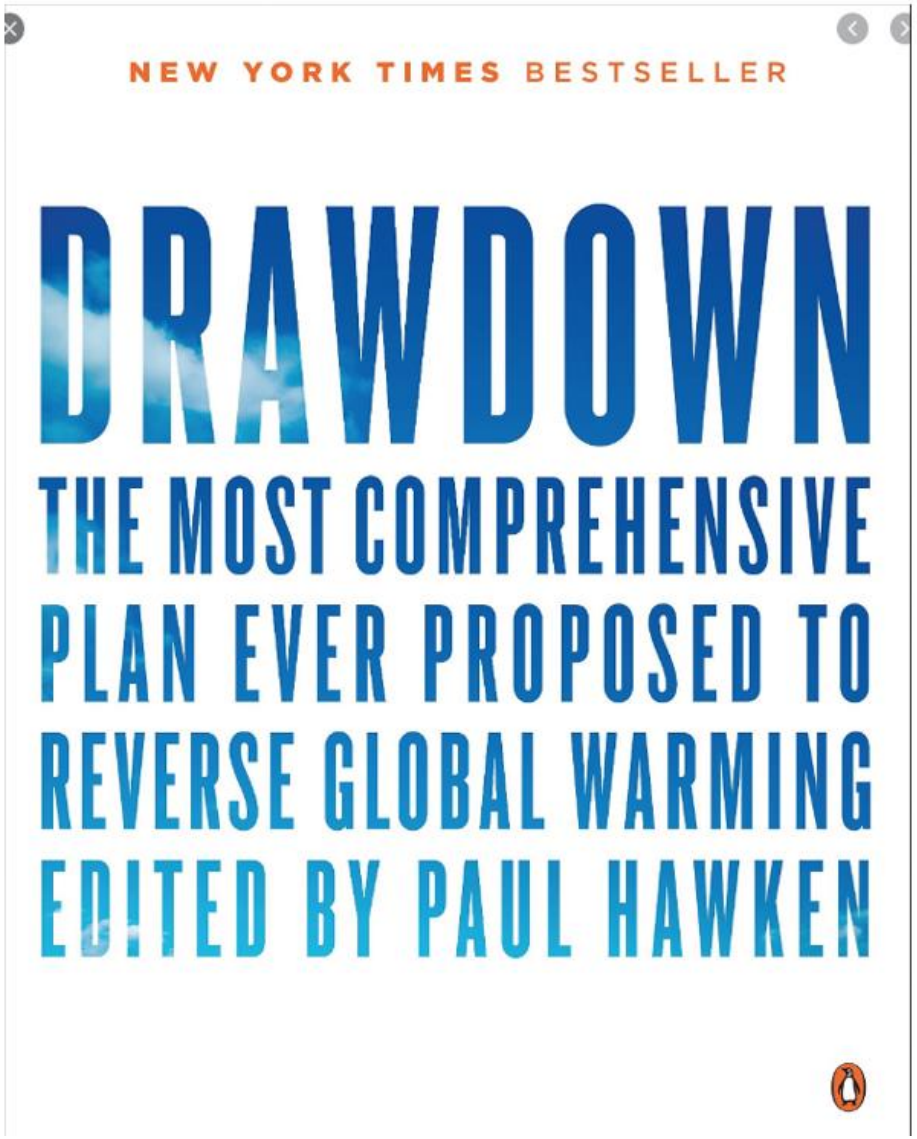
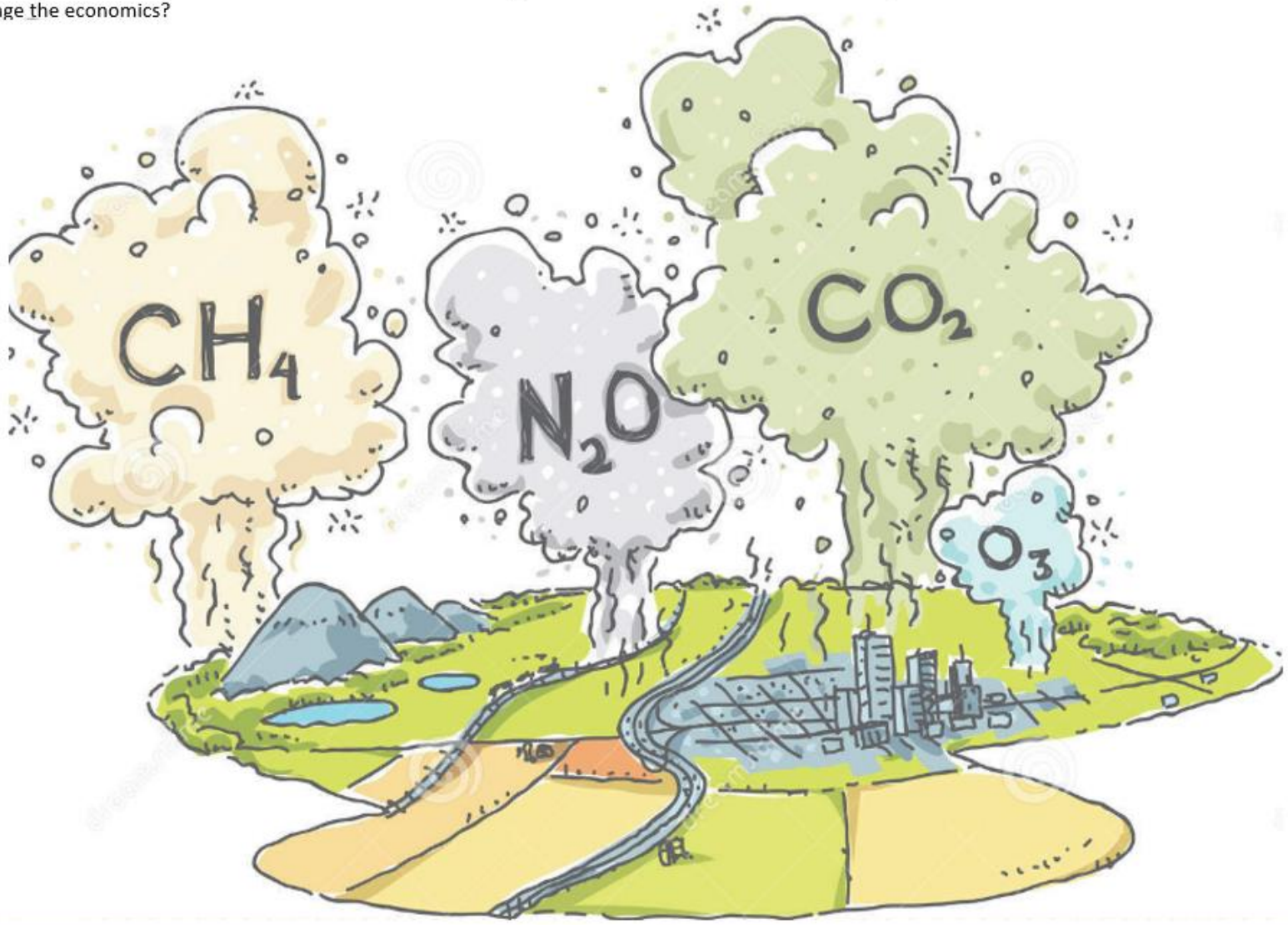
Growing food for people is the worlds largest industry



Growing, harvesting, distributing and disposing of this food is the planets third largest source of greenhouse gases

ISSUES: Conventional Agriculture using NPK fertilizers emits greenhouse gases from the use of nitrogen-based manufactured fertilizers=NO2, and CO2 release from dying soil microorganisms. Urban living --creates methane from landfilling. Landfills also dead-end valuable minerals like phosphorus and potassium in greenwaste/food scraps, and epitomizes a linear system that uses resources only once. We need a cyclical resource and economic system but currently the short-term linear system is "cheaper". We estimate raising the waste levy to $160/tonne would make food scrap diversion to farms instead, economically viable. How do we value the environmental benefit enough to change the economics?



Explaining Zero Waste Zero Carbon

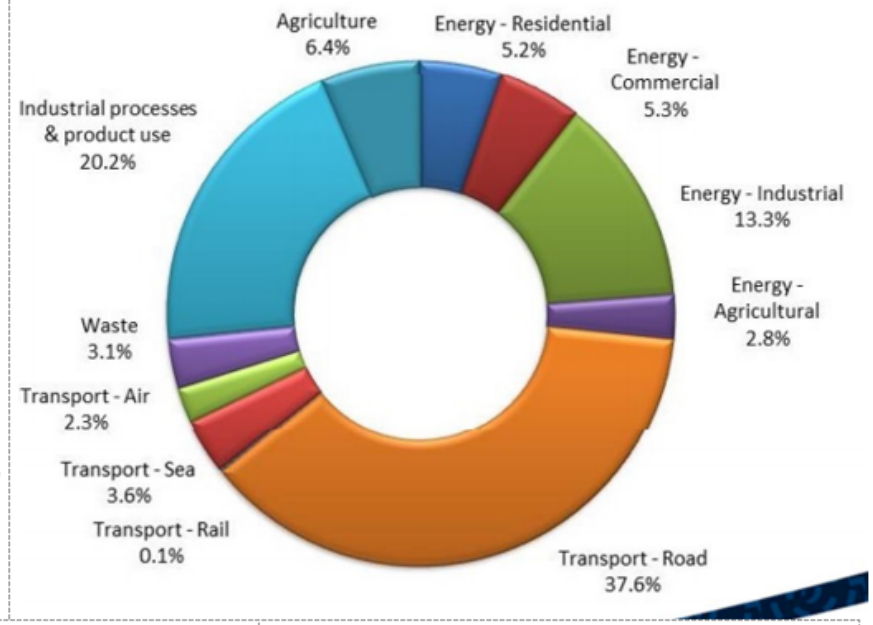
Auckland Council adopted a Climate Action policy in July 2020: Te Tāruke-ā-Tāwhiri: Auckland's Climate Plan in conjunction with the Zero Carbon Bill

- halving emissions by 2030
- reaching net zero emissions by 2050

GHG emissions Landfilling 3.2% + Agriculture 6.4% + Energy and Agriculture 2.8%=**12.4%**

We believe the City to Farm System offers solutions to both of these issues because food scraps along with AMF, and biochar can be used to "drawdown and build stable soil carbon". Also, the food carbon footprint is smaller with local, organic, food production

Auckland's greenhouse gas emissions profile (2016)



Auckland City has adopted a Zero Waste by 2040 Policy which seeks to:

