This initiative is supported by **PacWastePlus**-a 72 month project funded by the European Union (**EU**) and implemented by the Secretariat of the Pacific Regional Environment Programme (**SPREP**) **to sustainably and cost effectively improve regional management of waste and pollution.**

# Composting Common Organic Materials in the Pacific and Timor-Leste: Handbook for Compost Operators

**December 2022**

**This Handbook is part of a range of resources to assist Pacific Island Countries and Timor-Leste to divert organic materials from landfill into a beneficial use.**

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Our vision: A resilient Pacific environment sustaining our livelihoods and natural heritage in harmony with our cultures.

# PacWastePlus Programme

The Pacific – European Union (EU) Waste Management Programme, PacWastePlus, is a 72-month programme funded by the EU and implemented by the Secretariat of the Pacific Regional Environment Programme (SPREP) to improve regional management of waste and pollution sustainably and cost-effectively.

**About PacWastePlus**

The impact of waste and pollution is taking its toll on the health of communities, degrading natural ecosystems, threatening food security, impeding resilience to climate change, and adversely impacting social and economic development of countries in the region.

The PacWastePlus programme is generating improved economic, social, health, and environmental benefits by enhancing existing activities and building capacity and sustainability into waste management practices for all participating countries.

Countries participating in the PacWastePlus programme are: *Cook Islands, Democratic Republic of Timor-Leste, Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Republic of Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu*.

**Key Objectives**

**Outcomes & Key Result Areas**

The overall objective of PacWastePlus is "*to generate improved economic, social, health and environmental benefits arising from stronger regional economic integration and the sustainable management of natural resources and the environment*".

The specific objective is "*to ensure the safe and sustainable management of waste with due regard for the conservation of biodiversity, health and wellbeing of Pacific Island communities and climate change mitigation and adaptation requirements*".

**Key Result Areas**

- **Improved** data collection, information sharing, and education awareness
- **Policy & Regulation** - Policies and regulatory frameworks developed and implemented.
- **Best Practices** - Enhanced private sector engagement and infrastructure development implemented
- **Human Capacity** - Enhanced human capacity

**Learn more about the PacWastePlus programme by visiting**

EUROPEAN UNION

SPREP Secretariat of the Pacific Regional Environment Programme

PacWastePlus PACIFIC WASTE MANAGEMENT

**www.pacwasteplus.org**

# Our Regional Organics Project

Organic material is biodegradable matter such as kitchen scraps (*food*); garden cuttings, grass and branches; and paper. Combined data from 13 waste audits in the Pacific found that approximately 40% of waste disposal to our landfills and dumps is organics.

When processed correctly (*in an "aerobic" or oxygen-filled environment*), organic materials can produce valuable nutrient rich products, such as compost, suitable for soil enhancement and food cultivation. However, when intermingled with other waste and disposed in a landfill or dump (*an "anaerobic" environment*), organic material can release toxic leachate and generate methane gas.

The purpose of this regional project is for Pacific stakeholders, now and into the future, to have practical and resources and decision-support needed to design and implement their own effective organics management solutions, appropriate for their own context and communities. Fiji, FSM, RMI, and the Solomon Islands have chosen organics as a priority or secondary priority of their PacWastePlus country project.

The Organics regional project will review existing Organic facilities from the region, undertake technical research, and adopt findings and resources from Country Projects to develop:

- a "Minimum Standard" technical framework for countries to have as a resource when designing and operating their own organics processing facility
- a "decision guidance resource/tool" – to guide informed decision making around processing system design/technologies, size and equipment requirements, operational processes, etc to suit any context and scale
- on-line training package to guide the application of "decision guidance resource/tool"
- resources to communicate with and empower communities to convert their organic "waste" to a valuable "resource" using appropriate solutions available (*i.e., backyard, on-farm, community-level, or national-level organics processing*).

This **Composting Standard** is part of a range of resources to assist Pacific Island Countries and Timor-Leste to divert organic materials from landfill into a beneficial use.

Use this **Composting Handbook** in **combination with the other resources** to guide all aspect of organics management, from choosing the appropriate management solution for your compost, operating your facility, and complying with recognised standards.

**RELATED RESOURCES**

**Decision support tools** to support the selection of suitable organics management solution for the Pacific and Timor-Leste

A **series of Factsheets** introducing eight types of organics management solutions appropriate for the Pacific and Timor-Leste context

**Framework Operations Plans** and editable **Design Drawings** for eight organics management solutions

A **Composting Standard** providing minimum standards for accepting and processing organic inputs and the use of generated compost and digestate, specific for the Pacific and Timor-Leste context

**Learn more about our regional organics management programme by visiting**
**https://pacwasteplus.org/regional-project/organics-management/**

# Table of Contents

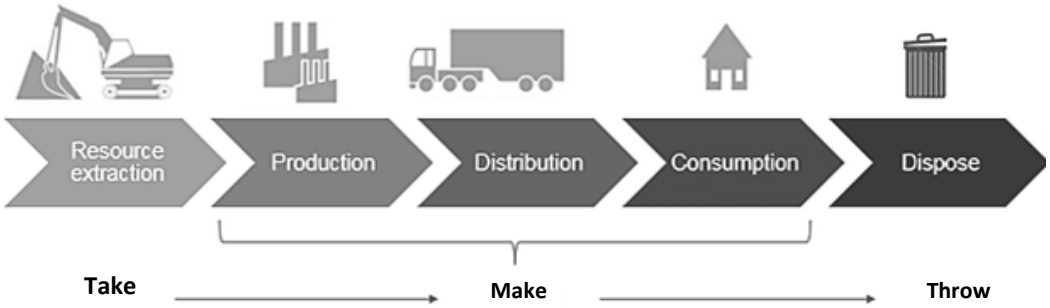
# Glossary

| Term | Description |
|---|---|
| **Aerobic process** | An aerobic process is a composting process with oxygen or air, as opposed to an anaerobic process that does not require it. |
| **Anaerobic process** | An anaerobic process is a composting process in which organic matter is degraded by micro-organisms in the absence of oxygen. |
| **Bacteria** | Bacteria are the smallest living organisms and the most numerous in compost; they make up 80 to 90% of the billions of microorganisms typically found in a gram of compost. Bacteria are responsible for most of the decomposition and heat generation in compost. They are the most nutritionally diverse group of compost organisms, using a broad range of enzymes to chemically break down a variety of organic materials. |
| **Bioaerosol** | Bacteria or fungi in drops of mist in the air. |
| **Carbon** | Carbon is an energy-element and is one of the basic building blocks of life. Plants are nearly half carbon. In composting, carbon provides an energy food that sustains the microbes. Some organic materials, like fallen palm fronds and flax/tree litter, dead clippings from yard/community beautification projects, and paper / cardboard, have a lot of carbon. |
| **Carbon to Nitrogen (C:N) ratio** | The proportion or ratio of the amount of carbon to the amount of nitrogen contained in organic materials. This ratio can be calculated for a mix of different materials to be composted.<br><br>Carbon is the main ingredient in organic material. It is used for energy and building bodies by all living things. Nitrogen is an important ingredient in organic material. Used for building amino acids in living things that are used as building blocks in bodies. |
| **Compost** | Organic material that has been broken down during composting and now looks and smells like dark, fertile garden soil. |
| **Composting** | Composting is a natural biochemical process in which naturally occurring microorganisms transform raw organic materials into compost products. Although these processes are natural and will happen on their own, compost facility operators are recommended to understand and control the process to provide ideal environmental conditions for bacteria, fungi, and other decomposing organisms. |
| **Composting facility** | Facility that accepts compostable material, and processes this into a recycled organic product (*compost*) through either aerobic or anaerobic processes. |
| **Compostable material** | Material that was once part of a living thing. Includes: clippings from yard/community beautification projects, fallen palm fronds and flax/tree litter, peelings and scraps from food preparation, by-product from food production facilities, manure, and paper / cardboard. Does not include petrochemicals. Has the same definition as organic material. |
| **Fungi** | A group of spore-producing organisms feeding on organic matter. Fungi include moulds, yeast, and mushrooms. Fungi are heterotrophs (*cannot make their own food*) and have important roles in nutrient cycling in an ecosystem. |

| Term | Description |
|---|---|
| **Food organics** | Residues from food, which can be from food preparation, such as fruit and vegetable peelings and trimmings, or leftover, unconsumed food. Spoiled food that is no longer fit for consumption.<br>**Note**: References to composting food organics in this FOP also apply generally to other inputs that are moist and high in nitrogen, such as animal manures. |
| **Front End Loader (FEL)** | Tractor with hydraulic bucket on the front that mechanically lifts and moves large quantities of material. General term that also covers bobcats and telehandlers. |
| **Garden organics** | Vegetation residues from gardens, parks, or landscape management. Can include grass clippings, leaves, weeds, crop residues, twigs, branches, vines, palm fronds, |
| **Leachate** | Liquid that seeps out of a compost pile. |
| **Microbes** | Tiny living organisms including bacteria and fungi which process organic materials into compost. |
| **Nitrogen** | Nitrogen is a protein-element essential for growth and reproduction in both plants and animals. In composting, microbes use nitrogen to grow and reproduce. Some organic materials, like fresh clippings from yard/community beautification projects, peelings and scraps from food preparation, and manure, have a lot of nitrogen. |
| **Organics / Organic Material** | Organics or Organic Material are materials that were once part of a living thing. Includes: clippings from yard/community beautification projects, fallen palm fronds and flax/tree litter, peelings and scraps from food preparation, by-product from food production facilities, manure, and paper / cardboard. Does not include petrochemicals. Has the same definition as compostable material. |
| **Odour** | Bad smells. In compost facilities they come from not enough oxygen, or too much nitrogen. |
| **Palm Organics** | Trunks and leaves (*fronds*) from palm trees and similar species. Contains tough fibres that can be hard to work with. |
| **Parasite** | A living thing that steals from another living thing to stay alive |
| **Pathogen** | A microorganism (*bacteria, fungi, virus*) that can cause disease or death in plants, animals, or humans. |
| **Physical contaminants** | Non-organic materials that cannot be composted, including all types of plastic, glass, metal, rubber, and stones. |
| **Shredder** | Machine designed to break up woody organic material into smaller pieces. While chippers produce a slightly different output a reference to a shredder in this FOP is also a reference to a chipper. |
| **Turning** | Mixing and fluffing up of composted material. Turning often involves moving of the material, (*e.g., from one composting bin to another, or from the centre of a composting pile to the outside*). |
| **Virus** | An ultramicroscopic, metabolically inert, infectious agent that replicates only within the cells of living hosts, mainly bacteria, plants, and animals. Many viruses cause diseases as part of their reproduction process. |
| **Windrow** | A long pile (*row*) of organic material undergoing the composting process |

# Introduction

Consumption patterns in the world today generally follow a linear "**buy, use, and throw**" model.




