideally around 40%.
Total Nitrogen	> 1.0	% DM	Generally not greater than 1.7%.
NH ₄ + NO ₃	> 100	mg/L	Also indicates N availability for crop.
NO ₃ /NH ₄ ratio	> 0.14	(m/L)	High ammonium level indicates immaturity.

Compost storage

Composting is a continuing process so that maintaining compost quality during storage requires both the level of biological activity and storage time to be minimised.

The biological activity associated with composting is dependent on moisture levels so that drying will reduce biological activity and permit storage with minimal change to the compost.

Therefore if storage is required, continue turning the compost without any addition of water. However to avoid the compost becoming hydrophobic and difficult to re-wet, moisture levels should be maintained between 25 to 30%. This will also maintain biological diversity, which is likely to be reduced at lower moisture contents.

Compost type and feedstock

For horticultural production the major consideration is whether the compost is best suited to soil incorporation prior to crop establishment or application as mulch after the crop has been established.

Composts suited to soil incorporation and production of annual crops, including vegetables or orchard and vineyard establishment have the most exacting quality requirements, see Table 1.

This quality is most readily achieved with non-woody organic materials such as crop waste, straw and leafy materials takes on fine granular appearance and takes the least amount of time to make. This is because the carbon in these materials more readily degraded and these composts develop a good crumb structure that is visibly soil like in appearance. The addition of clay materials can further enhance this characteristic.

High quality compost can also be made from lignified woody materials. However because the carbon from these sources is more difficult to degrade, these materials can require longer processing times to achieve a given level of maturity. Composting time for woody materials is reduced by increasing the level of milling or grinding because it exposes more of the carbon to microbial attack. The use of purpose built compost- turning equipment rather than front-end loaders will also speed up the composting process. This is because of their superior ability to break up and thoroughly mix materials within the compost pile.

Composts based on woody green organic materials can behave as unstabilised composts because, depending on their age and coarseness, they can contain un-decomposed woody material. Soil incorporation processes, particularly involving rotary cultivators, will further break up this woody material, which increases the amount of exposed, un-decomposed woody material. This results in increasing microbial activity and decomposition that can potentially reduce crop growth through competition for available nitrogen. For this reason, fine, 10 mm or less, screening of woody green waste based composts will further reduce the risk on undecomposed materials being present.

Compost sold as a mulch may not have completed the thermophilic phase, however it should have undergone adequate periods of temperatures above 55°C, as defined in the Australian Compost Standards, AS 4454 - 1999, in order to control pests, pathogens and weeds.

Even when used as mulches, these materials will compete with crops for nitrogen, and when using them some consideration should be given to providing additional nitrogen to counter this possible affect.

To minimise possible growth reduction when using mulch composts, minimum quality standards including C/N less than 35 and an NDI above 0.3 are suggested, see Table 2.

Composts contribution to crop nutrition

The nature and ratios of the materials or feed stocks used to make compost will influence the nutrient content of the compost produced.

Being derived largely from plant materials (typically 80% of the initial mix), compost nutrient contents and their ratios will be similar to those in most crops. Depending on the rate used, compost therefore has the potential to supply a significant proportion of a crops nutrient needs.

Please note that the following suggested contributions from compost to horticultural crop production are based on preliminary research findings and our interpretation of overseas information.

Nitrogen contribution

Overseas research reports suggest that only 20% to 30% of the total nitrogen in a compost will be available to a crop, following its initial application. This is because in mature compost, nitrogen is almost totally stabilised in organic molecules such as amino acids, proteins and tissues. When applied to the soil, the organic nitrogen pool is slowly released as nitrate nitrogen for use by plants and microorganisms. Its actual availability will vary with climate, soil type and compost type, and will increase with repeated compost application.

Nitrogen levels in well made, mature compost rarely exceeds 2.0% and is typically in the range of 1.0 to 1.5% on a dry weight basis. Overseas experience indicated that 25 to 30% of compost nitrogen would become available to a crop following its application. **Therefore as a guide, compost is likely to contribute 10 to 15 kg of nitrogen per 10 cubic metres of applied compost per crop, which is equivalent to between 20 and 30 kg of Urea.** This assumes that the compost is mature, has 50% moisture content and a density of 0.8 t/m³.

To date, our work with composts made from woody (green organic) plant materials indicate that they are unlikely to contribute these amounts, particularly if their Carbon nitrogen ratios are less than 20 and their nitrogen draw down index is above 0.5 to 0.6.

With repeat compost applications, this amount is likely to increase, however even at high rates, compost is unlikely to supply sufficient nitrogen, at least during periods of high nitrogen demand, for most crops.

One of compost's advantages is its potential to significantly reduce nitrogen leaching, particularly nitrate nitrogen. Strategic nitrogen application in conjunction with the use of compost therefore has potential to reduce total crop nitrogen applications and minimise increased ground water nitrogen levels.

Phosphorus and potassium contributions

Phosphorus content will depend largely on the amount of manure used as a raw ingredient to manufacture the compost. It is likely to be in the range of 0.3% to 1.0% on a weight for weight (w/w) basis. Compost based on woody green organics will be at the lower end of this range.

Preliminary trial results indicate that around 30 to 40% of the phosphorus content is available to a vegetable crop grown on Karrakatta sand. **Therefore at 0.5%(w/w) phosphorus content, 10 m³ of mature compost would contain 20 kg of phosphorus. This would provide 6 to 8 kg of plant available phosphorus and be equivalent to 65 to 90 kg of super phosphate.** Again this assumes that the compost is mature and has a density of 0.8 t/m³.

Compost normally contains between 0.8 and 1.2% of potassium on a w/w basis. Potassium from compost is more readily available than both nitrogen and phosphorus, and from our current results, we can assume that 90% would be available to a crop.

Therefore with a 1.0% (w/w) potassium content, 10 m³ of mature compost would contain 40 kg of potassium. This would provide 36 kg of plant available potassium and be equivalent to 90 kg of potassium sulphate. Again this assumes that the compost is mature and has a density of 0.8 t/m³.

Strategies for using compost

Maximum benefits from compost will only be obtained from regular, repeated use.

Most of the benefits of compost will be associated with its impacts on soil organic matter. As soil organic matter levels and microbial populations develop, significant reductions in fertiliser, irrigation and pesticide applications will be possible. However with light soils, maximum value of these benefits are unlikely to be achieved unless organic matter can be increased to adequate levels (probably at least 2% with coarse sands). Compost contributions to crop nitrogen are also likely to be inconsistent and relatively minor.

Suggested rates for using compost and mulch compost in various horticultural crops are provided in Table 2. For vegetable production on sandy light soils, trial work suggests that rates in the order of 20 tonne/ha is sufficient to achieve significant results. In the longer term, it is feasible that lower rates of 10-15 tonnes/year will be sufficient to maintain these benefits; however it must be stressed that these rates will be determined by our ability to adopt management practices that encourage the maintenance of effective soil organic cycles. These include the reduced use of cultivation, greater use of cover or break crop, as well as the use of pesticides and fertilisers that are less disruptive to beneficial microbial populations. The addition of clay, either directly or as a component of compost, is also likely to assist organic matter build up.