- create a circular economy, turning waste into resource
- apply a targeted rate to all rateable properties within the urban area to cover an organic collection (but only residential properties will receive a kerbside collection service)
- divert commercial waste from landfill, estimated to be 80% of current tonnage to landfill –currently outside the Council's influence

Auckland produces an estimated 150,000 tonnes of organic waste a year
The Anaerobic Digestor may be able to take 75,000 tonnes, what to do with the rest?
We think the answer should be localised, medium scale, on-farm composting for soil building

ZERO WASTE

To lessen the impact of our current food system

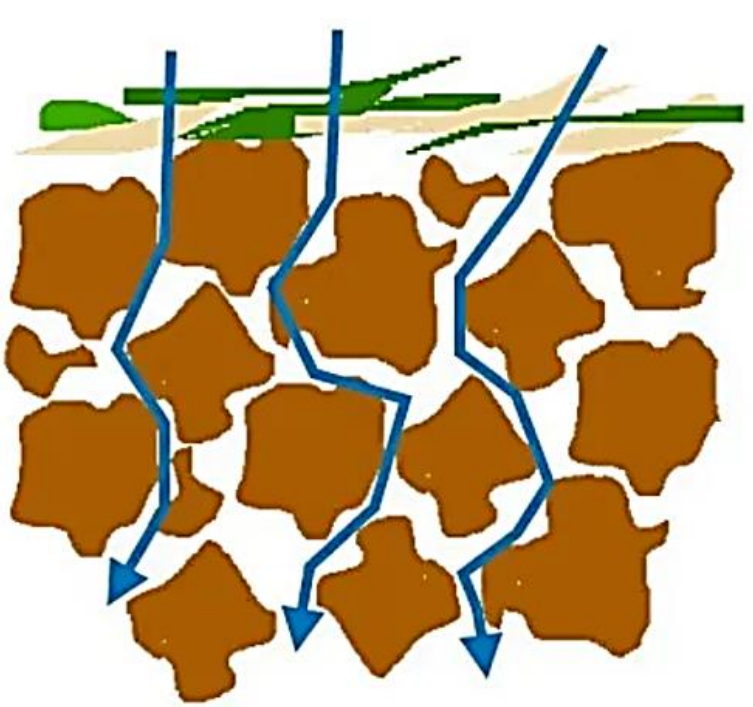
Grow veggies at Home

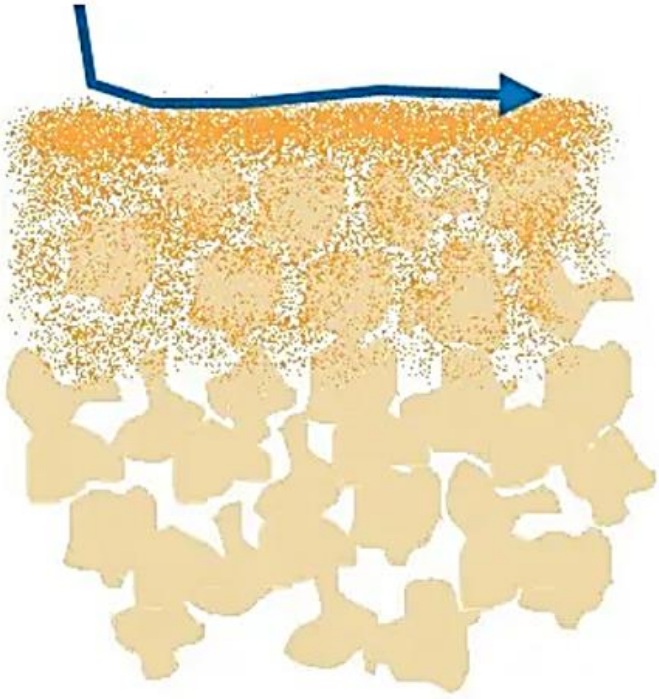
Eat NZ grown veggies in season

Choose imperfect veggies

Don’t use the garbage disposal or rubbish bin to dispose of food scraps

Before we can grow we need healthy soil





Healthy Soil

- Good structure
- Water infiltration into soil pores
- Slows water velocity
- Dark color
- High organic matter
- Soil surface is covered with dead vegetation

Degraded Soil

- Weak structure
- No water infiltration soil pores clogged
- Water runs off quickly
- Light color
- Low organic matter
- Soil surface is covered with a soil crust

https://symbiosis.co.nz/natures-teaching/soil-health/soil-structure/ Symbiosis

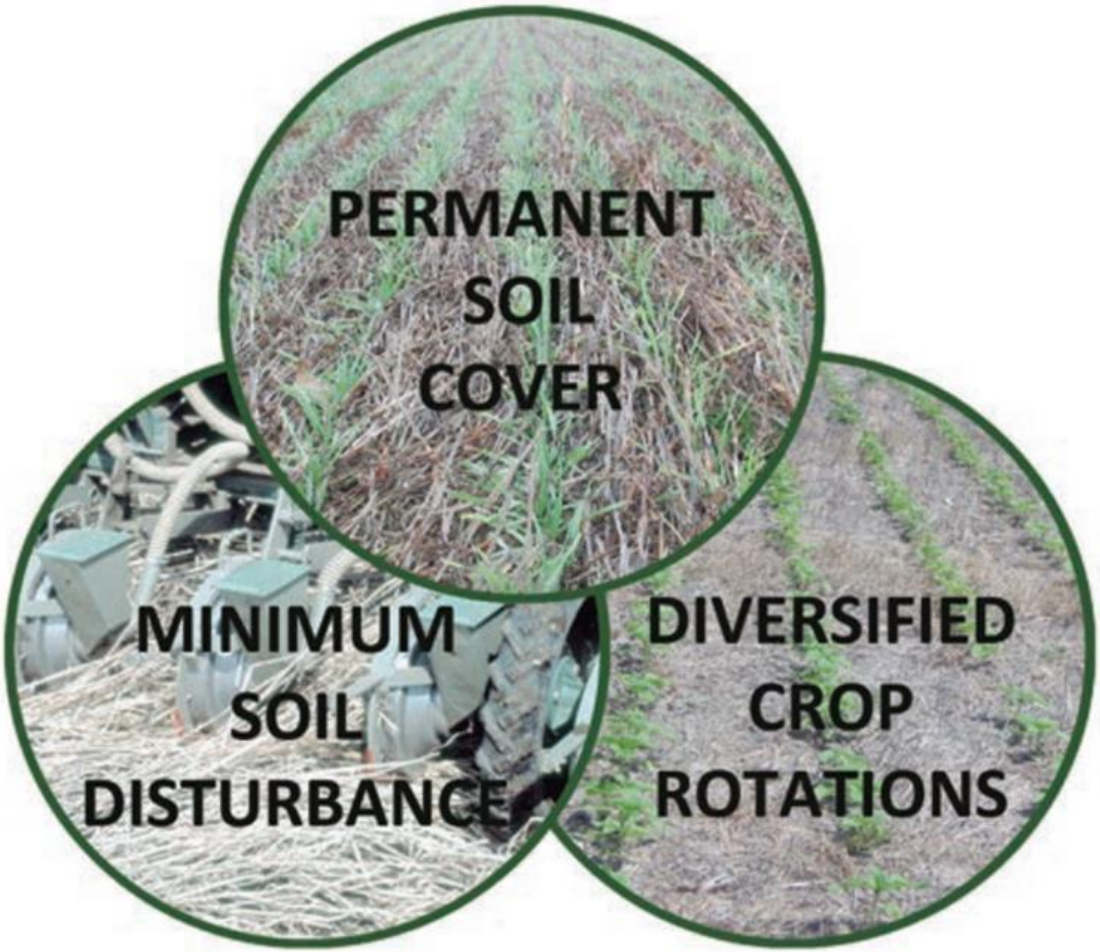
The City to Farm Local Food Resilience Composting Project improves rural soils

Changing compacted clay into freer draining soil, organically without chemical fertilizers, "clay busters" or pesticides is a challenge. Here is a "before" picture of the soil on the Graingers farm compared to an "after".
Soil test results show increased water infiltration, nutrient levels, and water holding capacity.

After

C2F is about growing topsoil for climate action and food resilience

- The soil changes from dense to more porous
- The depth of topsoil increases for improved water infiltration, less erosion and greater stream health
- As topsoil depth increases so does water holding capacity and drought-proofing
- As the soil improves there are greater opportunities to grow higher value horticultural crops
- In the future topsoil building may offer rural property owners carbon credits for additional income
- local food production lessens the GHG impact of “food miles”
- local food production = greater local food security



Conservation Agriculture has been proven to build topsoil slowly

over time if 3 things are done together:

- **Minimum Soil Disturbance**
  The soil is not deeply turned over, ploughed or dug. Only the top 50-75mm are disturbed.

Permanent Soil Cover
The soil is always growing something, or mulched

Diversified Cropping
The soil is always growing a diversity of crops, not a monoculture