In the Pacific and Timor-Leste, this linear model is becoming more challenging as all "waste" items, including imported plastics, metals, and other material, along with locally grown food scraps and vegetation clippings from gardening and landscaping, are disposed into rapidly overflowing landfills and dumps, or burnt in backyard burn pits.

This "waste" when intermingled together in landfills and dumps decomposes "anaerobically" (*without oxygen*) – resulting in production of greenhouse gases and toxic leachate entering surrounding waterways.

When burnt, this "waste" can release dangerous carcinogens like dioxins and furans, contributing to climate change and affecting our health through the release of these Persistent Organic Pollutants.

**BUT WHAT IF** the largest component of the **"waste"** filling up Pacific and Timor-Leste landfills and burn-pits was **not a "waste" at all, it was a beneficial product that was good for soils and increase crop yields** with an easy ability to convert that "waste" into a valuable **resource** in our backyards, communities, and cities using **familiar and low-tech methods?**

**Strengthens Community Bond**
Physically connects people to each other and places they live

**Reduces Vehicle Emissions**
Cuts transportation distances between material generators & compost producers

**Improves Soil Quality**
Adds nutrients back into the soil that are essential for plant growth

**Supports Local Food Production**
Reduces reliance on buying harmful fertilizers and increases crop yield using organic products

**Builds Local Economy**
Keeps resources and money circulating within the local community

**Reduces Water & Pesticide Use**
Compost can hold an amount of water equal to 200% its dry weight

*It is true! The magic material is our* **everyday organics.**

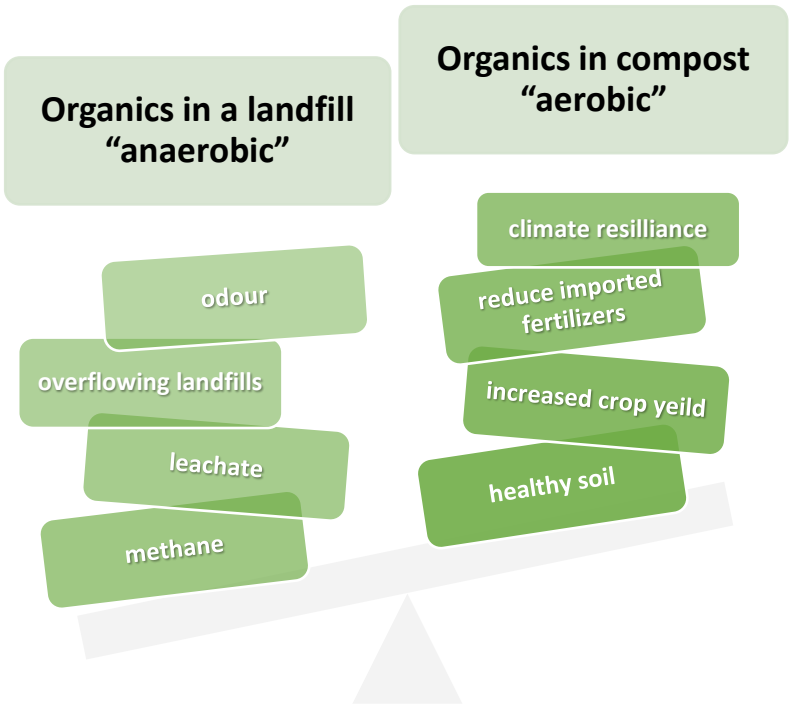
Organics are materials that were once part of a living thing. They include clippings from yard/community beautification projects, fallen palm fronds and flax/tree litter, peelings and scraps from food preparation, by-product from food production facilities, animal manure, and paper / cardboard.

Common organic materials found in the Pacific and Timor-Leste include:


**Legend (***see* ***Section 2.1*** *for more details*)**:**

**High Carbon Items** **High Nitrogen Items** **Neutral Carbon / Nitrogen**

By diverting organic material away from landfills and dumps into a compost facility, the lifespan of a landfill will be substantially increased and compost which will enrich soil quality, improve crop yield, increase soil water retention, enhance food security, and increase climate resilience for local communities will be created.




Composting mimics nature's method of decomposition, allowing organic material to break down "aerobically", with oxygen. Composting can be undertaken in the Pacific and Timor-Leste with non-specialist methods and without expensive specialist equipment or reliance on overseas shipping, it provides an excellent ability to divert a significant volume of material away from landfill (*a "liner" model*) and implement a "circular economy" approach for waste management.

**Figure 1:** Composting as a Circular Economy Approach for Waste Management

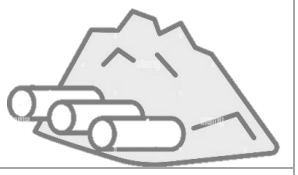

Composting is a "tried and true" waste management practice in the Pacific, Timor-Leste, and across the world. Humans have been composting for many generations and have produced a significant amount of literature on the composting process, and on why and how to compost.

The Pacific and Timor-Leste have one of the richest complexes of marine and terrestrial ecosystems on Earth. Our habitats range from mountain forests to volcanic islands and low-lying coral atolls, and we are home to hundreds of plants species that are found nowhere else on the planet. Until now, little information exists on how to compost our unique vegetation in our unique environment. This Handbook fills this gap, providing a guide to practical techniques and methods for composting typical organic materials found in the Pacific and Timor-Leste.

# Who can use this Handbook?

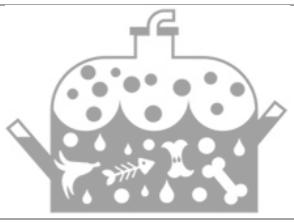
This Handbook was developed to assist anyone making compost in the Pacific and Timor-Leste, using any scale of compost operation - from a pile or bay in your backyard or community, through to a large central facility processing >1 tonne per day. Compost operators in Small Island Developing States (*outside of the Pacific Region*) with similar vegetation and climate, may also benefit from this Handbook.

**Table 1:** Possible Composting Techniques in the Pacific and Timor-Leste

| Backyard / Community Compost | Bay Composting | Windrow Composting | Aerated Static Pile Composting |
|---|---|---|---|
| Processing small quantity of organic materials (*less than 100 kg or 2 wheelbarrows per week*) in small piles or bays at households and communities, turned manually | Processing medium – large quantity of organic materials (*more than 1 tonne or 20 wheelbarrows/day*) in covered bays, turned with machinery | Processing medium – large quantity of organic materials (*more than 1 tonne or 20 wheelbarrows/day*) in long piles (*windrows*), turned with machinery | Processing medium – large quantity of organic materials (*more than 1 tonne or 20 wheelbarrows/day*) in large piles that are aerated through perforated pipes at the base of the pile |
|  |  |  |  |
| Factsheet 3 | Factsheet 6 | Factsheet 7 | Factsheet 8 |
| *For details on these technologies and how to establish a facility, please refer to the accompanying factsheets.* | | | |

There are other methods of organics management appropriate in the Pacific and Timor-Leste that may be also suitable to your context. These include animal feed, mulch, or anerobic digestion.

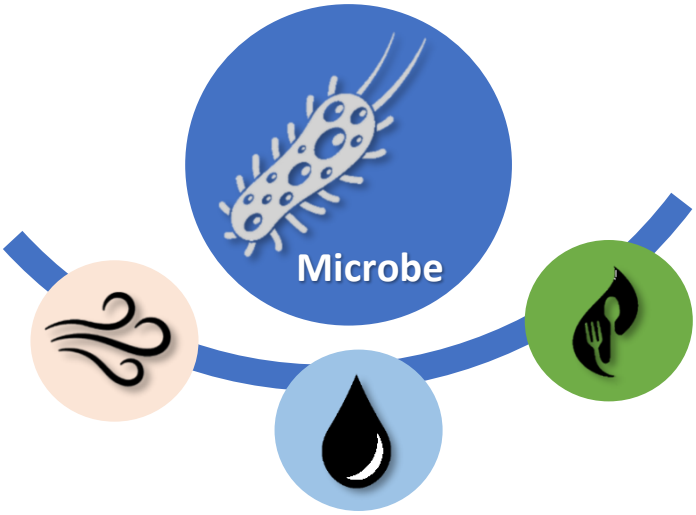
**Table 2:** Other Organics Management Options in the Pacific and Timor-Leste

| Animal Feed | Mulch | Anerobic Digestion |
|---|---|---|
| Collecting suitable organic materials (i.e., fresh food organics) and feeding it to animals | Collecting and shredding suitable organic materials (i.e., garden, and woody organics) for use as mulch and / or animal bedding | Controlled decomposition of organic materials in a sealed enclosure that produces biogas and liquid fertiliser |
|  |  |  |
| Factsheet 1 | Factsheet 2 | Factsheet 4 Factsheet 5 |
| *For details on these management systems and how to establish a facility, please refer to the accompanying factsheets.* | | |

# How to use this Handbook

Composting mimics nature's method of decomposition, where creatures too small to see (*microbes*) process organic materials and convert it to a nutrient rich product, "compost".