Compost selection

Many factors determine compost quality and its suitability for a given use. As the compost industry develops, materials specifically suited to different crops and purposes such as suppression of particular diseases will become available. However at this time the choice is limited, as is our ability to measure aspects of compost quality that accurately predicts its performance. Table 2 provides a preliminary guide to selecting compost for either soil incorporation (vegetable production and orchard/vineyard establishment) or application as surface mulch.

Table 2. Suggested rates and critical quality factors for using compost in horticulture

Factor	Soil incorporation		Surface mulch
	Vegetables and annual crops	Orchard, vineyard and perennial crop establishment	Surface application to orchards, vineyards and perennial crops
C:N (Carbon to nitrogen) ratio	< 17	< 20	Not as critical, prefer < 35 to minimise N competition
NDI (Nitrogen drawdown index)	> 0.6	> 0.5	Not critical, prefer > 0.3 to minimise N competition
Electrical conductivity (dS/m)	< 6.0	< 8.0	< 8.0
pH	6.5–7.5	6.0–8.0	6.0–8.0
Moisture content (% Dry matter)	> 35	> 35	> 35
Total nitrogen (mg/kg)	> 1.5	> 1.0	Not critical, prefer > 0.7
Soluble nitrogen (mg/kg)	> 100 ppm	> 100 ppm	Not critical
Ammonium/nitrate ratio	> 0.14	> 0.14	Not critical
Toxicity %	> 60	> 60	> 30
Application rate, suggested typical range	15-30 m ³ /ha	25-75 m ³ /ha trenched into planting rows	50-75 mm depth to 15-25% of land centred on the row

PLEASE NOTE: The values provided in Table 2 need to be treated with caution, they are based on our collective knowledge and experience, and they are not based on any systematic testing or evaluation procedures.

Cost considerations for using compost

Estimated percentage saving in fertiliser, pesticide and irrigation production costs needed to cover a range of compost prices and rates are presented in Table 3. They are based on typical fertiliser, pesticide and irrigation costs that are associated with major vegetable crops grown on the sandy soils of the Swan Coastal Plain (*Vegetable Budgeting Handbook for the Swan Coastal Plain, Peter Gartrell, (1998) Agriculture Western Australia Miscellaneous publication 13/98*). These estimates indicate that a 25% reduction in the cost of these inputs will cover the cost of a 20 t/ha compost application.

This break even figure does not include any consideration of increases to marketable yield. The rates of compost used in Table 2 are those for which we have achieved yield increases in practice and the current costs of compost, typically vary around \$35 to \$45 per tonne, depending on source and transport requirements. Factors such as increasing landfill reduction targets, Landfill Levies and restrictions on the use of raw poultry manure are likely to increase the use of compost.

Costs of mulch compost applications in typical vineyard situations are comparable with standard straw applications of 2 kg of cereal straw/m of vine row. Mulch compost at \$17/m³ plus \$7.50/m³ delivery and spreading cost, applied 50 mm thick to a 0.5 m wide strip, will cost around \$0.60/m of vine row compared to straw at \$0.50 to \$0.60/m of row.

Table 3. Per cent cost savings in fertiliser, pesticide and irrigation costs required for economic compost application

Rate of compost (t/ha)	Compost price per tonne (\$)			
	20	30	40	50
10	6.7	10.2	13.5	16.9
20	13.5	20.2	27.0	33.8
40	27.0	40.6	54.1	67.5

Compost production and potential markets

Compost is a bulky material made from bulky ingredients. In any area or region, the success of composting will be determined by the economics of assembling these raw ingredients for compost manufacture and the distribution costs.

Compost production has grown significantly in the last 2 to 3 years and this growth is likely to continue at faster rates over the next 5 to 10 years. Production is largely based around Perth where at least five companies produce a range of composts from a range of agricultural and metropolitan waste streams.

Compost is currently used in a range of horticultural crops, some broad acre crops, as well as domestic and commercial landscape situations.

The growth in compost production is and will continue to be constrained by market growth. Horticulture, with its relatively intensive nature and potential for continued strong growth is a very important market for compost. However its cost, concerns about its quality and limited knowledge of both its benefits and how best to use it, are all limiting its use in horticulture.

Horticulture has the added advantage of being close to large population centres that are large sources of materials for compost manufacture. Ultimately if compost is to be used in substantial amounts by horticulture and agriculture, adequate levels of production will be increasingly dependent on organic feed stocks from urban centres.

Department of Agriculture Western Australia's involvement

The Department is working to develop compost based horticultural production systems. This activity has the potential to play an increasingly important role in the development of horticultural production systems that will be both competitive and sustainable as a result of:

- lower production costs as a result of more efficient use of fertiliser, irrigation and pesticides;
- improved soil structure and soil organic matter cycling;
- minimising risks of ground water contamination; and
- safer 'clean/green' food production.

The program also promotes communication between horticultural industries and the developing waste management industry. To do this and to guide our involvement, a Compost working group with representatives of the horticultural industries, compost producers, waste managers including local government, universities and government agencies has been established.

Conclusions

The presence, effectiveness and build-up of soil organic matter and more importantly, effective organic cycles, will be influenced by climate, soil type and management practices. These factors will ultimately determine how much compost is needed. Using compost has the potential to substantially improve soil health and develop more effective organic cycles.

The use of compost in horticulture has potential to make significant contributions to the continuing growth of these industries. Apart from improving yield and reducing fertiliser, irrigation and pesticide inputs, the use of compost is also likely to minimise adverse affects on soil and water quality.

However it must be stressed that maximising these benefits to production and sustainability for horticultural production, will require continued repeat use of compost and changes to components of current crop production systems.

DISCUSSION PAPER

Compost production for agricultural use – issues for the developing recycled organics industry

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Purpose

This paper is intended to stimulate discussion and foster greater understanding of the issues and considerations that are necessary for the development of agriculture, and in particular horticulture, as a significant market for the recycled organics industry.

This document reflects almost ten years' work by the Department of Agriculture, Western Australia that has increasingly recognised the essential role that soil organic matter plays in the development of 'best practice' production systems.



Courtesy of Custom Composts, Nambeelup, WA.

The benefits of compost in terms of crop production, soil fertility and the environment have been widely reported. Considerations include market development, compost quality, the development of a common understanding and consistent use of terminology, feedstock and process management, the need for policy and regulation, the potential synergies between agriculture and the wider community and the limitation associated with current application of land use planning process.

Executive summary

The numerous benefits of using compost in a range of horticultural crops have been extensively reported and this discussion paper considers factors that are limiting the development of these industries as significant sustainable markets for compost derived from urban and agricultural organic wastes.

While market development and product quality have and continue to be the focus for the compost industry, the lack of appropriately focussed policy to support and facilitate market growth is being increasingly acknowledged as the key limiting factor.

It is argued that the process of successfully recycling organic wastes needs to be supported by strong overarching policy that recognises the critical importance of soil organic matter in both the management of our soil and water resources, and our organic wastes. The findings of our extensive research and development programs unquestionably validate the importance of recycling our organic wastes through land application and in particular to the more intensive horticultural industries.

This approach will provide a framework within which existing policy and regulations can be modified and new ones implemented to bring about effective recycling of organic wastes and maximise the potential benefits. Key elements of this include regulations implementing minimum standards that will meet public health, including fly breeding, environmental and biosecurity requirements for the application of all organic materials to land.