The City to Farm Composting Project does all this

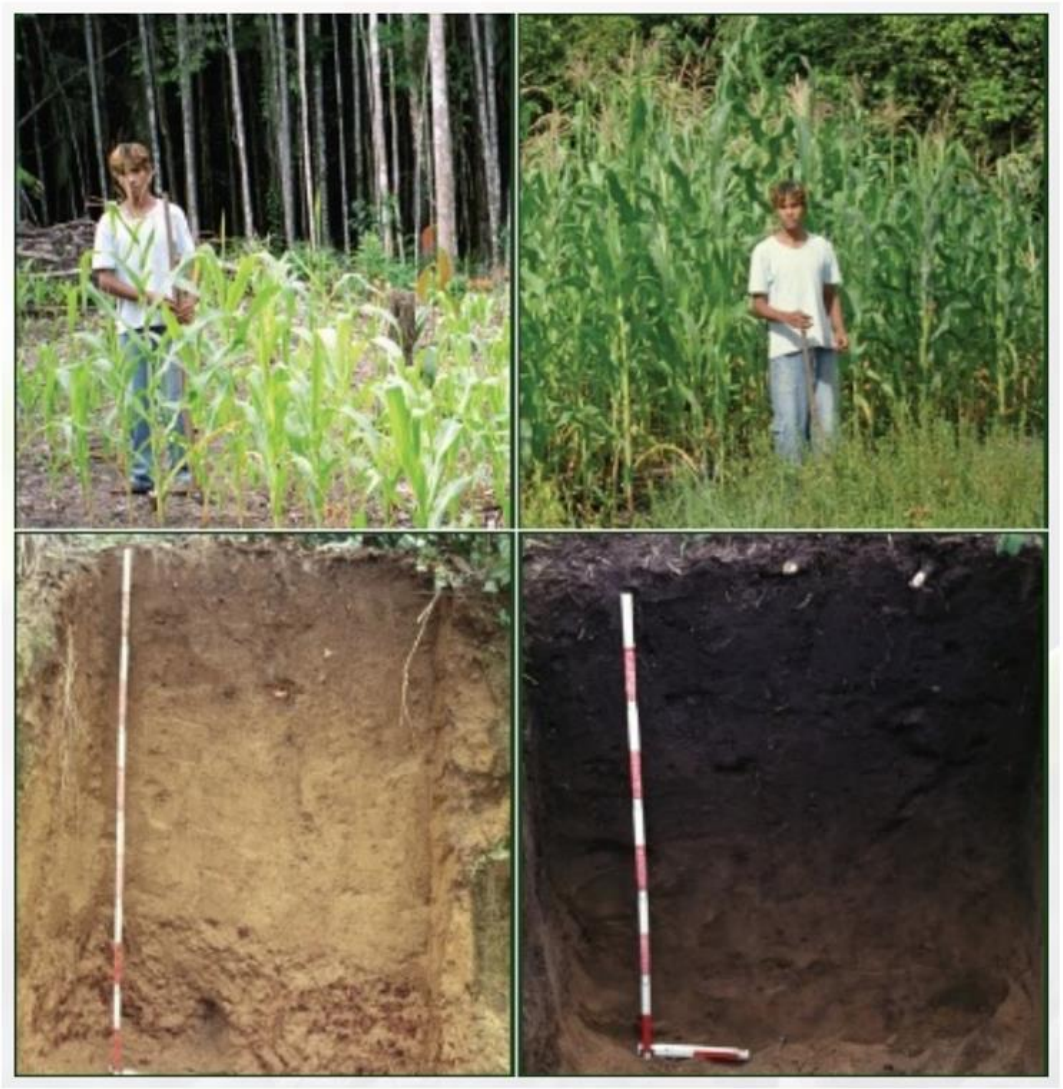
Adding biochar, organic waste in the form of food scraps, creating an ideal home for microorganisms and beneficial soil fungi has been used before to develop topsoil in far worse clay than ours.

It was done in the Amazon and these soils still exist today. What seems most remarkable about them is they seem to have retained their fertility, even after hundreds of years.

Slash and Burn Agriculture

Today in the Amazon, the rain forests are being cut down and burned for agriculture that is productive only a few years.

This is called “slash and burn” and is a highly destructive form agriculture as the soil quickly loses its fertility and the jungle struggles to regrow.



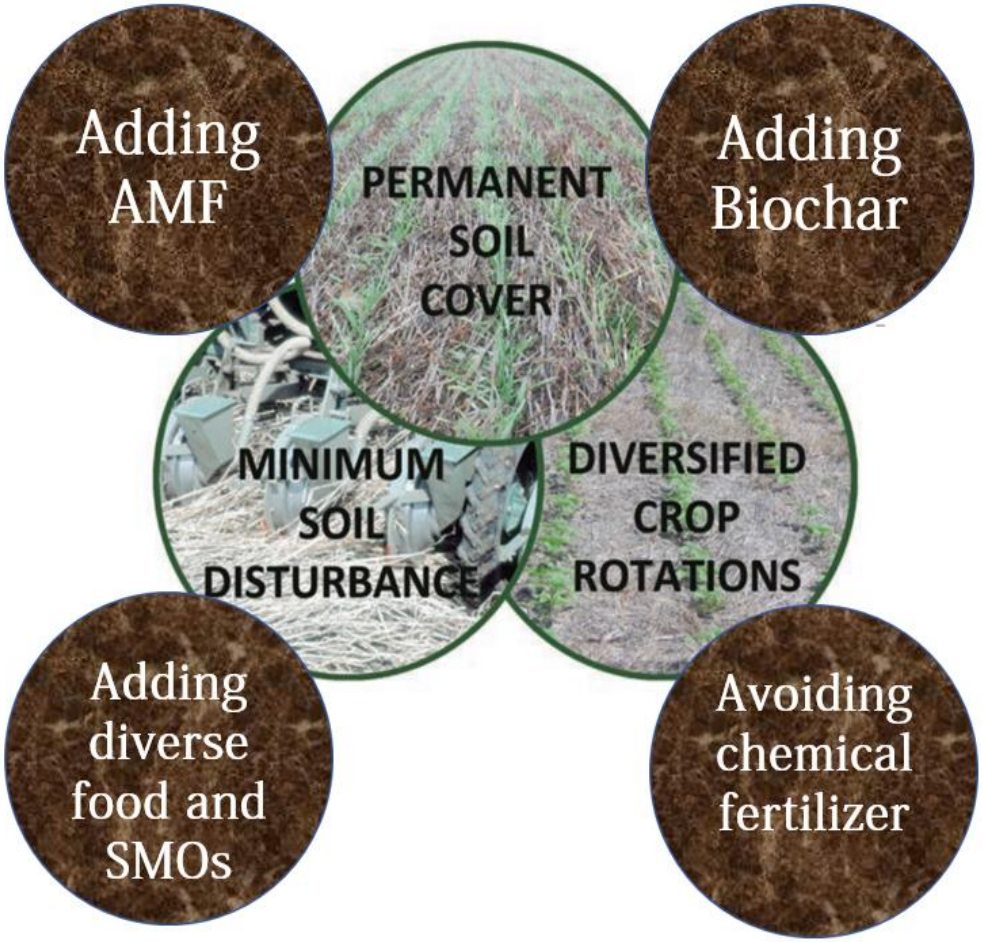
Terra Preta Agriculture

The Terra Preta soils made by the Amazonian people over 500 years ago have maintained their soil fertility and are still used today to grow healthy crops.

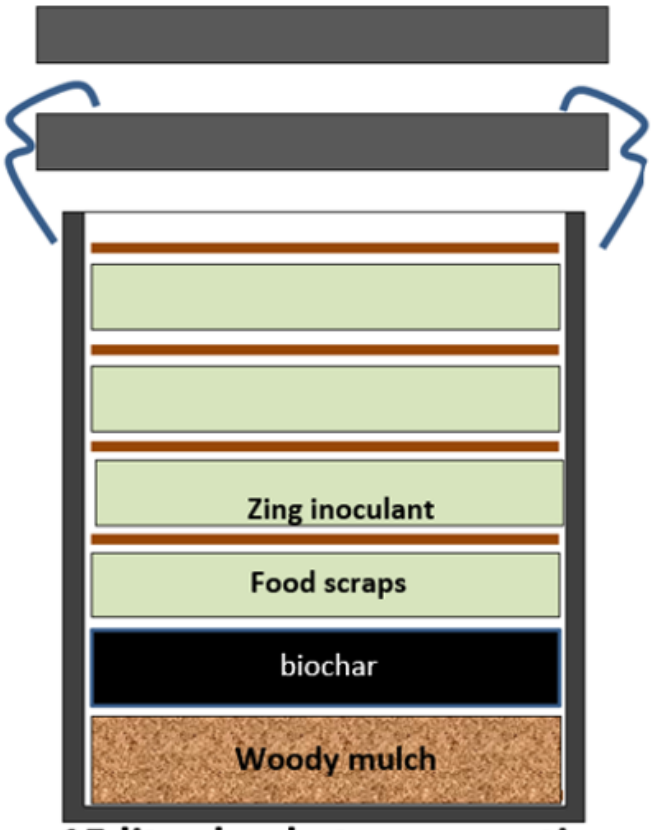
How did they do it?

The City to Farm Composting Project takes conservation agriculture and adds biochar, avoids chemical fertilizer, adds microorganisms/food from bokashi composting adds/stimulates (beneficial mycorrhizal soil fungi esp Arbuscular Mycorrhizal Fungi)

Together, these 7 farming practices should grow a very stable form of topsoil that contains “glomalin” a stable form of soil carbon which can last in the soil for hundreds, maybe thousands of years– storing carbon from the atmosphere at a greater rate than growing forests. This is what the City to Farm Composting project is about—growing soils with stable carbon and good soil structure for organic food production—growing Terra Preta.



Biochar, Compost, and Soil Go Well Together



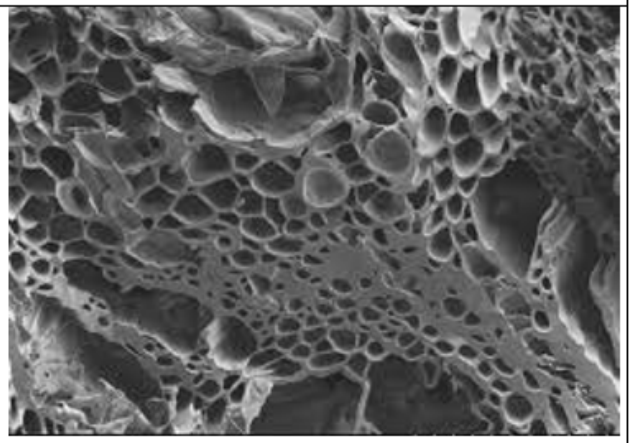
15 litre bucket cross section

The City to Farm Project uses Biochar in the bottom of wheelie bins and some buckets

Biochar should not go into the soil "raw."

It needs to be inoculated with microorganisms and charged with minerals. This happens naturally when it goes through a composting process, such as bokashi, garden compost or worm bins.

