Kon-Tiki 'Essential' manual

by Permachar.net - Version 7, 7/2/2023

What is the Kon-Tiki biochar kiln?

The Kon-Tiki biochar kiln is the fastest, cleanest way to make medium-sized batches of biochar from local biomass with minimal processing, and condition it for application.

The Kon-Tiki deep-cone flame-curtain process was developed by Dr Paul Taylor (author of 'The Biochar Revolution' book) and Hans-Peter Schmidt at the Ithaka Institute in Switzerland in 2014. In 2020 its use has been recorded in 80+ countries. The kiln was named Kon-Tiki after the Peruvian sun God, and inspired by the voyage of discovery of the Kon-Tiki raft Thor Heyerdahl sailed across the pacific.

Why the Kon-Tiki biochar kiln?

1. Low cost, simple and elegant compared to other biochar production technologies.
2. Proven, high quality biochar – fulfills all conditions for the European Union Premium Certificate for biochar.
3. The natural vortex dynamic of the Kon-Tiki cone kiln supports an “air-curtain” and flame cap that pyrolyzes the feedstock, burns the smoke and protects the char.
4. The Kon-Tiki has tested lower air emissions compared to other low cost kilns.
5. Rim shield provides safety, and heat protection, as well as clean combustion and uniform biochar.
6. Low feedstock processing requirements compared to other technologies.
7. Accepts a range of feedstocks, including mixed feedstocks and higher moisture content feedstock, in sizes from small off-cuts, through hog fuel and limb wood up to 1.2 metres in length and up to 6-8cm in diameter which could be a little less (faster burning) and a little more (slower burning).

8. Ideal moisture content for pyrolysis is 15% but anything up to 19% is OK. Wetter material can be used during the middle of the burn if the fire is 'going strong'/'going well'

9. A high volume of biochar can be produced in a few hours. The volume yield is about 45% and mass yield about 17%, comparable to other kilns and gasifiers that produce a high temperature biochar.

10. Nutrient charging can be conveniently done during charring, quenching or post-production right in the kiln. Add,eg. sea minerals such as liquid kelp or SEA-90, microbes, fertiliser et al

11. Quenching liquid and nutrients can be easily captured and recycled or used for multiple purposes via an optional drain at the base of the cone or via IBC containers for inoculation (in the case of the KTE)

12. Agronomic trials show the Kon-Tiki system to be especially effective for improving crop yield.

13. Relatively little training required to safely and effectively use the Kon-Tiki.

14. Clean up your property, and enjoy the fire while making valuable biochar.

15. The Kon-Tiki provides heat from biochar production, which can be developed for other purposes (e.g. cooking, water purification, drying, distillation of essential oils etc.)

Who can use the Kon-Tiki biochar kiln?

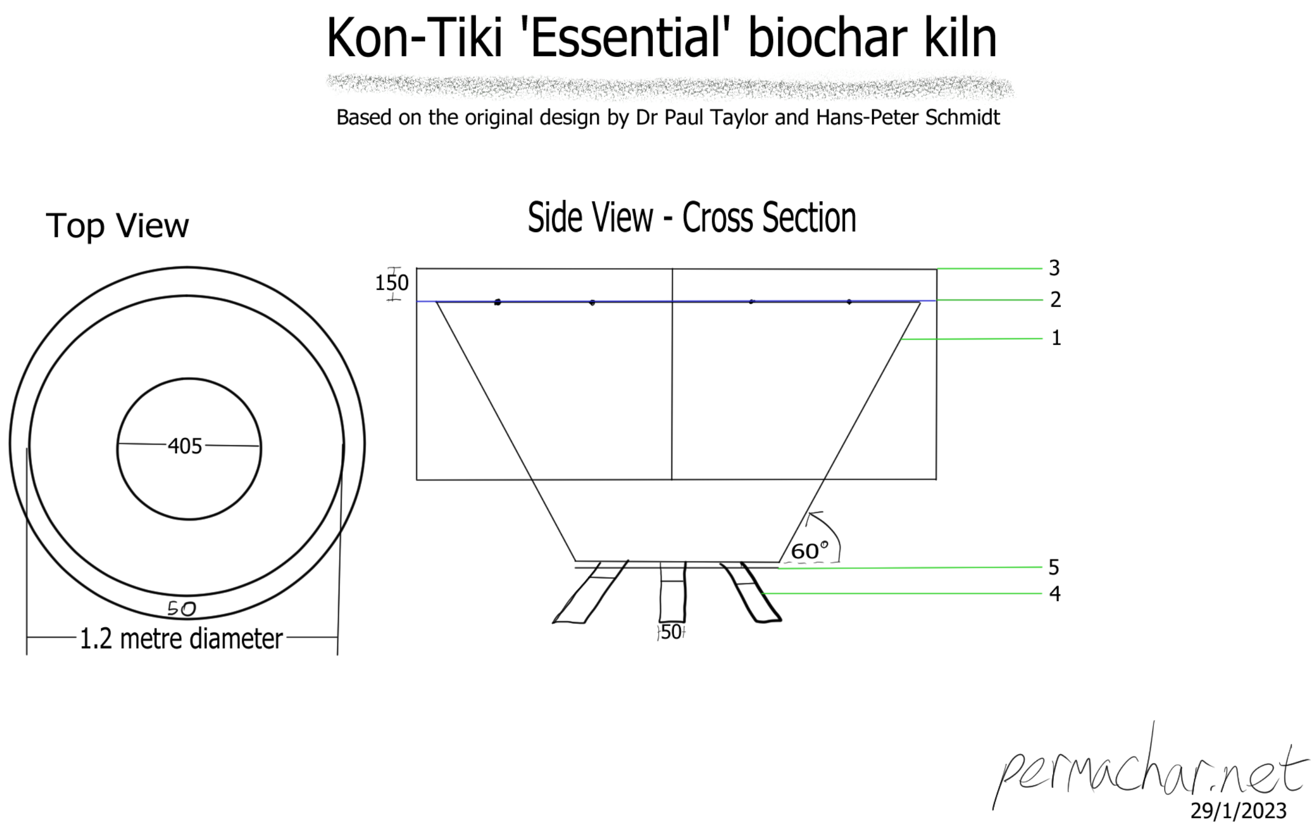
- Small property holders, farmers, Foresters, sawmill operators and others with readily available feedstock, stranded biomass.

- Landowners and agencies concerned with toxic water and land pollution and remediation.

- Gardeners, farmers, and community gardens seeking greater yield and healthier more nutrient density crops.

- Entrepreneurs seeking early entry into the biochar revolution and market.