It is also argued that retaining horticultural industries adjacent to urban centres in particular, needs to be given greater recognition. Minimising the costs of recycling both organic waste streams that include reclaimed or reprocessed water, maintaining capacity to provide best quality fresh food and contributions to a range of other benefits for society are key reasons why land use planning paradigms that prioritise urban development, need to be challenged. Requiring the 'Property development industry' to account for the broader strategic needs of our society in terms of fresh food production, responsible waste management, environmental protection and other community benefits, will make the intentions of the recently established Statement of Planning Policy for the protection of productive agricultural land, more achievable.

Cost competitiveness with a number of raw organic products including manures and raw mulches is a major barrier to developing the horticultural market for compost products. Establishing a need to process all organic materials in order to achieve safe minimum application standards will assist composted products to compete on the basis of performance rather than least cost. Other considerations include setting an appropriate balance between cost to the waste producer and product price in order to create a demand driven rather than the current largely supply driven market.

Product quality is critical to market development, and apart from facilitating, but NOT regulating product quality, issues associated with feedstock collection and management along with removal or management of contaminants such as improved chemical collection, requirements for new chemicals and pesticide registration to include biodegradability within composting processes, and mandating the use of compostable polycarbonate plastics based on cellulose rather than hydrocarbons are considered.

Introduction

Considerable progress has been made with developing a better understanding of the factors that influence compost quality and therefore its performance and fitness for purpose.

Product quality and wider recognition of the benefits from compost use have increased, however progress with developing the agricultural market for compost has been hampered by its cost, particularly in relation to other organic wastes such as animal manures, and inconsistent quality.

Concerns about the a potential for increasing production of composts made from Municipal Solid Waste (MSW) to reduce continued market growth, have also emerged.

Landfill diversion targets have given way to the broader and more useful concept of zero waste and the 'Waste Hierarchy' provides general guidance on relative priorities of options for managing wastes. However the level of market development coupled with anticipated growth in compost production is increasing concerns that significant quantities of potentially valuable organic 'waste' resources will be diverted to energy recovery.

It is accepted that composting (recycling organic materials) represents a higher order use of the organic 'waste' resource than energy recovery. The need to provide the organic recycling industry with at least equivalent financial incentives to the renewable energy credits available to the renewable energy sector is also considered.

While organic diversion processes are in place, there is a lack of policy and appropriate regulations to drive the marketing of compost and the Recycled Organic Products in general.

Finally the dominance of urban growth in land use planning processes are threatening to impact on the ability of urban centres to effectively engage with appropriate sectors of agriculture such as intensive horticultural production, in managing the recycling of their organic wastes. This is already the case in Sydney where recycled organic products have to be transported considerable distances.

Issues considered therefore include:

- compost market development in agriculture - impediments to growth;
- compost quality and maturity - determining compost quality and 'fitness for purpose';
- terminology - the use and meaning of words commonly used to describe the composting process and product quality;
- the Waste Hierarchy – achieving 'zero waste' and clarifying component definitions;
- policy, regulation and standards – what is needed to underpin market development;
- source separation - compost quality and mixed waste composting;
- building linkages between agriculture and the community – land use planning, the soil fertility cycle and sustainable society.

Considerations

Agricultural compost market development:

Recognition that agriculture is potentially a major compost market has resulted in the national 'Compost Roadmap Project' focussing on this market sector.

Of the agricultural markets, horticulture and particularly intensive vegetable, vine and fruit growing offer the most potential because of their intensive use of inputs (fertiliser, irrigation and pesticides) and their usual proximity to urban waste generation.

Improvement to the bottom line from compost use in these crops is widely demonstrated (Paulin 2004); however they are often relatively small and are dependent on savings associated with reduced fertiliser use.

The benefits associated with improved soil quality are not realised immediately and require regular use of compost. Further, potential savings from reduced pesticide use is widely accepted but has yet to be consistently achieved on a large scale. Maximising the future economic benefits of using compost will require the development of production system packages that focus on better managing soil organic matter and consequently soil performance. Present difficulties include:

- raw manures, biosolids and shredded green waste compete directly at prices that are not achievable for composted products;
- most growers are unable to adjust fertiliser programs to achieve potential fertiliser savings when using compost; and.
- soil management in vegetable production and other intensive annual crops is highly damaging to soil organic matter and quality.

Difficulties with developing agricultural compost markets, particularly in the short term, are therefore associated with its cost and our still limited understanding of how it can be used to best advantage. Consideration therefore needs to be given to making the use of compost more attractive to growers.

Compost quality and maturity

Compost maturity is a major factor in determining compost quality and its best use. It reflects the degree to which the second Mesophylic composting stage (Figure 1) has progressed.

There are large volumes of research into compost maturity and a consistent conclusion is that it cannot be defined by a single measurement. Recent work to develop a compost maturity index by a group led by Dr Marc Buchanan (Buchanan 2000) for the Californian Compost Quality Council (CCQC) has considerable promise.

The CCQC compost maturity index involves three tests that include the Carbon:Nitrogen ratio, one test for potential plant toxicity (germination, Ammonium Nitrogen level) and one for compost stability (rate of oxygen uptake, carbon dioxide production, and reheat test). Based on critical values from each of the tests, the compost is given a maturity score/rating between 1 (immature) and 5 (highly mature).

Determining compost maturity will aid consistent performance and market development.

This index has been validated in trials using commercial composts in commercial vegetable production in the Salinas Region of California. This work indicated that composts at the lower end of the maturity rating scale are most likely to improve crop performance. The potential importance of this maturity index is to provide a quantitative measure of maturity

that aids production of consistent quality compost.

Composts made with woody wastes as a significant component of the feedstock present additional considerations. Decomposition of woody lignified materials during the initial decomposition phase is limited because the microbes responsible are principally bacteria and they can only act on the exposed surface carbon. Unless time is not a concern, the production of compost from woody feedstock needs to involve the use of compost turners that continuously agitate and break up woody particles and screening to remove larger fractions that contain undecomposed carbon. Undecomposed carbon has the potential to out compete crops for available nitrogen, resulting in nitrogen draw down and reduced crop production.

With conventional windrow composting, the normal expectation is to produce compost suitable for use in vegetable production within 10 to 14 weeks. Our work in WA, supported by the findings of a recent tour of compost production in California (Paulin 2002, 2002A) indicate that this is achievable with screen sizes in the order of 10 mm.

Terminology

A Recycled Organics Dictionary and Thesaurus of terms associated with the Recycled Organics industry has been produced by the Recycled Organics Unit at the University of NSW. See the link: www.recycledorganics.com.

It is currently in its second edition (August 2002) and changes are suggested to the terminology of composting, products, feedstock and markets. These are summarised in Table 1 and detailed in appendices 1 to 4 respectively.

Composting is the process that produces compost, a stable safe to use product that is the result of aerobic high temperature (> 55°C) decomposition.

Basic composting terminology and critical stages of the composting process and its management are outlined in Figure 1. The two stages of the composting process are well accepted, namely the initial primary decomposition phase (Thermophylic or 'hot' stage) and the second maturation phase (Mesophylic or cooling stage).

The initial Thermophilic phase provides pasteurisation and the necessary requirements for this is defined by a set of minimum temperature by time conditions that need to be applied to the entire composting mass. In conventional windrow composting, this is achieved by achieving the conditions, as defined in the Australian Standard for Compost, Soil Conditioners and Mulches (AS-4454), after a minimum three turns. In California, a minimum five turns is recommended.

