Sustainable Soil Management
Course Manual – Part 1, 2 & 3

Trust Nature's Bio-Vital™ system

http://www.trustnature.com.au/

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This manual is intended to be used in association with Trust Nature's *Sustainable Soils Management Course* and is designed to compliment course notes and other course materials. This manual contains basic information that is further discussed and elaborated on during the course. For more information about the courses or the material and instructions contained herein, please contact info@trustnature.com.au

Introduction

Trust Nature's Bio-Vital system has been carefully developed over many years. It is the synthesis of the complex sciences of soil microbiology and plant nutrition combined with organics, traditional knowledge and permaculture principles. This system takes the mystery out of complex sciences and delivers knowledge in an easy to understand, easy to apply form.

In this manual, we redefine sustainable agriculture as 'the ability to improve production while reducing cost and improving soil fertility'. Learn this 3-part biological management system as the path forward to improving your productive soils:

1. **'Smells good' compost made easy: Trust Nature's Bio-Vital system.**
2. **Making soil probiotic: Soil microbiology simplified.**
3. **Making bio-fertilisers: The cheapest and best way to feed your plants.**

1-2-3- Grow!

Redefining Sustainable Agriculture:

One of the major global demands we face today is the heavily depleted state of our soil. The past few decades have seen an unprecedented demand on natural resources from modern agriculture, and this demand has proven to be unsustainable. Modern agriculture is artificially stripping the soil of its long-term nutrients to such extremes that we are essentially eating our grandchildren's food and leaving behind an agricultural wasteland as a primary burden for future generations.

At Trust Nature we offer solutions to these confronting issues; solutions that combine modern science and natural systems with traditional knowledge so that we can begin to use agriculture as a regenerative system of management instead of a degrading one.

As with the science of plant nutrition, the science of soil life is a complex one. At Trust Nature we endeavour to take the mystery out of the science and teach the essential principles of a regenerative system we have termed Bio-Vital. We offer this knowledge through on-going courses and as open source information available for those who wish to grow their own food and for those committed to food sovereignty[1].

As communities, we have the responsibility to share information and resources. For example, many of us have the ability to grow our 'food for free' by better managing many of our local waste products as a resource.

The most meaningful indicator of the health of the land and the long-term wealth of a nation is whether soil is being formed or lost.

If soil is being lost, so too is the economic and ecological foundation on which production and conservation are based. Production can no longer be at the expense of soil health. At Trust Nature we believe we can use biological agricultural practice as a path forward for regenerating our productive soils rather than continuing to deplete them.

Current modern agricultural practice is based on a military approach where the first response to imbalance in the productive system is to kill something. In a biological system the first response is to add life so that nature can do what nature does best, which is create balance in our productive systems.

One of the primary ways to do this is through the production of specialist compost that is rich in plant nutrient and has a high diversity of beneficial soil microorganisms. This diversity and richness supports the balance and vitality of the growing system by empowering the natural processes rather than overriding them.

Bio-Vital compost is specifically designed to regenerate degraded soil, reduce input costs, make liquid soil probiotic[2] (specialist compost tea) and improve production. While many compost methods have been practiced over the centuries, we have endeavoured to create a specialised compost system that has all the intended benefits of good compost while containing more than 30% living microorganisms. It is the beneficial plant and soil microbes in high diversity in Bio-Vital compost that is the significant point of difference.

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1 Food sovereignty is the right of peoples, communities, and countries to define their own

2 Making soil probiotic is much like making yoghurt where a spoonful of culture is used to make a litre of product. We take small amounts of compost and wash the microorganisms into an aerated tank of water and quite literally grow 'hundreds of thousands' of organisms into 'thousands of millions' in just 24 hours. This uses simple methods, low cost and low energy and makes a powerful solution of beneficial microorganisms that we can spray onto our productive soils.

Sustainable plant health and production depends on specialised relationships with beneficial soil microbes. Microbes found in compost include many organisms that are found in healthy soils. These microorganisms affect the grower's ability to maintain or increase production while increasing soil vitality and fertility. It is the natural balance and management of the trilogy of minerals, microbes and organic matter that ultimately decides if we are going to be successful in increasing soil fertility while maintaining profitable production. In healthy soils, the biomass of fungi, bacteria, worms and protozoa can be several tonnes per hectare, all working around the clock to support your productive systems.

The diversity of microbes is essential, especially since we are often working with largely degraded soils with poor structure and low amounts of organic matter and humus. All of these elements affect nutrient cycling (the exchange of nutrients between plants, soils and organisms) and the soil's ability to build long-term carbon and fertility.

Plants require specific nutrients and a healthy food web is achieved when the diversity of organisms the plant requires are present and functioning within a healthy soil system. Microbiology works to make non-plant available nutrients in the soil plant-available and deliver nutrients to the plant when the plants need them. One of the many functions of a healthy food web is to hold nutrients in non-leachable forms so they remain in productive soils. This enables plants to release chemical signals through their roots and leaves as exudates to trigger specific biology to release specific nutrients in a plant-available form.