THE KON-TIKI 'ESSENTIAL' (KTE) BIOCHAR KILN



- Tech specs
  - 1
    - 1.2m rim diameter 3mm 'Redcor' HW350A inverse truncated cone (weathering and watertight) with flat bottom
  - 2
    - 12mm cone reinforcement ring at cone rim with 50mm gap plus extra reinforcement at ground contact point during tipping/kiln emptying
  - 3
    - 1.6mm 'Redcor' HW350A rolled 'quad heat shield' (weathering, 4 pieces for easy attachment & removal via pop riveted hooks) with 150mm height above the cone rim for safety, greater energy conservation, higher temperatures for higher surface area and toroidal convection loops for cleaner pyrolysis
  - 4

    - 3 galvanised screw-in legs (2" diameter, 250mm length) screwed into bottom welded 2" 45 degree galvanised bends for smoother logistics from A to B, especially with multiple units, stable tipping to empty biochar after a burn and when not in use, adequate water drainage after rain along and inside the tipped cone
- 5
    - bottom heat shield, welded 12mm below the base with 12mm solid tube matrix and hollow thermocouple tube in between the cone bottom and heat shield, for greater energy conservation and thermal observation

Photos of the KTE prototype

EQUIPMENT

- A KTE biochar kiln

- IBC with top cut off and filled to top with water from
  - mains water
  - rainwater tank
  - water bladder
  - dam/creek/river/lake
- PPE
  - thick cotton/hemp clothes
  - welders gloves (the blue ones)
  - steel capped work boots
  - protective glasses/sunglasses
- fire lighting equipment
  - Kerosene/firestarter
  - newspaper/tinder

    - matches
- additional tools
    - 2 X Stainless Steel 20 litre buckets (Very handy for many things, including quenching, irrigation and small-scale biochar milling)
    - Food grade Phosphoric acid
    - shovel
    - Laser thermometer
    - pH meter
    - Moisture meter
    - wheelbarrow
    - tarps

SETUP

- Carry with 2 people (quad heat shield inside cone) or slowly roll kiln (without the heat shield), to the desired location using the reinforcement ring in your right hand and rotating the legs in your left hand - avoid any obstacles!
- The location should be free from burning hazards eg 5m above and around kiln.
- Once KTE is in place, remove the heat shield from the cone/carry the heat shield separately (if rolling) and place next to the kiln
- IBCs
    - I suggest buying 3 to get the operation started
    - Cut the top off one of them
        - move to 3+ metres away from kiln
        - fill the IBC with water eg. mains/pumped/gravity fed to the top
        - This will be used for quenching the burn

    - the other 2 leave aside for the paired IBC inoculation system, preferably near a water access point
- have dried and processed feedstock nearby and ready for the burn
- wear all recommended PPE

OPERATION OF THE KTE

- Create a large pile of sticks inside of the cone eg. a tipi or layered square stack (a 'Tom Reed pile') with newspaper/dry tinder (and a dash of kerosene/firestarter) in the middle.

- Light the stack from the top

- Wait until the stack has burnt down and formed a layer of hot coals in the bottom

- Add the first and thin eg.2" layer of feedstock covering the entire top surface of the hot coals. There may be some smoke at this stage. This is a combination of water vapour being released (white smoke) and regular smoke produced from the layer starting to pyrolyse/burn at the bottom of the feedstock layer

- When the top of the layer begins to ash, it is time to add the next layer. The layer should completely cover the bottom layer. Once again, the layer should only be thick enough eg. 3" to cover the under layer surface and still allow limited air to move through the upper/new layer. This is an art that needs to be perfected for every different feedstock type, size of processed feedstock and feedstock moisture content. If forestry waste is being used as feedstock, note that smaller feedstock pieces need to be used in the lower half of the kiln and larger pieces in the upper half of the kiln

- Once again, wait until the top layer is starting to ash under the 'flame cap' then add the next layer and repeat adding layers until the cone is filled with biochar right up to the top of the cone

- Add some small pieces of feedstock to the top layer to finish the burn. Once the flames have almost died down it's time to quench! If you leave it any longer, the biochar will start to break down beneath the flame cap, ash and reduce the biochar yield.

- Quenching.
    - Fill a 20L stainless steel bucket water/quench water from the nearby IBC
    - Use as many water filled buckets as needed to throw over the flame until there is no more flame
    - There will be lots of steam so patiently wait between each bucket for the steam to finish
    - Fill the kiln with water until the water level is just above the top biochar layer in the cone
- Push the biochar into the water/water mix (the back of a shovel works well) until there are are no more flames or burning biochar pieces

- Leave overnight then next morning pH adjust the quench water. Measure the pH of the quench water with a pH meter eg.Digitech. It will probably be slightly alkaline. You can customise pH for alkaline or acidic biochar which may be required for some soils eg. for more alkaline, add ash. For more acidic, add Phosphoric acid. So, for a neutral pH, add a small amount of food grade Phosphoric acid eg. 100mL, stir biochar in the quench water with a shovel, then remeasure pH. The pH should have dropped below 7 and will gradually increase back to around 7 (over the next 6 hours).

- In 6 hours remeasure the pH of the quench water. There may be some final adjustments. When happy with the pH remove water from the kiln using a 20 litre SS bucket to transfer the top water back into the IBC ready for the next burn. Unfortunately, the remaining water can't be recycled - probably the main difference between the KTE and Kon-Tiki's with drains but I made this choice as I kept breaking pumps and I wanted to reduce the parts and supply chains for the parts. It's also more flexible to do microbiology in a separate IBC system.

- The quench water now includes 'smoke water' from the biochar. If nothing was added to the IBC or only liquid kelp, the quench water can be used as a foliar spray or reused for the next burn/quench. I wouldn’t recommend using quench water for foliar spray if NPK and/or microbes and fungal spores were added.

- Remove the quad heat shield. Tip the cone over 2 legs (with the extra reinforcement on the reinforcement ring in between the 2 legs) onto a clay/steel surface using the reinforcement ring as your lever

- The biochar will partially empty from the cone

- Use a shovel to either empty the cone on site or transfer to a wheelbarrow and take to a North facing (Southern hemisphere) or South facing (Northern hemisphere) site for drying or added directly into a dual IBC inoculation system for Biochar Mineral Complex (BMC, coined by Professor Stephen Joseph). If you need to dry it if selling unmilled biochar by weight not volume, with access to a suitable area of soil, scrape the top layer of soil until you reach clay and place the biochar on top. Place a tarp on top of the biochar when it's rainy or overcast and remove the tarp when it's sunny.