Manure tea, strong worm tea and compost tea can also be used.
Biochar neutralizes the acidic pH of the bokashi leachate and absorbs odours during the bokashi fermentation process



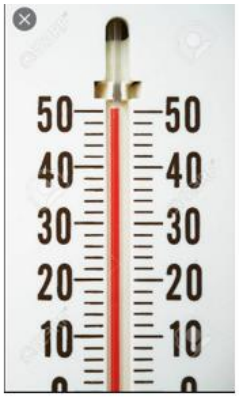
Close up of Biochar under an electron microscope

- Biochar seeds soil aggregate formation to absorb dissolved organic matter through wet and dry cycles to build long-term soil carbon storage. Its porosity provides a permanent home for soil micro-organisms

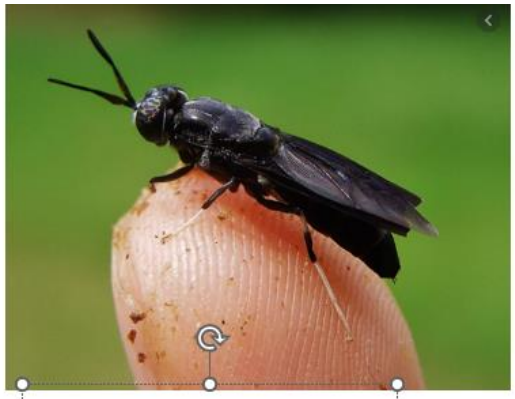
Swales are filled using a tractor with fast feeder for both food scrap and woody mulch layering

Composting goes through 4 stages in the C2F swale project

1. **Bokashi fermentation-** The bokashi-ed food scraps are placed between a layer of woody mulch on the bottom and a layer of woody mulch on top



2. **Hot composting--** The food scraps heat up to 40-50 C° as micro-organisms multiply rapidly



3. **Black Soldier Fly Composting-**Depending on the season, black soldier flies move in when the compost is between 25 and 35 degrees C. Their larvae munch through the food scraps quickly.

4. Vermicomposting Worms move in when the compost is between 15 and 25 C°. They break the food scraps down further into rich, fine vermicast

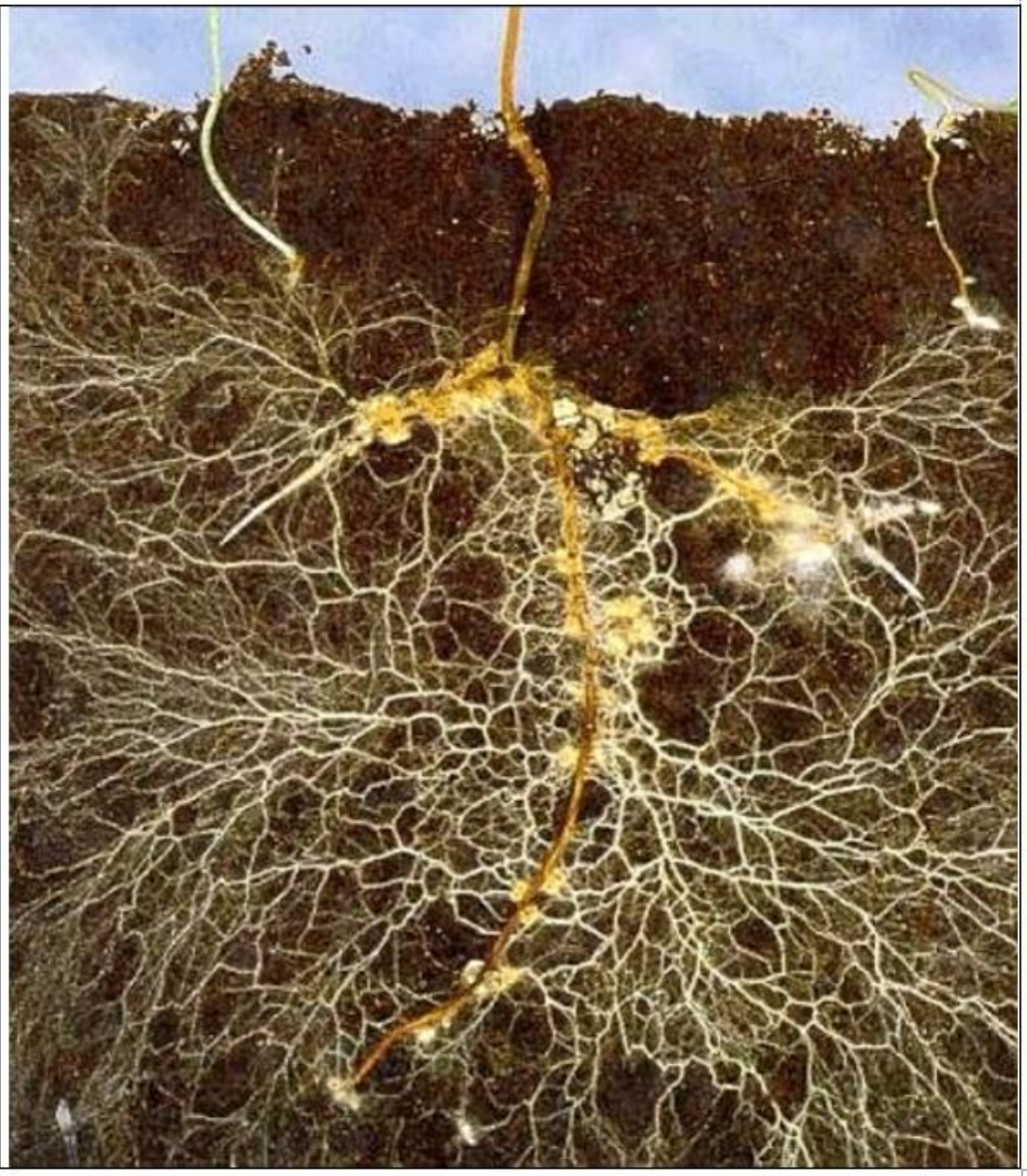
Planting bananas with a beneficial fungal inoculant is done when the composting is finished

Growing Glomalin could mitigate Climate Change

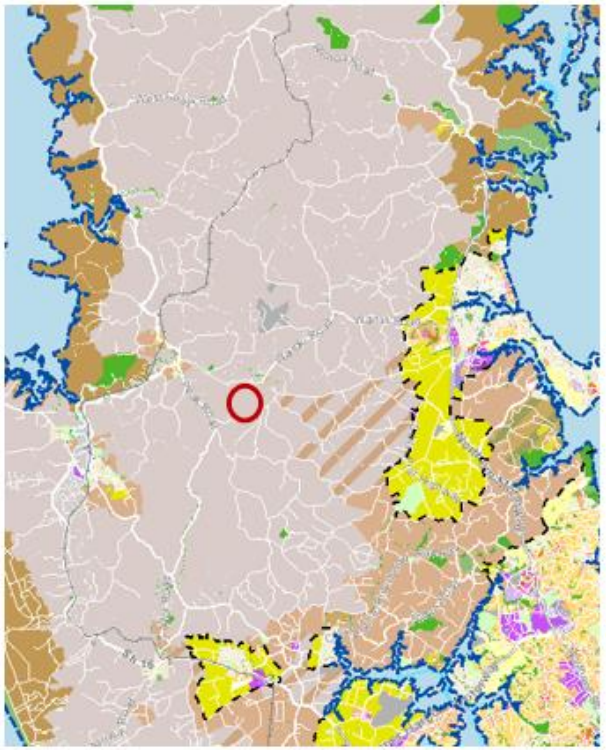
Glomalin is a very stable form of carbon made by some types of soil fungi. The build-up of glomalin is nature's way of sequestering carbon in the soil for a long time. Glomalin is the name of the material arbuscular mycorrhizal fungi (AMF) build their hyphae tubes out of. Somehow, biochar helps this process as it is a unique ingredient in Terra Preta but exactly how is unknown.

Carbon stored in the form of soil microorganisms (SMOs) is released back into atmosphere when the SMOs are killed—this can happen if the soil is deeply ploughed, surface plants are killed, or chemical fertilizers are added.

However, glomalin seems to be a very stable form of carbon that can last in the soil for decades, maybe centuries, maybe millennia if left undisturbed and un-poisoned. Biochar, too is a very stable form of carbon in the soil that seems to last centuries or millennia.

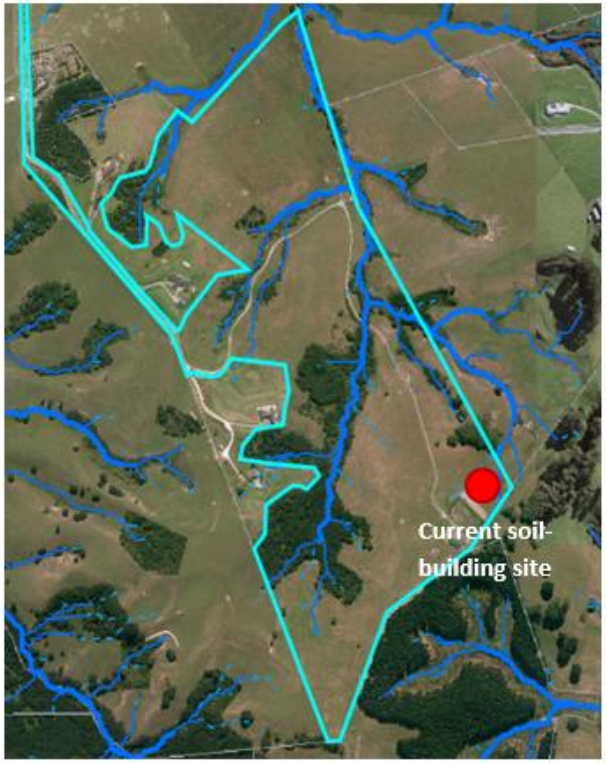


Next: What is involved If you want to improve your soil and take climate action on your own property

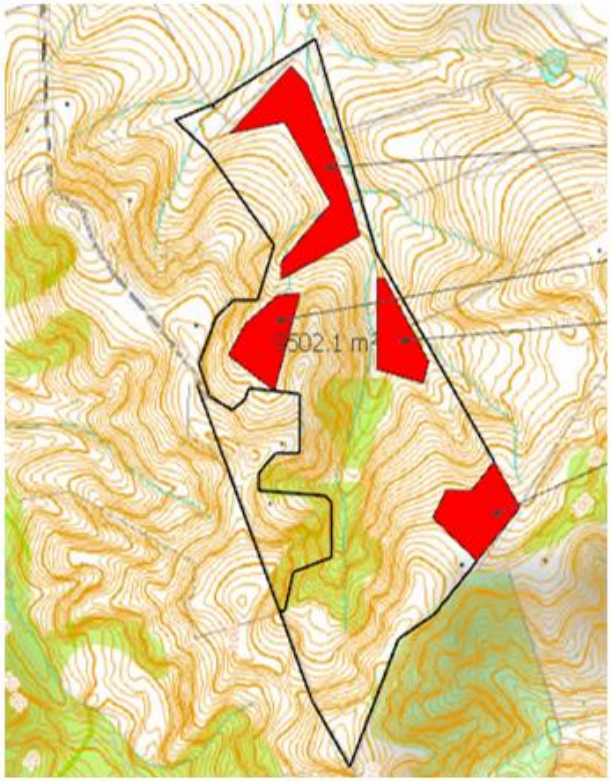


Ideal sites are in Rural Production Zones and are surrounded by Rural Production Zones (shown in gray).

