BLACK GOLD

A vermicompost manual for smallholder farmers and backyard gardeners in Fiji

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Compiled by Leikitah Katah Naituku, Leslie Ubaub,
Michael Furlong and Mereia Fong Lomavatu

Pacific Community
Communauté du Pacifique

Suva, Fiji, 2025

Original text: English

Pacific Community Cataloguing-in-publication data

Naituku, Leikitah Katah

Black gold: a vermicompost manual for smallholder farmers and backyard gardeners in Fiji / compiled by Leikitah Katah Naituku, Leslie Ubaub, Michael Furlong and Mereia Fong Lomavatu

1. Vermicomposting – Fiji – Handbooks, manuals, etc.

2. Compost – Fiji – Handbooks, manuals, etc.

3. Earthworm culture — Fiji – Handbooks, manuals, etc.

4. Earthworms – Fiji – Handbooks, manuals, etc.

5. Farms, Small – Fiji

I. Naituku, Leikitah Katah II. Ubaub, Leslie III. Furlong, Michael IV. Lomavatu-Fong, M. V. Title VI. Australian Centre for International Agriculture Research VII. Pacific Community VIII. University of the South Pacific

631.875099611 AACR2

ISBN: 978-982-00-1605-7

Prepared for publication at SPC's Suva Regional Office, Private Mail Bag, Suva, Fiji, 2025

www.spc.int | spc@spc.int

This manual was funded by

Australian Centre for International Agricultural Research | Australian Aid

through its scholarship program

PASS-CR PROGRAM | USP THE UNIVERSITY OF THE SOUTH PACIFIC

Funding that supported the production of this manual was provided by the Australian Centre for International Agriculture Research (ACIAR), through the Pacific Agriculture Science Scholarship and Climate Resilience (PASS-CR) Program and the Future Thinkers Fund, that allows students to incorporate climate change into their projects.

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Acknowledgements

This manual was developed to help smallholder farmers in Fiji. I wish to acknowledge the support and funds provided by the ACIAR's PASS-CR Future Thinkers Fund. I also acknowledge the University of the South Pacific for managing the funds and Fiji National University, through the School of Mechanical Engineering and the Agricultural Engineering department, where the research was undertaken.

To my supervisors, Dr Leslie Ubauab, Prof. Michael Furlong, and Dr Mereia Fong, thank you for your support, guidance and advice that enabled me to do something I am passionate about.

My gratitude also extends to Dr Daniela Medina, for her patience and time; patience, especially when I struggled to grasp the climate change concept. She took her time to explain how I could use vermicompost as a climate-smart tool.

I would also like to acknowledge the Certificate III and IV Agriculture Engineering program students who designed the vermicompost bins. I appreciate the enthusiasm, commitment, and energy they put into developing beautiful isometric designs for the bins.

A big *vinaka vakalevu* also goes out to Mr Nemani Dralimaka, Mr Navneel Chand, Mr Jona Koroi, Mr Livai Tamanalevu and Mr Romano Naituku for taking those designs and turning them into the vermicompost bins. I appreciate your effort, time and commitment in developing and completing the vermicompost bins. To Dr Ramona Sulifoa and Dr Rohit Lal at SPC, I appreciate your help in reviewing this manual.

And to my family, thank you for the effort, the commitment, time and help rendered in developing this manual. Thanks for always having my back. To my God, thank you for your grace that sustained me throughout this project.

Leikitah Katah Naituku

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1.0 Introduction

Smallholder farmers play a crucial role in Fiji's agricultural sector. They are, however, particularly vulnerable to climate change.

Sixty-five per cent of farmers in Fiji fall into the smallholder category, managing land areas of less than one hectare while over 70% of the urban and peri-urban population engage in some form of backyard gardening.[1] Rising temperatures contribute to high evapotranspiration and soil water loss while changing rainfall patterns and increased rainfall intensity can result in flooding, erosion and nutrient runoff, especially for farms lacking protected structures. Erosion of topsoil reduces soil fertility thus reducing crop yield for backyard gardeners and smallholder farmers while intensive farming under protected structures can lead to soil degradation. In addressing soil-related issues, farmers commonly resort to chemical fertilizers, however, these fertilizers in Fiji are imported and are costly for farmers. Additionally, overuse of chemical fertilizers may contribute to increased greenhouse gases (GHG) and also negatively impact human health.

Vegetable and fruit wastes are used as earthworm food.

Moreover, the majority of small holder farmers and backyard gardeners lack access to the proper waste collections facilities for appropriate disposal of organic wastes. Locally, organic wastes constitute 60% of the waste stream directed to landfills that contribute to the release of leachates and methane gas, thus affecting our environment.[2] There are alternative interventions available such as vermicomposting, that uses earthworms and other soil microorganisms to decompose organic wastes. This technique is environmentally friendlier and considered a climate-smart technology that helps to mitigate GHG emissions by reducing household and organic farm wastes and converting them into nutrient-rich soil.[3] Secondly, vermicompost also increases the resilience of smallholder farms and backyard gardens by improving soil fertility, soil structure, texture and water-holding capacity, thereby reducing the risk of soil water loss during high temperatures and promoting increased food production. This vermicompost manual aims to offer farmers and backyard gardeners an alternative approach to managing their household and organic wastes and through this mitigating GHG emissions and enhancing their agricultural production.

2.0 Understanding the differences between vermiculture and vermicomposting

What is vermiculture?

Vermiculture or "earthworm farming" is about **breeding earthworms**. In most cases, the main aim of breeding earthworms is to sell them for vermicompost production or boost on-farm stocks.[4] This manual focuses on vermicomposting.

What is vermicomposting?

Vermicomposting uses earthworms to convert **organic waste** into nutrient-rich compost. The aim is to improve soil quality.[4]

Organic waste from sources like kitchens, backyards, crop or livestock wastes (shown in Table 1) can be converted into valuable products like vermicompost.

Table 1: Examples of organic waste

KITCHEN WASTE	BACKYARD	CROP WASTE	LIVESTOCK WASTE
Fruits	Grass clippings	Rotten fruit	Cow dung
Vegetable peelings	Brown leaves	Vegetable waste	Aged chicken manure
Egg shells	Shrubs	Sugarcane waste	Horse manure
Egg trays			Goat manure
Tea bags			Sheep manure
Cardboard			

What is the difference between vermicompost and vermicast?