FEEDSTOCK

According to Dr Paul Taylor, "It takes 1 hour per inch or 20-25 minutes per cm to pyrolyse to the centre of a piece of wood. For eg., for a 10cm diameter it would take nearly 2 hours, so you have to stop adding the big wood at least 2 hours before finishing. An ideal top size might be 6-8cm diameter for the 1.2m Kon-Tiki biochar kiln. An electric log splitter to split up the big stuff makes for a better run, but there is flexibility and you can find what is efficient and clean for the wood and moisture content you have. Bigger, wetter or variable just takes more time, care and smoke."

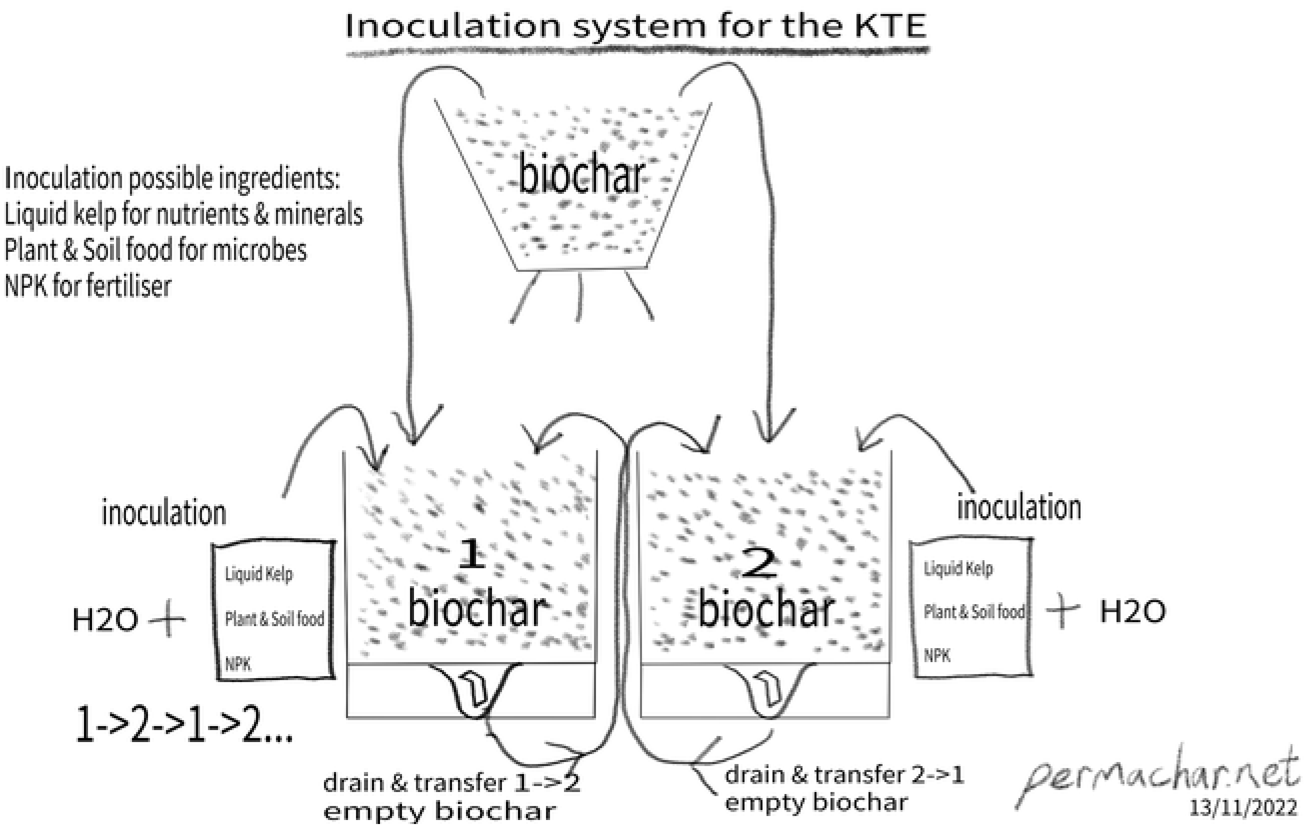
MILLING

Various options if needed from manual systems eg.a sledgehammer vertically pounding unmilled biochar in a 20L stainless steel bucket, to hammer mills (too much maintenance), to electric roller mills with an adjustable gap for different grades of milled biochar and others too.

INOCULATION FOR BIOCHAR MINERAL COMPLEX (BMC)

- Add whatever you wish to inoculate/charge the biochar with eg. liquid sea kelp (sea minerals), liquid fertiliser such as NPK, additional nutrients etc. Live microbiology such as microbes and fungal spores can be added to the quench water at the top of the cone and stirred in after initial quenching when the water has cooled down but most can't be recycled since there is no drain so here is a more appropriate system for the KTE:

  A dual IBC system!



In the above diagram, a biochar mineral complex (BMC) is produced by inoculating the biochar.

This approach solves the problem of 'hot charging' microbes in some cases but who knows how many use cases, some which will and some which won't survive the heat (depending on the microbes, eg.those found in cow urine seems to survive) in a recycling bottom quench drain system. However microbes can be sprayed onto biochar or the biochar can be co-composted for inoculation with Indigenous Micro-Organisms (IMOs)/added Non-Indigenous micro-organisms.

In this integrated design it is pump-free/drain-free (though unfortunately not plastic-free) and all of the inoculation using 'cold charging' can be done at the same time in one step with nutrient, mineral, microbe and fertiliser conservation and product savings.

The inoculation fluid from the first IBC is reclaimed and reused after inoculation by draining it from the first IBC into a 20 litre ss bucket and transferring it to a second IBC filled with biochar and vice versa. A top up of water and inoculation ingredients will be needed for every new inoculation. An additional benefit of reusing the inoculation water is the microbial populations will grow over time - unless of course you want a one-off inoculation, then you would have to clean the IBCs in between every inoculation with more work, more water and more IBC downtime - not what I would want to do

