A PRACTICAL GUIDE TO ON-FARM CO-COMPOSTING

AG WISE

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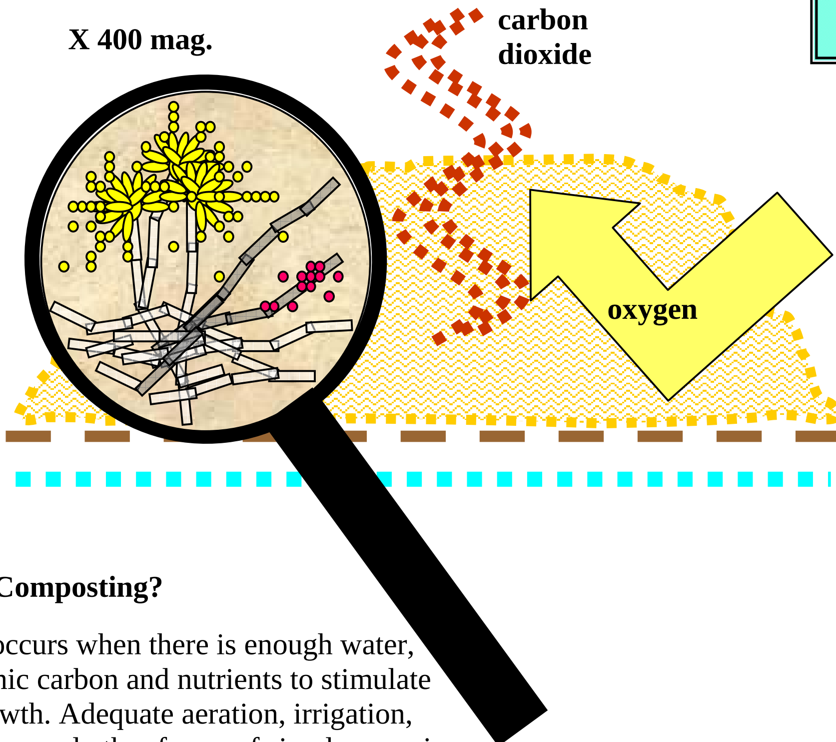

What Is Co-Composting?

Composting occurs when there is enough water, oxygen, organic carbon and nutrients to stimulate microbial growth. Adequate aeration, irrigation, available sugars and other forms of simple organic carbon are needed to stimulate this process. In practice not all materials are immediately suitable, so other ingredients must be added (**co-composting**).

What Are The Advantages Of Co-Composting?

Surplus organic materials such as manure from intensive animal industries, and straw or other residues from harvested crops are commonly used for co-composting. Manure may be applied direct to land as a fertiliser, but its physical consistency makes spreading inaccurate. Mineral fertilisers are prepared in the ratio of N:P:K that plants require, but in most manures there may be twice as much P or K above that needed. As a result, if manures are applied on the basis of their N content, the risk of these other nutrients ending up in local waterways is increased. **Co-composting** matches the microbial demand for organic carbon and nutrients in the compost mix, locking up the nutrients in the microbial bodies. The composted product can be applied to soil more accurately, and the nutrients become available for crop growth over time (**slow-release**). Unlike mineral fertilisers, the addition of compost increases the organic matter content of the soil, and the **slow-release** nature of the product minimises the risk of nutrient losses to waterways. Heat generated during composting also kills weed seeds and pathogens, improving **farm hygiene** if materials are brought in from other properties.

Matching Ingredients For Co-Composting

On dairy farms manure stockpiled from feeding pads and the milking shed can be mixed with feed refusals, spoilt silage and/or straw. The high organic carbon content of the straw offsets the high nutrient content (NPK) of the manure (see **Table 1** below). The organic carbon in silage (see lucerne/grass clippings equivalents in the table) is readily available for microbes, with the tougher **lignin** fraction in straw (or corn stalks) increasing the **humus** content and the **slow-release** potential of the finished compost. In Queensland cattle feedlots are the best source of bulk manure, however larger piggeries which screen manure prior to treatment in anaerobic ponds may also be a potentially useful source.