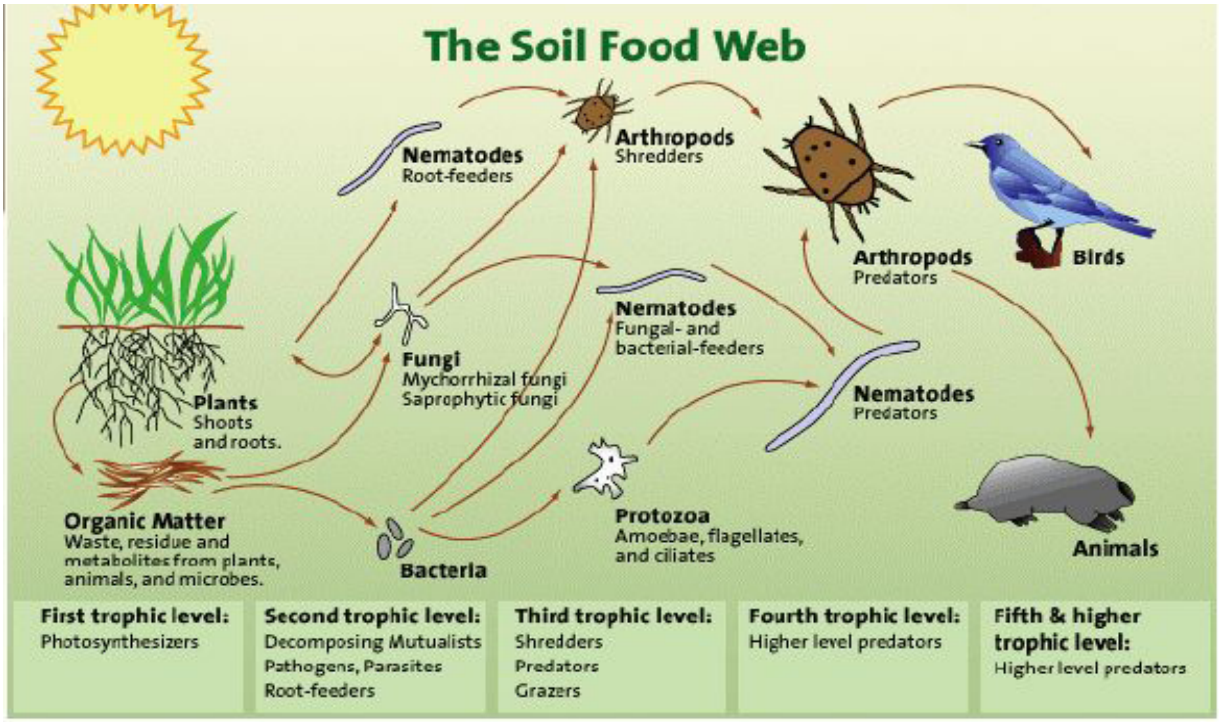

Figure 1: The Soil Food Web (Source: www.soilfoodweb.com.au)

Benefits of Soil Microorganisms:

- Building soil carbon as humus

- Building soil carbon in association with beneficial fungi
- Building soil structure
- Decomposing organic matter and building topsoil
- Increasing the soil's ability to hold and store water
- Making mutually beneficial relationships with productive plants
- Balancing soil pH in the rhizosphere (root zone)
- Increasing soil fertility
- Storing plant available nutrients in non-leachable forms
- Enhancing natural nutrient cycling processes
- Building the soil food web (the balanced diversity of organisms required to achieve nutrient cycling and sustainable management)
- Protecting productive plants from disease and insect attack
- Reducing soil toxicity
- Reducing weed impact
- Protecting productive plants from pests and disease

Natural principles apply to all systems. Whether you are growing food in your own backyard or in broad-acre production, it is simply a matter of scale. In part 1 of this manual, we demonstrate how to make specialised compost as the source of the beneficial soil microorganisms needed to achieve sustainable soil management on any scale.

There are 3 natural principles that are essential to our system:

1. **We support natural processes without overriding them.**
2. **When composting, the diversity of materials ensures the diversity of minerals and the diversity beneficial microorganisms.**
3. **As we build plant and microbial bio-diversity we advance soil succession, reduce input costs and improve production.**

Part 1

Specialist Compost Made Easy: Bio-Vital Compost

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Using the Bio-Vital method, we start by building a 3 cubic metre 'stack' and by the time the process is complete, we end up with more than a tonne of vital compost capable of regenerating soil and providing adequate microorganisms to establish nutrient cycling in the productive system. Like all good compost, it is rich in organic matter and plant nutrients, but has the added benefit of having a high diversity of beneficial plant and soil microorganisms essential for achieving sustainable production.

One tonne of finished Bio-Vital compost will provide**:**

- **The source of microorganisms as an inoculant to make several thousand litres of liquid soil probiotic capable of treating over 100 ha of productive soils;**
- **An adequate amount of compost to build a 100 m^2 vegetable garden in very poor soil;**
- **Compost for planting 100 fruit trees;**
- **Essential microorganisms as probiotic for adding an invaluable diversity of beneficial microorganisms to commercial composting systems.**

1. Assembling the Bio-Vital Compost Stack

The basics for making Bio-Vital compost: (an 8-10 week process requiring 4-6 turns) http://www.youtube.com/watch?v=LAB3KP0KLj4

When building the stack, we use approximately 3 parts 'high carbon' material, 2 parts 'green' material and 1 part 'high nitrogen material' as a general rule of thumb. This means that we can easily measure the materials as we build the stack, e.g. 3 wheelbarrows of straw mixed with wood chip, 2 wheelbarrows of hay mixed with weeds, and 1 wheelbarrow of mixed barnyard manure.

Materials Required:

- 1.5m^3 (cubic meters) of high carbon material, e.g. fallen leaf litter, straw, cardboard, wood chips, etc.
- 1m^3 of green material, e.g. fresh grass, hay, alfalfa (lucerne), weeds, etc.
- ½m^3 of high nitrogen material, e.g. cow or horse manure, blood and bone meal and legumes that have not been harvested for seed. This can include food scraps but meat products should be kept to a minimum.

Primary Principle: A diversity of inputs ensures a diversity of organisms. Where possible use a mix of materials, e.g. a mix of straw, cardboard and wood chips for the high carbon layer.

High carbon material: Straw and aged wood chips

Green material in high diversity

High nitrogen material: Farmyard manure with straw

Examples of Materials:

- High carbon material (brown): Straw as a grain harvest by-product, sawdust, wood chips, prunings, cardboard and paper, fallen tree leaves as a result of drought or seasonal change, corn stalks and processed sugar cane waste.

Vineyard pruning example of high carbon material 'brown' waste

- Green materials**:** Weeds (a favourite), grass clippings, landscaping clippings, hay, vegetable waste, seaweed, etc.

- High nitrogen materials (N): lucerne (alfalfa), clover, manures, blood and bone meal, restaurant food scraps, etc. Pure fowl manure can have twice the nitrogen content of cow manure so use half as much. It is important to note however, that cow manure has a diversity of microbes that are beneficial to the composting process and add value to the final product. If adhering to the basic principle of composting where the diversity of input ensures the diversity of beneficial microbes, attempt to include a component of cow manure or at least a diversity of high nitrogen materials where possible.