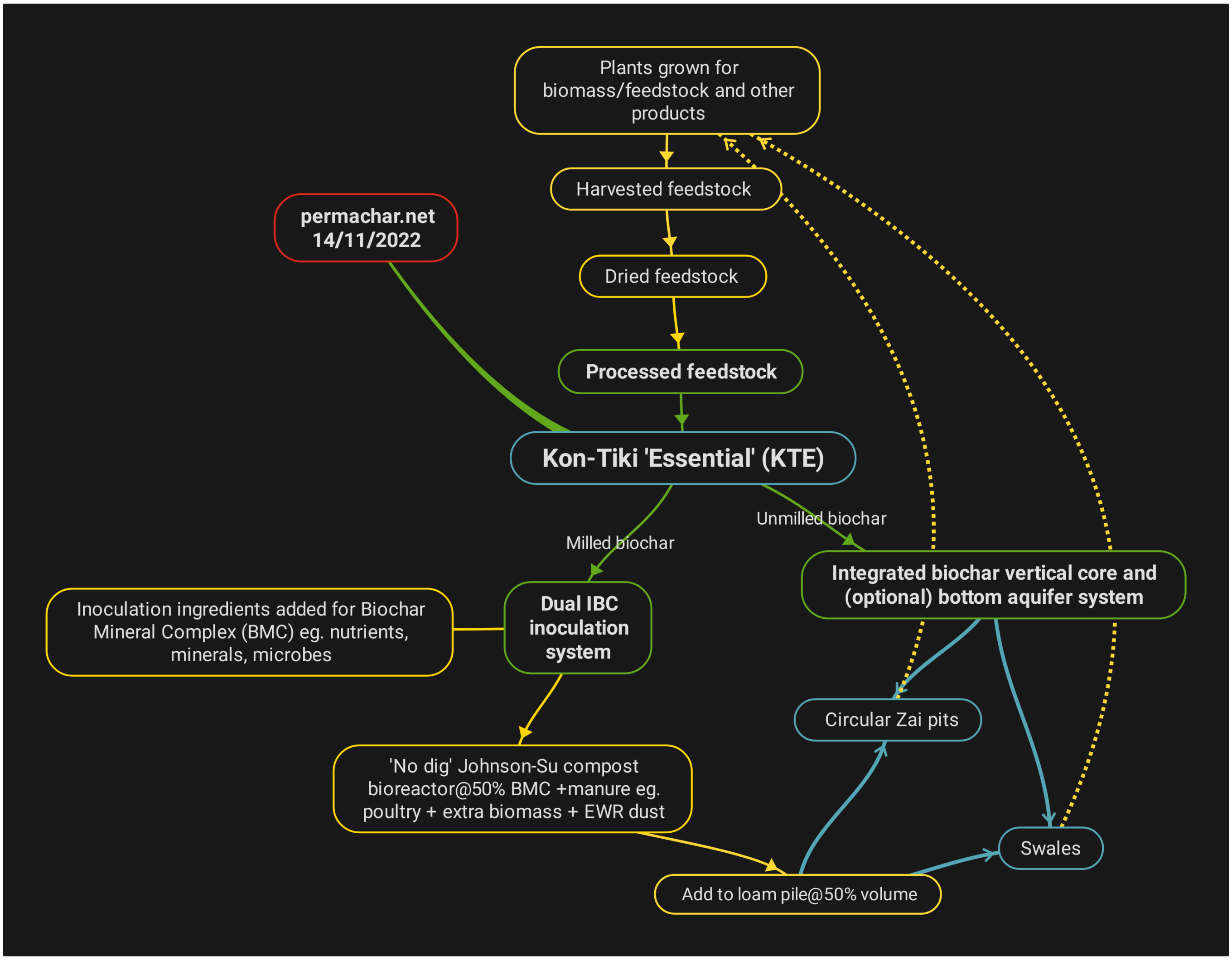
If more IBC capacity is needed then pairs of IBCs can be added to the system with geometrical scalabiity (including more KTEs as needed).

Some other variables to consider are:
-the time needed for 'effective' inoculation
-using unmilled/milled biochar for the inoculation
unmilled will have less surface area for inoculation than milled biochar but probably won't block the internal mesh drain at the tap. Different grade/diameter mesh needs to be tested.
-since every ingredient of inoculation has different dilution rates, an ideal ratio of the ingredients would need to be researched for possibly a single uniform liquid input eg.customised for a specific plant monoculture (or take an average result for a plant guild or polyculture) that could be premixed before adding at a single dilution rate to a measured amount of water added to the level of the top of the biochar in the IBC.

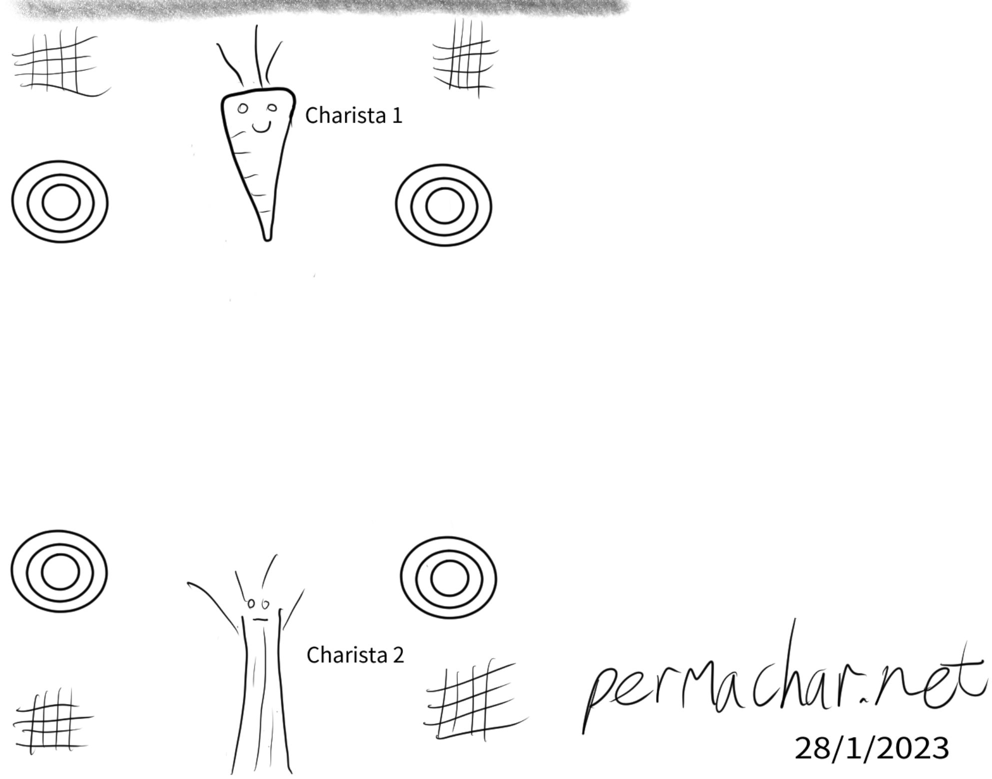
GENERAL INFORMATION

I'm trying to simplify my business due to all these supply chain issues emerging around the world.