Vermicompost is what you get when earthworms and helpful microorganisms break down organic matter. It is packed with plant nutrients.[4, 5] Vermicast is literally worm poop. It forms as earthworms process soil and organic matter in their gut. Similar to a bird's gizzard, the worm's gut grinds and mixes the food into tiny particles. Helpful bacteria and antibiotics in the gut kills harmful pathogen and the waste gets coated with mucus before its expelled. The mucus binds the waste into soil-like aggregates. Vermicast is a natural fertilizer because it is rich in plant nutrients, enzymes and hormones.[5]

3.0 What are the benefits of vermicompost?

Vermicompost has various benefits including the following:[4, 5]

Environmental benefits

1. Reduce landfills wastes.
2. Produces an eco-friendly fertilizer from waste.
3. It is odour free.

Benefits to soil physical properties

Improves the soil texture and structure to promote better root growth. The mucus in vermicast acts as a natural glue, binding soil particles and creating more pore spaces. This improves air circulation and retains soil moisture.

Benefits to soil microbiology

1. Worm castings are rich in beneficial microbes, bacteria and enzymes and hormones crucial for plant growth.
2. Earthworms aid in reducing soil pathogens, thus suppressing plant diseases.

Benefits for soil nutrients and plant growth

Boosts plant growth with high levels of essential nutrients like:

N
Nitrogen
For leafy growth

P
Phosphorous
Strengthens the roots

K
Potassium
Supports flower and fruit production

- Rich in other macro and micro nutrients.
- Acts as a slow-release fertilizer without causing plants to burn.
- It is a faster method of composting compared to traditional methods.

Vermicompost was used to improve capsicum production.

4.0 What are some constraints to vermicompost?

While vermicompost offers advantages, there are some drawbacks to consider.[4]

a. The initial set-up cost can be high.
b. Neglect may lead to odour issues.
c. It is a time-consuming process.
d. It requires more space since earthworms are surface feeders and cannot process material over one metre high.

Despite these challenges, many farmers in tropical climates are embracing vermicompost production. It is essential that Fijian farmers are informed of this alternative method of converting waste into nutrient-rich soil, offering a sustainable alternative to chemical fertilizers.


Partially decomposed mixture of cow dung, shredded paper, and round cabbage at two weeks after adding earthworms.

5.0 Types of earthworms to use in Fiji

Not all earthworms are suitable for vermicomposting. The recommended ones are surface feeders, found near or just below their food source. In Fiji, the usual composting earthworm is the Indian or the Malaysian blue worm *(Perionyx excavates)*. The red wigglers *(Eiseina fetida)* have also been recently imported by the Grace Road company.

Figure 1:
Indian blue worm
(Perionyx excavates).

Indian Blue Worm[6]

- Length: Approximately 8–15 cm long.
- Longer and thinner than the red wriggler.
- Exhibits a glowing blue sheen on their head when placed under light.
- Reacts actively to touch or exposure to light by thrashing wildly.
- Efficiently process large amounts of organic matter.
- Widely used as a compost worm in the tropics.
- No visible banding.

The Red Wriggler

- Reddish-brown in colour.
- Adult length ranges from 2–12 cm.
- Exhibits small light and dark rings around their body.
- Tails are yellowish.
- Native to Europe but is now found worldwide.
- Tolerates temperature from 0–35°C.
- Can survive in frozen organic material.
- Can reproduce rapidly.

Figure 2:
The red wriggler *(Eiseina fetida)*[7]

Figure 3 below shows the main difference between the two species of earthworms. This manual will focus primarily on the Indian blue worm because it is the most commonly found locally.

Adult Indian Blue

Adult Red Wiggler

Figure 3:
Differences between the two earthworm species.[8]

6.0 The earthworm's basic needs

Vermicompost production involves moving earthworms from their natural environment to a man-made setting. Understanding the earthworm's habitat is important for achieving the desired outcomes. Earthworms have six important needs for effective decomposition process. Happy earthworms will produce high-quality vermicompost.

i. Comfortable beddings

An earthworm's bedding is its habitat or home, therefore it should be comfortable for it to thrive in. The bedding should have the following characteristics:

a. **Moisture absorption** – Beddings should be moist like a wrung-out sponge, releasing only one or two drops of water when squeezed.
b. **Good bulking potential** – Beddings should be loosely packed to allow proper air circulation.
c. **High-carbon content** – Use brown materials (high carbon) rather than green (high protein) to avoid excessive heat from fast decomposition, which can harm earthworms.

Table 2: Examples of earthworm beddings[4]

BEDDING MATERIAL	ABILITY TO ABSORB MOISTURE (Poor – Medium – Good)	COMMENTS
Newspapers	Good	Must be: ○ Shredded ○ Moistened
Corrugated cardboard/ egg trays	Good	
Dry leaves	Medium	
Wood chips/shavings	Poor	
Hay/dried grass	Medium	
Straw	Poor	
Saw dust	Medium	Moisten before use
Coco peat	Good	Soaked in water to dissolve prior to use

Note: Aged compost (over a year old) is also another suitable bedding material for earthworms.

Figure 4:
A: Shredded newspaper
B: Cardboard
C: Egg trays
D: Aged compost – all good bedding materials.

ii. Food

Earthworms love their food and under ideal conditions they can consume food at half of their body weight per day. They can consume almost any kind of decaying organic matter. However, to produce high-quality vermicompost, it is essential to feed them the right amount of food. Table 3 provides examples of common locally available feed stock.

Table 3: Commonly available feedstock[4,9]

FEED STOCK	COMMENTS
Aged cow manure	Pre-compost to kill weed seeds and quickly breakdown deworming medicine in animal wastes.
Sheep manure	
Goat manure	
Aged chicken manure	High in nitrogen so use sparingly. Pre-compost to avoid overheating.
Pig manure	If it is in liquid form, use absorbent beddings.
Vegetable peelings/ agricultural wastes (crop residues)	Pre-compost to prevent overheating. Some crop residues may take longer to decompose.
Seaweed	Rinse off salt to prevent killing the worms.
Legumes	Need to be mixed with manure. Fresh legumes, needs pre-decomposition.
Coffee grounds and tea bags	Can be mixed with vegetables. Pre-compost to prevent overheating.
Egg shells	Crush before adding to vermicompost to provide grit for earthworms.

Figure 5:
Vegetable wastes that can be used as earthworm food. Pre-composting must be carried out to prevent the overheating of bins.