Table 1. Outline of suggested changes to ROU Recycled organics dictionary – see Appendices 1-4 for detail

Term or subject	Critical comments
Composting terminology - Appendix 1	
Composting	A process that is NOT time bound!
Maturation	Determines quality and fitness for purpose.
Maturity (of compost)	Relates to the second composting stage.
Stability (of compost)	Critical to defining compost.
Product terminology - Appendix 2	
Compost	Include stable/safe to use product.
Compost mulch	Amalgamate fine/coarse mulch – arbitrary, unnecessary division.
Pasteurised Recycled Organic product	'Recycled Organic' added to description.
Pasteurised mulch	Amalgamated with fine categories – an unnecessary division.
Soil conditioner	Modified description – NOTE compost included in categories.
Other products	Manufactured soil, potting mix, playground surfacing added.
Feedstock terminology - Appendix 3	
Biosolids	Incorporated into sludge category – need to reduce its 'bad' connotations!
Food organics	Comment on recalcitrant materials.
Garden organics Garden Woody organics	Replace with Green and Woody green organics – Garden is not a universal term and unlikely to be acceptable to agriculture!
Sludges, liquid - watery waste	To include biosolids.
Market terminology – Appendix 4	
Horticulture – Annual Perennial	Annual crops - major market for compost. Composted mulch important to Perennial crops.
Agriculture	Broad acre and tree crops (Silviculture).
Urban amenity	Domestic, landscaping, nurseries, sport and recreation.
Rehabilitation	Revegetation, restoration, landfill cover.
Enviro/bio- Remediation	Contaminated sites, storm water purification.

To be called compost, a product of a composting process must achieve stability. Stabilisation is the interface between the two primary composting stages.

Figure 1 defines stabilisation as the junction between the two stages of composting and defines the point at which the composted materials can be termed compost. The achievement of stability is largely determined by process management and feedstock. It is unlikely that stabilisation, and therefore the production of compost can be achieved in less than 20 days (Ed Stentford, University of Leeds, UK, personal communication).

Further, this minimum period can only be achieved in closed composting vessels where continuous precise management of moisture, temperature and oxygen levels are possible. The variation in time to achieve stability is diagrammatically depicted by the shaded area in Figure 1.

Note that Figure 1 depicts enclosed vessel composting and does not show temperature fluctuations associated with turning compost piles or windrows.

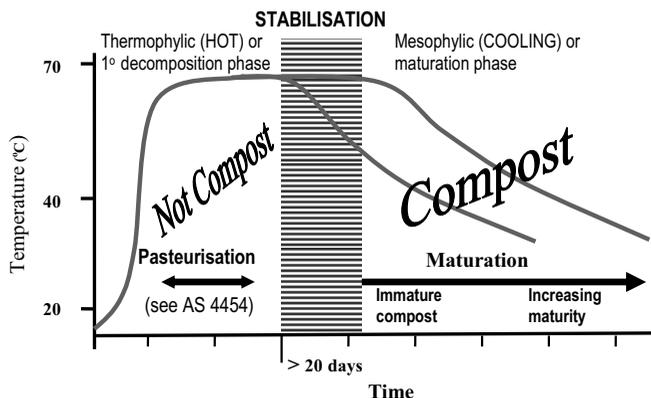


Figure 1. Diagrammatic depiction of an in-vessel composting process.

Management of the second 'maturation' composting stage is CRITICAL to final quality of compost.

The second Mesophilic composting stage is characterised by declining temperatures and is the important maturation phase of the composting process that determines how it will be best used, or its 'fitness for purpose'.

This maturation phase requires continued management and in particular, the maintenance of adequate moisture and oxygen levels within the composting mass. Compost quality will be compromised when this phase of the overall composting process is inadequately managed.

The Waste Hierarchy

The waste management hierarchy usefully defines relative preferences between options for managing wastes. In respect to organic waste, it has in the past at least, clearly identified composting as a more beneficial reuse than energy recovery.

Assigning a 'greater best use' value to composting recognises that it allows for the safe reuse of organic waste and acknowledges that compost provides a number of additional advantages that are associated with its contribution to increased soil quality and performance that increases to soil organic matter bring about.

More recently, the 'Strategic Directions for Waste Management in Western Australia (August 2003) described the hierarchy as Avoid, Minimise, Recycle, Treat and Dispose (Figure 3). The text clearly stated that composting, but not energy recovery is considered to be recycling.

It is acknowledged that the term Treat(ment) covers the entire waste stream. However when discussing the waste hierarchy in relation to organic materials, it would be preferable to use the term 'Energy Recovery' instead of 'Treat' (Figure 4) because of the possibility that composting could be regarded as a treatment. Any concern about the positioning of hybrid composting energy recovery systems would be better served by this approach as well as it is clearly positioned between the two options.

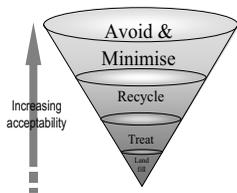


Figure 3. Current hierarchy -Strategic Directions for Waste Management in WA' 2003.

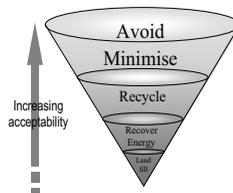


Figure 4. Preferred hierarchy - includes energy recovery.

This approach will better support the development of composting and other equivalent processes as the preferred methods for managing organic wastes

Policy, regulation and standards

Diversion of wastes from landfill commenced some time ago and although agriculture was identified as a potential market for the significant organic component of the waste stream from the outset, strategically focussed efforts to develop this market have only just began.

In July 2004, the National Compost Roadmap Project, funded by the composting industry along with Federal and State Governments, commenced to primarily develop the agricultural market for Compost. One of the preliminary findings by the consultants running the project has been that while there are a range of government policies, strategies and regulations in place to direct organic diversion from landfill, there are few if any in place to drive the marketing of Recycled Organic and principally compost products.

We LACK policy and regulation to drive marketing of compost and Recycled Organics!

There is also national interest in regulating the application of compost, however without clear policy acknowledging the importance of recycling organic wastes back to agricultural and other land uses, the risk is that they will focus on managing risks rather than promoting benefits and therefore restrict this potentially significant market.

Because of the benefits of soil organic matter, policy and regulations that assist the safe recycling of organic wastes will benefit and protect our soil and water resources, community health, agricultural performance and biosecurity.

Policy and regulation is needed to:

- **Prioritise the safe recycling of organic waste to land; and**
- **Implement regulation to underpin the safe application of all organic materials to land.**

In Western Australia, the Minister for the Environment has initiated a working group to establish minimum standards for applying all organic materials and not just compost to land. This broad approach has been taken because manures, sludges and food waste all have significant potential to spread disease, pests and weeds and often contain high levels of heavy metals.

The uncontrolled distribution of 'raw' mulched plant material also contributes to the spread of

Unregulated distribution of 'raw' mulched plant material poses a biosecurity risk.

diseases, pests and weeds and presents an unacceptable risk to commercial agriculture. It should also be unacceptable to the community because this practice poses a significant risk to biosecurity when unavoidable delays between a biosecurity incursion and its detection result in its significant spread, as was the recent case in California with Sudden Oak Decline.

The composting process provides a mechanism for managing all of the risks associated with recycling organics because it is amongst the best and most adaptable technologies for pasteurising organic materials (Millar 2002). Further as composting usually involves blending a range of feedstocks, dilution can also be used to manage contaminant levels.