Note: The source of the diversity of beneficial microorganisms is the organisms already on the materials used for the composting process. This means that it can be worth the effort to get small amounts of materials from healthy natural systems such as creek beds, forest floor, etc. This adds a diversity of local microorganisms (IMO's) to systems that lack the full range of microorganisms to support nutrient cycling, build fertility and improve production.

Additional Inputs:

Rock phosphate, wood ash, crushed shell, kelp, humic acid crystals, animal products, old compost, forest floor material, good soil, etc. Add additional materials in moderation so as not to override or overly interfere with natural processes. For example, 10L of each additional input is considered adequate.

Carbon to Nitrogen ratios:

All organic matter and organisms are made up of larger amounts of carbon (C) combined with smaller amounts of nitrogen (N); this is called the carbon-to-nitrogen ratio (C:N ratio). Composting microorganisms requires reasonably correct proportions of carbon for energy and nitrogen for protein production. Research says that the most productive way to produce fertile, 'smell good' compost is to begin with a C:N ratio somewhere around 30 parts carbon to 1 part nitrogen (C:N 30:1).

If the C:N ratio is too high (excess carbon), decomposition slows down. If the C:N ratio is too low (excess nitrogen), you could end up with a stinky pile that defeats the primary intentions of composting, which are:

1. **To create long and short-term soil carbon as humus.**
2. **To grow a high diversity of beneficial plant and soil microorganisms.**
3. **To break down organic matter as a soil amendment and as a source of plant nutrients.**

When fresh organic material undergoes decomposition during composting, both the rate of decomposition and the amount of humus formed are related to the C:N ratio of the residue. When other conditions are correct, the rate of decomposition increases as the C:N ratio narrows. 'Faster', however, is not necessarily 'better'.

Humus and C:N:

- Approximately 35% of the carbon from organic material can be converted into soil humus when there is sufficient nitrogen present.
- Humus formed from the decomposition of organic matter contains approximately 50% carbon and 5% nitrogen, this means that the C:N ratio of the humus is 10:1.

Below are the average C:N ratios for some common composting ingredients. For our purposes, we classify the materials into 3 categories: 'High carbon' or 'brown', 'green' and 'high nitrogen'.

Note: This is only a general list to give you an understanding of the C:N ratios of compostable materials. These may vary considerably but are important indicators when appraising waste for composting.

C:N Ratio Indicator:

High Carbon or 'Brown' Ingredients:

- Sawdust and wood chip 500:1
- Newspaper and cardboard 200:1
- Straw 100:1
- Fallen leaves 80:1
- Corn Stalks 60:1

'Green' Ingredients:

- Lawn Clippings 25:1
- Hay 25:1
- Vegetable scraps 25:1
- Weeds 20:1
- Fresh seaweed 20:1

High Nitrogen Ingredients:

- Lucerne (alfalfa) 15:1
- Mixed food scraps 15:1
- Cow manure 15:1
- Humanure (composting toilets) 15:1
- Farmyard manure (mixed) 10:1
- Blood and bone meal 10:1
- Poultry manure (pure) 5:1
- Fish waste 5:1
- Poultry carcasses 5:1

Note: We monitor by moisture and temperature. This helps give us an indication of C:N ratios 'in the field'. If moisture is correct at about 50%, the temperature gives an indication of C:N ratios in correct balance, with a temperature range between 45ºC and 65ºC during the composting process. When moisture is correct and temperature is low, add high nitrogen material. When moisture is correct and temperatures are high, add high carbon material.

2. Building the Bio Vital Compost Stack

- Construct a wire ring from a 6m length. This will be approximately 2.5m in diameter and 1m high. The wire should be strong with small sized mesh. Secure the ring together with clips. **Note:** Wire usually comes 1.2m high. Fold the top edge of the wire over to make it 1m high, which will make it more rigid and easier to fill.

Construct the wire ring and begin with a high carbon layer

Note the layering of materials

- The ‘capping off’ process: Once the stack is 1m high (to the top of the wire cage), stop the layering process and make a pre-mix of 3 measures of high carbon material, 2 measures of green material and 1 measure of high nitrogen material. Be sure to moisten the materials as you mix them all together and then add this pre-mix to the top of the stack. This will ‘cap off’ the stack, which will end up being about 450 mm higher than the wire cage. At this point, every layer should have been well moistened with a misting nozzle and is ready to be loosely covered with a perforated tarp.
- Place a 20L bucket or something similar under the tarp for moisture and airflow management. This gives the tarp a dome shape ensuring heavy rain does not enter the compost stack and also ensuring there is plenty of airflow around the stack. When you cover it with a tarp, make sure you don’t seal the compost stack, as you need to be able to maintain airflow. You do this by keeping the tarp a couple of hundred millimetres off the ground so that air can enter the stack from the bottom.

Managing Materials:

1. Begin building the stack with a high carbon base layer using 3 wheelbarrows of high carbon material (about 200mm deep). Wood chips mixed with leaves and cardboard works well.
2. Mist with water as you add the material, then add 2 wheelbarrows (150mm layer) of green material and continue misting.
3. Now add 1 wheelbarrow (50mm layer) of high nitrogen material and mist well.
4. Repeat the layering process at least three times to build the material to the top of the wire cage. Once the cage is filled to the top, it is ready to be capped off. (See further capping off instructions below).

Note: We use the pre-mix for capping off the stack; the high carbon layers are bulky enough to allow for adequate diffusion of oxygen into the core of the stack (before the first turn). The capping off process helps the stack decompose at the same rate, while the layering ensures adequate diffusion of oxygen into the core. This specific method ensures early success and helps to maintain microbial diversity.