- The Rural Production Zone allows for up to 50m3 of composting as a permitted activity provided controls around location, air and water discharges are met



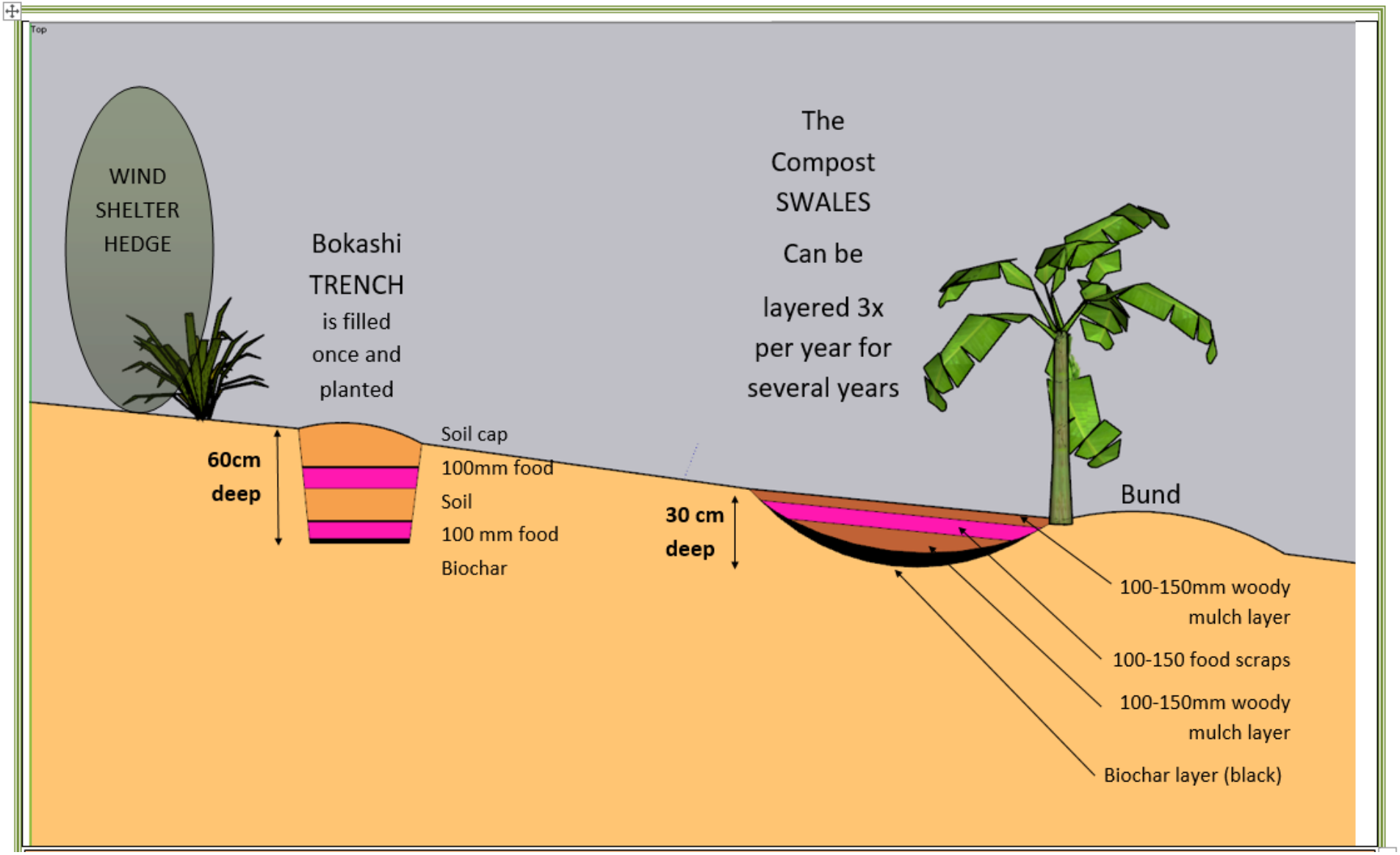
- The composting site needs to be 250m from the nearest neighbour and 20m from boundaries and waterways
- The composting site must consider: Air Discharges (odours and dust), Water Discharges (leachate and run off) and vectors (rats and flies)



Suitable land needs to be less than 8% slope.

But is the City to Farm project "composting" or "soil building?" No "compost" is leaving the site, all inputs are being used to improve the soil with the aim of increasing cropping productivity. No "compost" is being sold.

Planning and Consenting Considerations



Decide if you want to do trenches, swales or Johnson-Su composting

Swales are shallow ditches, on a slope, parallel to the contours so the bottom of the swale is level or with a slight fall. We have found a 1% fall is good in high rainfall areas.

Swales

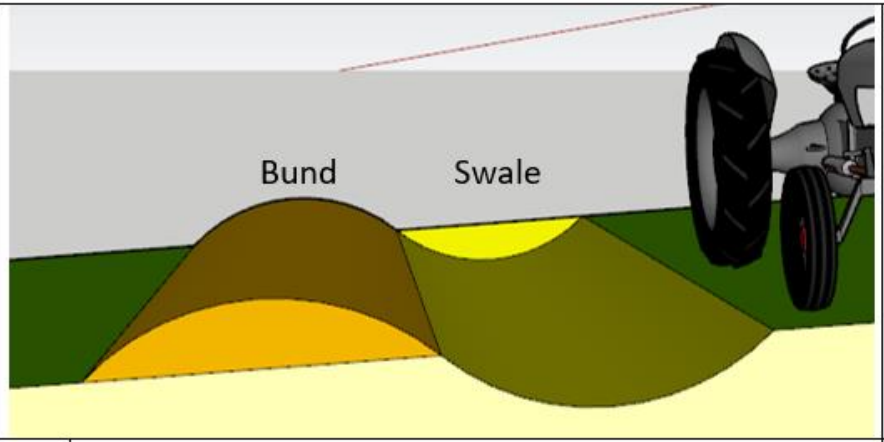
- Capture rainwater
- Maximise water infiltration
- Act as stop dams for heavy rain
- Infiltrate leachate from composting

Swales

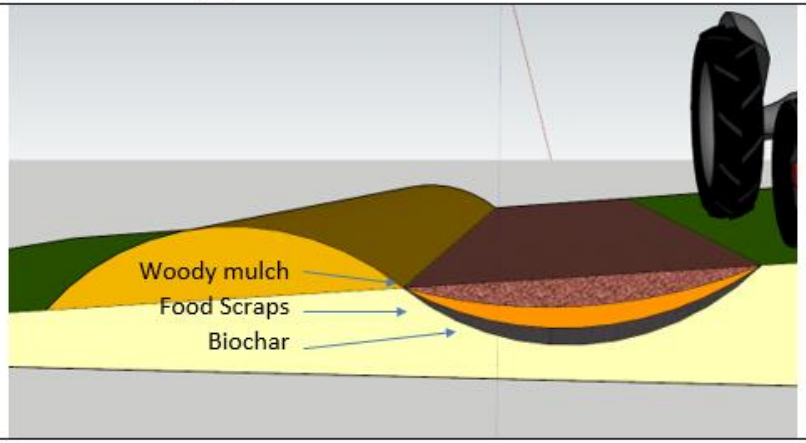
Swale E March 2021 Nov 2021 May 2022

Development of a Compost Swale

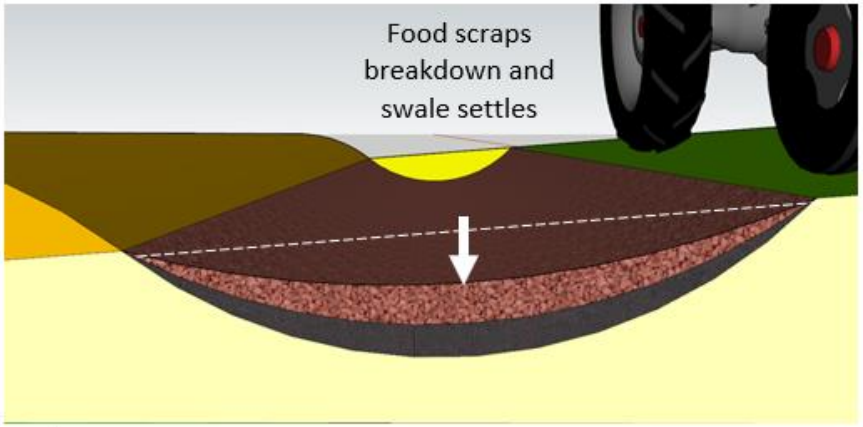
How Swale Composting works



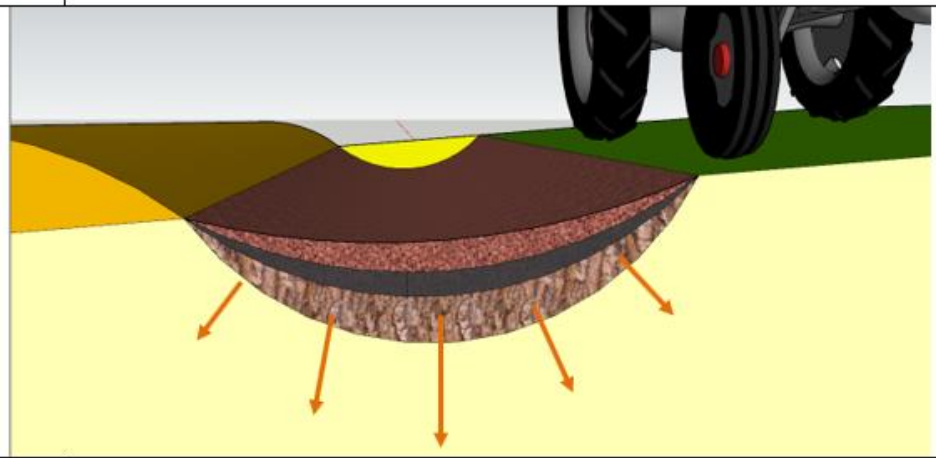
1	Swales are excavated almost parallel to the contour—a 1% slope to drain is good. The bund is made of the excavated material placed downhill



2	Swales are lined with 100mm of biochar, then 100mm of bokashi-food scraps then covered with 100mm of woody mulch



3	Food scrap breakdown is monitored. When all the food scraps have disappeared and compost worms are rampant, then the material Is classified as enriched mulch. It is no longer considered compost and the swale is ready for another layer of food scraps and mulch



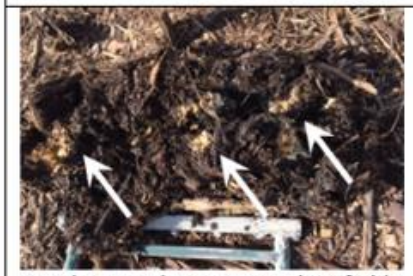
4	Water, worms, and roots move biochar, microorganisms, and organic material into the subsoil, restructuring it with greater porosity, faster infiltration rates and increasing ground water storage

Decomposition Scale Developed 11 Aug 2019

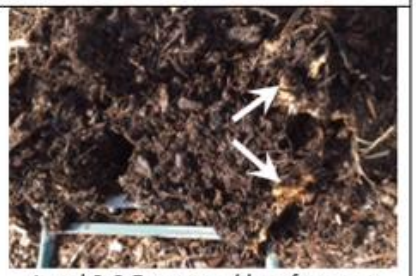
Insert broadfork, lean back and expose material down to 300mm depth

Level 1-- Raw food scraps, continuous layer, food type is identifiable

Level 1-2 –many clumps of identifiable food but transforming into clumps of orangey colouration.