Ecoshelter piggeries and poultry sheds where sawdust or straw is used for bedding, have the advantage of a lower **water content** and a lower **bulk density** in the material at source. A lower initial water content makes the material easier to cart and to mix, whilst a lower **bulk density** is critical if adequate aeration is to occur. **Bulk density** is a measure of the weight per unit volume of a substance (kg/m^3 in **Table 1**). Materials with a **high bulk density** (such as manure in the table below) typically have very few air spaces, with most of the fine pores filled with water. Under these conditions bacteria which grow in the absence of oxygen will predominate, producing methane (associated with spontaneous combustion) and other foul-smelling gasses. Mixing manure with materials with a **low bulk density** (bulking materials) improves air exchange, minimising the need for artificial aeration (typically achieved by **turning the pile**).

Sawdust is a valued ingredient in composts not only because of its **low bulk density** and high **lignin** content, but also because the chemical products of decomposition are known to suppress the activity of plant pathogens. Bark tends to have higher levels of these compounds, and for this reason is often the ingredient of choice in plant nursery potting composts.

Material (fresh)	**C:N ratio**	**%N**	**%P**	**%K**	**% lignin**	**Bulk density**	**%water per wt**
dairy manure	11-18	2.7-4	0.5	1.7-2.4	8.1	460-582	67-87
feedlot manure	6-14	1.7-4	0.5-1.0	1.8-2.3	8.1	460-582	67-87
pig manure	7-24	1.9-5.6	0.4-1.2	0.1-4.8	2.2	272	65-91
pig litter		0.3-1.0	0.05-0.6	0.2-0.7			54-98
poultry m’ure	2-24	1.6-10	1.1-2.3	1.7-2.2	3.4	263-563	22-75
abattoir waste	14-17	8-11	3.0-3.5	2.0-2.5		507	80-85
grass clippings	9-25	2-6	1.1	2.0	2-7	104-278	82
fresh lucerne	16-20	2.4-3			5.3		8-10
grain dust	23-33	1.6-2.1			2-5		8-10
cotton trash	30	1.3	0.45	0.36	15	112	
peanut shells		0.8	0.15	0.5	23		
corn stalks	60-73	0.8		0.8	11	11	12
wheat straw	100-150	0.3-0.5	0.15-.26	0.6-1.02	7-18	20-131	4-12
rice hulls	113-1120	0-0.4					7-14
coconut fibre	100-920	0.1-0.5				66	83
sawdust	200-511	0.1	0.01-0.5	0.04-1.4	15-28	122-156	19-65
newsprint	398-852	0.06-.14			22	68-84	3-8

Table 1: Chemical characteristics of materials suitable for co-composting. Bulk density units are kg/m^3

Managing The Composting Process

Constructing the windrow:-

Windrow composting is the least capital-intensive method, requiring a front-end loader or bobcat for turning the pile. You will need to construct a compacted **earthen pad**, with **bunding** and a **spoon drain** to divert overland flow away from the composting site. Any water leaching from the pile should be contained in a **sediment pond**.

The selection of compatible ingredients for co-composting is essential to achieve both good aeration and good water retention in the pile. Experiment with mixing small volumes of selected ingredients in a bucket, until the mix resembles a good **seed bed tilth**. Record the volumetric ratio used to achieve this mix (eg 1 part wheat straw to one part manure). Layer a windrow pile in alternating portions of the ingredients (ie layer 2 buckets of trash with one bucket of manure on top). Construct a pile about **1.5 m high, 3-4 m wide at the base and 1-1.5 m wide at the top**. Leave enough space in between piles for turning. Turn the pile once before watering, to mix the ingredients.

Watering and turning the pile:-

The compost pile should only be watered to **field capacity** and no further. Additional water will puddle at the base of the pile, causing foul odours and the loss of nutrients in the leachate. An estimate of the **field capacity** of the mix can be obtained by following the instructions in the appendix (Automating the composting process). Watering can be achieved by placing a soaker hose with holes face-down along the top of the pile. Time the watering at one hour intervals, to estimate the time required for the centre of the pile to reach field capacity. Alternatively low pressure, pressure-compensating microjets with an in-line filter can be used, set at 1-2 m centres along the top of the pile. Watering will be more uniform with this system, and can be calibrated for more accurate watering (see appendix).