To date the compost industry has been well served by the Australian Standard for Compost, Soil Conditioners and Mulches (AS-4454). They define minimum processing requirements for pasteurisation and provide a range of minimum test values for compost and related products. It also defines procedures and protocols for their measurement that allow reliable comparison between test results. Through reference to the standards for the application of 'Biosolids' to land and to relevant Health Regulations provided under the Health Act. Compliance with these standards will enable the recycled organics industry to demonstrate compliance with community health and natural resource protection requirements.

Further, care must be taken to ensure that compliance with a minimum standard are not used to support the universal use of a compost product. This is an unrealistic expectation given the wide range of attributes necessary to determine suitability for the almost infinite range of possible uses. This can be the case with the Australian Standard (AS-4454) because compliance tends to be used to imply suitability for all agricultural uses. This is not an appropriate use of these standards and these problems are in the authors view

Compliance with minimum standards MUST NOT be interpreted as implying specific quality attributes and therefore a products suitability for specific use(s).

Regulation should ONLY be used to implement compliance with minimum standards that protect health and natural resource quality.

Quality above these minimum standards MUST be left to voluntary processes!

exacerbated because the focus of this standard is directed to the nursery and urban landscaping market use of potting mixes and soil conditioners. For this reason the Californian approach of compliance with minimum standards accompanied by a voluntary process of disclosure is preferred.

The use of standards or other regulatory devices to manage quality, over and above minimum health and resource quality protection, cannot be supported. The Californian Compost Quality Council investigated the establishment of minimum quality product standards without success (Paulin 2002 Report).

This was largely because of the difficulty in defining a limited number of product categories for which practical minimum standards could be described. Ultimately they resolved to leave compost quality management to industry.

The implementation of minimum standards for application of organic materials to land in Western Australia could be modelled on the Californian approach. They require licensed compost producers to demonstrate compliance with minimum standards, usually via independently audited Quality Management programs.

The Council had subsequently developed a voluntary process of disclosure. This requires participating members to provide customers with a minimum set of product specifications that can be used to assess a product's suitability or 'fitness for purpose' for a given use.

They have also invested in education processes to better inform the market on how to select products for specific needs.

Carbon/greenhouse gas emissions and renewable energy credits are being implemented internationally for the production of energy from renewable resources that include organic wastes. They provide economic incentive to the renewable energy industry that predominantly, are not available to composting and preferred processes that will recycle organic wastes back to the land.

Carbon credits can be applied to the use of compost; however the accounting system is not well suited to most composting operations. Also they do not account for the range of additional environmental benefits associated with long term improvements to soil quality that can be attributed to compost use. A system of environmental credits is therefore needed to provide additional financial incentives to assist the beneficial recycling of organic wastes back to the land.

Cost is a major issue for recycling organic wastes and the situation will be exacerbated by the proposed implementation of minimum standards that will impose at least minimum processing requirements on recycling all organic materials.

This inequity needs to be challenged on the basis that recycling organic wastes provide greater benefits than energy recovery because when they are applied to the land:

- Some of the carbon will be retained as soil organic matter and will directly contribute to reducing atmospheric carbon dioxide levels; and
- Organic matter provides numerous benefits to soil quality, agricultural productivity and will contribute additional environmental benefit by improving the quality of both our water and air.

The major driver for the diversion of organic wastes from landfill has been its contributions to greenhouse emissions and groundwater contamination. Diverted organic materials are accumulating as diversion continues to increase, readily accessible urban markets for recycled organic wastes are becoming saturated and the slow agricultural market development continues. This is increasing the risk that significant quantities of organic wastes will be diverted to energy recovery and it needs to be accepted that once the necessary capital investments have been put in place, this process will not be easily reversed.

Source separation and issues for Mixed Waste Composting

Composting Municipal Solid Waste (MSW) is being increasingly considered as a means of achieving greater recovery from this waste stream that typically contains more than 70% by weight of compostable organic material.

Concerns include:

- Contaminant levels associated with metal, chemicals, biotoxins, possibly unknown substances and inert materials.
- Likelihood that capital investment required by MSW composting facilities will reduce further investment in source separation of organic wastes.
- Likelihood of greater disruption when a significant contaminant enters the waste stream. This has been illustrated by recent herbicide (clopyralid) contaminant in the United States and New Zealand. Because the lawn clipping source of this contaminant could not be readily removed, several MSW plants were closed down in the United States; and
- Potential environmental concerns associated with the impacts of the 'in vessel' composting process on some relatively inert contaminants such as plastic film and polystyrene (H. Hoitink, personal communication).

MSW compost quality concerns based on US and European experience may not be relevant in Western Australia because of lower heavy metal levels and improved technology for dealing with contaminants such as glass.

Some of these concerns have been discussed in a report from the New York Environmental Institute, October 1991 'Garbage in / Garbage out? A hard look at Municipal Solid Waste Composting'. These concerns are increased by the history of MSW composting in the USA and Europe that has seen its importance significantly decline. In Western Australia however, it is

argued that improved processing technology and better separation of urban from industrial wastes result in lower contaminant levels.

The debate on the merits of source separated waste stream composting also relate to its management. Blending feedstock allows flexibility in managing C:N ratio and the texture or porosity of the composting mass. This can have quality implications by allowing better process management. These considerations are particularly important in conventional windrow and static pile systems where either mechanical agitation or forced aeration is needed to manage the decomposition process.

Compost from source separated waste streams allows contaminant levels, such as heavy metals, to be adjusted by varying quantities of different feedstock.

Source separated organics also provide an opportunity to blend materials and to manage unacceptable contaminant levels that may be present in some feedstock's or components of waste streams.

Building linkages between agriculture and the community

A recent resolution by the Soil Science Society of America advocating global enhancement of soil organic matter highlights growing international recognition for the value of soil organic matter, and therefore the benefits of reusing organic waste in agriculture to manage and enhance soil organic matter. The resolution put up for international adoption, stated:

“We resolve that organic matter is a resource that must be restored and increased globally to reduce the net rate of increase in greenhouse gases, to increase plant productivity and improve environmental quality”. *Global climate change, food security and environmental quality are interrelated issues of importance to all Nations and our Planet, and these can be favourably and simultaneously addressed by global enhancement of soil organic matter.*

The significance of managing soils, and particularly the potential to use composted organic waste, is also being addressed by the European Union through development of a comprehensive policy to protect soil. EU-25, the Thematic Soil Strategy for 'Organic matter and compost quality in the future', brings together the findings of five interdisciplinary working groups. In summarising their work it emphasises the inherent link between soil quality and the use of composted exogenous organic matter.

Recognition of the strategic importance of agricultural land in the planning process resulted in the recent establishment of a Statement of Planning Policy for Productive Agricultural Land (SPP 2.5) in Western Australia. However despite this initiative, managing the continued urbanisation of rural (Peri urban) areas around the city has not been successful, largely because of the paradigm that favours urban development over the need to retain rural areas and associated agricultural activities.