Level 2 –Food scraps not identifiable, fewer pockets of orangey clumps

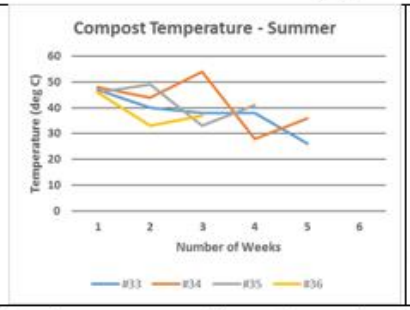


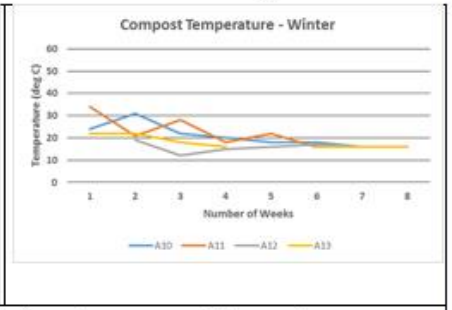
Level 2-3 Fewer and less frequent clumps of orangey food scraps.

3 – Mainly mulch with only a few bits of dark orangey colour remaining.

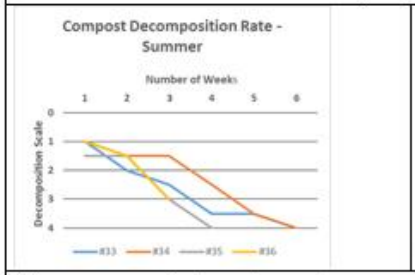
Level 4 – All mulch, no visible food scraps or orange clumps.

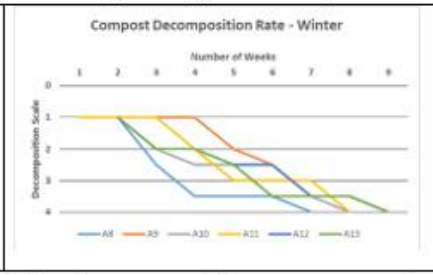
Monitoring for Safety





Swales are monitored regularly for decomposition rate, temperature and compost worm/black soldier fly populations. This is to assure the food scraps have completely broken down before adding another layer of food scraps. We follow the National Standards NZ 4454.2005 for Composts, Soil Conditioners and Mulches, Vermicomposting Section p.54





Our research has found complete decomposition can occur in as little as 4 weeks in ideal summer conditions and take as long as 9 weeks in cold, wet winter conditions. We make sure there is a minimum of 6 weeks between applications even when it appears the food scraps have broken down entirely in less than that period.

How to Have Food Scraps Delivered for Composting on your Property

The City to Farm Truck can deliver bokashi food scraps with biochar in Wheelie Bins to your Property if:

Swale Composting Needs the following Preparation:

1. Swales or trenches pre-dug on Less than an 8% slope. We can provide the surveying and marking to layout the swales
2. At least a 6m3 mulch pile on site near the swales
3. Enough biochar to lay a 100mm deep layer on the bottom of the swales
4. Box Truck Access to be able to drop off the wheelie bins near the swales
5. It will be up to you to
   a. lay the biochar in the bottom of the swale
   b. Dump the wheelie bins of food scraps onto the biochar and rake it out 100mm deep
   c. Cover the food scraps with 100mm of woody mulch
   d. Rinse out the wheelie bins so they are free of food residue and call us to pick them up
6. Up to a tonne of food scraps can be delivered at a time. There may be a cost for delivery depending on the travel distance.

If this seems like too much work but you are interested, please sign the grant application letter saying you would contribute towards rental of a tractor with a fast feeder to do all this work for you.

Johnson Su Bioreactor Needs the following Preparation

1. You will need to modify an IBC as per instructions on YouTube
2. At least a cubic metre of woody mulch per IBC
3. About 100L of biochar per IBC
4. Between 5 wheelie bins and 20 buckets of food scraps per ICB. The exact amount will depends on desired fungal to bacterial ratio which depends on the compost will be used for (pasture, orchard, bananas, veggie garden or native plantings)
5. A way to lift and tip woody mulch and wheelie bins into the IBC
6. Box Truck Access to be able to drop off the wheelie bins near the IBC
7. It will be up to you to
   a. layer the biochar, woody mulch and food scraps in the proper depths. We can advise on what are proper depths for food and woody mulch
   b. Rinse out the wheelie bins so they are free of food residue and call us to pick them up

Call us to arrange a food scrap delivery

021 0826 8196

Or leave a message on the website

www.citytofarm.co.nz

Or an email info@citytofarm.co.nz

More about the City to Farm Project

- Is Auckland Council looking into on-farm composting?
- Why take food scraps to rural farms instead of centralised composting or local community gardens?
- What benefits would rural properties have by taking food scraps?
- How much of Auckland's organic waste could be swale composted?
- Why isnt this being taught in schools?

Hierarchy to Reduce Food Waste and Grow Community

City to Farm

Prevention. Do not generate food waste in the first place! Reduce portions, buy what you need, and organize your fridge for optimal food usage.

Feed hungry people. Divert food not suitable for people to animals such as backyard chickens or to local farmers' livestock.

Composting in backyards or in homes.
Avoid collection costs!

Onsite composting or anaerobic digestion, and community composters can accept material from off-site or simply process their own material.

Composting or anaerobic digestion at the small town or farm scale. These systems handle typically between 10 and 100 tons per week and are designed to serve small geographic areas.

Facilities serving large geographic areas that typically handle more than 100 tons per week. Material generally leaves the community in which it is generated.

Mixed garbage is mechanically and biologically processed to recover recyclables and reduce waste volume and the potential for methane emissions before landfill disposal.

Food waste should be banned from landfills and trash incinerators due to their high capital costs, pollution, and contribution to greenhouse gas emissions.

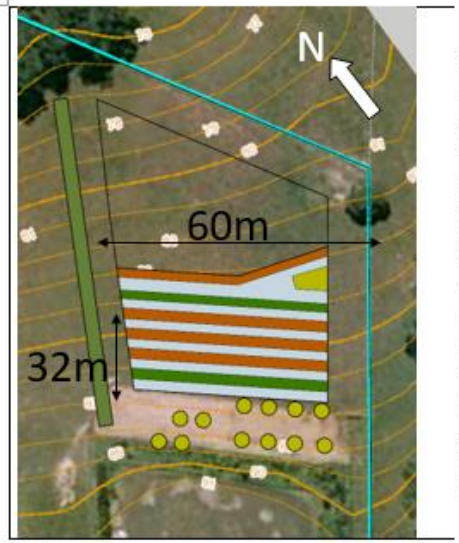
ILSR

Diversion Quantities

Constructing a swale

Food Scrap Diversion per swale

One swale, 1m wide, 50m long, averaging 100 mm of food scraps applied 3x a year = can take 200 kg/linear meter per year. This 50m swale can take 10 tonnes per year



Food Scrap diversion per ha per year. If 5 swales 50m long covering 0.2 hectare can process 50 tonnes per year then if the Auckland Region needs to divert 75,000 tonnes it would take between 300 and 400 hectares. If one farm has 0.2 ha of land available for swale composting it would take 300 to 400 farms.

Q: If the Auckland Region generates 150,000 tonnes of organic waste and half goes to the anaerobic digestor, then 75,000 tonnes remain to be processed. At this rate, how much land would it take to swale compost it?

A: 375 ha

Q: How much total carbon could be diverted from landfill per ha/year?

from food scraps=45 tonnes total carbon/Ha/yr

1 trench/windbreak per 3 swales and access roads, gives 1,500 LM of swale per ha times 200kg of food scraps per linear metre of swale/yr gives 300 tonnes of food scraps/hectare/year, @ 15% total carbon = 45 tonnes total carbon/hectare/yr.

- **from woody mulch=45 tonnes total carbon/Ha/yr**

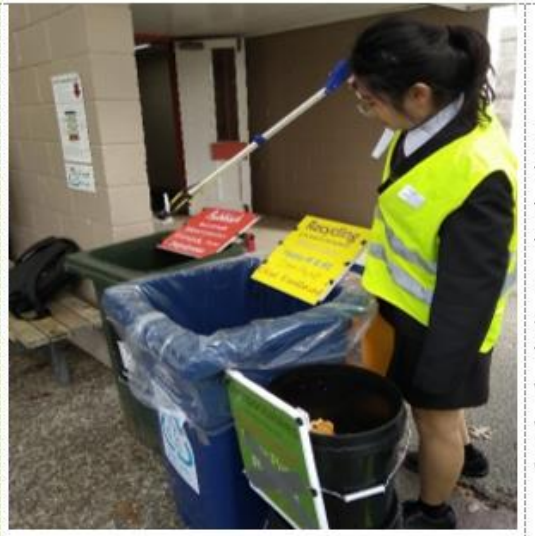
1,500 LM of swale @ 150 kg of mulch per LM of swale/yr with 20% total carbon = 45 tonnes per ha

- **from biochar =4 tonnes total carbon/ha at startup**

Initial layer of biochar on the base of the swale (15 litres/lineal metre) is 13 tonnes per hectare @ 33% total carbon = 4.3 tonnes of total carbon per hectare at startup.