Covering the stack

Watering and Moisture:

As mentioned earlier, as the stack is being layered with various materials, it needs to be moistened for the microbes to be active. Moisten each layer of material as it is being added. It is essential to use a misting nozzle as moisture is better absorbed as a fine spray. If you see water running out of the bottom of the stack at any time, cease watering (or use a finer watering nozzle) until you add the next layer. Once the stack is built and covered, check the moisture daily.

Adding moisture as a mist for better absorption

Aerobic Thermal Composting:

The Bio-Vital compost stack relies on an aerobic, thermal process, which is regulated by moisture, temperature, structure and its ability to access oxygen and the turning cycles. This process requires free access for oxygen to be able to penetrate the stack in order for the dominance of aerobic microbes to occur. We treat the compost stack as a single living organism. As long as it has the correct moisture and access to oxygen, it can control its 'body temperature'. Hence, we use the vertical stack wire net system to allow easy access to oxygen.

The easiest way to check for adequate moisture is to take a handful of material from about 300mm into the stack, squeeze tightly and test to see if you can squeeze out a single drop of water. If so, the moisture content of the stack is most likely fine. You should at least have a very wet hand after squeezing. If the stack is drier than this, it requires additional moisture, which may be done by applying a fine mist to the stack. If the stack is too dry to wet your hand, the stack needs to be turned and watered with a fine mist whilst turning.

Generally, a well-dampened hand indicates 40% moisture and the ability to squeeze out a single drop of water indicates 50% moisture content. If the stack is too wet, open the wire cage and spread the material so it can dry out. Once moisture levels are balanced, reassemble the material within the cage.

Note: Ideally, we wait for ten days between turning the stack to encourage the natural processes for decomposition. In order to achieve this, the stack needs to be kept moist. Moisten the outside of the stack with a fine spray for five minutes daily and check for moisture penetration. Should the outer layer of the stack be well moistened and the inner core dryer, water the core with an open stream of water rather than a fine mist to help moisture penetration. If you cannot get good moisture distribution throughout the entire stack, you may need to turn the stack and mist as you turn.

Temperature:

Once we have the correct moisture, we can monitor the temperature of the stack. We suggest using a 900mm long compost temperature probe to do this. The optimum temperature range for an aerobic thermal compost during its active stage is between 45-65°C. Trials show that the most seeds and pathogens in the mix are destroyed when the temperature is maintained at 55°C for three days. It is recommended that all parts of the compost stack achieve at least 55°C for a minimum of three days. In order to ensure that all compostable materials achieve this temperature, move the outer materials into the core of the stack when turning.

Microbial activity increases temperature

Correcting the Mix:

Once you have checked the mix for sufficient moisture, you may need to make amendments to the stack to achieve the desired temperature. Ideally, the stack should reach 55ºC within three days. If you do not achieve temperatures between 55ºC and 65ºC by the 5th day of the composting process, you will need to add additional high nitrogen material during the first turn on day 10. This can take some trial and error, but adding 10% of the total volume of the stack as additional high nitrogen material should work nicely. Should the stack reach temperatures above 65°C by the 5th day, it will be necessary to add approximately 10% of the volume of the total stack as additional high carbon material when you turn it on day 10 in order to cool the stack down.

Note: Only in extreme circumstances will it be necessary to correct the mix before the initial ten-day period required for the first turn. Of course, the layering will be lost during the first turn, which is why corrections need to be done at this stage. The layered system ensures oxygen diffusion and reduces risk of losing microbial diversity before the first turn. The layered system with the wire net allows easy diffusion of oxygen and significantly reduces the activity of anaerobic microbes that are often counterproductive to our objectives for building soil health.

Bio-Vital compost depends on the dominance of the aerobic process. This is one reason why we use the wire net approach for building the stack. The wire net method allows for better diffusion of oxygen into the core of the stack. Be aware, however, of using material that is too fine to allow for easy diffusion of oxygen into the core as this may defeat the aerobic process. For example, when using sawdust and wood chips be sure to mix the two materials so that the stack has adequate structure for it to breathe. Similarly, when using wet grass clipping be sure to make a mix of clippings and hay.

The key to the wire net approach of building the stack is that we start with, and repeat a pattern of, three or more high carbon layers before capping of. The high carbon layers are

intended to have sufficient structure to allow for the diffusion of oxygen into the stack at each carbon layer and at the base of the stack. This ensures the dominance of aerobic processes, and also ensures that the end product has a high diversity of beneficial microorganisms.

The Turning Cycle:

Once you have built the stack, moistened the material properly and covered it with a tarp to manage moisture and airflow, the turning cycles need to be tended to (first turn at day 10). Consider the compost to be a living being that requires attention to stay alive and healthy. Air, moisture and temperature are your monitoring tools to ensure the good health of the compost stack.

Ideally, the stack should be turned every 10 days over the 8-10 week period. We wait 10 days between turnings because we want to support the natural process of decomposition without overly interfering. Waiting 10 days between turnings allows for complex microbial guilds to develop, including the all-important fungal successions. Turning too quickly can impede this complex development and reduce the benefits of the Bio-Vital system.

At the end of each 10-day period, the stack will be ready for turning. In order to do this, unclip the wire cage, remove it from around the existing stack and reassemble the cage next to the existing stack. Move the material from the outside edges of the existing stack to form the core of the newly placed wire cage using a four-pronged pitchfork. This way you are rebuilding the stack by using the outer materials of the original stack to form the new core. This ensures that all materials reach required temperature of 55º C and are equally processed.

Be sure to mist the material as you are moving it into the newly positioned cage. During this process the stack will no longer be layered and the materials will be completely mixed together. This gives the material that has been on the outside the opportunity to reach higher temperatures because they now form the core of the new stack.

Mist the material each time you turn the stack to maintain correct moisture

Compost after 4th turn

Note: The first turn is when you can make amendments to the stack should they be required, e.g. if the core of the stack did not reach 55ºC in the first 10 days you need to add 10% of the total stack of additional high nitrogen material. If the core of the stack exceeds temperatures of 65ºC during the first 10 days you need to add approximately 10% of the total stack in high carbon material. When making these additions, simply mix and mist the new material in as you go.