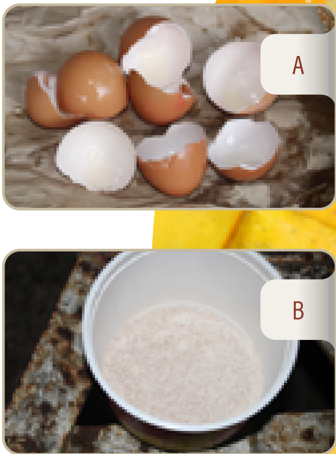


Figure 6:
A: Dried egg shells
B: Crushed before adding into vermicompost.

Figure 7: Fresh cow dung.

Always wear gloves when handling cow dung.

Note: Feed stock should be pre-composted before feeding to the worms to reduce the heat in the worm bins. The heat may kill the worms. Not all organic products are suitable for vermicomposting. Table 4 has a list of feed stocks to avoid.

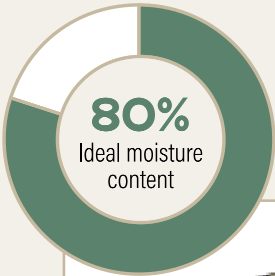
Table 4: Feed stock to avoid[2–4]

ORGANIC MATERIALS TO AVOID	COMMENTS
Pet manure and human waste	Do not include because it causes a foul smell.
Fat, meat, bones and dairy products	Can deplete the oxygen level in the bins and produce a foul odour.
Diseased plant	Pre-compost to kill diseases.
Non-degradable items	Earthworms will not consume them.
Greens with pesticides	Pesticides harm earthworms.
Garlic, onion and orange peels	Earthworms avoid garlic and onion. Pre-compost orange peels in small amounts.

Figure 8: Onion, garlic, and lemon are some feed stocks that earthworms do not like.

iii. Adequate moisture

Earthworms breathe through their skin as they lack lungs, requiring a moist environment.



If it is too dry, the earthworms will die.

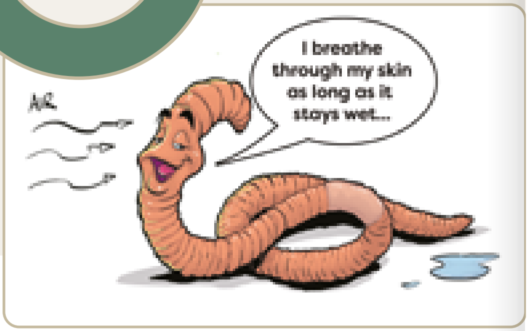


Figure 9:
A cartoon that depicts the importance of moisture.[10]

iv. Adequate aeration

Earthworms require oxygen to breathe, so their environment needs to have good airflow. Excessive moisture in the bedding can suffocate earthworms in the bins leading to their death.

v. pH

Earthworms thrive in environments that have a neutral pH of 7. Acidic conditions may cause earthworms to escape the bins and attract mites. Calcium carbonate can raise the pH level.

vi. Protection from high temperatures

Earthworms prefer temperatures between 15–25°C and may die if exposed to higher temperatures. The Indian blue worm thrives best below 25°C, so earthworm bins should be shaded to prevent overheating. On hot days, lightly sprinkle water in the bin to reduce the temperature.

7.0 How to collect earthworms

Figure 10:
Chopped vegetable waste.

Step 1:

Collect and finely chop kitchen peelings.

Figure 11:
Chopped vegetable waste mixed with cow dung slurry.

Step 2:

Mix about 30 grams of cow dung in 1 litre of water in a bucket before adding the vegetable waste in the slurry. Cow dung contains beneficial microbes that will aid in decomposing kitchen waste.

Figure 12:
Vegetable pile covered with moist cardboard.

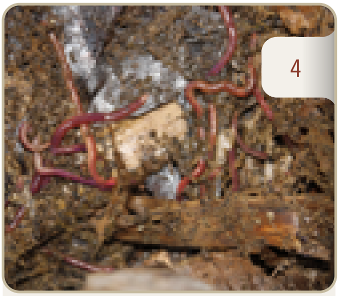


Figure 13:
Presence of earthworms after two weeks of decomposition.

Step 3:

Place the mixture in a shaded area in your garden, covering it with damp cardboard.

Note:
Ensure to moisten the cardboard daily.

Step 4:

After two weeks, collect your earthworms to begin vermicomposting.

8.0 Types of vermicompost systems

Vermicompost can be done outdoors or indoors depending on the system used. Two systems are explained in this manual.

i. Batch system

Earthworms are added to pre-composted bedding and food. Let the earthworms break down everything before adding a new batch. As the suggests, vermicompost is produced in batches.[4,5] Examples below further clarify this.

a. Bed method

Characteristics

Layers of pre-composted bedding and food are piled on top of each other to make a one-metre-high pile, before introducing earthworms to the pile. Cover the pile to maintain moisture and humidity at 80%.

Figure 14: Vermicompost beds covered with straw and commercial vermicompost beds.[10,11]

Image credits: Top: https://www.redwormcomposting.com/ Bottom: https://www.agrifarming.in/vermicompost#

Advantage

- Does not require expensive materials.

Disadvantages

- In Fiji, mongoose and toads may dig up the beds to feed on the earthworms if it is not covered properly.
- Requires more space.

b. Static pile bins

Characteristics

- Holes are drilled in the base of bins for aeration and drainage.
- Layers of pre-composted beddings and food are piled on top of each other before introducing earthworms into the bins. Close bins with lids that have drilled holes for airflow.
- Nothing more is added until all the food and beddings are decomposed.

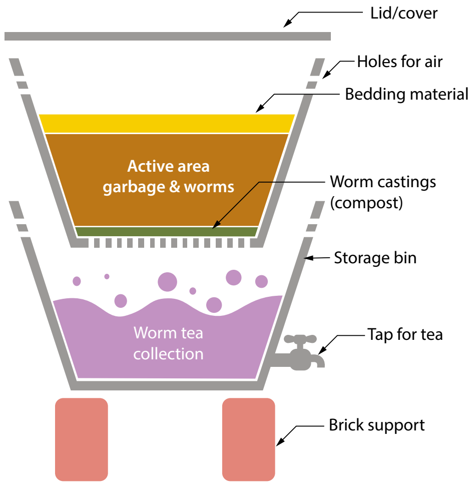


Figure 15: Diagram of the cross section of a static pile bin.[12]

Advantage

- This system uses less space.