The Kon-Tiki 'Essential' is an affordable, supply chain hardened biochar kiln with for Carbon-negative 'regenerative' food and medicine production along with hundreds of other applications.



A Kon-Tiki 'Essential' 'Quad core of biochar'



A diagram of 4 KTEs in a square for easy access and safe operation plus upward scalability from using just one 1.2m Kon-Tiki biochar kiln. The kilns can be operated at the same time or different times. Basically, a multi-core CPU that can scale 1 to 4 cores at a time for your biochar operation! A simplified system with no drain, pump and IBC for each unit, instead utilising a scalable dual IBC inoculation system that should be able to cover many microbe inoculation scenarios.

2 or 4 KTEs?

I'm selling 2 or 4 units @AUD$2700/unit.

2 KTE's (a 'Dual core of biochar') for AUD$5400 is a great entry point for 1 Charista if the feedstock is well prepared.

4 KTE's (a 'Quad core of biochar') would be perfect for 2 Charistas, running 2 kilns per Charista if the feedstock is well prepared. By my calculation, it's the best entry level price point (AUD$10,800) for medium-scale biochar production for a small settlement/biochar product business

For eg. in a product business, the following products could be made:
-unmilled biochar
-BMC, for adding to soil or possibly direct seeding/planting
-pelletised BMC and Asparagopsis for livestock feed, chicken feed, dog feed, cat feed etc.
-pelletised BMC (eg.biochar and kelp) for perlite replacement in seedling and hydroponic systems
-BMC compost eg.with poultry manure, for agriculture, viticulture, agroforestry, horticulture etc.

In permaculture inspired 'ecovillages' with better access to resources, 4 KTEs at the centre of the village could be used to build out the growing systems with BMC and biochar possibly used in some building materials eg.charcrete, hempcharcrete etc. Construction of biochar water filtration systems is possible too. The list goes on...

4 KTE's is great value considering how expensive and complicated the larger kilns currently are which also require maintenance. There's no maintenance for the KTE as it is weatherproofed with the only moving parts being the quad heat shield which is very easy for most people to add and subtract to the kiln and the kiln itself when it's tipped over to empty the biochar and remaining water.

A 4 unit order is also best from a laser cutting and logistics point of view. I'm open to larger orders too but it depends on the workload of the fabricator for wait times before product delivery. Maybe we've almost beaten COVID-19 in some countries but large scale logistics in Australia is tight and increasingly expensive. Future upgrades of renewable energy for engines eg.Diesel to Hydrogen, Hydrogen, Hydrogen/Electric or Electric and Carbon neutral payloads will hopefully drive logistics costs down. One day logistics may even be Carbon negative with biochar solid state batteries and Carbon based perovskite PV panels.

Any number of 'Lu'au' biochar pits could work in a small village too with no access to steel fabrication.

The idea is the kiln cone is a kernel for any 1.2m modded Kon-Tiki design, such as the Kon-Tiki 'Rolls' (KTR). The KTR has a cradle (wheels and tipper) and drain which has pros and cons and at this stage has been taken off the market.

There are many factors to consider when choosing the perfectly intregrated Kon-Tiki kiln for your needs. Water, agricultural resource input, tech/tools and their availability, skillsets, accessibility, cost and probably other factors too. There's always the 'Lu'au' pit but still faces similar constraints however this is probably the cheapest way to make small to medium batches of biochar but requires more labor, soil and is less ergonomic than the Kon-Tiki biochar kilns. No drain too. Could be an interesting option for Terra Preta making which I intend to test in the KTE. Ultimately, it depends on what you want to do with the biochar and how you integrate the biochar into your growing system(s). Every design choice is imperfect but I believe the KTE will cover most bases for small-scale biochar research and development and provide versatile hardware for the 'Charista' well into the future - very high quality weathering steel and as the biochar firmware integration with other system hardware eg. Zai pits and swales, improves.

The eventual goal is to make Kon-Tiki biochar kilns all around the country. I believe the key to success will be installing roughly USD20k fibre optic 1000W 2D laser cutter (as far as I know there are no Oz manufactured laser cutters), with possible Government subsidies, at small to medium sized fabricators in agricultural regional towns, possibly an industrial area in some cases. This would be good for making other machinery and parts too.

Note that StyleCNC offers spare parts for their laser cutters and are leaders in their field. Note that if it is assessed that the supply chain risk is too great for imported laser cutters, the sheet metal can also be cut with a plasma cutter (less parts but probably still imported) but will take more time, less energy efficient, less accurate eg.possible rough edges, which depends on the tech and cutter, and a plasma cutting skill set but affordable to many more fabricators. For eg, you could spend AUD$800 at Bunnings to get a plasma cutter - but would still need access to the other equipment eg. roller, welding gear, or use multiple fabricators which is less efficient.

The laser cutters could probably be powered from a standalone power bank with solar PV panels either ground mounted or on top of the workshop roof.

Here's a couple of links for further research:

Bluetti Power: https://www.bluettipower.com.au/

StyleCNC: https://www.stylecnc.com/fiber-laser-cutting-machine/fiber-laser-cutter.html

KTE as a biochar maker, firepit and outdoor sculpture - 3 in 1

The KTE makes biochar! The advantage of the top quench (for the KTE - no drain) is greater observed steam activation than bottom quenching, though it will use more water (which may not be such an issue for stationary use with an available and abundant stationary water source). Unmilled biochar, not inoculated and no additional ingredients, can be used for the integrated vertical core and bottom aquifer system (see latest RAS notes page in the next section) and the high surface area will hold a lot of water for slow-release wicking into the soil.

The KTE should also make a great firepit and outdoor sculpture too!

KTE scalability opens up the medium-scale biochar market for more punters wanting to enter the Biochar Revolution and produce the most future proof material on the Planet!

Latest Regenerative Agroforestry System (RAS) notes - current web page at the time of this document being published

The RAS is an opportunity for an adaptation strategy working towards a more resilient and sustainable future with integrated Carbon removal and offsetting and geometric scaling potential. R&D of the systems could be done in a network of field testers. Maybe help save a dying Planet too.

1.The biochar kiln system

Kon-Tiki 'Rolls' (KTR)

-alley crops eg.viticulture, agroforestry

-orchards

Kon-Tiki 'Essential' (KTE)

-stationary kiln in one or many stationary locations

2.Compost system

Johnson-Su compost bioreactor modded and simplified (experimental) with:

-1- A hexagonal vertical star picket formation (driven into the ground) can be made, 6 short Rio rod guides driven into the ground supporting 6 vertical 150mm PVC pipes. Hessian cloth wrapped around the star pickets. Unmilled biochar bottom aquifer added. BMC, manure and biomass filling around the pipes. Pipes removed and the pipe void then filled with unmilled biochar for vertical biochar cores which act as irrigation points for the bioreactor.