Temperature Cycles:

Temperature cycles are intended as guidelines only. Temperatures vary according to materials, quantities, moisture, structure and climate. They are however, a significant guide to good management and the following temperature guidelines help to ensure early success. Compost made during the warmer months may be faster and may be slower during cooler

periods. We manage the compost with a water resistant cover, which helps to keep the moisture in during dryer times and keeps the moisture out during wetter times. When using a cover, remember to loosely cover the stack to allow for oxygen diffusion.

Note: Should the temperature of the stack be higher on the outside than in the core, it may be that the core has dried out and the stack needs to be turned and watered.

- Day 1: 20°C (Air temperature may vary but core temperature should reach 20ºC provided there are good moisture levels).
- Day 2: Approximately 10°C increase in core temperature to 30-40°C (Check moisture daily and maintain moisture accordingly).
- Day 3: Optimally, we have achieved 50-65°C in the core of the stack.
- Day 3-10: Maintained between 50-65°C in the core.
- Day 10: 1st turn: Turn the stack (see point 8 above). Core temperature may drop to about 30°C once turned. Moisten with a fine spray whilst turning and mixing the stack to maintain proper moisture levels. The stack should be turned every ten days for aeration and to maintain moisture.
- Day 12: Core temperature returned to 50-65°C and maintained until 2nd turn at day 20.
- Day 20: 2nd turn: Turn and moisten the stack. Core temperature should be in the 30°C's
- Day 22-24: Core temperature should be similar to day 12 or slightly cooler. Maintain temperature at around 55°C.
- Day 30: 3rd turn: Turn and moisten. Materials should show signs of decomposition.

- Day 30-35: Core temperatures should return to the 50's°C and be maintained for an additional ten days with good moisture management.
- Day 40: 4th turn: Turn and moisten. Core temperatures drop when turned and increase to 40-45°C over the next five days. There should be significant signs of decomposition.
- Day 40-45: Core temperatures in the high 40's°C and maintained for the next ten days until stack is turned on day 50.
- Day 50: 5th turn: Turn and moisten. Core temperatures should be dropping with increased signs of decomposition. Stack may now be about half of its original size but close to its original weight. Note: At this stage you might reduce the diameter of the wire cage to increase the height of the stack or combine two stacks into a single stack if making multiple stacks.
- Day 50-55: Core temperature dropping to 30-40°C with extensive decomposition. Once temperatures drop to 25°C the compost is ready to be used.
  Note: Compost can be left to 'cure' further in some composting systems. However, we endeavour to use the compost at 25ºC when organisms are still active.

The finished product after an 8-12 week process

Bulk composting from municipal waste: Managing the process

Additional Notes:

- If your compost smells bad, something is very wrong. It may be too wet or have no structure, which means it has gone anaerobic and may be toxic to plants.
- The finished product should be dark brown not black; dark brown is the indication of humus, and is the final and healthy result of good composting.
- When using compost as a component of your growing medium (e.g. greenhouse, garden or nursery mix), restrict your compost to a maximum of 30% of the mix and reduce your watering. Compost accepts and holds more moisture than soil.
- Finished compost has structure; it crumbs and is not like glue. Finished compost should be kept moist to maintain microbial diversity (40% moisture).
- Finished compost, stored properly, will be an active inoculant for making soil probiotic (actively aerated compost tea) for 3-6 months.
- The Bio-Vital compost process must be treated as a living organism in its entirety, managed and watered daily if needed and turned as recommended. The 10-12 day disturbance of turning is a necessary part of the management regime.

Glossary of Terms:

- **Sustainable agriculture:** The ability to build soil fertility while we reduce expensive inputs and improve production.
- **Aerobic soil bacteria**: Bacteria are single celled organisms that can number as many as a billion per gram of soil. What they lack in size they make up for in numbers. When making compost tea as soil probiotic, a single bacterium can become millions in just 24 hours. During nutrient cycling they release nitrogen and minerals in a plant-available form. Bacteria help hold nutrients in your soil and assist in building aerobic soil structure.
- **Nutrient cycling:** A nutrient cycle depends on an intact soil food web and is the movement and exchange of organic and inorganic matter back into the production of living matter. The process is regulated by microorganisms that decompose matter into nutrients. Nutrient cycles occur within all ecosystems.
- **Soil Food Web:** (www.soilfoodweb.com) The high diversity of soil macro and microorganisms that work in cycles to digest and release plant-available nutrients, Plants require specific nutrients build soil structure, protect your productive plants and build soil fertility.
- **Aerobic:** Means 'in the presence of oxygen'. We select for aerobic microorganisms as they support healthy soil and healthy plant development. Aerobic soil structure paves the way for the development of mycorrhizal fungi, essential for reducing expensive input costs for 90% of our productive plants.
- **Anaerobic:** Means 'without the presence of oxygen'. In soil systems, anaerobic is an unhealthy soil state. It helps to breed pathogens, defeats root development and collapses soil structure. Beneficial fungi breathe oxygen and are responsible for soil structure; they cannot live in anaerobic conditions.
- **Mycorrhizal Fungi:** Fungi that sequester soil carbon from mutualistic exchanges with productive plants. They exchange minerals and water for liquid carbon, sugars and proteins directly in the root zone. Fungi breath oxygen and are non- photosynthetic, therefore relying on intimate relationships with productive plants. Recent research has shown that mycorrhizal fungi produce glomalin; a protein that binds soil particles and stores both carbon and nitrogen. These glomalin-related soil proteins are an important part of building soil carbon as humus.
- **Saprophytic Fungi**: The largest group of fungi. They grow on dead organic matter such as fallen trees and other forms of organic detritus. These fungi have enzymes that decompose cellulose and lignin found in the organic matter and provide an important source of available carbon for many organisms.
- **Humus:** Makes soil dark and is the final decomposition of organic matter. It is partly made up of long and short-term carbon. Humus can hold the equivalent of 80–90% of its weight in moisture, and dramatically increases the soil's capacity to withstand drought conditions. The overuse of high nitrogen fertilizers strips out soil humus and collapses long-term soil fertility for short-term gain.