Land use planning of rural areas needs to recognise the potentially important linkages that exist between rural and urban development. These linkages relate to:

- Agriculture's contribution to zero waste objectives through its potential to beneficially reuse the major, 50 to 60% organic component of the waste stream.
- Recognition that vegetable production and other irrigated horticultural activities are major potential users of reclaimed water. Justifying the capital investment for this to occur will probably require the establishment and retention of permanent agricultural zones or precincts, close to urban centres.
- Agriculture's reuse of organic waste will reduce the potential negative impacts of these industries on soil and groundwater quality. This outcome will be of immediate importance to the establishment of precincts for long term intensive horticultural production.
- Growing recognition for the potential for locally produced fresh food to contribute to reducing spiralling health cost. Fresh food quality and benefit is maximised and the energy costs associated with its production minimised when reliance on transport and storage is minimised; and
- Contribution to employment, tourism and agri-business opportunity and to the diversity of social and community values associated with rural landscapes in the peri urban environment. These values are already recognised in planning policy for the Swan Valley and are being developed in conjunction with the North Wanneroo 'Rural Way' process.

The current situation, and the failure to effectively address it, is common to urban development areas throughout Australia and most of the Western World.

Conclusions

Conclusions and recommendations are presented under the following headings:

- Market development
- Quality – including terminology and feedstock management
- Policy, Regulation and Standards
- Land use planning

Market development

The development of appropriate policy and regulation that is dealt with separately in a following section is arguably the most important component in the rapid development of the agricultural market for Recycled Organic Products. This aside, the immediate improvement to returns from using compost, information and production system changes that maximise the benefits of compost use will be needed.

Market development requires:

- Policy and regulation.
- Improved returns.
- Information.

Improving returns: In addition to policy and regulations, developing the agricultural market for compost will require a concerted effort to improve grower returns in the short term and to build confidence in its long term value through the development of improved production systems.

Key to this will be to increase their competitiveness with a range of existing organic 'waste' products including manures, biosolids and 'raw' shredded green waste. These products have few if any processing costs or as in the case of biosolids, are heavily subsidised. In addition to strategies discussed under policy and regulations, approaches include:

- Redirecting a proportion of current landfill levies to provide a rebate on the use of Recycled Organic Products, possibly within targeted market sectors. This approach would better drive the compost consumption than the current use of levy funds that tend to encourage processing without a well defined 'market development focus.
- Adjusting the balance of costs between waste producer and the product user. Reductions in compost cost need to be achieved through the application of 'extended producer responsibility' (EPR) principals that shift the balance of costs to the waste generators rather than by reducing the returns to the compost industry; and
- Increasing the landfill levy; the current level of the \$3 per tonne of putrescible waste landfilled is insufficient to provide a real disincentive to landfill disposal. Increasing the landfill levy on putrescible wastes will increase 'gate fee' revenue to the Recycled organics Industry and will contribute to making products more competitive.

Improving returns:

- Rebates on use.
- Application of EPR principals.
- Increasing landfill levy.

It can be argued that current applications of the levy are providing disincentives and barriers to the continued development of the existing composting industry by encouraging the production of minimum cost and 'minimum' quality products. Whilst there are always going to be low grade products on the market, an increase in the landfill levy and use of levy funds to provide rebates on compost use will provide significant change.

Information and production systems: Market development will be assisted by products and information packages that enable growers to adjust their practices associated with compost use, with minimal disruption to tight and often complex cropping schedules. These products should also be capable of assisting on going improvement to their overall management practices.

They would include electronic packages that can adjust fertiliser and irrigation management to accommodate changing soil fertility and performance associated with compost use. The packages would address specific cropping situations, be able to interpret soil analysis results, adjust fertiliser and irrigation programs to match identified best nutrient management practice and incorporate capacity to quantify changes to costs and estimate changes to returns. Ultimately these packages could also assist with pesticide use and the development of integrated programs for managing disease, pests and weeds.

Growers, particularly in the intensively managed horticultural industries, are under increasing pressure to reduce potential adverse impacts of their management on soil and water resources. Assisting growers to build better overall management programs will be critically important to this. The development of better management systems will inevitably increase grower recognition for the importance of improving soil performance and consequently the importance of compost through its role in building soil organic matter levels.

Quality

Compost quality and hence maturity is related to its intended use and is a major consideration for market development. Measuring compost maturity is a complex issue and investigating the application of the Californian Compost Maturity Index under local conditions could also make an important contribution to agricultural compost market development. Quantifying compost maturity will enable better process control and should result in more consistent compost quality, allowing growers to more regularly achieve maximum benefit from its use.

Compost quality is complex and related to maturity.

Encourage voluntary disclosure of product quality within Industry marketing management programs.

A voluntary process of disclosure providing information that enables end users to make an informed choice between composted products (modelled on the Californian example) will also assist market development.

Terminology: The definition of compost and the terminology associated with compost quality needs to be clarified and widely promoted. It is suggested that any definition of compost includes reference to its stability (Figure 1) and that compost quality will be related to its level of maturation. Compost maturity reflects the level of further composting, once stability is achieved, and significantly influences its best use.

Feedstock management: The use of source separated feedstocks is likely to maximise quality, particularly in the more challenging markets such as vegetable production. This is because it maximises the potential for blending feedstocks to achieve required nutrient characteristics, microbial diversity and other aspects of compost quality.

If a contaminant enters the waste stream, source separation can also minimise disruption to compost production because its removal will be restricted to certain waste streams and therefore unlikely to shut down the entire composting process. Better resource recovery will also be possible because source separation reduces the potential for cross contamination of waste stream components.

MSW composting provides a mechanism for reusing a significant component of our waste streams that are currently being lost to landfill disposal. New technologies to manage physical contaminants will continue to emerge and support for MSW composting should continue providing:

- Efforts to increase source separation are not reduced.
- Minimum safety standards for protecting the soil and water resources as well as human and crop health are met; and
- They compete with conventional compost production on the basis of performance rather than cost.

Source separation of wastes can increase compost quality and enhance perceptions of the composting industry by:

- Increasing process management options.
- Minimising nutrient/heavy metal content problems.
- Minimising potential disruption by more effectively excluding contaminants.
- Maximising resource recovery; and
- Increasing marketability of products.

A challenge lies in ensuring that products of a lower grade are not seen as substitutes for higher grade products in a compost market that is still in its early stages of development. Therefore opportunity to create a market distinction that differentiates between products that meet the minimum requirements of AS4454-2003, need to be considered. This could involve embedding the 'disclosure' approach with an industry managed quality management 'Seal of Approval' program for which a number of models exist.

Contaminant management: In the interest of improving compost from both MSW and source separated feedstock, efforts should also be supported to remove contaminants from the organic waste stream that potentially reduce compost quality. In addition to household chemicals and other biologically toxic substances and chemicals, consideration also needs to be directed at other relatively inert contaminants and in particular, plastic films and bags.

Legislation to make the use of compostable plastic in the manufacture of shopping bags and possibly other products compulsory, will improve compost quality and have minimal cost effect to the community.

Replacing plastic 'shopping bags' with biodegradable bags made from 'compostable' Polycarbonate plastics derived from starch and cellulose rather than hydrocarbons from the petroleum industry would significantly improve the quality of most composts. The use of biodegradable plastic film/bags and potentially other plastic products will be more expensive. Their introduction therefore needs to be managed in conjunction with regulatory compliance rather than through voluntary process in order to ensure that additional costs are applied equally to all parties. This approach is likely to significantly benefit the composting of food wastes that invariably have high levels of plastic contamination.