Lots of aeration and watering is needed. For eg. 50% BMC, poultry manure, additional biomass and Enhanced Rock Weathering (ERW) dust could be co-composted. The ratio of ingredients will depend on the microbe, nutrient and mineral profiles of the biochar, manure, loam/soil and plants you want to grow. Normally, it's a ratio of Carbon/Nitrogen @30:1. Keep in mind that most of the Carbon is locked into the C matrix in the BMC hence a high BMC percentage is possible with additional C in the form of biomass is still needed. The ratio should be optimised with experimental compost trials which I intend to do.

When the composting is complete (after a variable time period) the hessian cloth, star pickets and Rio rods are removed for reuse in additional bioreactors.

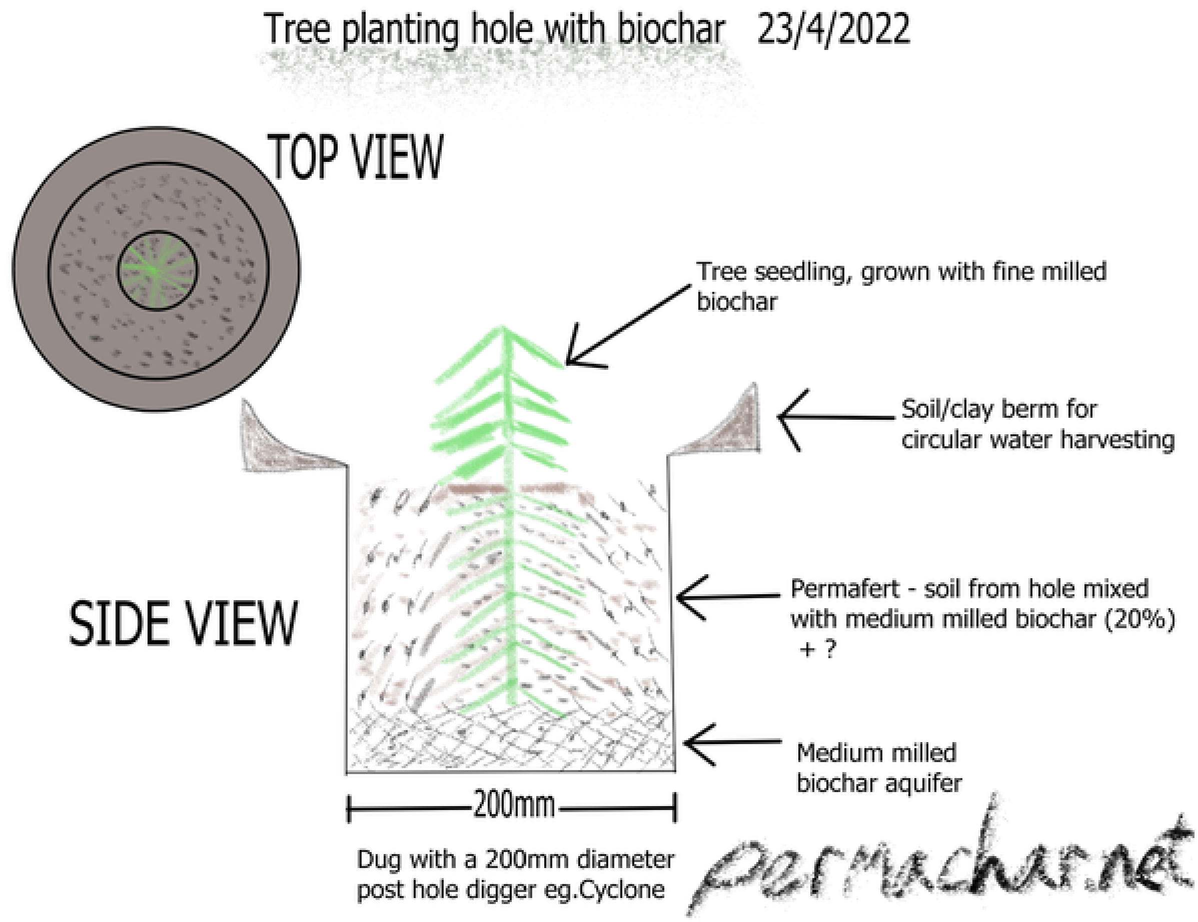
Middens can be built around the compost piles after the composting has completed with clayey loam added eg.dug from swales. This material, 'BMC compost and loam' is the updated definition of 'Permafert', which was previously defined as a midden made from loam with biochar added, not necessarily BMC, and just about anything else organic added.

It makes logistical sense to build the bioreactors near the swales, pits, cut 200L drums or whatever your growing system happens to be.

-2- Could use a 'no dig' donut chicken wire structure based on wire mesh resting on 2 logs, kept in the shade, see below.

3.Tree planting holes for trees

Eg. Biomass, fibre, fruits, nuts, medicine et al



4.Square Zai pits with integrated central biochar cores and biochar bottom aquifers

KTE, Pits are built out from the kiln centre in a keyhole fashion.

After digging a Zai pit and berms are made, add unmilled biochar for the aquifer eg.150mm deep

Place a 150mm diameter PVC pipe in the centre of the pit lodged into the bottom biochar aquifer and up to the top pit level.