Part 2

Making Plant and Soil Probiotic: Restoring the Soil Food Web

Benefits of Bio-Vital soil pro-biotic:

www.trustnature.com.au / www.hiddengarden.com.au

Probiotic (actively aerated compost tea) is a high diversity of beneficial plant and soil microorganisms that have been extracted from compost into a solution that is sprayed out onto our soils and productive crops for multiple benefits. Over a 24-hour period, we are able to grow hundreds of thousands of organisms into thousands of millions to apply onto degraded soils. Microorganisms work to build fertility, reduce input costs, protect crops, improve production and are an essential element of soil regeneration.

Making soil probiotic requires a specialist aeration machine. The aeration machine is called a 'bubbler' or 'brewer' and several are commercially available. Go tho this link for photos of the Bio-Vital 'compost tea brewers' in action.

https://www.youtube.com/watch?v=WlcX2WpnQWI#t=21
https://www.youtube.com/watch?v=1dEJg0Ob5cg

Trust Nature's 1000L Bio-Vital brewer for commercial use

Bio-Vital 200L stainless steel brewer, perfect for nurseries and horticulture


DIY 60L brewer

20L home garden brewer

Making soil probiotic is much like making yogurt where we take a small amount of culture to make large new batches. With probiotic, we wash the organisms out of small amounts of compost and grow them in a solution to make a powerful soil amendment rich in microorganisms that revitalize degraded soils, build fertility and aid production. The organisms washed out of just 10L of quality compost makes 1000L of plant and soil probiotic.

Probiotic adds a high diversity of beneficial microorganisms to the soil in an easy-to-spray out solution; these include bacteria, fungi, protozoa and nematodes. Beneficial microorganisms are sprayed onto the soil and onto your productive plants as probiotic and work 24 hours a day, 7 days a week to biologically restore degraded soil and support and protect your crops. Beneficial organisms are responsible for improving production, reducing management, advancing soil structure, balancing soil pH, establishing long-term soil fertility and improving the ability for soils to accept and hold nutrients and water.

As we build a diversity of organisms in the soil, we achieve nutrient cycling. Nutrient cycling depends on the complex relationships of organisms in the Soil Food Web. It is not just about introducing a high number of organisms back into depleted soils; it is that they are introduced *in high diversity.* Nutrient cycling depends on a healthy and appropriate diversity of organisms. It is the soil's ability to sustain nutrient cycling that enables us to achieve sustainable production and reduce cost as we improve soil fertility.

When nutrients are available to keep bacteria and fungi actively growing, it provides a resource to be taken up by the organisms or plants and cycled and recycled through the system. When nutrients are released in the system through nutrient cycling, nutrients not taken up by plants are again taken up by organisms and continue to be held in the system. This is the essence of nutrient cycling. This is especially important in high rainfall or irrigated systems because it is how we hold nutrients in the system so they are not washed out and lost before conversion into profitable production.

What makes plant-available minerals, enzymes, hormones, and plant- growth-promoting materials from organic matter and the soil's parent material?

The bacteria, fungi, protozoa, nematodes and micro-arthropods do this and depend on mutual relationships with living plants to be able to do this effectively. In any sustainable system, microbes depend on living plants and plants depend on living microbe. When we lose this relationship, we depend on expensive inputs and increased management, thus highlighting the importance of the soil food web for sustaining nutrient cycling.

Soil probiotic adds soil microbiology to disturbed soils to restore complex diversity. It is these microbes that make the plant-available minerals, enzymes and hormones that your productive plants need plus delivers them to your plants at the optimal rates. This is one of the many reasons we recommend applying consistent applications of soil probiotic to our productive systems.

By having the ability to make probiotic as needed, we can apply beneficial microorganisms to the soils and crops at any time. As we add microorganisms, we build the soil's ability to sustain a more complex array of plants because we are building a more complex array of organisms. This is an essential part of the microbial restructuring of soils and is key to nature's ability to advance soils and build soil nutrients (natural secession).

Probiotic is a solution of microbes originally extracted from aerobic compost. Probiotic is also an aerobic process and selects for aerobic microorganisms and grows these organisms in abundance. The consistent application of probiotic restructures anaerobic (compacted) soils as the aerobic organisms out-compete the anaerobes that are responsible for the maintenance of anaerobic conditions. As aerobic organisms dominate, soils become restructured as an aerobic medium, which promotes plant and soil health.

As we aerobically restructure soils we increase the plant's ability to build deeper and more complex root systems. The root systems become more efficient as they develop more complex mutually beneficial relationships with soil organisms, such as soil fungi. Soil Fungi significantly extends the plants nutrient absorption capabilities and the plant's access to nutrients because *the plant is no longer limited to its photosynthetic capabilities for improved production*.

Without understanding and developing the relationships between productive plants and soil microbiology, we are left with 'organic production' or chemical based agriculture, which often fails in productivity and requires excessive inputs and management.

The key to reducing input costs for organic production is the bio-organic relationships of plants, soils, and microorganisms.

Compost as inoculant:

We need to make certain that the compost as inoculant for the probiotic contains the diversity of species of bacteria, fungi, protozoa and nematodes so the process we want will occur. The diversity of organisms needs to be in the compost. We need to extract the organisms out of the compost to increase them in numbers as probiotic, but remember, we can't grow what we don't have; the diversity has to *already* be in the compost.

Primary Principle: When making compost as an inoculant, the diversity of materials ensures a diversity of microbes.

We include weeds, woody materials, green waste, manures, fish waste, etc. to make biologically rich, aerobic, thermal compost, assuring a rich diversity of organisms for making probiotics.

Bio-Vital 'inoculum' compost

Just like using a spoonful of yogurt to make several litres, we use just a few kilos of inoculum compost to make 1000L of probiotic

Application methods and rates can vary considerably

Pobiotic applied to 50L per hectare on pasture: 'Which side of the fence are you on?'