Disadvantages

- Vermicompost is produced in batches, not continuously.
- The initial production cost might be higher, and harvesting can be time-consuming as earthworms must be manually separated from the vermicompost.

ii. Continuous system

Earthworms are introduced into the beddings and then food and additional beddings are continuously added from the top. Meanwhile, vermicompost is harvested from the bottom allowing for a continuous harvest. Examples include continuous flow beds and stack continuous flow beds.

a. Continuous flow beds

Characteristics

- It requires setting up with a concrete base, walls and a roof.
- The beds are divided up into sections and a layer of loose soil is added to the bottom to cover the concrete and allow earthworms to dig into it.
- Earthworms are introduced after adding a layer of bedding and food. Materials are continuously added until this section is filled.
- Place fresh feed in another section allowing earthworms to migrate.
- Vermicast is harvested from the previous section.

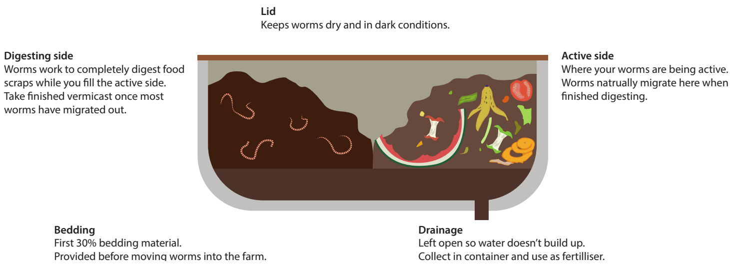


Figure 16: An example of a continuous flow bed where earthworms can migrate to new food source.[13]

Image credit: https://kats-garden.nz/blog/worm-farming

Advantage

- Enables a continuous harvest of vermicompost.

Disadvantage

- High initial cost of production to build shelter and concrete floors and walls. For a 5 x 2 m structure the estimated cost of production is FJD 2,564.35 (Appendix 1).

b. Stacked continuous flow bins

Characteristics

- Bins are stacked one above the other.
- The lower bins collect excess water and liquid produced during the vermicompost process while the bins above are where the pre-composted beddings and food are decomposed by earthworms.
- After all the beddings are decomposed, a new bin with pre-composted beddings and feed is positioned above it. Mesh is installed at the bottom of the bin, enabling earthworms to move through it to access the fresh material above. Vermicompost is then harvested from the bottom bin.

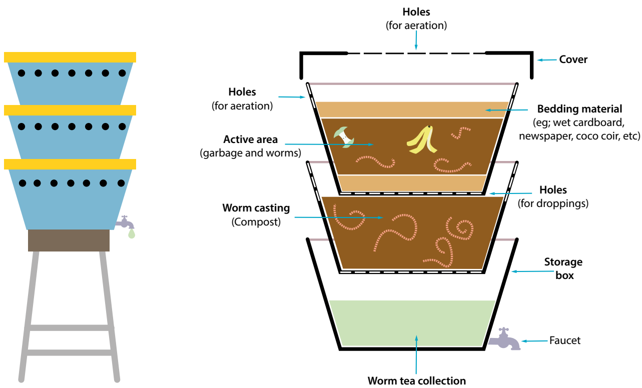


Figure 17: A diagram showing the cross section of a stacked continuous flow bin system.[14]

Advantage

- Occupies less space due to vertical stacking of bins, and harvesting vermicompost is easier.

Disadvantage

- Initial setup cost for this system can be expensive and time intensive. An estimated cost for producing on unit in Fiji is FJD 1,595.65 (at 2024 prices) (Appendix 2).

Moist shredded paper and cardboard ready for pre-decomposition

9.0 Steps in vermicompost bin development

1. Plan the bin structure

- Determine the size and structure of the bins.
- Decide on the number of bins needed.

2. Choose the bin location

- Select appropriate site with suitable environmental conditions.

3. Bin construction

1

Step 1: Gather recycled containers

Gather recycled containers such as 5 kg biscuit buckets, 25-litre empty cooking oil containers and old storage containers. Ensure thorough washing of any recycled containers to eliminate debris that might impact the earthworms. Wash empty oil containers with warm water and soap to remove excess oil.

In this manual, an empty 200-litre plastic drum, as seen, was opened, thoroughly washed and dried before cutting.

Figure 18:
Left: Empty biscuit bucket and
Right: Rubbish bins that can be used for vermicompost bins.

Figure 19:
Empty 200 litre containers that was used to make our vermicompost bins.

Step 2:
Cut to size

If the containers are too long, cut them to a manageable height. In this case, they were shortened to create two pieces.

Figure 20:
Cutting the bins.

Step 3:
Drill drainage outlets

At the bottom section of the bin, drill holes for drainage. In this bin, a 22 mm hole is drilled in the centre, and then a ¾ inch valve is inserted for the drainage outlet.

An alternative method is to drill a one-centimetre hole at the bottom of the bin and position a container underneath this to collect the wastewater.

Figure 21:
Left: Marking out the centre of the bin.
Right: Drill a hole at the centre using 22 mm in diameter drill bit.

Figure 22:
Left: Drain out (22 mm).
Right: Inserting the ¾ inch valve and sealed with silicon to prevent any leakages.

Figure 23:
Turn the red valve manually allow the drainage of vermicompost leachate which is the liquid that drains out from the vermicompost bins.

Figure 24:
A basin placed under the bin to collect leachate.

4

Step 4:
Insert galvanised grille

Galvanised grille is measured, cut and securely placed above the bottom half of the bins to support the weight of the soil.

Figure 25:
Grille cutting.

5

Step 5:
Cover grille with fine mesh

Cover the grille with fine mesh to keep the soil in place and prevent earthworms from escaping or drowning in the leachate. This combination of the grille and fine mesh also stops the soil from blending with the leachate. For this example, a black mesh material is measured, cut and then glued onto the grille.