What is not known is how much carbon the soil can store through topsoil building. We are taking soil samples to monitor this change. Testing by Hill Labs says 180 tonnes per Ha of Total Carbon currently exist in the top metre of soil at this farm-how much can we increase the stable soil content through building topsoil through swale composting?

The Zero Waste Zero Carbon Programme is run by the Sustainable North Trust to teach students the link between rubbishing food scraps, landfilling, soil building and climate change.



First attempts to get students to separate out food scraps revealed most students felt food scraps were yucky and would not engage

YouTube Video: The Soil Story by Kiss the Ground

When food scrap diversion is explained in terms of mitigating climate change, student attitudes change

Year 7 students at NX Intermediate study the relationship between soil colour and soil carbon as part of the program

The Programme has been professionally developed by Monique Russell. It consists of two 45-minute class sessions, includes before and after waste audits and impact surveys.

Chuffed at completing their carbon cycle puzzle

Students also learn that carbon can be taken out of the atmosphere by plants and stored in the soil in the form of topsoil along with many benefits to the environment

More about The Zero waste Zero Carbon in School Programme

The Māori view of soil, its importance, and the need to care for it is explained

Our connection with the earth and our relationship with it is explained

The ZWZC Programme explains the Maori view of soil in terms of whakapapa, we all come from Mother Earth, Papatuanuku, so we are all related to Mother Earth, therefore we need to look after Her.

Explained is the importance of keeping food scraps out of the landfill, along with the problems of landfilling and incineration and their impact on Climate Change

Students are reminded of the many benefits of growing food at home using compost and different composting techniques. Soon they will be learning about how to modify clay soils as a carbon sink using bokashi-composted food scraps and biochar.

By not wasting food, composting at home, buying NZ grown food or growing one's own food, the carbon footprint of the planet's third largest emitter of GHG, global agriculture, can be reduced

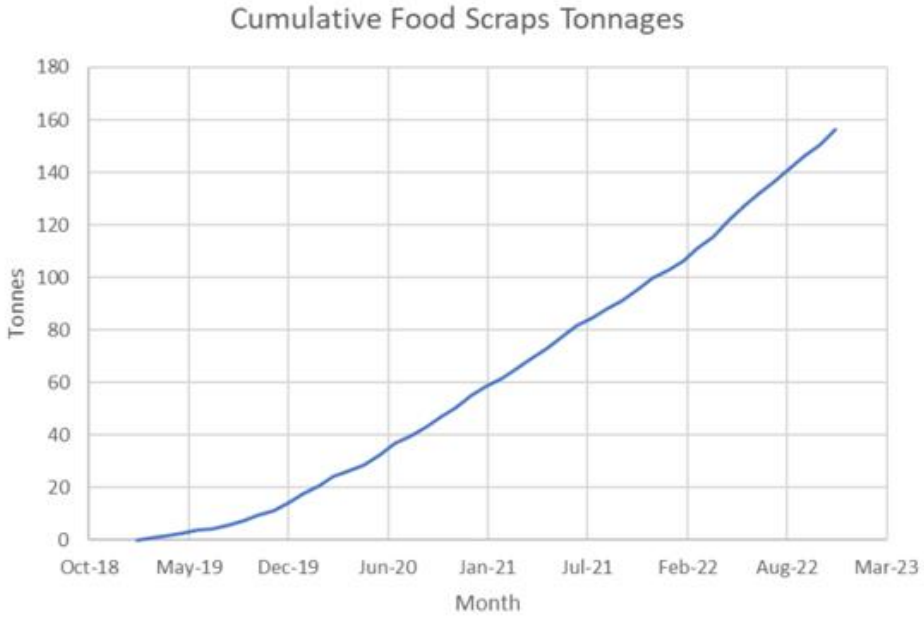
The Zero Waste Zero Carbon in Schools Programme is made possible with help from

FOUNDATION NORTH
Pūtea Hāpai Oranga
Funding to Enhance Lives

Auckland Council
Te Kaunihera o Tāmaki Makaurau

SUSTAINABLE SCHOOLS
EDUCATION FOR SUSTAINABILITY
Auckland Council

The City to Farm Project has diverted over 150 tonnes of food scraps to rural properties between Oct 2018 and Dec 2022



Food scrap Collection

Food Scrap Curing

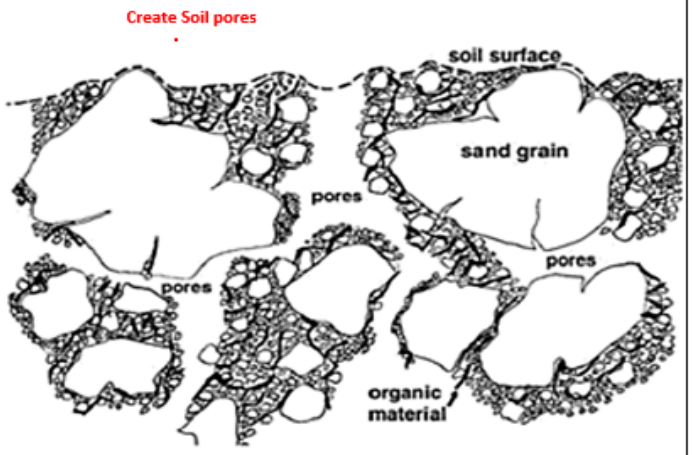
Food scrap spreading

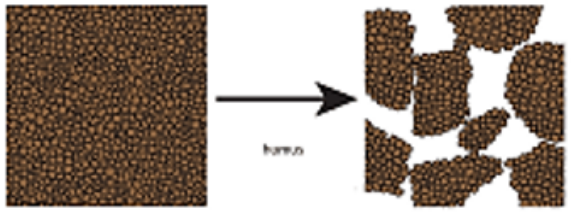
Reasons NOT to Hot Compost on Farms	Reasons for Johnson-Su Bioreactors and Swale Composting instead	
Turning compost breaks up the fragile fungal development – which are a vital component of soil health "Composting" quantities are limited to 10m3 in an urban zone and 50m3 in rural zones Centralised composting is energy intensive and therefore GHG intensive to transport large quantities of materials to one central location, mechanically shred, layer, and repeatedly turn and distribute Hot composting releases most of the carbon back into the atmosphere as the microbes rapidly eat through the carbon in the organic matter and respire C02 and water.	 *Johnson-Su systems produce aerobic fungal and bacterial compost and do not require turning.*	*Swale composting is actually topsoil building so there should not be an upper limit on composting quantities* 
	Both Johnson-Su and Swale composting are less GHG intensive since the material stays on site to build soil carbon –which should be carbon negative instead of carbon positive but long term testing is needed	

Why should Rural Properties Owners consider using Bokashi Food Scraps and biochar for on-Farm Composting?

The combination of bokashi food scraps and biochar builds topsoil and transforms clay soils very rapidly

The ultimate proof of a healthy soil microbiome is an improvement in soil structure. A biologically diverse microbiome will shift, clump and stick soil particles, organic matter and themselves together creating porosity, lessening bulk density, increasing water infiltration, water/nutrient holding capacity (CEC) and decreasing erosion. Together with a permanent planting on top, a continuous supply of food for the microbiome is created by the plants pumping down starches and sugars to feed the microbiome and continue the transformative process. Usually soil re-structuring takes decades or centuries—here it seems to have been accomplished in the swales in 2.5 to 3 years. Using lime, gypsum, and regular compost also work, but the effect is temporary.





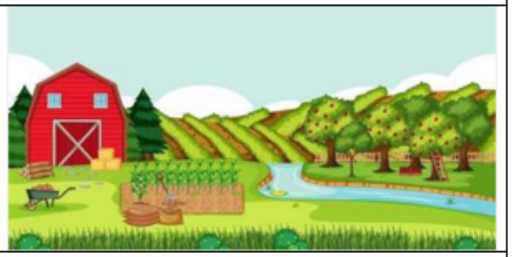
The biochar should permanently transform of clay soil structure and food scraps provide a rich source of food to kickstart microbial diversity

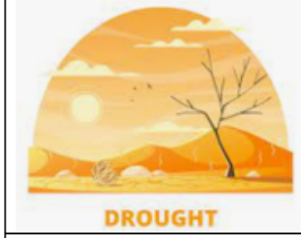
High quality, productive soils are roughly half air space. Soil microorganisms will re-organise the soil particles to create an ideal "porosity" because it allows air and water to reach those microorganisms deep in the soil profile. To form "soil aggregates" microorganisms need minerals (sand, silt, clay) moisture, organic matter, and food. Biochar is a permanent form of organic matter that does not decompose over time. It forms a home for microorganisms, holds onto moisture and nutrients thus providing a permanent home for microorganisms to maintain soil structure. Biochar is being used by Pukekohe growers by the thousands of cubic meters, to reduce erosion and hold onto water and minerals so it works on even "good soil", not just clay.

Why should rural property owners consider swale or Johnson-Su composting with biochar and food scraps on their land?

Because on-site swale and Johnson-Su composting improves the soil and when soil is improved YOU get

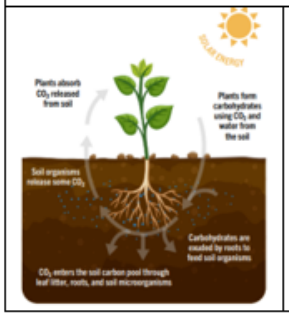
- *More productive land*
  - that can grow orchards, food forests, vegetable gardens, and perhaps even commercial horticulture crops





- *Buffering* against the extremes of changing weather patterns.
  - Its easy to drain water away, but hard to drought-proof. Improved soil structure and swaling capture and store water so soil moisture is available during times of drought. Increased infiltration will soak in heavy rain and less will run off.

- Increased environmental health such as streams that run all year round instead of drying up in the summer, less run-off/erosion, and greater transplanting success



Climate change mitigation – building topsoil with biochar puts carbon back into the soil permanently and encourages plant growth that stores carbon in the form of wood roots, and mycorrhizal fungal species, especially arbuscular mycorrhizal fungi (AMF)

Why Use Biochar and Bokashi Food Scraps in Composting?