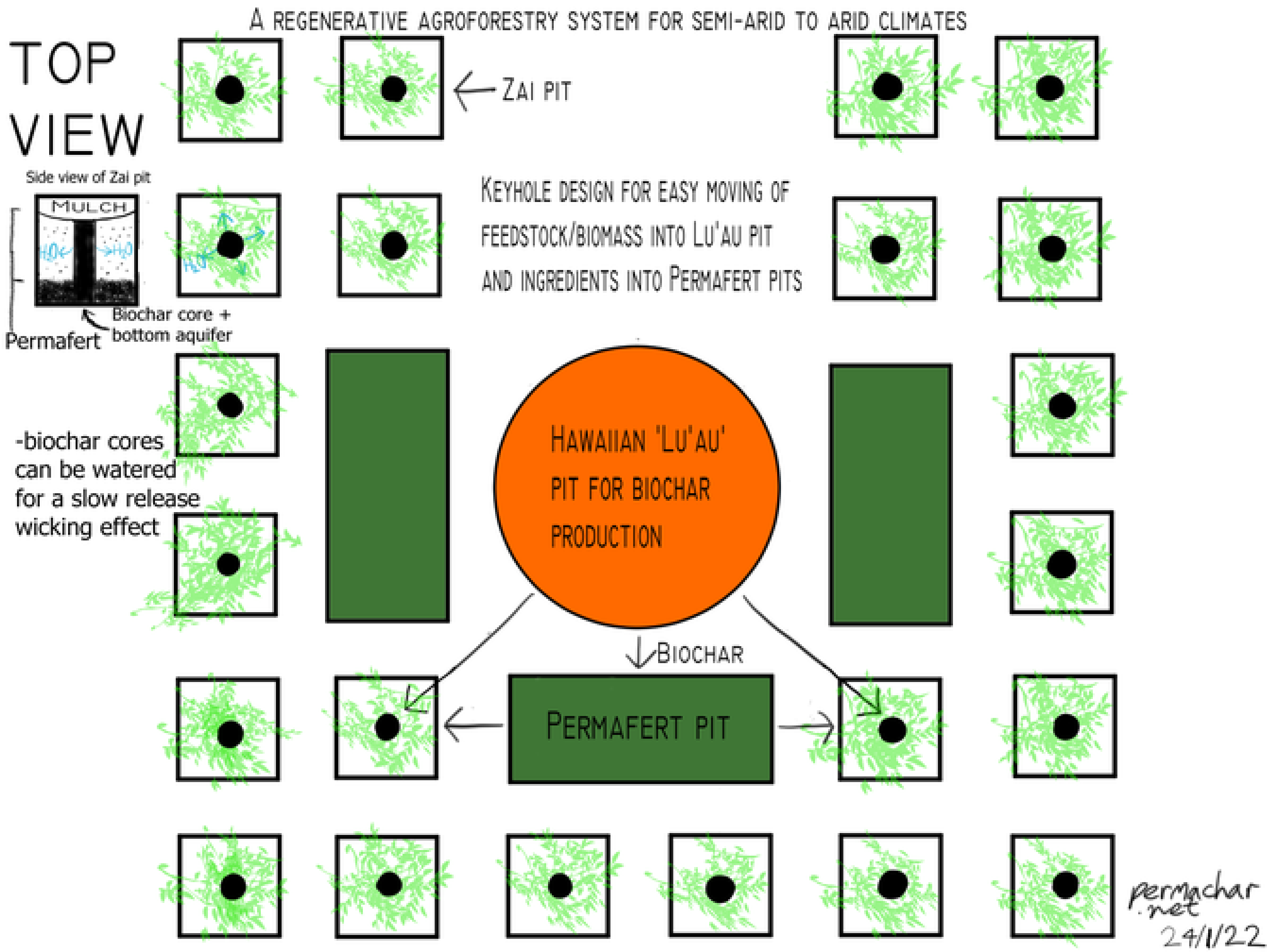
Add permafert around the central pipe and make a concave shape.

Fill the pipe void with unmilled biochar up to the level of the permafert around the pipe then lift up the pipe to remove it and produce a biochar core.

The shallow/concave pit will concentrate rainfall to the centre of the pit and into the biochar core/aquifer T junction.

Irrigate the central biochar core as required.

Calibrate the central core to a Reotemp 'Moisture Meter' once the first seedlings have sprouted (experimental).



5.Same as above design but Permafert piles with central biochar cores in half of the Zai pits for '3 Sisters' planting

A design for '3 Sisters' (maize, beans and squash) growing. Square Zai pits (built last Spring) updated with central permafert mounds for drainage, central biochar cores linked to bottom biochar aquifers forming a T junction for water wicking and conservation, nutrient reclamation, microbe housing and Carbon removal. Flooding events will concentrate water via the berms in the 'moat' around the mound for outer mound irrigation and additional irrigation as needed via the central biochar cores which will irrigate the inner mound and to an extent fill the bottom aquifer.

6.Circular Zai pits with integrated central biochar cores and biochar bottom aquifers

My preferred Zai pit design, a little bit more earthworks than the square ones but better water distribution and wicking and easy to make consistent berms around the pit. Depending on the rainfall pattern (which will become more unpredictable with climate change), the berms could be C shaped if too much water is accumulating in the pits and/or the depth of the biochar aquifers could be modified for more (deeper) or less (shallower) water storage. These will be used for my next pit trial over the Summer and Autumn growing 3 different pumpkin varieties (hard-skinned gourds) in 1 metre diameter pits using unmilled biochar from agroforestry waste for the cores and bottom aquifers.

I'm using a cross + of 2×1m lengths of thin bamboo screwed together in the centre as a guide for pit building.

Variables:

Diameter of pit eg.1 metre

Depth of clay

Feedstock used for biochar and size of biochar pieces

Depth of biochar bottom aquifer

Width of vertical biochar core eg.150mm diameter PVC pipe/core

Permafert recipe

Depth of root system of the plants you want to grow which will determine the depth of the permafert