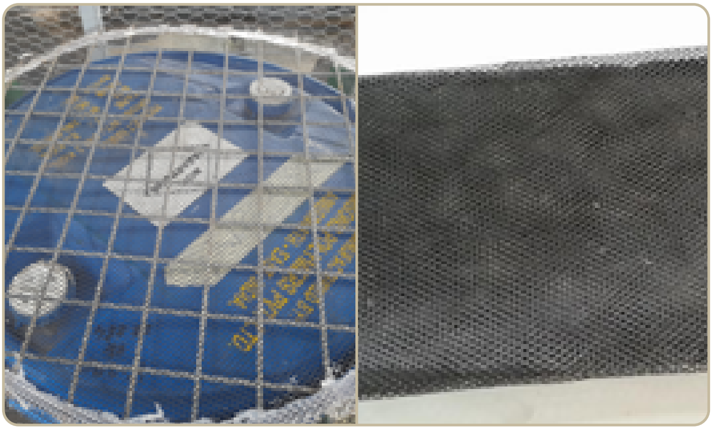


Figure 26:
Left: Grille covered with cancan material.
Right: Black mesh material.

Step 6: Complete assembly

Place the main compartment of the bin onto the galvanized mesh, securing it with silicon glue. Strap and pop rivet it to prevent tipping. The upper part of the bin serves as the lid and holes are drilled into it for proper air flow.

Figure 27:
Two compartment vermicompost bins with lid placed in a shaded area.

10.0 Steps in vermicompost-making

Before starting with your vermicompost, consider the following:

1. Clearly define your goals, such as:
    a. Producing vermicompost or selling earthworms to fellow farmers?
    b. Opting for large-scale or small-scale vermicompost production?
2. Choose a vermicompost system that aligns with your goals and the materials you have on hand.
3. Decide on the type of bedding and feedstock suitable for your vermicomposting endeavour.

Note: If your aim is vermiculture, maintain an earthworm stocking density of 5–10 kg per square metre of the bin to achieve the optimal number of earthworms.

List of materials

Table 5: List of materials needed for vermicompost production.

EARTHWORM SPECIES	BROWN MATERIAL/ EARTHWORM BEDDING	ORGANIC AGRICULTURAL WASTE	OTHERS
Indian blue worms *(Perionyx excavates)*	Shredded paper, cardboard, and egg trays	o Vegetable waste from kitchen o Cow dung	o Crushed eggshells o Earthworm bins o Water o *Lactobacillus* bacteria o Soil/river sand/ aged compost o Gloves o 5 mm mesh

Vermicompost process

1

Step 1:
Collect all the materials

2

Step 2:
Finely shred vegetable waste

Figure 28: Round cabbage waste collected from the Suva Municipal Market.

Figure 29: Cabbage shredded in a blender.

Figure 30: Shredded cabbage.

Figure 31: Vegetable waste can also be chopped up using a knife in the absence of blender.

Note: Chopping vegetable waste into finer pieces will help to speed up the decomposition process.

3

Step 3: Mix cow dung well

Crush the dried cow dung into finer particles and mix with water to moisten. Alternatively, you can use fresh cow dung, but it should be pre-composted before adding to the vermicompost system.

Figure 32:
Moist cow dung was pre-composted for two weeks.

4

Step 4: Prepare water

In a bucket, add 3 litres of rainwater or dechlorinated tap water and a teaspoon of *lactobacillus* bacteria (optional) and mix well.

Figure 33:
Tap water collected in a bucket and kept overnight to allow chlorine in the water to evaporate before use.

Figure 34:
A teaspoon of *lactobacillus* bacteria added to bucket of dechlorinated water.

Step 5:
Prepare brown materials

Shred the brown materials like shredded newspaper, egg trays, A4 paper and leaves.

Figure 35:
Shredded paper and cardboard.

Step 6:
Soak brown materials

Soak the shredded brown materials in a mixture of rainwater/dechlorinated water/*lactobacillus* bacteria, then squeeze to remove excess water, aiming for a consistency similar to a wrung-out sponge.

Figure 36:
Left: Shredded paper and cardboard soaked in a mixture of dechlorinated water and *lactobacillus* bacteria solution.
Right: The mixture is squeezed to remove excess water.

Step 7:
Mix bedding with vegetable waste

Mix the damp bedding with either vegetable waste or cow dung in the ratios mentioned in the table below by building it in layers.

Table 6: Ratio of vermicompost green-to-brown materials[15]

BROWN AND GREEN INGREDIENTS	RATIO (V:V)
Vegetable residues + shredded paper/cardboard	2:1
Cow dung + shredded paper/cardboard	2:1
Cow dung + vegetable residues + paper/shredded cardboard	2:2:1

Note: v:v stands for volume-to-volume ratio indicating how much of the green materials is used in relation to brown materials.

Step 8:
Assemble layers

Place a layer of aged compost at the bottom of the bins to introduce additional microbes before mixing the damp bedding with either vegetables waste or cow dung manure as per above ratio. Repeat the process. Ensure that there are two layers of soil/aged compost and two layers of materials.

Figure 37:
Left: Layering of beddings with aged compost as the first layer.
Right: Add in the second layer of shredded paper and cow dung.

Step 9:
Seal bin for two weeks

Seal the bin tightly for two weeks to allow for partial decomposition. After the first week, turn the pre-composted material in the bins to allow for even decomposition.

Figure 38:
Pre-decomposition done in tightly closed bins with holes drained at the bottom.

Step 10:
Check bin temperature

Pre-decomposition should be completed within two weeks. To check, insert your hand into the bins. If the pre-decomposing material feels warm, let it sit for another week, as adding earthworms at this stage could harm them. If it feels cold, you can add two tablespoons of crushed eggshells onto the layer of pre-composted materials and mix thoroughly.

Figure 39:
Finely crushed eggshells that are added to the vermicompost will act as grit for earthworms.

11

Step 11:
Add composting earthworms

Finally add composting earthworms to the bedding. The earthworm's stocking density is 2.5 kg of worms per square metre of the bin.

Figure 40:
The composting earthworms always clump together into a ball.

Figure 41:
Adding earthworms to the bins.

12

Step 12:
Add final layer of cover layer

Complete the process by adding a final layer of shredded newspaper or cardboard to cover the compost. Leaving the compost uncovered may attract fruit flies and black soldier flies, creating competition for food with the earthworms.

Figure 42:
Vermicompost covered with newspaper.

Step 13: Place bin in shade

Replace the lid and place the bin in a shaded place as **earthworms do not like direct sunlight.**

Step 14: Place bin on stand

The bins should be raised to allow for proper drainage and a container should be placed under the bins to collect any leachate that may drain into it.

Another example of a stand would be placing two blocks together to help raise the bins above ground.