Microbes, like humans and animals, need three elements to live and thrive:




| Air | Water | Food |
|---|---|---|
| Oxygen provides microbes air to breath. Oxygen makes the composting process work faster and more effectively, and it also reduces likelihood of a compost pile producing bad odour. | Water provides the microbes liquid to drink. Microbes will dehydrate if the compost pile is too dry but will drown if the compost pile is too wet, slowing down the microbes and producing bad odour. | Microbes eat organic material to create compost. Microbes need the right sort and balance of food to be effective at creating compost, the two key nutrients are "carbon" and "nitrogen" (*further details in* **Section 2.2**). |

Effective composting occurs when these three elements are operating in a balance, as microbes get the correct amount of air, water, and food to thrive. This handbook provides guidance for composters on how to attain the right balance, and therefore make good compost from common products in the Pacific and Timor-Leste.

Each common organic material found in the Pacific and Timor-Leste is presented in a section of this handbook. Information is provided on what the material is, where is it found, how it is currently managed, and how that organic material can either **enhance** one of the key elements of composting [*Air, Water, Food*], or where care is recommended so the product does not **inhibit** that element.

Compost is more than the sum of its parts; it is an ecosystem. Understanding each element in the system – and how they balance together – is the foundation for building a healthy compost pile.

Through understanding the behaviour for each material type, compost operators can mix materials and develop their own compost "recipes" to effectively turn the organic materials they have into valuable compost.

The following examples provide an overview on how this handbook can be used to make informed decisions.

**Table 3:** Illustration of Material Type Influence on Elements in the Composting Process

| Air | | Water | | Food | |
|---|---|---|---|---|---|
| ***Enhance*** | **Helpful for aeration** | ***Enhance*** | **Helpful for water retention** | ***High carbon*** | **High in carbon** |
| ***Neutral*** | **Neutral** | ***Neutral*** | **Neutral** | ***Neutral*** | **Neutral / Ideal** |
| ***Inhibit*** | **May impede aeration** | ***Inhibit*** | **May impede water retention** | ***High nitrogen*** | **High in nitrogen** |

**EXAMPLE:**

High Fibrous Palm and Flax Material such as coconut fronds, banana stems and leaves, and pandanus flax are common organic items in the Pacific and Timor-Leste.

As illustrated in **Section 3.1**, when in a compost pile, this material will influence the three key elements of the composting process by:

1. **Enhancing** Airflow, "helpful for aeration"
2. Potentially **inhibiting** Water, "May impede water retention", and
3. Providing a **High Carbon** source of food

**How will High Fibrous Palm and Flax Material ENHANCE or INHIBIT Composting?**

AIR **Helpful for Aeration**

WATER **May Impede Water Retention**

FOOD **High in Carbon**

By themselves, palm and flax materials will not make effective compost as the microbes, while they may be getting enough oxygen, are not getting sufficient water or a balance of food to thrive. But by understanding how this material will influence the elements in a compost pile, we can look though **Section 3** of this Handbook and find other organic materials that may influence the elements in a different or counteractive way, allowing us to mix items together and create a balanced composting environment for the microbes.

When looking for a material to mix with the palm and flax material, look for materials with different or opposite behaviours, for example:

1. Are **helpful** for water retention *(to counter the palm and flax being dry and difficult to soak up water*), and
2. Contain high quantities of **nitrogen** (*to counter the palm and flax being high in carbon*)

   **Note**: *As the palm and flax material is helpful for aeration, it is ok for the blended material to impede this element.*

An example of a suitable material may be fish processing by-product (**Section 3.4**). On its own, fish by-product will not make effective compost, as the microbes do not have the correct balance of food and, while they may be getting enough water, are too small and may "clump" together, restricting oxygen and airflow.

**How will Fish Processing By-product ENHANCE or INHIBIT Composting?**


**May Impede Aeration**


**Helpful for Water**


**High in Nitrogen**

Through mixing fish processing by-product with palm and flax, the compost pile will have a good balance of air, water, and food, keeping the microbes happy and healthy – resulting in the production of good compost.

**Note**: *Be aware that the properties of organic materials are naturally highly variable between locations and over time. Different composting processes and technologies also require different mixes of organic materials. While this guide provides a starting point, mixes of organic materials (composting recipes) may be needed to be adjusted based on the results of monitoring and trial mixes.*

**Compost experts can use a lot of terminology and jargon which can be confusing if you are not familiar with it. This guide has tried to limit the use of these words, but there are some we may have to use. If a word doesn't make sense, check it in the Glossary at the beginning of the Handbook**

# Food – getting the right Carbon: Nitrogen Balance

### What are Carbon and Nitrogen?

The two most important foods for microbes in a compost pile, are "carbon" and "nitrogen":

| Carbon | Nitrogen |
|---|---|
| Carbon is an energy element and is one of the basic building blocks of life. Plants are nearly half carbon. In compost, carbon provides an energy food that sustains the microbes. Carbon-heavy materials are generally old, rigid, and dry. | Nitrogen is a protein-element essential for building cells in plants. In compost, microbes use nitrogen to grow and reproduce. Nitrogen-heavy materials are generally fresh, flexible, and moist. |
| Examples of carbon in the Pacific and Timor-Leste include fallen palm fronds and flax/tree litter, dead grass or clippings from yard/community beautification projects, and paper / cardboard. | Examples of nitrogen in the Pacific and Timor-Leste include fresh grass and clippings from yard/community beautification projects, peelings and scraps from food preparation, by-product from fish process and other food production (noni, coffee, beer brewing, etc) and manure. |

**Note:** All organic matter includes both carbon and nitrogen; they just show up in different percentages. The carbon to nitrogen ratio (*C:N Ratio*) of common organics materials in the Pacific and Timor-Leste are illustrated in **Figure 2** and general percentage of carbon and nitrogen in the materials is provided in **Table 4** below.