Efforts are needed to minimise the potential for unexpected contaminants to disrupt all components of the Recycled Organics Industry. Recent issues, principally in the USA and New Zealand, with herbicide (clopyralid) highlight this potential risk. Approaches to registration authorities such as the National Pesticide Registration Authority are therefore needed to ensure that future pesticide and other chemical products are tested for their biodegradability within aerobic composting processes.

Policy, Regulations and Standards

The reality is that without appropriate policy and the consistent application of regulations, the development of agriculture as a market for compost, at least in the short to medium term, will be limited.

Organic policy: Debate on the interpretation of the 'Waste hierarchy' highlights the need for policy that acknowledge the importance of soil organic matter conservation and the potential for organic wastes to contribute to soil organic matter management. This policy will underpin the waste hierarchy and the importance of recycling organic wastes over energy recovery from organic waste. It would not rule out energy recovery but would clearly direct it to handling components of the organic waste stream that cannot be processed by the Recycled Organics Industry.

Policy is needed to recognise the importance of soil organic matter and the potential for recycling organic wastes to contribute to its management.

Establishing this policy will also be in line with declarations by the American Society for Soil Science and the European Union directive EU-25 relating to soil protection. Both recognise the contribution that land application of organic wastes will make to the long term sustainability of agriculture, to society and to environmental health.

The reuse of organic wastes is a mechanism for building soil carbon that has significant benefit for developing more sustainable crop production as well as sustainable communities.

This policy approach is in general agreement with the Sustainability Guide and Industry Code of Practice developed by the Waste Management Association of Australia (WMAA) Energy from Waste Division.

A system of 'environmental credits is urgently needed to support the preferred strategy of recycling organic wastes to land.

Environmental credits: At present, the renewable energy and carbon credit processes support the development of the Renewable Energy Industry and the importance of this is acknowledged. However given the potential for energy recovery to compete with recycling of organic wastes and limitations for developing markets for recycled products, priority should be given

to developing a parallel incentive system for recycling organic wastes that is at least the equivalent of renewable energy credits.

Regulating the Recycled Organics Industry: Imposing minimum quality standards for the application of all organic materials to the land will protect land and water resources, environmental and social values, and aid biosecurity. It will also provide a market that better allows compost and other recycled organic products to compete on the basis of performance rather than least cost as is currently the case with a range of organic materials.

Licensing the Recycled Organics Industry and requiring demonstration that all products meet minimum standards for application of organic materials to land will facilitate orderly industry development and protect community, industry and environmental standards.

Regulatory processes MUST not be used to manage compost quality. However, using regulations to impose minimum standards on the manufacture of composted products will make a significant contribution towards building market and community confidence in their use.

A model for implementing minimum standards for land application of organic materials could be the Californian approach that licenses compost producers and requires them to demonstrate compliance with a set of standards that protect health and natural resource quality.

Minimum standards are needed for the application of ALL recycled organic materials to land.

Processing more than 1000 tonnes per annum of organic wastes in Western Australia requires a license and compliance with proposed minimum standard could be made part of that license and or the license renewal process. An important element of this would be to implement a compliance auditing process.

These minimum standards for all recycled organic products, including manures, liquids and sludges including biosolids, grease and food waste, as well as shredded/ground plant material, could be based largely on existing standards and regulations that apply to various materials and industry sectors. The proposed minimum standards would ensure that Recycled Organic Products:

- Are adequately pasteurised to manage disease, pest and weeds and address biosecurity concerns – AS 4454.
- Comply with heavy metal standards – the Californian standards developed by the US Department of Agriculture should be considered.
- Comply with or develop standards for chemical, biotoxins and other contaminants based on risk assessment based on the use of Hazard Critical Control Point (HCCP) analysis.
- Comply with human health standards – Health Act.
- Address Occupational Health and Safety concerns associated with contaminants such as glass and possibly plastics.
- Comply with other appropriate regulations such as fly breeding regulations under the Health Act.

This approach will underwrite orderly market development for Recycled Organic Products and allowing different products to compete on the basis of performance rather than lowest cost.

The introduction of these proposed uniform quality standards will increase costs associated with managing manure wastes from the intensive animal industries in particular. Acknowledging that most of these industries will have limited capacity to absorb these added costs, considerations will need to be given to managing their introduction and allowing them to adjust. Support mechanisms such as the proposed 'Environmental credits' would assist.

Consideration should also be given to allowing the reuse of organic wastes that are generated and reused on the same site without the application of the proposed minimum standards. The definition of same site would need to be accurately defined and the reapplication would need to be within the environmental receiving capacity of the site. This would assist industries such as Agro Forestry where current practice is to reuse harvesting wastes for the next on site tree crop.

Finally an important consideration in establishing minimum application levels will be to minimise requirements for management plans and to ensure that the compliant recycled organic products (compost) are subjected to exactly the same requirements as other agricultural inputs. In sensitive areas, they would be included when the preparation of nutrient and irrigation management plans is required.

Supporting compost/product quality: Acknowledging the considerations by the Californian Compost Quality Council outlined earlier, the development of quality standards to aid 'best use' determination for recycled organic products, will be best managed by

Quality MUST not be regulated.

the composting industry. These could include the use of the Californian 'minimum disclosure' approach in which participants agree to provide a minimum level of product information to their customers.

In California, 'Product disclosure' provides information for determining the fitness of a product for a given purpose, enabling more informed product choice!

Industry organisations such as the recently established Recycled Organics Western Australia (ROWA) group, a sub group of the Waste Management Association of Australia, could play a significant role in developing this process and could possibly develop 'Fit for purpose' compost specifications that could underpin the development of a minimum disclosure process.

These fit for purpose specifications could also be incorporated into the Australian Standards, AS 4454.

Approval process for Recycled Organic Businesses establishment: There is a need to reduce the time and costs associated with establishing a Recycled Organics Business. Difficulties are associated with significant up front capital investment, annual licence renewal, and general community resistance based on the 'Not in my back yard' approach. Costs and delays are exacerbated by elements of the process being managed by the Department of Environment and the Department of Planning. The approval process will be assisted by:

- Deferring capital requirements that generally involve establishment of extensive hard stands and capacity to store run off from a 100 year rainfall events, and making them a requirements of future licence renewal.
- Extending the license renewal cycles based on the level of capital investment involved and the need to recover those costs.
- Manage community resistance by facilitating early communication between neighbouring land holders, community groups, government and the proponent.
- Coordinating the requirements of planning and environmental licensing processes.

Land use planning

Land use planning policy needs to be further strengthened to manage the continued urbanisation of rural areas and the associated productive agricultural land.

There is also growing recognition of the strategic importance of rural land and the associated activities to urban communities. A key element of this includes recognition is that vegetable production as well as other intensive horticultural industries are ideally located to utilise both organic wastes and reclaimed water from urban development.

Further opportunity to strengthening the implementation of the Statement of Planning Policy (SPP 2.5) for 'Productive Agricultural Land' to protect productive agricultural land should also arise from promoting recognition of their importance in:

- Providing local fresh food - imported food can not adequately meet requirements for food quality, safety and security of supply.

- Underpinning rural economy, better managing soil and water quality through the use of composted wastes; and facilitating the retention of environmental, ecological and social diversity associated with rural landscapes; and
- Servicing urban community by providing additional employment, business opportunity including tourism, and greater social diversity, in addition to managing their wastes.