Figure 43:
This vermicompost system consists of a three-compartment bin placed on a steel frame.

11.0 Bin maintenance

The bins should be monitored weekly for the following:

1. Avoid feeding the bins for the first two weeks after establishment. The earthworms have enough feed in the bins to keep them happy. Overfeeding will increase the temperature in the bins and kill the earthworms. Earthworms may escape from the bins or die if the temperatures are higher than 25°C or if they sense a change in their environment.
2. After the first two weeks, add 1–2 cups of partially decomposed kitchen waste or any organic material if needed. Cover it with shredded newspaper or cardboard to prevent fruit flies and black soldier flies, whose larvae may compete with the earthworms for food.

Figure 44:
Left and centre: Black soldier fly pupae in harvested vermicompost.
Right: Adult black solider fly resting on a capsicum leaf.

Figure 45:
Left: Dried up vermicompost.
Right: Vermicompost hardens and clamped up. This happens when the moisture content is not maintained.

3. Stop feeding two weeks before harvesting to give the earthworms enough time to fully decompose the feedstock and bedding.
4. Keep the bins in a shaded area away from direct sunlight.
5. If the temperature gets too hot, sprinkle a bit of water in the bins. Avoid adding too much water as excess water may drown the earthworms.
6. Protect your bins from pests such as ants and mongoose that feed on the earthworms.

12.0 Harvesting vermicompost

The vermicompost should be ready to harvest approximately 30 to 45 days later. It is ready to harvest when:

- All the materials are fully decomposed.
- The vermicompost emits an earthy smell.

There are few methods to harvest vermicompost.

i. Light method

Earthworms avoid light, so shining light on the vermicompost will prompt them to move away, making it easier to harvest the vermicompost. Dump the vermicompost on a flat plastic sheet and shine a light above it.

Figure 46:
Left: Vermicompost harvesting using the light method.
Right: dumping vermicompost on a sack and separating vermicompost from the earthworms.

Earthworms will quickly move below the surface allowing for manual removal of the top layer of vermicompost layer by layer. Pause only if earthworms become visible and repeat the process several times until only earthworms remain.

ii. Migration method

Earthworms have the tendency to migrate to new food sources. A quarter-inch screen is constructed at the bottom of a box that is placed over the earthworm bed. The box is filled with a layer of bedding to attract the worms to feed.

Figure 47:
Air drying vermicompost.

Figure 48:
Sieved vermicompost.

The harvested compost should be cured by air drying for one to two weeks before use. If the vermicompost is not used immediately, it can be sieved and stored for later use.

13.0 Vermicompost application

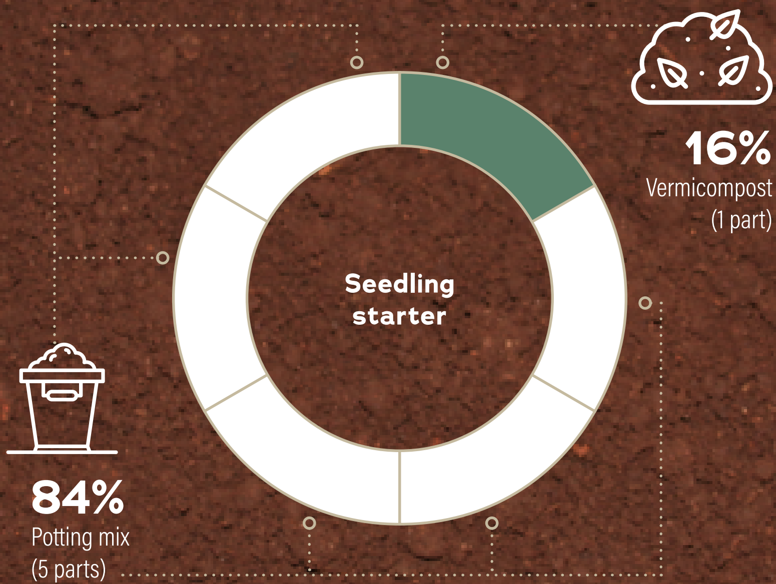
The harvested vermicompost can be used in the following ways:

a. **Seedling starter** – vermicompost can be mixed with potting mix at a ratio of 1:5 to improve germination and growth of seedlings, for example, 1 bucket of vermicompost soil mixed with 5 buckets of soil.

Note. Do not sow seedlings in 100% vermicompost because the seeds will not germinate. That is because it is too nutrient-rich and thick, which can prevent seeds from sprouting.

b. Apply vermicompost directly to the soil at a rate of 2.5 tons per hectare two weeks before transplanting seedlings. Use it as a side dressing every two weeks to enhance the soil's physical properties.

c. Apply vermicompost tea directly to plant roots or as a foliar spray for better growth and increased resistance to pests and diseases.


16%
Vermicompost
(1 part)
Seedling
starter
84%
Potting mix
(5 parts)

14.0 Types of vermicompost tea

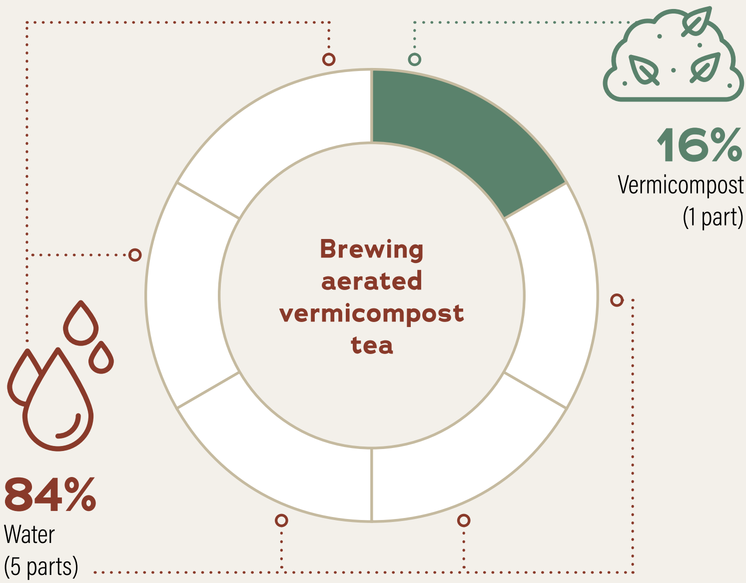
Vermicompost tea is beneficial as it requires less vermicompost than directly applying it to the soil. Two brewing methods are described below:

i. Aerated vermicompost tea

Materials required include:

- Vermicompost
- 10 litre buckets
- Old T-shirt/grog cloth/cheese cloth/old reusable shopping bags
- Air pump
  (Can be purchased from Things and Movies shop in Rewa Street, Suva for $80)
- Molasses
- Measuring cup
- Dechlorinated water or rainwater
  (Tap water is allowed to sit in the open for 24 hours to allow chlorine in water to evaporate).