**Figure 2:** Carbon and Nitrogen Ratios in Pacific and Timor-Leste Organics

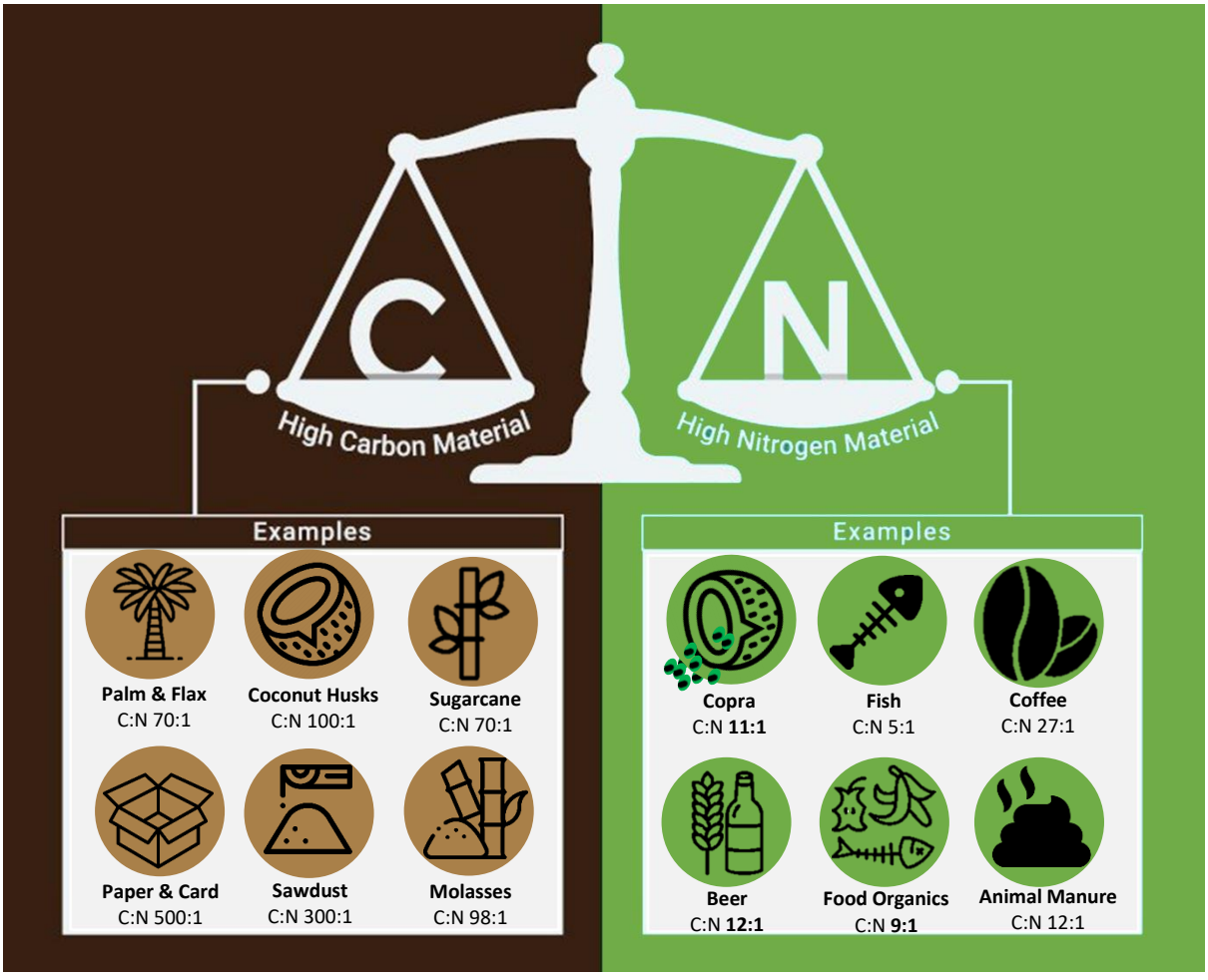


**Table 4**: Organic Material Properties

| | Bulk density kg/m$^3$ | Carbon % | Nitrogen % | Water % | C:N |
|---|---|---|---|---|---|
| **Palm, Stem-fibre, and Flax** | 450 | 42 | 0.6 | 42 | 70:1 |
| **Coconut Husks** Error! Bookmark not defined. | 480 | 42 | 0.25 | 69 | 100:1 |
| **Copra Processing By-product** | 560 | 42 | 4 | 10 | 11:1 |
| **Fish Processing By-product** | 680 | 46 | 10 | 70 | 5:1 |
| **Coffee Processing By-product** | 260 | 43 | 1.6 | 9 | 27:1 |
| **Beer Processing By-product** | 430 | 48 | 5 | 75 | 12:1 |
| **Sugarcane Processing By-product** | 100 | 45 | 0.7 | 50 | 70:1 |
| **Molasses** | 1,600 | 45 | 0.4 | 23 | 98:1 |
| **Yard / Community Clean-up Organics** | 400 | 42 | 0.8 | 20-40 | 52:1 |
| **Plantation Organics** | 400 | 45 | 0.6 | 40 | 75:1 |
| **Food Organics** | 680 | 47 | 5 | 75 | 9:1 |
| **Paper & Cardboard** | 500 | 45 | 0.02 | 5 | 500:1 |
| **Sawdust** | 250 | 42 | 0.1 | 30 | 300:1 |
| **Seaweed** | 700 | 27 | 2 | 80 | 13.5:1 |
| **Noxious Weeds** | 400 | 45 | 0.6 | 40 | 75:1 |
| **Cooking Fire Ash** | 662 | 60 | 0 | 0 | - |
| **Animal Manure** | 500 | 45 | 3.5 | 40 | 12:1 |
| **Biosolids** | 1100 | 26 | 6 | 85 | 5:1 |
| **Crushed Coral** | 800 | 12 | 0 | 5 | - |
| **Crushed Seashells** | 800 | 12 | 0 | 5 | - |
| **Certified Compostable Diapers** | 400 | 29 | 0.4 | 54 | 82:1 |
| **Certified Compostable Plastics** | 250 | 30 | 0 | 0 | - |

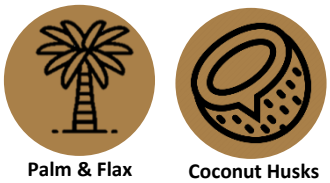
### Calculating Carbon and Nitrogen for Compost

The microbes in a compost pile use carbon as a source of energy and nitrogen for building cell structure. They need more carbon than nitrogen. To calculate the correct C:N Ratio for effective composting, it helps to understand how microbes behave.

There are two main groups of microbes, (i) fungi, and (ii) bacteria.

**Fungi**

prefer to eat less nitrogen and more carbon (high carbon materials)



Palm & Flax | Coconut Husks

**Ideal C:N Ratio: 40:1**
(40 units of carbon for 1 unit of nitrogen)

**Bacteria**

prefer to eat more nitrogen and less carbon (high nitrogen materials)

Copra By-product | Fish By-product

**Ideal C:N Ratio: 20:1**
(20 units of carbon for 1 unit of nitrogen)

**Overall Microbes**

**Ideal C:N Ratio for effective composting**

halfway between the preference for fungi and bacteria:

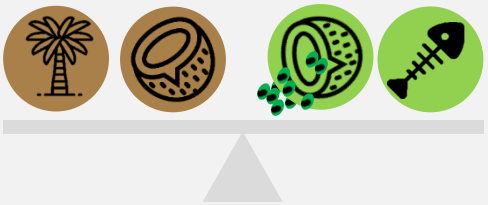
**C:N = 30:1**

Therefore, combining organic ingredients to achieve a C:N of around 30:1 will make good compost. There are two options to help achieve this ratio, as detailed below.

**Note:** as illustrated in **Table 4**, each material type has different carbon and nitrogen percentages, moisture content, and density. As such, the 30:1 C:N ratio is not related to material volume and cannot be achieved by simply adding 30 shovels of carbon material to 1 shovel of nitrogen material.

Options for achieving a 30:1 C:N:

1. to keep things simple, build your pile by generally adding **1 part carbon** material for every **1 part nitrogen** material (*i.e., for each shovel of carbon materials (Palm & Flax and Coconut Husks*) add one shovel of high nitrogen materials (*i.e., Copra and Fish Processing By-product*)) and monitor the composting performance by undertaking regular self-assessments (**Figure 3**).



2. build your compost pile following this formula:

$$C{:}N = \frac{Q_1(C_1 \, x(100 - M_1) + Q_2(C_2 \, x(100 - M_2) + Q_3(C_3 \, x(100 - M_3) + \ldots}{Q_1(N_1 \, x(100 - M_1) + Q_2(N_2 \, x(100 - M_2) + Q_3(N_3 \, x(100 - M_3) + \ldots}$$

where: **Qn** = weight of material (*calculated by weighting your material*)
**Cn** = carbon (%) of material (*found in Table 4)*
**Nn** = nitrogen (%) of material, (*found in Table 4)*
**Mn** = moisture content (%) of material (*found in*

*Contact PacWastePlus if you wish to learn more about using this formula to calculate your C:N ratio.*
It is good practise to monitor the composting performance by undertaking regular self-assessments (**Figure 3**).

# Self-Assessment; Getting the Right Balance

This Handbook is designed to provide an understanding of the common organic materials found in the Pacific and Timor-Leste and can be used to create a suitable compost recipe.

Once the composting process has started, it is useful to undertake "self-assessments" to ensure the air, water, and feedstock is correctly balanced to enable the microbes to thrive.

**Figure 3** provides guidance on undertaking these assessments.

**Figure 3:** Self-Assessment, Achieving the Right Balance of Air, Water, and Food


Visually inspect the compost pile to confirm it has a mix of large and small items, with large pieces (enabling air to flow through).

If there is a foul odour, it may indicate insufficient airflow.

If there is a foul odour and/or the compost material is clumped together, turn the pile and add additional items that are "Helpful for aeration" (*from **Section 3***)


Compost should be damp to the touch but not too wet. To assess water content, collect a handful of material and squeeze-if a just few drops of water are released the moisture content is about right.

If there is a foul odour, it may indicate too much moisture (*restricting airflow*).

If the compost is too dry, add water or additional items that are "Helpful for water retention" (*from **Section 3***)

If the compost is too wet, turn the pile and add additional dry items that are "Helpful for aeration" (*from **Section 3***)


Carbon and nitrogen should be used following the method described in **Section 2.1.2** and using the percentages in **Table 3**.

If too much **nitrogen** the compost may appear wet and soggy (*due to an excess of nitrates*). There will also be a bad ammonia-like smell. Excessive nitrogen may be detected through monitoring temperature, too much nitrogen will have a high temperature.

If there is a foul odour and/or a surplus of **high-nitrogen** materials (*i.e., materials that are fresh, flexible, and moist*), turn the pile and add additional items that are "High Carbon" (*from **Section 3***)

If too much **carbon**, the compost in the pile will be dry and be very slow to decompose. Excessive carbon may also be detected through monitoring temperature, too much carbon will have a low temperature.

If the composting process has stopped and there is a surplus of **high carbon** (*i.e., materials that are old, rigid, and dry*), turn the pile and add additional items that are "High Nitrogen" (*from **Section 3***)

# Composting Tropical Organic Materials

# High Fibrous Palm and Flax Material

Woody Palm and Flax Material includes vegetation from coconut trees and fronds, banana tree leaves, and pandanus flaxes. These materials are very common items in landfills in Pacific and Timor-Leste.

While from different plant families, vegetation from palm, stem-fibre, and flax has similar properties in that they are all woody and “high fibrous”, with tough fibres and a waterproof skin that is difficult to breakdown.

The process of composting these materials is similar.

### Where is Palm and Flax Material Found?

High fibrous palm and flax material comes from fallen fronds and branches. This material is usually generated through yard or community clean-up events. This material can also come from coconut or banana plantations, anywhere this type of vegetation is grown in large numbers.

### Current Management?

High fibrous palm and flax material are currently commonly disposed at landfill or burned. In some areas they are shredded and used as a dry mulch.

## How will High Fibrous Palm and Flax Material ENHANCE or INHIBIT Composting?


### Helpful for Aeration

High fibrous palm and flax material composts well if they are broken into smaller pieces. This is best done with a drum type chipper (*see **Note** below for details*).

**Note**: *If you don't have access to a chipper, you can break fronds into 5cm pieces with a machete or saw. If the material cannot be cut, an option may be to put them aside in a pile to slowly degrade and add to the compost later when easier to cut with a machete.*

Chipping or shredding palm and flax materials will typically turn this material to a consistent particle size of <100mm. This material is bulky and therefore effective at increasing airflow into a compost pile. It is an excellent product to mix with materials with small pieces (*such as fish organics or grass cuttings*). For example, if fish organics and chipped woody palm and flax materials are blended, the material matrix will provide for airflow throughout the pile and significantly reduce odour from the fish.


### May Impede Water Retention

High fibrous palm and flax materials have tough fibres and a waterproof skin and can therefore take a while to soak up water in a compost pile. This material will usually be very dry when reaching a compost facility. It is a good material to mix with wet items such as fish organics. You may need to allow extra time for water to soak in.