Probiotic applied to 200L per hectare on cropping

Probiotic applied to 500L per hectare on food forest

There is an optimum diversity of species of microorganisms for each combination of crop type, climate, region, soil type, amount of organic matter and water supply. We make and apply the highest diversity possible and let nature select for the appropriate balance. *When in doubt, trust nature.*

Lower secession, bacterial-dominated soils are still able to maintain pH, have available N, achieve soil structure and nutrient cycling but are better suited for annual plants. Perennials will be more productive in more advanced, fungal-dominated soil. If we are designing for a specific crop, then it is a matter of balance, but remember that 90% of our productive crops depend on mycorrhizal fungal relationships *or* expensive inputs. The

choice is yours. As a general rule, more advanced soils are more productive. It is important to note that the less disturbed soils are, the more likely that they will have a healthy fungal diversity. When we include a diversity of species and mix annuals with perennials, we let nature select for the diversity and balance of species of soil organisms. When we apply probiotic, we give nature the tools to do what nature does best; find balance in our productive systems. This paves the way for sustainable production and reduces cost over time while we build soil carbon and long-term soil fertility as humus.

Understanding plant and soil probiotic:

Soil Probiotic is alive with a high diversity of beneficial microorganisms and is a powerful accelerator for soil recovery. There are more microbes in a handful of healthy soil then there are people on the planet.

The use of probiotic is recommended any time the organisms in the soil or on the plants are not at optimum diversity. Chemical-based pesticides, fumigants, herbicides and fertilizers kill a range of the beneficial microorganisms that support plant growth and soil health while probiotic improves the life in the soil and on plant surfaces. High quality probiotic will inoculate the leaf surface and soil with beneficial microorganisms, building plant and soil health instead of destroying it.

Probiotic production is a continually aerated 'brewing process', specifically designed to grow aerobic microorganisms.

Benefits of using of probiotic containing the full diversity of organisms include:

- Protecting plant surfaces with beneficial organisms which prevent disease-causing organisms from attacking the plant
- Improved plant growth efficiency as a result of improving nutrient retention in the soil
- Improved plant nutrition by increasing nutrient availability in the root system through nutrient cycling
- Advancement of soil ecology for the development of mycorrhizal fungi
- Reduced negative impacts of chemical-based pesticides, herbicides and fertilizers on beneficial microorganisms in the soil ecosystem by restoring diversity
- Improved uptake of nutrients by increasing foliar uptake as beneficial microorganisms increase the time stomata's stay open and work to reduce evaporative loss from the leaf surface
- Reduced water loss, improved water retention in the soil
- Increase of soil fertility as we improve production

When using a probiotic aeration machine, you need to understand that while the process is relatively simple it is remarkably specific. Please follow directions carefully.

Additional notes for making soil probiotic:

1. Firstly, you will require good quality compost, not commercially available at the local hardware. Make your own or get some made by the local community garden or a quality supplier. Note different compost tea brewers require different formulas. Follow directions and if you are relying on a commercial result, get the compost and the soil probiotic tested by a reliable laboratory.
2. Carefully choose you compost tea brewer. It needs to be able to wash the microbes out of the compost into the solution in the initial process known as the 'extraction process'. In Australia, we recommend the 'Bio-Vital Compost Tea Brewer'. In the U.S.A., we recommend the 'Geo-Tea Brewer'. These are the machines used by Harvard University and have been extensively tested by the Soil Food Web Institute and by AgPath at Melbourne University.
3. Once you have the compost tea brewer of choice, read the directions carefully and then fill the brewer with water to the required depth. The water must be non-chlorinated or the chlorine must be gassed off for at least an hour before adding compost.
4. Add the recommended microbe foods to the non-chlorinated water and turn on the aerator to mix the foods. Some typical foods may include liquid fish fertilizer, liquid kelp, liquid humic acid, oat flour, minerals, and some specific types of bio-fertilizers. Liquid foods are concentrates and have either very low or very high pH that can kill your organisms, so mix the foods with the water before adding the compost.
5. Fill the compost tea bag with the recommended amount of quality compost and begin the extraction process with the air blower. After about an hour, 75% of the compost should be extracted out of the bag into the solution. DIY compost tea brewers may not have an extraction bag, so place the compost directly into the solution of non-chlorinated water and microbial foods. Any debris can be strained out later. DIY compost tea brewers should be tested to ensure you are getting a worthwhile result. (See soil food web laboratories or search for a biological testing laboratory of preference near you).
6. The water in the brewer should appear to be 'boiling' from the aeration into the tank; the water should be circulating as a result of the aeration to ensure that there are no low oxygen sites in the solution.
7. Let the brewer brew for the recommended amount of time (often 24 hours) so that the organisms can eat all the foods and you achieve maximum results for saturating the solution with a high diversity of organisms.

   Once you have completed the process, you now have 'living water' containing many millions of organisms in high diversity. Any good brewer will maintain the oxygen levels above 6ppm. Therefore, you have selected for a dominance of *aerobic organisms* that build soil and plant vitality.

Notes of common failures:

1. Poor quality compost.
2. Not having a good quality brewer.
3. You need to follow directions carefully. This is a simple process but it is also very specific.
4. You can kill your microorganisms if the foods contain preservatives so make sure that you mix foods with the water before adding the compost.
5. A common mistake is believing that 'more is better' when it comes to adding microbe foods. In reality it is a matter of careful balance. Follow directions or test with a laboratory.
6. Application rates vary tremendously due to conditions of plants and soils, climate, crops and management. For broad acre pasture, we use a minimum of 50L per ha; for greenhouses, we use up to 500L per 1000M2 of greenhouse. Follow the brewer instructions or consult your biological consultant or laboratory.

Now that you have attended the training and followed the instructions, we will move onto the third part of the Bio-Vital System: Bio-fertilisers and related products. Once you understand the 3 essential components of the system we will give some specific application recommendations and guidelines including how to feed organisms once applied, build organic matter and soil carbon, maintain fertility and manage for profitable enjoyment. It is a blessing that we can turn a degrading system into a regenerating system in just a couple of years and join a system that ***returns the life back into your soils and the profits and enjoyment back into agriculture.***

For further information contact paul@trustnature.com.au or visit the website:
www.trustnature.com.au

Part 3:

Bio-fertiliser 101 & 102

A bio-fertiliser is an anaerobic fermentation that effectively makes non-plant available nutrients plant-available. Bio-fertilisers contain plant-available nutrients and living microorganisms that promote growth by increasing the supply or availability of primary nutrients to your productive plants.