The problems with the current failure to prevent this include:

- The use of compost and associated changes to management practices represent a relatively long term investment for farmers. The transitory nature of intensive horticultural industries that are strategically located to utilise compost and reclaimed water generated by urban populations is therefore a significant disincentive.
- The availability of land that has the same combination of resources (soil, water and climate) becomes increasingly limited. This reduces both the range of crops that can be grown and the season in which they can be produced, further restricting options for maintaining economic viability.
- The costs of organic recycling increases because of greater transport costs and in the case of the reuse of reclaimed water for irrigated crop production, significant costs for relocating infrastructure.
- Reduced opportunity for increasing proportions of urban communities to interact with rural community values and services; and
- Continued decline in the extent and range of natural ecosystems that will be better supported when there are viable agricultural and associated rural based industries available to support local rural economies.

The dominance of urban planning over rural is driven by short term economic considerations that benefit the property development industry; as well as rural landholders who are provided with a capital return that either funds retirement or expansion. It does not consider triple bottom line considerations that reflect the wider values associated with the above listed.

Because under the present situation, land values in rural areas reflect their potential for urbanisation, expansion by purchasing neighbouring property is not viable in most situations. Consequently, expansion has to be accomplished by selling out to urban development and moving further ahead of the advancing urban boundary to purchase and develop larger properties. Around the metropolitan Perth boundary, this cycle has been repeating every 10 to 15 years.

Recommendations

Recommendations presented include comment on any current progress and key steps needed.

1. Market development

Investigate ways to improve grower returns from using compost.

RECOMMENDATION 1.1 – Utilise some of the land fill levy funds to provide a rebate incentive for compost use in prescribed/approved situations.

Landfill levies could in part be redirected to provide a rebate for a period of time in selected compost markets.

RECOMMENDATION 1.2 – Reduce the final cost of composted products in the market place by:

- Increasing landfill levy on putrescible wastes and hence the related costs of alternative disposal to the organic recycling industry.
- Increasing contributions from generators of organic wastes relative to 'cost recovery' required by the Organic recycling industry.

This recommendation reflects the principals of 'Product Stewardship', 'User Pay's and EPR – 'Extended Producer Responsibility'.

RECOMMENDATION 1.3 – Develop information and electronic management packages that enable growers to adjust their practices to utilise compost with minimal disruption to their management.

Recommendations to directly influence agricultural use of compost include:

The development of packages to facilitate grower use of compost could be funded by stakeholders and is likely to be identified in the outcomes of the current 'Compost Roadmap Process'.

RECOMMENDATION 1.4 – At a national level, develop improved production systems that focus on managing soil carbon (Soil Organic Matter) and the development of 'best practice, 'Triple Bottom Line' sustainability for industries identified as key markets for recycled organic products.

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This acknowledges the need to satisfy growing global requirements for 'clean, green and safe food production, and their potential to contribute to sustainable organic waste recycling.

This recommendation has been put forward for consideration by the Roadmap Project and would include the development of management packages, Recommendation 1.4.

2. Quality

The development of the compost market will be assisted by the development of reliable measures for compost quality/maturity.

RECOMMENDATION 2.1 – Support the development of cost-effective compost maturity standards that are appropriate to local and national conditions.

The development of a cost-effective compost maturity index could be included within research and development outcomes from the current 'Compost Roadmap Process'.

Suggested changes to selected definitions in the ROU Recycled Organics Dictionary are provided in the appendices to this discussion paper.

RECOMMENDATION 2.2 – Develop an agreed consistent terminology to describe compost production and quality as outlined in Figure 1.

Recommendations to this effect, developed through the Compost Roadmap process, rather than submitted by individual state registration committees and groups, could simplify the process of getting this dealt with as a national imperative.

RECOMMENDATION 2.3 – Influence National Pesticide Registration processes to ensure that all new chemicals are tested for their biodegradability within aerobic composting processes.

Recent herbicide (clopyralid) contamination highlights the potential for chemicals to significantly disrupt compost production and marketing.

Recommendations to this effect, developed through the Compost Roadmap process, rather than submitted by individual state registration committees and groups, could simplify the process of getting this dealt with as a national imperative.

RECOMMENDATION 2.4 – Provide policy and resources to support the collection of source separated organic wastes and the removal of contaminants that impact on compost quality.

3. Policy and regulation

The strategic importance of the potential value of reusing organics to manage soil organic matter warrants support by appropriate policy.

RECOMMENDATION 3.1 – Promote policy that:

- States the importance of Soil Organic Matter and the potential role of recycled organics in its management and conservation.
- Prioritises safe recycling of organic wastes through their land application and principally to agriculture;
- Supports recycling organic wastes above energy recovery.

ROWA could seek support of the Department of Agriculture in promoting the development of policy for the protection and enhancement of soil organic matter within the Environmental Protection Act.

RECOMMENDATION 3.2 – Develop 'Minimum Standards' for land application of all organic materials that manage:

- disease, pest and weed contaminants, including associated biosecurity risks, as set out in AS 4454;
- health concerns in line with Public Health requirements, including fly breeding;
- contaminant levels that include heavy metals/nutrients, chemicals and biotoxins, and when there are Occupational Health and Safety concerns, inert materials.

Note: *Consideration MUST be given to exempting organic wastes that are generated and that can be safely reused on site.*

Implement regulation and appropriate compliance to implement minimum standards for the safe application of ALL organic materials to land.

Minimising the associated cost and restrictions on the development of organic recycling industry needs careful consideration and management. The application of the HACCP approach should help to ensure that sectors of the industry are not unfairly burdened.

The Organics Standards Working Group is currently addressing the need to create uniform conditions for the land application of all organic materials on behalf of the Waste Management Board and the Minister for the Environment and Science.

RECOMMENDATION 3.3 – Promote planning approval process for Recycled Organic Industry development that supports process development sites by:

- facilitating up-front community consultation between all stakeholders, including community, government and industry and to minimise planning delays when rezoning processes are involved;
- using license renewal process to defer the implementation of significant capital requirements including hard stands and leachate storage over a period of several years;
- extending the license renewal process significantly beyond the current annual requirement.

Coordinating the requirements of the approval process for Recycled Organic processing facilities could be undertaken by ROWA/WMAA.

RECOMMENDATION 3.4 – Support and encourage the development of compost quality management and processes such as disclosure of appropriate information for determining best use of a product.

Promote compost quality through voluntary programs rather than by regulation.

Voluntary disclosure of information to allow 'best use' of a product to be more readily determined could be supported with disclosure guidelines for major compost product categories within AS 4454.

RECOMMENDATION 3.5 – Promote provision of 'Carbon Credits' and or 'Environmental credits' for appropriate recycling of organic wastes through the Department of Premier and Cabinets 'Greenhouse Unit'.

4. Land use planning

Support and strengthen the Statement of Planning Policy (SPP 2.5) for the 'Strategic importance of productive agricultural land' because of its importance for:

- Managing waste that includes waste (reclaimed) water reuse.
- Management of soil and water quality, and environmental values.
- Servicing urban community through greater employment, business opportunity including tourism and greater social diversity.
- Production of locally produced fresh, safe food that will have maximum benefit to community health.

RECOMMENDATION 4.1 – Promote development of rural 'zoning' policy that allows land values to reflect their use for rural/agricultural purpose rather than potential urban values.

The strategic importance of retaining productive agricultural land should be promoted to the community, to the Department of Planning and Infrastructure, and to the Departments of the Environment and Agriculture by the Waste Management Board.