**Note**: *If palm and flax organics haven't been through a chipper, they may not take up water at all.*


### High in Carbon

High fibrous palm and flax materials are a high carbon item. For effective composting, mix palm and flax with material with more nitrogen to get the C:N Ratio right. If palm and flax material is composted by itself, the process will run very slowly and may never finish

## Using High Fibrous Palm and Flax Material in Compost

### Suggested Compost Mix

| Ingredient | High Fibrous Palm and Flax Material | Manure / Fish / Food |
|---|---|---|
| % of pile (volume) | **80%** | **20%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | Water % | C:N |
|---|---|---|---|---|---|
| High Fibrous Palm and Flax Material | 450 | 42 | 0.6 | 42 | 70:1 |

**Note:** The high fibrous vegetation in the Pacific and Timor-Leste requires careful selection of the type of mulch/chipper equipment to purchase. Research suggests that "drum style" chippers are better for processing this woody vegetation compared to disc/flywheel style chippers. Before selecting equipment, it is recommended to read operating manuals carefully and speak to suppliers and experts. If the manual only refers to wood as a suitable input or the manufacturer cannot supply evidence of the equipment managing high fibrous vegetation, further research may be required.

# Coconut Husks

Coconut husks are the rough exterior shells of the coconut. It is also known as coir.

The husk of a coconut comprises fibre and pith, with is a strong tissue to store water and sugar nutrients.

### Where are coconut husks found?

Coconut husks are found in high quantities in coconut plantations, copra processing facilities, or locations where quantifies of juicing coconuts are husked and sold.

### Current Management?

Coconut husks are commonly placed around trunks of trees to provide additional drainage and nutrients. Coconut husks can be broken up and sold as mulch or used in potting mix, or the fibres used to make products like door mats, brushes, rope, or particle board however no large-scale occurrences of this were found in the Pacific and Timor-Leste. Husks that are not used are commonly discarded in the environment, burnt, or disposed to landfill.

## How will Coconut Husks ENHANCE or INHIBIT Composting?


### Helpful for Aeration (*when whole*) but may impede aeration (*when powdered*)

When coconut husks are broken up in pieces of <250mm, they are very good at letting air into the pile and can be useful for helping to prevent odours.

In a shredded or powdered form, the air holes of coconut husks are much smaller and when water is added to the pile it is easy for the air holes to get blocked. It is best to mix powdered coconut husks with another organic material with bigger pieces in it, such as shredded coconut, banana, pandanus.


### Helpful for water (*when whole*) but may impede water retention (*when powdered*)

Coconut husks can contain a lot of water in their broken open form. They will allow water to move easily through the compost pile as it will be hard to block air spaces in the pile.

Coconut husks are a useful way to save water in composting if you don't have much water available.

In powdered form, coconut husks can be much lower in water. It will take up water very easily but holes between the particles can easily be blocked. It will work better mixed with another material that has larger particle sizes like garden organics or whole coconut husks.


### High in Carbon

Coconut husks are high in carbon. To compost effectively, they should be mixed with a high nitrogen material like manure, food organics, or copra meal.

Coconut husks can come in large pieces which can make them hard for microbes to break down. Coconut husks may compost better if they are put through a chipper to break them into smaller pieces. Drum chippers recommended for coconut, banana, pandanus organics should also work for chipping coconut husks.

## Using Coconut Husks in Compost

### Suggested Compost Mix

| Ingredient | Coconut Husks | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **25%** | **20%** | **55%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | Water % | C:N |
|---|---|---|---|---|---|
| Coconut Husks | 480 | 42 | 0.25 | 69 | 100:1 |

# Copra Processing By-product

Copra Processing By-product is what is left over after a coconut kernel is pressed to get the oil out. It is also known as copra meal.

Copra Processing By-product is a fine dry powder or granules.

### Where is Copra found?

Copra Processing By-product is found in high quantities in copra factories, or where coconuts are processed for oil.

### Current Management?

Copra Processing By-product is mostly used in animal feed as a protein source. When not used for animal feed, it may go to landfill or be spread in fields.

## How will Copra Processing By Product

## ENHANCE or INHIBIT Composting?


### May Impede Aeration

Copra meal is made mostly of fine particles. This means that the air holes between them are small, making them easy to block and reduce airflow into the pile.

Copra meal can also make microbes work fast and need a lot of oxygen.

Copra meal will compost better if it is mixed with a material with large particle sizes like garden organics or coconut husk.


### May Impede Water retention

Copra meal is low in water, it will need a lot of water added to it.

The small particle sizes in copra meal mean that it is easy for water to block the holes between them and cause issues with oxygen supply.

Copra meal will handle water better if it is mixed with a material with large particle sizes like garden organics or coconut husk. It may also help to mix copra meal with a material that already contains water like food organics.


### High in Nitrogen

Copra meal is high in nitrogen. It will compost best if it is mixed with a material that is low in nitrogen like garden organics, coconut husks, or by-product from sugarcane processing.

## Using Copra Processing By-product in Compost

### Suggested Compost Mix

| Ingredient | Copra Meal | Garden Waste |
|---|---|---|
| % of pile (volume) | **85%** | **15%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | Water % | C:N |
|---|---|---|---|---|---|
| Copra Processing By-product | 560 | 42 | 4 | 10 | 11:1 |

# Fish Processing By-product

Fish Processing By-product is the bits left over from fish processing, including  scales, bones, and guts.

It has a lot of water and a lot of nitrogen that makes it likely to smell bad if left out for too long before processing.

### Where are fish by-products found?

Fish Processing By-product or any fish organics can be found where fish are caught and processed for shipping or sale. This could be at factories, or at fish cleaning stations on the shore, or at places where people sell fish.

### Current Management?

Fish organics are often discarded in landfill, thrown back in the ocean, or fed to animals. They need to be cleaned up quickly to avoid bad smells.

## How will Fish Processing By Product ENHANCE or INHIBIT Composting?


### May Impede Aeration

Fish Processing By-product are very easy for microbes to break down. They will use a lot of oxygen and it will be easy for the compost pile to run out.

Fish Processing By-product should be mixed with a material with large particle sizes, like garden organics, to enable airflow to pass through the pile and facilitate microbe activity.

To reduce potential for odour, it is recommended to compost fish organics as less than 10% of the volume of a compost pile and mix with larger particles.


### Helpful for Water

Fish Processing By-product has a high-water content, potentially providing the compost pile more moisture than it needs.

Mixing fish organics with dry material like paper and cardboard will help balance out the water content of the mix.


### High in Nitrogen

Fish Processing By-product has a lot of nitrogen in it. Fish organics will compost better if it is mixed with a material with low nitrogen (includes sawdust, paper and garden organics), working best with only a little bit of fish organics and a lot of low nitrogen material.

## Using Fish Processing By-product in Compost

### Suggested Compost Mix

| Ingredient | Fish Processing By-product | Garden Organics |
|---|---|---|
| % of pile (volume) | **10%** | **90%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | Water % | C:N |
|---|---|---|---|---|---|
| Fish Processing By-product | 680 | 46 | 10 | 70 | 5:1 |

# Coffee Processing By-product

The main by-product from the coffee industry are coffee husks, with 1kg of coffee husk produced for every 1kg of coffee bean.

Coffee husks are the part of a coffee fruit that is inside the flesh of the fruit and covers the coffee bean.

## Where is coffee by-product found?

Coffee husks can be found at factories that process coffee.

## Current Management?

Excess coffee husks either go to landfill or are dried out and burnt. Other uses include fertiliser and bedding for animals.

**Note**: Animals may get sick if they eat too many coffee husks.

## How will Coffee Processing By Product ENHANCE or INHIBIT Composting?


### Coffee Processing By-Product Helpful for Aeration

Coffee husks are very light and will "fluff up" a compost pile well.

Coffee husks will use a medium amount of oxygen, which should be easy to supply. They should still be monitored for odour if they are mixed with other materials.


### May Impede Water Retention

Coffee husks are low in water, they will need a lot of water added to a compost pile.

Care should however be taken to not add too much water, they can make odour if there is too much water in them that blocks oxygen supply.


### Ideal Nitrogen

Coffee husks are one of the few organic materials that are already at the ideal nitrogen content, they will compost well without anything but water being added.

It is still a good idea to mix coffee husks into other organic materials to give the microbes different types of foods to eat.

## Using Coffee Husk in Compost

### Suggested Compost Mix

| Ingredient | Coffee Husks | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **20%** | **15%** | **65%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | Water % | C:N |
|---|---|---|---|---|---|
| 3.5 Coffee Processing By-product | 260 | 43 | 1.6 | 9 | 27:1 |

# Beer Processing By-product

By-product from beer brewing comprises of are mostly the spent grain with the sugars extracted. It also includes used hops and yeast.

Beer processing by-product is usually wet and have fine particles.

### Where is Beer processing waste found?

Beer by-products is found at breweries

### Current Management?

Beer by-products are often used as animal feeds. Excess by-products that are not used usually go to landfill.

## How will Beer By-products ENHANCE or INHIBIT Composting?


### May Impede Aeration

Beer processing by-product is quite open and allow air through, however air spaces between the particles is moderately small and can be blocked, which could produce a foul odour.

Beer processing by-product could have a high oxygen demand.

Beer by-products will compost best when they are mixed with a material with larger particle sizes like garden organics or coconut husks.


### Helpful for Water

Beer by-product has a large amount of water already in it, they do not need any water added.

If extra water is added the holes in the compost pile could be blocked and lead to bad smells.

Beer by-products will compost best when mixed with a dryer material like paper and cardboard to balance out the water.


### High in Nitrogen

Beer by-products are high in nitrogen. Combined with their high-water content and small particle size they can be a risk for bad smells.

Beer by-products will compost best if they are mixed with a low nitrogen material like paper and cardboard as well as garden organics.

## Using Beer By-products in Compost

### Suggested Compost Mix

| Ingredient | Beer By-products | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **20%** | **10%** | **70%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | Water % |
|---|---|---|---|---|
| Beer processing by-product | 430 | 48 | 5 | 75 |

# Sugarcane Processing By-product

By-product from the processing of sugarcane is the organics left over after extracting the sap that contains sugar. It is also known as bagasse.

Sugarcane processing by-product contains all the fibres that hold the sugarcane up when it is alive. It is a light material with lots of long fibres in it.

### Where is sugar cane waste found?

Sugarcane organics can be found at sugar mills. There is often a lot left over from the sugar production process.