All composting needs layers of carbon (C) and nitrogen (N)	Fruit and veggie peels, spent grain, fish frames, meat, dairy are nitrogen layers and add moisture (green)	Woody mulch is a carbon source and lets air in (brown)	Its important to have correct ratios of C:N, moisture and air

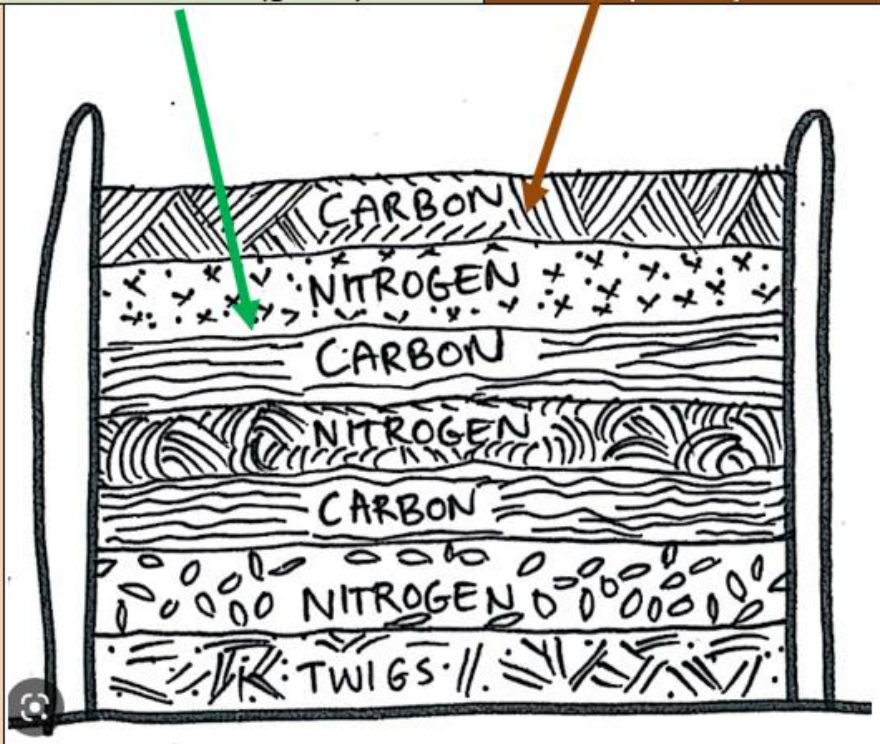
Benefits of Bokashi Composting

1) Takes all food types of scraps (citrus, onions, spicy, meat, dairy, fish

2) Begins the break down process in the bucket to compost in the swales or ICB more quickly

3) Ferments the food scraps to minimise odours to allow storage of the food scraps for infrequent collection

4) Adds microorganisms that might not otherwise occur



Benefits of Biochar

1)Neutralises the acidity of bokashi fermentation

2)Absorbs odours

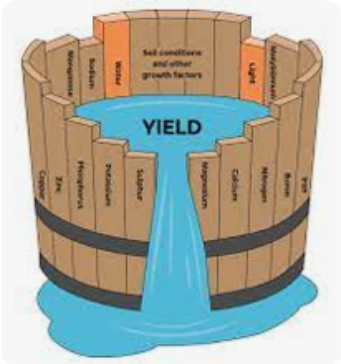
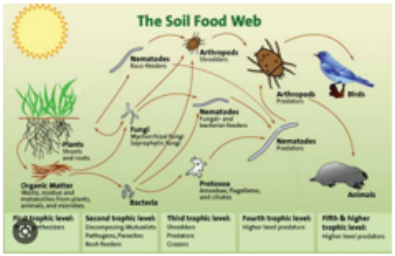
3)Adsorbs nutrients

4)Increases soil microorganisms by providing habitat

5)Creates a permanent home for microorganisms to maintain soil health

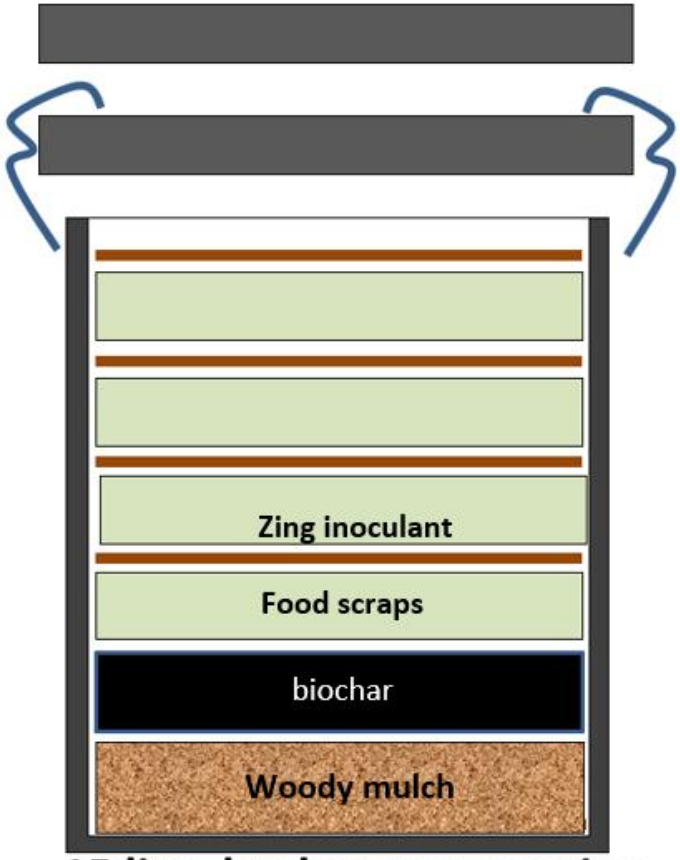
6)Adds a permanent form of carbon to the soil

The Old Banking System vs The New Soil Food Web Understanding of Soil Productivity

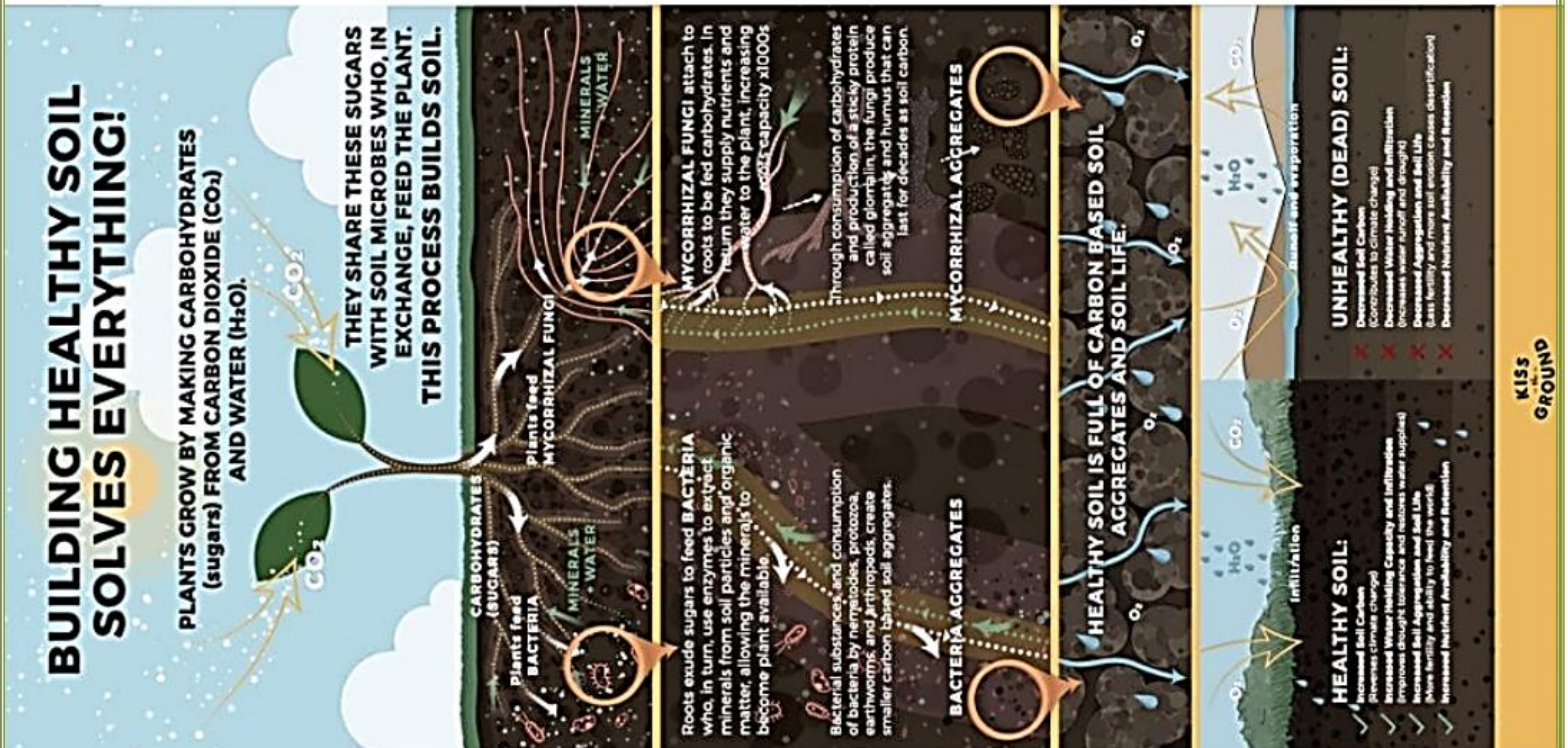
The Ancient Banking System Said:	The New Food Web understands that:
When the crops take nutrients out of the soil they needed to be replaced with new nutrients because the missing nutrients are depleted –hence the need for fertilizers If the crops are not healthy, the soils are missing something that needs to be identified and added. Plant growth is limited by the missing element -hence extensive soil sampling and lab testing  Soil microorganisms were bad, as they take nutrients away from the plants	It is the microbiology of the soil that makes nutrients available to the plants.  If there is an adequately diverse ecosystem of soil microorganisms, they will mine the subsoil and seek out nutrients to bring back to the plant. All soils have adequate nutrition but often lack the diverse ecology to mine and transport them Today, many of the soil microorganisms necessary to feed the plants have been knocked back or killed by the addition of too many nutrients , NPK fertilizers or compaction Soil microorganisms are not only good, but absolutely essential for plant health. However, a diverse ecosystem of microorganisms is essential

The C2F Project uses different containers and layering methods for different amounts and types of food scraps

Small 15 L buckets for less than 8kgs food scraps per day	80L, 100L, 120L or 140L for more than 8kgs of Food Scraps per day



15 litre bucket cross section



This slide explains how building topsoil can help solve many of our resource and climate change issues – from https://kisstheground.com/

Questions?

021 0826 8196

Or leave a message on the website

www.citytofarm.co.nz

Or send us an email

info@citytofarm.co.nz