After watering the centre of the pile should heat up, to between 50 and 65 ^{0}C. If readily available organic carbon compounds are present, this rise in temperature will occur within a day or so (provided there is sufficient water available). If the bulking material is high in **lignin** – with little readily available carbon (eg sawdust) then the temperature rise may take longer. Digging into the centre of the pile will indicate how hot it is becoming, or a long-stemmed thermometer could be used. If the pile becomes excessively hot (> 65 ^{0}C - bulk density too high, limiting aeration), beneficial microbes will be killed and spontaneous combustion may occur. If this occurs, reduce the height of the pile and turn the pile more often. Turning the pile during **the high temperature phase** will improve the chance of all portions of the compost pile passing through the heated central core, improving the **disinfection potential** of the process.

We recommend **a minimum of three turns**, at intervals within the first 6 weeks of composting. After six weeks, check if the core temperature of the pile returns to a high level after watering, and **turn at leat another two times**. A high temperature response after watering indicates that composting is still active, with organic carbon still fuelling microbial growth. The point at which the **temperature no longer rises**, is when the compost is approaching '**maturity**'. Once this point has been reached, no further watering is necessary. 'Rest' the pile for a minimum of 4 weeks, to reduce the water content for ease of handling and storage (25-30% of wet weight, based on the minimum required to suppress dust).

Making The Most Of Compost Application To Soil

The **organic matter content** of composts improves soil physical and chemical properties, and can aid in suppressing the activity of soilborne plant pathogens. Therefore to make the most of the compost available, preferentially apply it to paddocks with a history of soil physical problems (eg sodic soil), or with a higher incidence of root disease.

Composts have a high proportion of nutrients in the organic (slow-release) state, so chemical analyses must specify both the **total** and the **mineral** (or **available**) content of the NPK present. Applying the compost on the basis of the **mineral** P and K content required for **early crop growth**, will maximise the use of the nutrients. Topping up with plant-available (mineral) N may be required in the short-term, but the N in the **organic** form will become available over time (**slow-release** refer 'can do' sheet n^{o} 5 on Doing your own field trials).

Subtracting the **mineral** from the **total** value indicates the **organic fraction.** The **rate of mineralisation** is determined by field conditions (temperature, water content, tillage) and the type of organic carbon present. Experience with feedlot manure composts in SE Qld. indicates that mineralisation may not occur for up to 18 months after the initial soil application. Currently the only way to monitor the change in the availability (**mineralisation**) of these nutrients over time is through **soil tests**. Test results should be used to determine repeat application rates and adjustments to mineral fertiliser inputs for subsequent crops.

APPENDIX: AUTOMATING THE COMPOSTING PROCESS

Measuring field capacity using a microwave oven:-
Prepare by microwaving a disposable paper plate to remove any moisture. Weigh the plate and record the weight. Weigh out about 100 gm compost mix into a plastic sieve. Sit the sieve in 2 cm depth of water in a bucket until the mix is saturated. Place the sieve across the bucket to drain excess water. The point at which no further water drips from the sample, is **field capacity.** Add precisely 100 gm of this mix into a measuring jug, and gently hit the bench with the jug several times to settle the contents. Record the volume that this sample fills, and divide 100 by this figure to estimate the **bulk density**. (gm/L) **Place the contents of the jug (100 gm) onto the paper plate. Spread the mix over the surface of the plate, and microwave for 10 minutes, just below the maximum heat setting (8 if microwave 600 watts). Weigh the plate and compost and record. Repeat the heating until there is no further change in the weight recorded for the plate-compost sample. Subtract the original dry weight of the paper plate from the dry plate+compost. This is the **maximum** amount of water per gram of compost that you can water up to, with each irrigation. Multiply this figure by the bulk density to indicate the **volume** of water to be added to reach field capacity.

Calibrating microjets:-
Upturn one of the microjets into a 5L bucket. Time how long it takes to fill the bucket. Calculate how much water is sprayed per hour, per sprinkler (**rate**). Use the **area** that the microjet covers, and assume that capillary watering will follow a cylindrical pattern to the centre of the windrow, to estimate the **volume** that a microjet covers. Divide the **rate** of water flow by the **volume** of compost under a microjet, to estimate the irrigation rate per unit volume. Using the method above (from the asterisks**), sample 100gm of compost from the centre of the windrow under a microjet and determine the amount of water per gram. Subtract this value from the **field capacity** value, to indicate how much more water is required. Multiply by the **bulk density approximation** to indicate the additional **volume** required, and adjust the watering rate accordingly.

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