### Current Management?

Sugarcane is commonly burnt or discarded. It can be burnt in facilities to generate energy, used for making pulp for products like paper, and to make building materials like panels for walls however no occurrences are found in the Pacific and Timor-Leste.

## How will Sugarcane Organics ENHANCE or INHIBIT Composting?


### Helpful for Aeration

By-product from sugarcane processing is very light and fluffy. It lets lots of air into a compost pile and unlikely to cause foul odours through lack of oxygen.

By-product from sugarcane processing could be combined with dense materials high in nitrogen to facilitate aeration.


### Helpful for Water

Sugarcane organics already have about the right amount of water in them.

If you put them with a wet material, they might end up with too much water. It might help to add another dry ingredient like paper & cardboard, or coffee husks.


### High in Carbon

Sugarcane organics have only a small amount of nitrogen.

They would need to be blended with a higher nitrogen material to compost well. Copra meal might be a good combination with sugarcane organics.

## Using Sugarcane Organics in Compost

### Suggested Compost Mix

| Ingredient | Sugarcane Organics | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **20%** | **15%** | **65%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Sugarcane processing by-product | 100 | 45 | 0.7 | Sugarcane processing by-product |

# Molasses

Molasses is what is left of the sugarcane sap after most of the pure sugar has been extracted from it. It is a thick syrup that contains sugars and plant nutrients.

Molasses can be used to make brown sugar or sold as food.

**Where is molasses found?**

Waste molasses is found at sugar mills.

**Current Management?**

Waste molasses is sometimes used in animal feeds. Large amounts of molasses can be spread on fields as a fertiliser.

## How will Molasses ENHANCE or INHIBIT Composting?

AIR

### May Impede Aeration

Molasses is a dense thick liquid and contains no air spaces at all.

If there is too much molasses in a compost pile, it will slowly move down through the pile and fill up the air spaces. Only mix a small amount of molasses into a compost pile to avoid blocking up air spaces.

Molasses is very easy for microbes to use and can lead to microbes needing a lot oxygen. This could lead to the pile running out of oxygen and causing foul odours.

WATER

### May Impede Water Retention

Molasses can contribute some water to the compost pile. It doesn't like to take up very much water and if there is too much molasses in a compost pile, it might make it difficult for water to get into the pile.

Molasses will work better if it is mixed with other materials with larger particle sizes.

FOOD

### High in Carbon

Molasses is low in nitrogen and would need to be blended with higher nitrogen materials like manure or copra meal to compost well.

The carbon in molasses is very easy for microbes to use. This can mean that it helps the compost pile get hot very quickly, but the carbon may all be used up quickly. Molasses cannot be used as the only carbon source in a compost pile for this reason.

## Using Molasses in Compost

### Suggested Compost Mix

| Ingredient | Molasses | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **10%** | **30%** | **60%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Molasses | 1600 | 45 | 0.4 | Molasses |

# Yard / Community Clean-up Organics

Organics from Yard /Community Clean-up include all the clippings, trimmings, and cut grass produced from yard or community beautification or clean-up activities.

This may include fibrous vegetation like coconut fronds, banana leaves, and pandanus flaxes (*see* **Section 3.1**) that has fallen as tree litter, and branches, leaves and grass.

It can come in big (*branches, fronds, etc*) and little pieces (*grass, hedge trimmings, etc*). Big pieces may need to be cut into smaller pieces with a woodchipper or machete to work well in a compost pile.

### Where organic waste found?

The materials come from yards, roadsides, churches, schools, and other community facilities, anywhere people are doing a beautification or clean-up activity.

They then take them to landfill to get them out of their yard. There can be many tonnes of it available.

### Current Management?

Organics from yard and community clean-up activities often go to landfill in the Pacific and Timor-Leste, comprising almost **50% of the material to landfill**. They are also burnt, or sometimes composted or used as mulch.

## How will Organics from Yard /Community Clean-up ENHANCE or INHIBIT Composting?


### Helpful for Aeration

Organics from yard /community clean-up come in a variety of sizes, usually mixed together. The material will compost better if it is broken into smaller pieces, either through a chipper, providing an ideal mix of particle sizes to allow good air flow, or cut to 5cm pieces with a machete or saw.

If the material cannot be easily cut, an option may be to put them aside in a pile to slowly degrade and add to the compost later when they are easy to cut with a machete.

Organics from Yard /Community Clean-up are a good choice for combining with a high nitrogen and high-water organic material like fish organics.


### Helpful for Water

Organics from yard /community clean-up usually take in water well and drain excess water easily, making it hard to have too much water in the compost pile.

Without shredding, it may take some of the woody parts of the organic materials a while to soak up the water properly.


### Carbon/Neutral

Organics from yard /community clean-up usually come in a variety of dry and fresh materials. This material will compost without adding anything else, but it helps to add something with lots of nitrogen (fish by-product or manure) to get the composting process to work better.

## Using Garden Organics in Compost

### Suggested Compost Mix

| Ingredient | Organics from yard / community clean-up | Manure | Ingredient |
|---|---|---|---|
| % of pile (volume) | **80%** | **20%** | **% of pile (volume)** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Organics from yard / community clean-up | 400 | 42 | 0.8 | Organics from yard / community clean-up |

# Plantation Organics

Organics from plantations include all the offcut, clippings, trimmings, and weeds produced from harvesting or tending to crop, including taro, casava, breadfruit, and banana trees, and other gardens and orchards.

This can include fibrous vegetation banana leaves, and branches, leaves and grass. It can come in big (*branches, stems/trunks, etc*) and little pieces (*leaves, shoots etc*). Big pieces may need to be cut into smaller pieces with a woodchipper or machete to work well in a compost pile.

### Where is plantation waste found?

Organic materials including crop offcuts, clippings, trimmings, and weeds produced from harvesting or tending to crops can be found in plantations, gardens and orchards.

### Current Management?

Organics from plantations are used on-site as mulch, burnt, or disposed to landfill. Breadfruit tree leaves are commonly placed around trunks of trees to provide additional nutrients.

## How will Plantation Organics ENHANCE or INHIBIT Composting?


### Helpful for Aeration

Organics from plantations come in a variety of sizes, usually mixed together. The material will compost better if it is broken into smaller pieces, either through a chipper, providing an ideal mix of particle sizes to allow good air flow, or cut to 5cm pieces with a machete or saw.

If the material cannot be easily cut, an option may be to put them aside in a pile to slowly degrade and add to the compost later when they are easy to cut with a machete.


### Helpful for Water

Organics from plantations usually take in water well and drain excess water easily, making it hard to have too much water in the compost pile.

Organics from plantations are a good choice for combining with a high-water organic material like fish by-product.


### Carbon/Neutral

As with organics from yard /community clean-up, organics from plantations usually come in a variety of dry and fresh materials. This material will compost without adding anything else, but it helps to add something with lots of nitrogen (fish by-product or manure) to get the composting process to work better.

## Using Plantation Organics in Compost

### Suggested Compost Mix

| Ingredient | Plantation Organics | Manure | Ingredient |
|---|---|---|---|
| % of pile (volume) | **80%** | **20%** | **% of pile (volume)** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Plantation Organics | 400 | 45 | 0.6 | Plantation Organics |

# Food Organics

Food organics are the leftover materials such as peelings, scraps, and cut off meat from food preparation. Food organics can also include food that spoiled before it was cooked or left-over food.

### Where are food organics found?

Food organics are found in high quantities in where a lot of food is processed; at markets, restaurants, or factories that process food. Households produce food organics, if able to be collected it can make a large quantity.

### Current Management?

Food organics that are produced at home are usually fed to animals.

This can also happen with food from restaurants or factories. Food organics can also be disposed to landfill.

## How will Food Organics ENHANCE or INHIBIT Composting?


### May Impede Aeration

Food organics do not have much air spaces and when it starts to break down in a compost pile they will collapse further.

Food organics are very easy for microbes to digest so they will work very fast and need a lot of oxygen.

Food organics will work best when they are mixed with something with large particle sizes like garden organics or coconut husks.


### Helpful for Water

Food organics contain a lot of water. This water will be released in the first weeks of composting.

Without care, this extra water could make the pile too wet, blocking oxygen and make the pile smell bad.

It is a good idea to put a bit less water than usual into a pile with a lot of food organics in it.


### High in Nitrogen

Food organics contain a lot of nitrogen. This nitrogen is very available to microbes.

Food organics will compost better if they are mixed with materials that have a higher proportion of carbon like garden organics.

## Using Food Organics in Compost

### Suggested Compost Mix

| Ingredient | Food Organics | Garden Organics | Ingredient |
|---|---|---|---|
| % of pile (volume) | **25%** | **75%** | **% of pile (volume)** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Food Organics | 680 | 47 | 5 | Food Organics |

# Paper & Cardboard

Paper and cardboard include used office paper, paper used for packaging and cardboard used for packaging.

They are both made from fibres taken from wood, so they have similar chemical properties as wood.

### Where is paper & cardboard found?

Paper and cardboard are usually found at large businesses that use a lot of cardboard and collect it before they take it to landfill.

### Current Management?

Paper and cardboard are usually discarded into landfill or burnt at home. It can be recycled to make into new paper, cardboard, or items like firebricks, however no large-scale occurrences of this were found in the Pacific and Timor-Leste.

## How will Paper & Cardboard ENHANCE or INHIBIT Composting?


### Helpful for aeration (*when dry*) but may impede aeration (*when wet*)

Paper and cardboard can let lots of air into a compost pile when dry, but they can block air when they are wet.

Paper and cardboard work better when they are combined with large particles such as garden organics to hold the pile open.

It also helps if they are shredded into small pieces. This will make the pile open instead of sitting flat and keeping air out. Sitting flat when wet will block air from carrying oxygen into the pile.