To brew vermicompost tea, use a ratio of 1 part vermicompost to 5 parts water.[6, 7]



Steps to aerated vermicompost brewing:

Step 1: Mix molasses with water

1

Add a teaspoon of molasses to the water. Molasses will provide energy for the beneficial microorganisms.

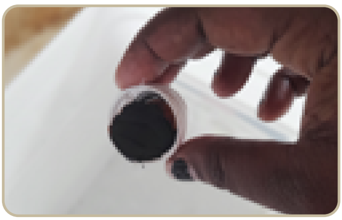


Figure 49:
Addition of molasses to dechlorinated water.

2

Step 2:
Steep vermicompost in water

Place four to six cups of vermicompost in an old T-shirt, grog cloth or reusable shopping bags, tie it securely and then submerge in a bucket of rainwater or dechlorinated water.

Figure 50:
Vermicompost soil placed in shopping bag.

3

Step 3:
Introduce oxygen

Place an air pump in the bucket to introduce oxygen into the mixture. Let it brew for 24 hours before use.

Figure 51:
Air pump circulates oxygen into the compost tea.

4

Step 4:
Maximum brewing time of 24 hours

After 24 hours, the vermicompost tea is ready to be used. It should not be brewed for more than 24 hours.

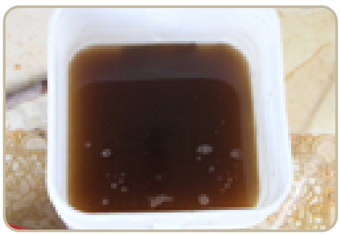


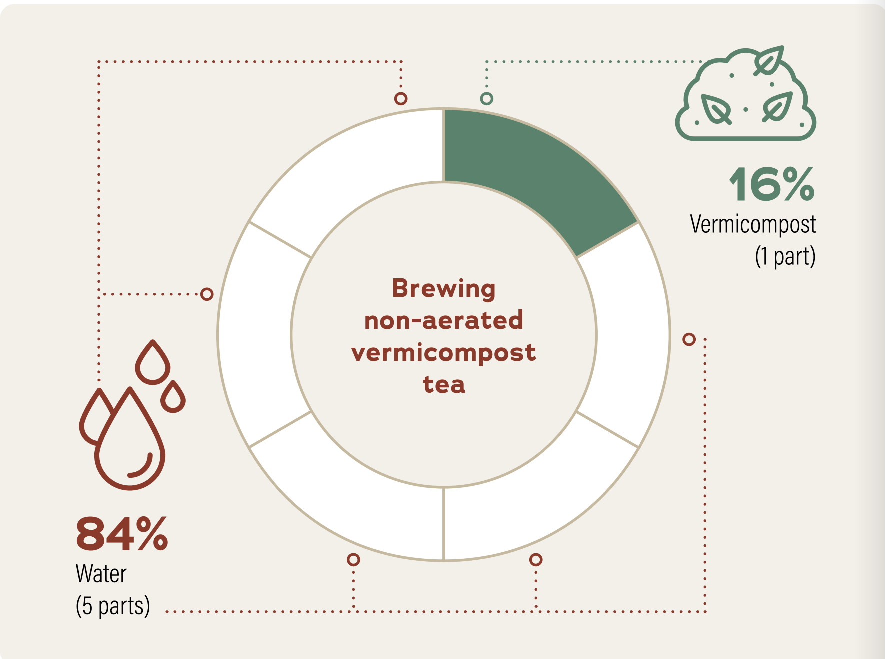
Figure 52:
A brewed compost tea.

ii. Non-aerated vermicompost tea

Materials needed include:

- Vermicompost
- 10 litre bucket
- Old T-shirt/grog cloth/cheese cloth/shopping bag
- Molasses
- Measuring cup
- Dechlorinated water or rainwater
  (Tap water should be allowed to sit in the open for 24 hours to allow the chlorine in the water to evaporate).

Similar to the aerated vermicompost tea, a ratio of one part vermicompost to five parts of water, which equates to 16.66% vermicompost in the mixture is used.



Steps to non-aerated vermicompost brewing:

1

Step 1:
Mix molasses with water

Add a teaspoon of molasses to the water. Molasses will provide energy for the beneficial microorganisms.

2

Step 2:
Steep vermicompost in water

Place four to six cups of vermicompost in an old T-shirt, grog cloth or shopping bags, tie it securely and then submerge in a bucket of rainwater or dechlorinated water.

3

Step 3:
Stir regularly for up to four days

An air pump is not required here but the water in the bucket should be stirred regularly for three to four days. The tea is ready in three to four days. It should not be kept for more than three days to prevent the buildup of harmful microorganisms.

Figure 53:
Opposite: A stick placed between the bag handles to enable easy stirring.

15.0 How to apply vermicompost tea

Once the tea is ready, remove the cloth containing vermicompost from the bucket, squeeze out the excess water and return the remaining solids back into your garden.

Figure 54: Remaining solids from vermicompost tea placed around base of plant.

Both the aerated and non-aerated vermicompost teas can be diluted at one part vermicompost tea to 10 parts of water. For example, 1 L of vermicompost tea to 10 L of water.