Bio-fertilisers provide eco-friendly organic agro-inputs and are more cost-effective than chemical fertilisers.

Bio-fertilisers feed your plants and soils and are especially good for replacing expensive inputs as your foundation input product. You may still need to add additional inputs but now you have a foundation product that works together with soil probiotic, these can be applied together as a single application for reducing input costs, building fertility, improving production and repairing degraded land. This is the 3rd element of Trust Nature's Bio-Vital system.

The final product may be amber to brown and smells strong but never 'putrid'

Decomposition of organic matter without oxygen results in fermentation. This assists recalcitrant organic compounds to break down into plant available nutrients by the action of living fermentative organisms. In turn, the nutrients are largely converted into living organisms as 'microbial protein'. As the microbes die and or excrete, they release plant-available nutrients. Other microbes' take up nutrients not taken up by the plant and are held in the system to be later released during nutrient cycling.

Bio-Fertiliser 101:

Bio-fertiliser 101 is the basic bio-fertiliser made in bulk as a general application product that can be applied to virtually all crops and soils to promote plant and soil health. As we will see in the section on 'Bio-Fertiliser 102', we can add additional materials to enhance the product into a more mineral rich bio-fertiliser.

Note: Never add anything to the bio-fertilisers that you would not feed a cow, e.g. blood and bone meal, fish fertilisers, etc. as they will cause the solution to become putrid and be counter- productive to plant and soil health.

The final product is rich in microorganisms including lactic acid, actinomycete and photosynthetic bacteria as well as plant-available major and minor nutrients.

The Process:

This is an anaerobic fermentation but is not in competition with the aerobic process of composting and soil probiotic. It is a complementary product.

- Assemble ingredients for a 200L open top drum:

1. 40 L of fresh cow dung.
2. 3L of milk
3. 2L of blackstrap molasses
4. 200grams of bakers yeast
5. 4L of wood ash
6. 2L of fine agricultural rock dust
7. Non-chlorinated water.

- Obtain a 200L drum that has a removable top. The drums need to be sealable so that no air can penetrate during the fermentation process.

200L drums with removable lids

Insert a fitting into the airlock

Pour 40L of fresh cow manure into each 200L drum

Note: Be sure that you add the manure before adding any water or you may experience an unpleasant 'splash affect'!

Add the dry products including sieved wood ash and rock dust

- Once you have added the manure, wood ash and rock dust to the drum, prepare the liquid ingredients in a separate bucket to activate the yeast before adding to the drum.
- Mix 2L of molasses with 2L of very warm water, and then add 3L of milk and 200 grams of dried bakers yeast. Stir well; the solution should be warm enough to activate the yeast. Wait a few minutes and add to the drum. **Note:** If you do not have fresh milk, use powered milk with a litre of living yogurt. Non-pasteurised fresh milk is the ideal.

Activating yeast in molasses

- Now that you have added all the ingredients for the basic bio-fertiliser, fill the drum to within 200mm of the top. The air space is an important factor for the working of the air lock. **Note:** The water must be non-chlorinated. As you are filling the drum with the water, mix well so you create slurry from a mix of all the ingredients. Now you are ready to place the top on the drum and fit the airlock, much the same as for making beer.

Stir mixture before sealing

Attach airlock

Note: Once you fill the bottle with water, you will create the airlock. Please check the airlock regularly; the most common reason for failure is the failure of the airlock working properly.

Bio-Fertiliser 102 (Advanced Bio-fertiliser):

While Bio-fertiliser 101 is a foundation product that is simple to make for very low cost and minimal effort, Bio-fertiliser 102 may be more costly and the ingredients more difficult to access. Both are used as foundation products and can be applied on their own or with probiotic as soil drench or as a foliar spray. The process is almost exactly the same with the following additions:

- If we have access to a freshly killed cow, the contents of the first stomach are called the 'rumen'. This is rich in specialist microorganisms that are expert at converting low energy foods into high-energy nutrients. Although we find these organisms in fresh cow manure, the rumen is the preferred source. If we have access to the rumen, it can be as much as 50L of material, which is enough to serve as an inoculant for 10 x 200L drums of bio-fertiliser, distributed evenly as an optional addition. **Note:** When emptying the contents of the first stomach, be very careful to not contaminate it with any of the stomach flesh. We only want the fermenting grass contents that smell very much like silage.

- The Bio-fertiliser 102 formula; the process is the same as Bio-fertiliser 101. See the additions in **bold:**

1. 40L of fresh cow dung- **Add 5L of fresh rumen.**
2. 3L of milk- **Increase to 6L of non-pasteurised milk.**
3. 2L of blackstrap molasses.- **Increase to 4L for mineralisation.**
4. 200 grams of dry bakers yeast or 500 grams of fresh bakers yeast.
5. 4L of wood ash- **Increase to 8L of wood ash.**
6. 2L of fine agricultural rock dust - **Add 5-10L of dried kelp and 1L of rock phosphate.**
7. Non-chlorinated water: As you are filling the drum, stir the ingredients into a slurry and leave a 200mm air space for fermentation.

Bio-fertiliser applied with probiotic is a powerful soil amendment

Making thousands of litres, made on-farm.

Note: We want reduced light conditions, so we simply cover the transparent containers with a tarp.

Filtering before spraying or storage; Bio-fertiliser lasts for months in storage

Preparation 252 with a 'boom-jet' nozzle

Application rates vary, as do application methods. Typically, we use 'Preparation 252' that we make in a spray tank. The formula is 200L of probiotic, 50L of bio-fertiliser and 2L of trace minerals. Fill the spray tank with non-chlorinated water and apply regularly.

Note: This manual is updated regularly with additional information and research.
For more specific information contact: info@trustnature.com.au

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