### May Impede Water Retention

Paper and cardboard are very dry. They will need more water than most other materials when added to a compost pile.

If shredded and mixed, they will take up water easily.


### High in Carbon

Paper and cardboard have almost no nitrogen in them.

They will only compost if they have a high nitrogen material mixed with them like manures and materials that provide structure.

## Using Paper & Cardboard in Compost

### Suggested Compost Mix

| Ingredient | Paper & Cardboard | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **10%** | **20%** | **70%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Paper & Cardboard | 500 | 45 | 0.02 | Paper & Cardboard |

# Sawdust

Sawdust (*or wood dust*) is a by-product or waste product of woodworking operations such as sawing, sanding, milling, plaining, and routing. It is composed of small chippings of wood.

**Where is sawdust found?**

Sawdust can be found where people work with wood, sawmills or carpentry/joinery factories where they make furniture or pallets out of wood.

**Current Management?**

Sawdust can be used as mulch to protect soil. It is also used as animal bedding and can be used to mop up oil or chemical spills. Sawdust often gets burned or discarded.

## How will Sawdust ENHANCE or INHIBIT Composting?


### May Impede Aeration

Sawdust is very light. Because the pieces of sawdust are so small, the holes between them are very small. When water is added to a compost pile, it is very easy for the holes to get blocked.

It is best to mix sawdust with another organic material with bigger pieces in it, such as chipped palm fronds.


### May Impede Water Retention

Sawdust can take a long time to soak up water properly into the sawdust pieces, and sometimes it is slow to let water into the pile. When it does get into the pile, it is easy to put in too much water and block the air spaces.

It helps to allow sawdust a longer time to slowly take up water and to let it drain if there is too much. Mixing it with other organic material will help.


### High in Carbon

Sawdust has almost no nitrogen in it.

Composting sawdust works much better blended with a high nitrogen material like fish organics or food organics. It also helps to blend with another carbon source like garden organics. This will give carbon that is easier for microbes to eat, and larger particles to help with air and water.

## Using Sawdust in Compost

### Suggested Compost Mix

| Ingredient | Sawdust | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **10%** | **20%** | **70%** |

### Properties Table

| Ingredient | Sawdust | Manure | Garden Organics | Ingredient |
|---|---|---|---|---|
| % of pile (volume) | 10% | 20% | 70% | % of pile (volume) |

# Seaweed

Seaweed is a type of algae that grows in the ocean. Growing in the ocean, it picks up lots of nutrients that have been washed off the land.

### Where is seaweed found?

Seaweed can be found washed up on the shore after storms.

### Current Management?

Seaweed washed up on the shore is often left to rot in place. This can cause a lot of odour. It can be collected and used as animal feed or made into fertiliser.

It makes a good fertiliser because it contains some nutrients that are hard to get from the land. It can also be collected and taken to landfill.

## How will Seaweed ENHANCE or INHIBIT Composting?


### May Impede Aeration

Seaweed is very heavy. It sits flat and doesn't let much air into a compost pile. To make sure that the compost pile receives enough air, it would help to mix seaweed with a material with larger particle sizes like garden organics.

Seaweed can break down quickly and the microbes need a lot of oxygen. Too much seaweed in a compost pile may produce foul odours if not enough air can get in.

To reduce potential for odour, it is recommended to compost seaweed as less than 20% of the volume of a compost.


### Helpful for Water

Sawdust can take a long time to soak up water properly into the sawdust pieces, and sometimes it is slow to let water into the pile. When it does get into the pile, it is easy to put in too much water and block the air spaces.

It helps to allow sawdust a longer time to slowly take up water and to let it drain if there is too much. Mixing it with other organic material will help.


### High in Carbon

Seaweed also has a lot of other minerals that most other organic materials don't have. Adding some seaweed to a compost pile can make the produced compost a more complete fertiliser for plants.

Seaweed will need to be mixed a low nitrogen material like garden organics to get the right C:N.

## Using Seaweed in Compost

### Suggested Compost Mix

| Ingredient | Seaweed | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **10%** | **15%** | **65%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Seaweed | 700 | 27 | 2 | Seaweed |

# Noxious Weeds

There are many different noxious weeds including trees, shrubs, grasses, herbs, or water weeds. Noxious weeds are a leading driver of biodiversity loss in the Pacific and Timor-Leste.

Noxious weeds can be composted, but it is important to ensure all the seeds and cuttings are pasteurised ("*killed*") during the composting process by ensuring the pile gets over 55°C and holds at this temperature for at least 3 days. The heat will kill the seeds and cuttings, regular turning will ensure all the compost pile gets fully pasteurised.

**Note**: *noxious weeds are not suitable for composting if the required heat cannot be sustained for the required timeframe. Unpasteurised compost will spread weeds to areas where the compost is placed.*

As with all vegetation, noxious weeds will compost better if they are broken into smaller pieces, either through a chipper or with a machete. When breaking up this material, care is recommended to ensure seeds are not spread and equipment is well cleaned after use. Care is also recommended to ensure the weeds to be composted are not covered in weed killer such as paraquat. Before accepting weeds at your facility, confirm with the owner that the material is not covered in this spray.

### Where are noxious weeds found?

Weeds grow throughout in the Pacific and Timor-Leste. It is often removed by hand from farms or forestry and back yards.

### Current Management?

When removed weeds often goes to landfill or is dried and burned.

## How will Noxious Weeds-climbers ENHANCE or INHIBIT Composting?

AIR

### May Impede Aeration

Noxious weeds vary but, as with most vegetation, come in a variety of sizes, usually mixed together. The material will compost better if it is broken into smaller pieces, either through a chipper, providing an ideal mix of particle sizes to allow good air flow, or cut to 5cm pieces with a machete or saw.

Noxious weeds are a good choice for combining with a high nitrogen and high

WATER

### Helpful for water (*when fresh*) but may impede water retention (*when dry*)

Noxious weeds usually take in water well and drain excess water easily, making it hard to have too much water in the compost pile.

Without shredding, it may take some of the woody parts of the weeds a while to soak up the water properly.

FOOD

### Carbon Neutral

Noxious weeds usually come in a variety of dry and fresh materials. This material will compost without adding anything else, but it helps to add something with lots of nitrogen (fish by-product or manure) to get the composting process to work better.

## Using Noxious Weeds in Compost

### Suggested Compost Mix

| Ingredient | Noxious Weeds | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **20%** | **20%** | **60%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Noxious Weeds | 400 | 45 | 0.6 | Noxious Weeds |

# Cooking Fire Ash

Cooking fire ash is left after burning wood or other material to cook food. It contains nutrients that are good for plants and animals but doesn't contain the nitrogen or available carbon that are needed for composting.

### Where is cooking fire ash found?

Cooking fire ash is normally found at homes that use open fireplaces for cooking. It is not usually available in big quantities unless at a commercial scale natural coffee or coco roasting business.

### Current Management?

Cooking fire ash is often spread in gardens. If there is too much of it, it may go in a storage pile or disposed to landfill.

## How will Cooking Fire Ash ENHANCE or INHIBIT Composting?


### May Impede Aeration

Cooking fire ash is light and lets in air easily when it is dry. When it gets wet it can collapse down into a sludge.

Cooking fire ash is recommended to be blended with a lot of a material with larger particles in it like garden organics or coconut husks.


### May Impede Water Retention

Cooking fire ash has no water in it but when water is added, it can easily be saturated.

Water moves slowly through it, so cooking fire ash is recommended to be blended with other materials to make sure there aren't large clumps that stop water from getting into the compost pile.


### Neutral

Cooking fire ash does not have nitrogen in it, and the carbon that it contains isn't available for microbes to use as food. It does have lots of minerals that can help microbes.

## Using Cooking Fire Ash in Compost

### Suggested Compost Mix

| Ingredient | Cooking Fire Ash | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **5%** | **20%** | **75%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Cooking Fire Ash | 662 | 60 | 0 | Cooking Fire Ash |

# Animal Manure

Manures are from any animal when they defecate. Manure is the decomposed form of dead plants and animals. It contains water and nutrients for helping plants grow and stay healthy.

Manure can be spread on fields to return the nutrients that the animals ate back to the field. There is some risk that diseases can be spread from one group of animals to another by doing this.

Manure recommended for use in compost are from herbivore animals such as chickens, cows, and pigs. Manure from carnivore animals (*dogs and cats*) are more likely to spread disease.

Pig manure may carry pathogens which can impact human and soil health, it is recommended to have pig manure tested in a lab before using them in composting. It may not be recommended for compost made from pig manure to be used for growing food (*in gardens or crop fields*). A separate organic facility may need to be established to process this material.

### Where animal manure found?

Often manures are spread out in the field where animals are living. It is easiest to collect it where animals are grouped together. This is in places like piggeries, chicken sheds, or feedlots.

### Current Management?

Manures can be swept out and collected as solids or can be stored in sludge ponds where it is washed out of the piggeries or other facilities. Solids are sometimes spread on fields as a fertiliser.

## How will Animal Manure ENHANCE or INHIBIT Composting?


### May Impede Aeration

Manure tends to pack down a lot in a pile and may restrict air flow.

It will help if manure is mixed with something with large pieces in it like garden organics. Manure can make microbes work very fast. If there is too much manure in the pile this can make them use up all the oxygen and produce odour.


### May Impede Water Retention (*when wet*)

Manure can be wet or dry, depending on if they come from a sludge pond or collected dry from a field. When they are wet the water can easily block the holes in the compost pile.

Manures compost better when mixed with something that soaks up water (*like sawdust or ground coconut coir*) and has large particle sizes *(like garden organics*).


### High in Nitrogen

Manure is high in nitrogen and very easy for microbes to digest. If there is too much manure in a compost pile it will get very hot. If there is a lot of manure and too much water the pile could run out of air and smell very bad.

Manure works best when they are mixed with something low in nitrogen with large particle sizes, like garden organics. Some manures come mixed with animal bedding material like straw or wood chip. A manure-bedding mix is often a good mix to compost by itself.