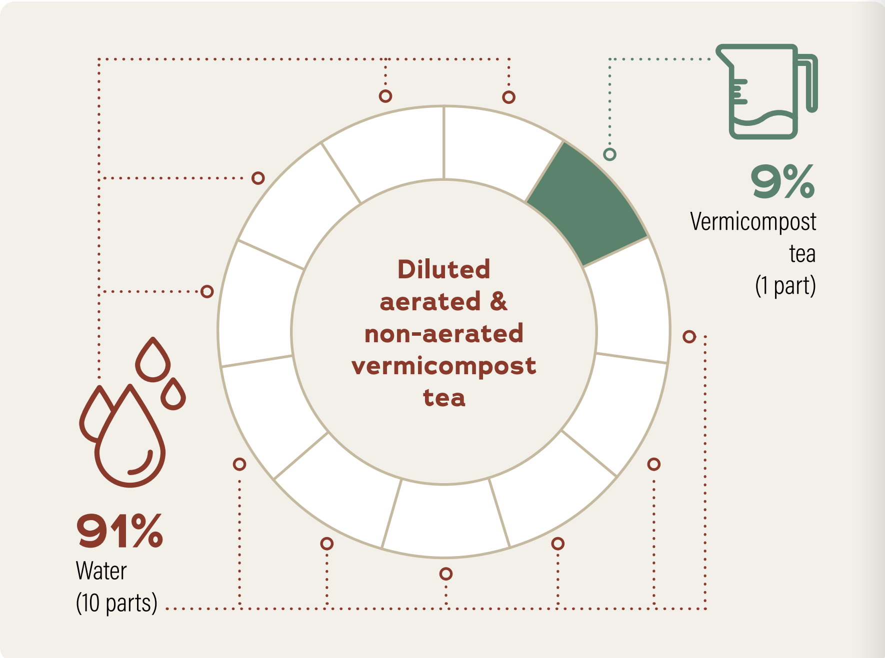


Figure 55:
Vermicompost tea dilution
Left: 1 L of vermicompost tea.
Centre: Mix in 10 L of water and
Right: Stir well.

The prepared vermicompost tea should be used immediately after it is made. The tea can be applied as follows:

Root drenching

Root drenching involves pouring the compost tea into the soil around the base of the plants near their root systems.

Figure 56:
Root drenching – applying vermicompost tea at the base of the plant around the root zone.

Foliar spraying

Foliar spraying involves placing the compost tea into spray cans and then spraying it onto the leaves of plants. The leaves directly absorb the nutrients in this process.

Time of application

Vermicompost tea can be applied as follows:

- Two weeks after seedling germination.
- Immediately after transplanting.
- The application can be repeated every two weeks after transplanting.

Figure 57:
Foliar spray can be done by spraying the vermicompost tea directly on the leaves of the plant.

Benefits of vermicompost tea

Vermicompost tea has the following benefits:

- Vermicompost tea boosts plant growth by providing nutrients in a quickly absorbable liquid form.
- It also contains helpful microbes that support plant health, reduce stress, and control pests and diseases.

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Appendix 1.
Estimated cost to build a 5 m x 2 m structure

An estimated cost of items needed to build a permanent continuous vermicompost flow bed structure with dimensions of 5 m x 2 m.

MATERIALS	QUANTITY	CALCULATED COST	COST FJD
Shelter			
Concrete Block	105	$2.90/block x 105 pieces	$388.50
Cement (40 kg bag)	3	$20.50 per bag x 3 bags	$61.50
Roofing nails	1	$5.30 x 1 bag	$5.30
Bil nails flat head	1	$7. 00 x 1 bag	$6.50
Pine post (150mm x 18 m)	4	$89 each x 4 pieces	$356.00
Timber (75 x 50)	10	$7.50 each x 10 pieces	$75.00
Roofing Corrugated iron (0.42 mm x 7 ft (2.13 m))	8	$29.40 each x 8 pieces	$235.20
Strapping (25 mm x 27 m)	1	$13.00 per reel x 1 reel	$13.00
Shelter cont.			
PVC pressure pipes (12 mm x 1 m)	1	$3.40 x 1 m	$3.40
Galv chicken Mesh	2	$25.60 x 2 rolls	$51.20

MATERIALS	QUANTITY	CALCULATED COST	COST FJD
Land reparation tools			
Post hole Spade	2	$34 each x 2 pieces	$68.00
Cane Knife	2	$16 each x 2 pieces	$32.00
Labour			
Land preparation and levelling	2	$50/day x 2 labourers/ 2 days	$200.00
Construction	2	$50/day x 2 labourers/ 3 days	$300.00
Vermicompost-making			
Vegetable waste/ cow dung collection	2	$50/day x 2 labourer/2 days	$200.00
Paper and vegetable shredding	1	$50/day 3 labourers/3 days	$450.00
PPE			
Hand Sanitizer (4L)	1	$40 x 1	$40.00
Hand gloves	5	$1.75 x 5 pairs	$8.75
Disposable Mask	5	$7.00 x 5 pkt	$35.00
Face masks	5	$7.00 x 5 pkt	$35.00
		Total FJD	**$2,564.35**

Appendix 2.
Estimated cost to build a permanent continuous stack flow bin

MATERIALS	QUANTITY	CALCULATED COST	COST FJD
Bins			
200 L blue plastic drum	1	$30 per block x 1 piece	$30.00
Angle line	1	$33.75 per bag x 1 piece	$33.75
Caulk gun	1	$10.05 x 1 piece	$10.05
Sealant	2	$14.70 x 2 pieces	$29.40
Inverter MMA welding machine	1	$390 each x 1 pieces	$390.00
Mesh and galvanised mesh	1	$80 each x 1 pieces	$80.00
PVC pressure pipes (12 mm x 1 m)	1	$3.40 x 1 m	$3.40
PVC ball valve, threaded	1	$4.50 x 2 pieces	$4.50
Thread seal tape	1	$0.60 x 1 piece	$0.60
Angle grinder	1	$135 x 1 piece	$135.00
Makita cutting discs (100 mm x 1.2 mm)	1	$15 x 1 pieces	$15.00
Bins cont.			
Paper shredder	1	$230 x 1 piece	$230.00
Cancan material	1	$103.35 x 1 roll	$103.35

MATERIALS	QUANTITY	CALCULATED COST	COST FJD
Bottle pack cable ties	1	$30.60 x 1	$30.60
PPE			
Hand sanitizer (4 L)	1		$40.00
Gloves	5	$7.00 x 5 packets	$35.00
Disposable mask	5		$40.00
Face masks	5		$35.00
Bin construction			
Preparation and cutting	1	$50/day x 1 labour/3 days	$150.00
Vermicompost-making			
Vegetable waste/ cow dung collection	1	$50/day x 1 labour	$50.00
Paper and vegetable shredding	1	$50/day x 1 labour/3 days	$150.00
Pre-composting bins			
Storage container (30 L)	2	$75 x 2 pieces	$ 50.00
		Total FJD	**$1,595.65**

Produced by the Pacific Community (SPC)

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ISBN 978-982-00-1605-7