## Using Animal Manure in Compost

### Suggested Compost Mix

| Ingredient | Manure | Garden Organics | Ingredient |
|---|---|---|---|
| % of pile (volume) | **20%** | **80%** | **% of pile (volume)** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Animal Manure | 500 | 45 | 3.5 | Animal Manure |

# Biosolids

Biosolids or sewerage sludge are products from human excrement. It is a heavy sludge that has a lot of nutrients in it and often smells bad.

This material can be composted but not recommend for the finished compost to be used for growing food (*in gardens or crop fields*). A separate organic facility may need to be established to process this material.

Some biosolids have high levels of chemical contaminants like heavy metals so it is recommended to have them tested in a lab before using them in composting.

**Where are biosolids found?**

Biosolids come from septic tanks or sewage processing facilities.

**Current Management?**

Biosolids can get pumped out into the ocean to disperse or disposed at landfill. In some places it gets spread on fields to use the nutrients as fertiliser. There is some risk that this can spread disease.

## How will Biosolids ENHANCE or INHIBIT Composting?


### May Impede Aeration

Biosolids are very dense and have almost no air spaces in them. This makes it very difficult for oxygen to get into a pile of biosolids.

Biosolids also make microbes work very fast, so they use up all the oxygen and can't get more without airspaces. This can lead to bad smells.

Biosolids need to be mixed with a lot of something with large particles in it like garden organics.


### Helpful for Water

Biosolids have a lot of water in them (*often over 90% water content*). This water will provide water for the pile and might help you save water. If they are mixed with something like garden organics, they might provide most of the water in the pile.

Some biosolids have some of the water taken out (*dewatered*) at the treatment plant making them easier to transport and handle. Dewatered biosolids might only be 70-80% water.


### High in Nitrogen

Biosolids are very high in nitrogen. They will make microbes work very fast and get very hot.

Biosolids will work best in a compost pile if they are mixed with a lot of something that has low nitrogen like garden organics or paper and cardboard.

## Using Biosolids in Compost

### Suggested Compost Mix

| Ingredient | Biosolids | Garden Organics | Ingredient |
|---|---|---|---|
| % of pile (volume) | **20%** | **80%** | **% of pile (volume)** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Biosolids | 1100 | 26 | 6 | Biosolids |

# Crushed Coral

Crushed coral is the coral broken up into small pieces. It is made of calcium carbonate, the same thing that makes limestone and shells of sea animals.

Crushed coral can be used to help neutralise acidic soils or provide calcium to soils that need it. If it is composted it is less likely to help with acidic soils, but it will release calcium more easily.

### Where is crushed coral found?

Crushed coral comes from sand that is made up of little bits of coral broken off by waves or parrot fish chewing on coral. Crushed coral can also come from mining of old coral reefs that are now on land.

### Current Management?

Crushed coral is usually only obtained or mined deliberately and does not need to be managed as a waste material.

## How will Crushed Coral ENHANCE or INHIBIT Composting?


### Helpful for Aeration

Crushed coral does not collapse during the composting and can help air to get into the pile throughout the composting process.

Crushed coral does not create microbial activity, so it does not cause a lot of oxygen use in a compost pile. It will not cause bad smells.


### Neutral

Crushed coral only contains and will only help hold a very small amount.

Crushed coral can assist in composting when mixed with wet ingredients with small particle sizes to drain freely.


### Neutral

Crushed coral is not something that can be used as food by microbes.

Crushed coral can be broken down by the acids produced in the composting process, helping to neutralise the pile. This releases calcium and some phosphorus. This can make the compost better as a fertiliser for soils that don't have enough calcium.

## Using Crushed Coral in Compost

### Suggested Compost Mix

| Ingredient | Crushed Coral | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **5%** | **20%** | **75%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Crushed Coral | 800 | 12 | 0 | Crushed Coral |

# Crushed Seashells

Crushed seashells are the hard outer shells of molluscs that live in the sea (like clams, conch, oysters, or puka). They are made of calcium carbonate, the same thing that makes limestone, coral, and shells of other sea animals.

Crushed shells have many uses, such as in gardens for pathways, and treating acidity in soils, and making lime for cement.

**Where are crushed seashells found?**

Crushed seashells either come from factories that process molluscs for food, and then crush the shells that are left over, or from beaches where old shells have been broken up.

**Current Management?**

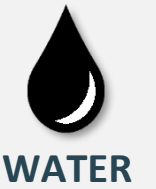
Crushed seashells are usually only obtained or mined deliberately and does not need to be managed as a waste material.

## How will Crushed Seashells ENHANCE or INHIBIT Composting?


### Helpful for Aeration

Crushed seashells do not collapse during the composting process and can help air to get into the pile throughout the composting process.

Crushed seashells do not create microbial activity, so they do not cause a lot of oxygen use in a compost pile. They will not cause bad smells.




### Neutral

Crushed seashells only contain and will help hold a very small amount of water. They will only a small amount of water.

Crushed seashells can assist in composting when mixed with wet ingredients with small particle sizes to drain freely.


### Neutral

Crushed seashells are not something that can be used as food by microbes.

Crushed seashells can be broken down by the acids produced in the composting process, helping to neutralise the pile. This releases calcium and some phosphorus. This can make the compost better as a fertiliser for soils that

## Using Crushed Seashells in Compost

### Suggested Compost Mix

| Ingredient | Crushed Seashells | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **5%** | **20%** | **75%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Crushed Seashells | 800 | 12 | 0 | Crushed Seashells |

# Certified Compostable Diapers

Compostable diapers are diapers used for babies that are made from a combination of certified compostable plastics (**see 2.23**) and other materials that can be composted.

There are very few completely compostable diapers available in the market so be aware of products claiming to be compostable: Some claim to be biodegradable but do not fully break down in the process and can leave small fragments of plastic in the compost.

It is very important to make sure that compostable diapers go into a hot composting process. They need high temperatures both to break down the compostable plastic and to make sure that any pathogens in the diapers are killed.

It is recommended to only agree to accept diapers that have been successfully tested in composting.

### Where are compostable diapers found?

Compostable diapers can be found mixed in with general rubbish from households, or at childcare facilities or hospitals.

### Current Management?

Diapers present a disease risk, so usually they go straight into landfill.

## How will Compostable Diapers ENHANCE or INHIBIT Composting?


### May Impede Aeration

Compostable diapers have air spaces when they are the only material in a small pile. In a large pile with weight above them they can easily collapse and will fill up air spaces to block oxygen. They contain baby excrement that is at risk of making bad smells.

Compostable diapers will compost better when mixed with something with large particle sizes to facilitate aeration.


### May Impede Water Retention

Compostable diapers contain a water absorbing gel. This gel will bind water in a way that is not useful for composting. Additional water will be required to fill up the crystals to ensure water is available for composting. The gel may be useful when the finished compost is put on soils.

The compostable plastic in the diapers can take a long time to absorb water. Extra water may be needed one or two weeks into the composting process to allow for this.


### Neutral

Compostable diapers are a mix of three materials: Baby excrement, compostable plastic and water absorbing gel. The baby excrement is very available to microbes, the compostable plastic is slowly available to microbes, and the gel is not available to microbes.

The mix of all three ingredients is low in nitrogen. Compostable diapers would need to be mixed with a material higher in nitrogen like copra meal or food organics or manures to compost well.

## Using Compostable Diapers in Compost

### Suggested Compost Mix

| Ingredient | Compostable Diaper | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **10%** | **20%** | **70%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Compostable Diapers | 400 | 29 | 0.4 | Compostable Diapers |

# Certified Compostable Plastics

Certified compostable plastics are plastics that look like normal plastics but can be broken down when put in a composting pile.

Certified compostable plastics have been checked by a special organisation to prove that they can be composted and are generally identified with a ‘seedling’ logo. Warning: Some brands claim to be biodegradable but do not fully break down in the process and can leave small fragments of plastic in the compost.

It is important for certified compostable plastics to reach high temperatures in a compost pile to start breaking down, usually over 50°C.

It is recommended to only agree to accept compostable plastics that have been successfully tested in composting.

### Where are compostable plastics found?

Compostable plastics are often mixed in with plastics for recycling or in general rubbish. They are too hard to separate from these waste streams. It is more likely to find enough compostable plastics to compost at an organisation where they only use certified compostable plastics.

### Current Management?

Compostable plastics often end up in landfill.

## How will Certified Compostable Plastics ENHANCE or INHIBIT Composting?


### Helpful for Aeration (*when hard*) but may impede aeration (*when soft*)

Hard compostable plastics are low density and suitable for allowing air into the compost pile without being mixed with anything. They allow air through the pile easily.

Soft compostable plastics can form thick mats if they are not mixed with other material with larger particle sizes, such as garden organics.

The materials in compostable plastics will not make odour. The compostable plastics will break down completely in the composting process.


### May Impede Water Retention

Compostable plastics only absorb water after they have been exposed to temperatures above 50°C for a period of several days.

Extra water might need to be added to the compost pile after a few days if there are a lot of compostable plastic in it.


### Neutral

Compostable plastics do not contain any nitrogen. The carbon that is in them is not available to microbes until it has been hot for a few days.

Compostable plastics cannot be used as the only source of carbon in a compost pile, they will need to be mixed with other organic materials that can provide both carbon and nitrogen at the start of the composting process.

## Using Certified Compostable Plastics in Compost

### Suggested Compost Mix

| Ingredient | Compostable Plastics | Manure | Garden Organics |
|---|---|---|---|
| % of pile (volume) | **10%** | **20%** | **70%** |

### Properties Table

| % Dry matter | Bulk density kg/m | Carbon % | Nitrogen % | % Dry matter |
|---|---|---|---|---|
| Certified Compostable Plastics | 250 | 30 | 0 | Certified Compostable Plastics |

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