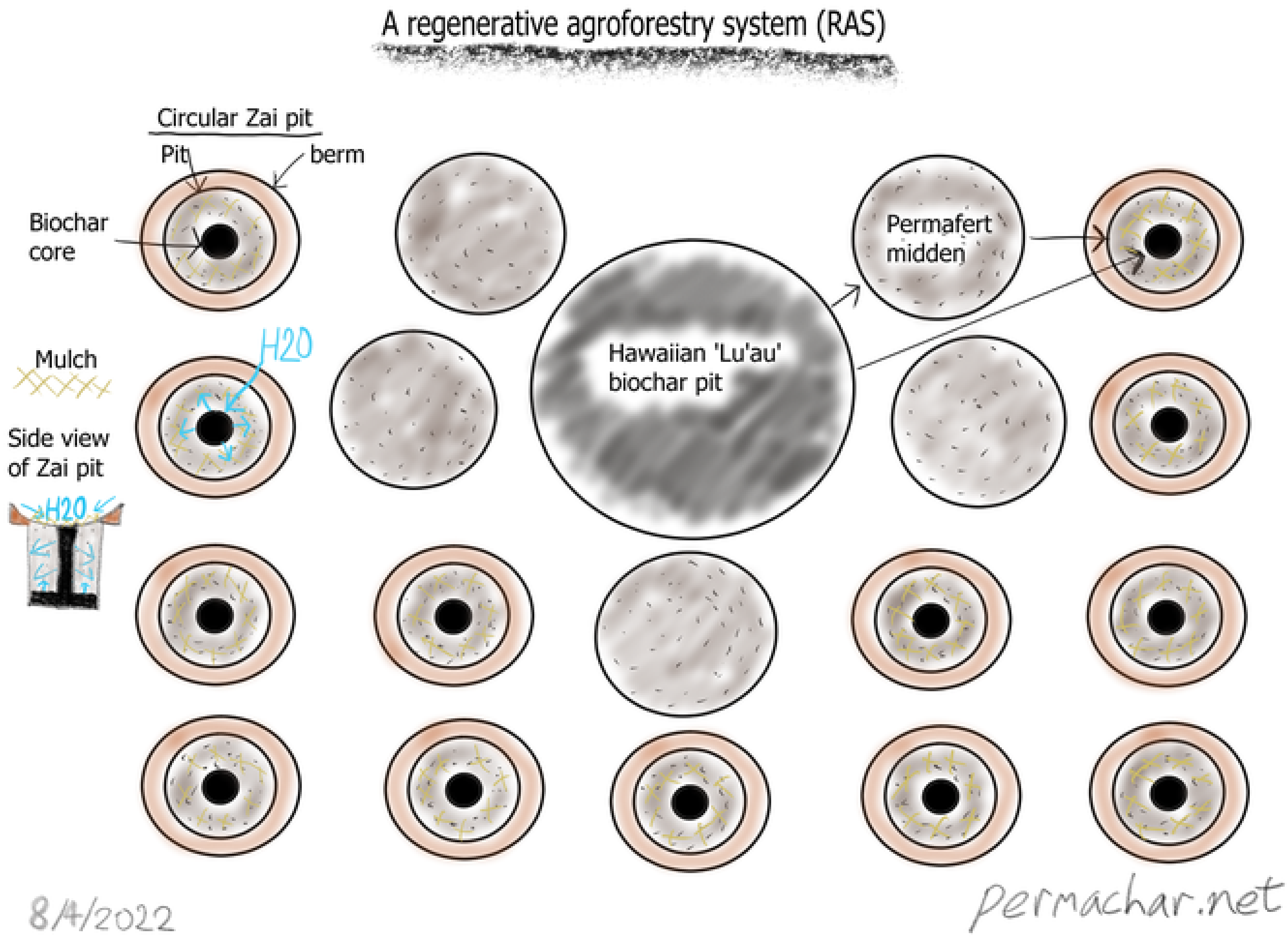
Amount of water needed by the plants during a growing period as it relates to rainfall, water harvesting of the pit, rate of wicking and evaporation

Size of berms

Access to growing area eg. 1 or 2 C shaped berms

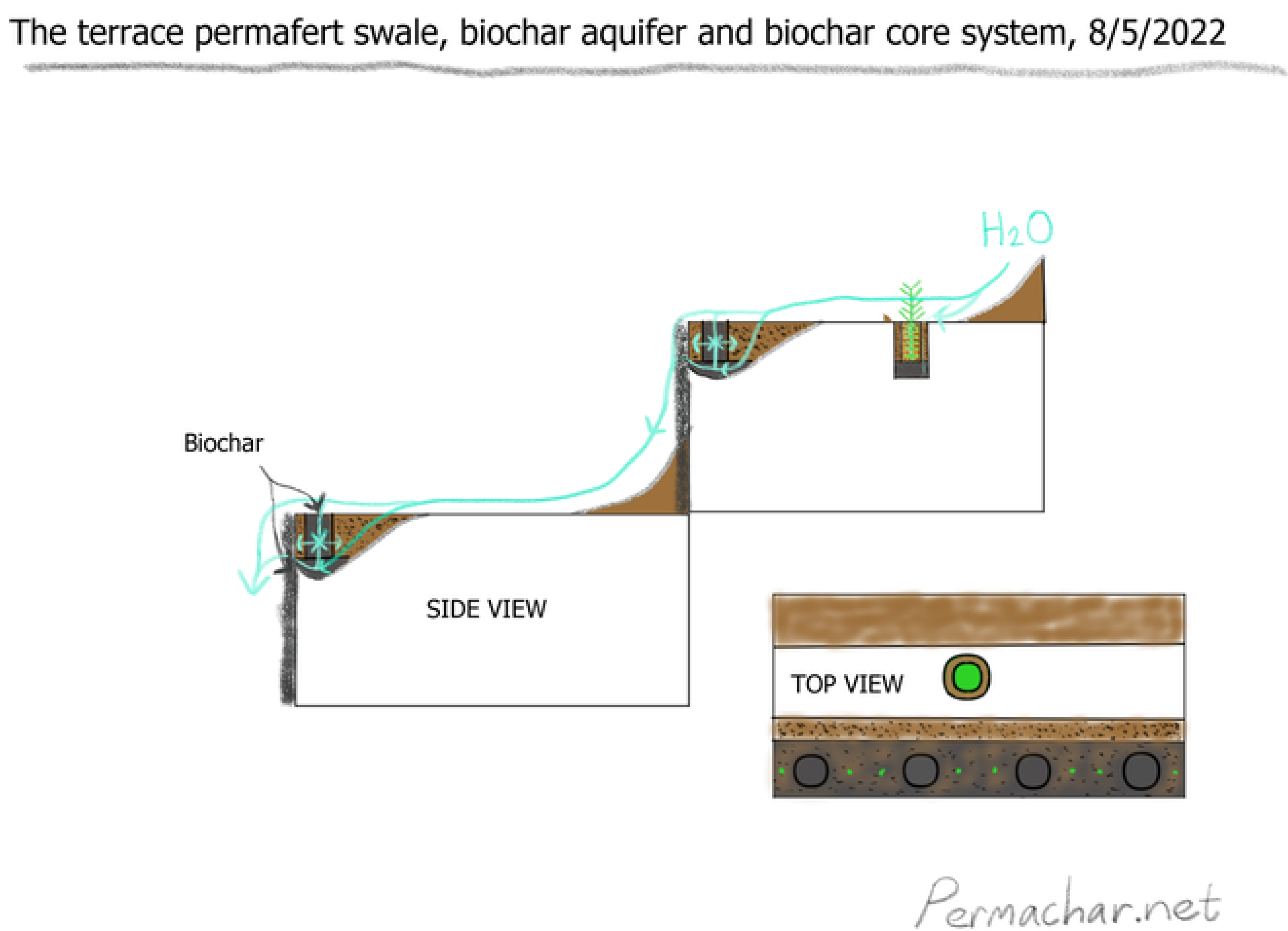
Slope of pit

In order to climate proof the growing system, 3 different pit configurations could be built that could adapt to different rainfalls and different plants as needed during the period of climate heating and disruption.



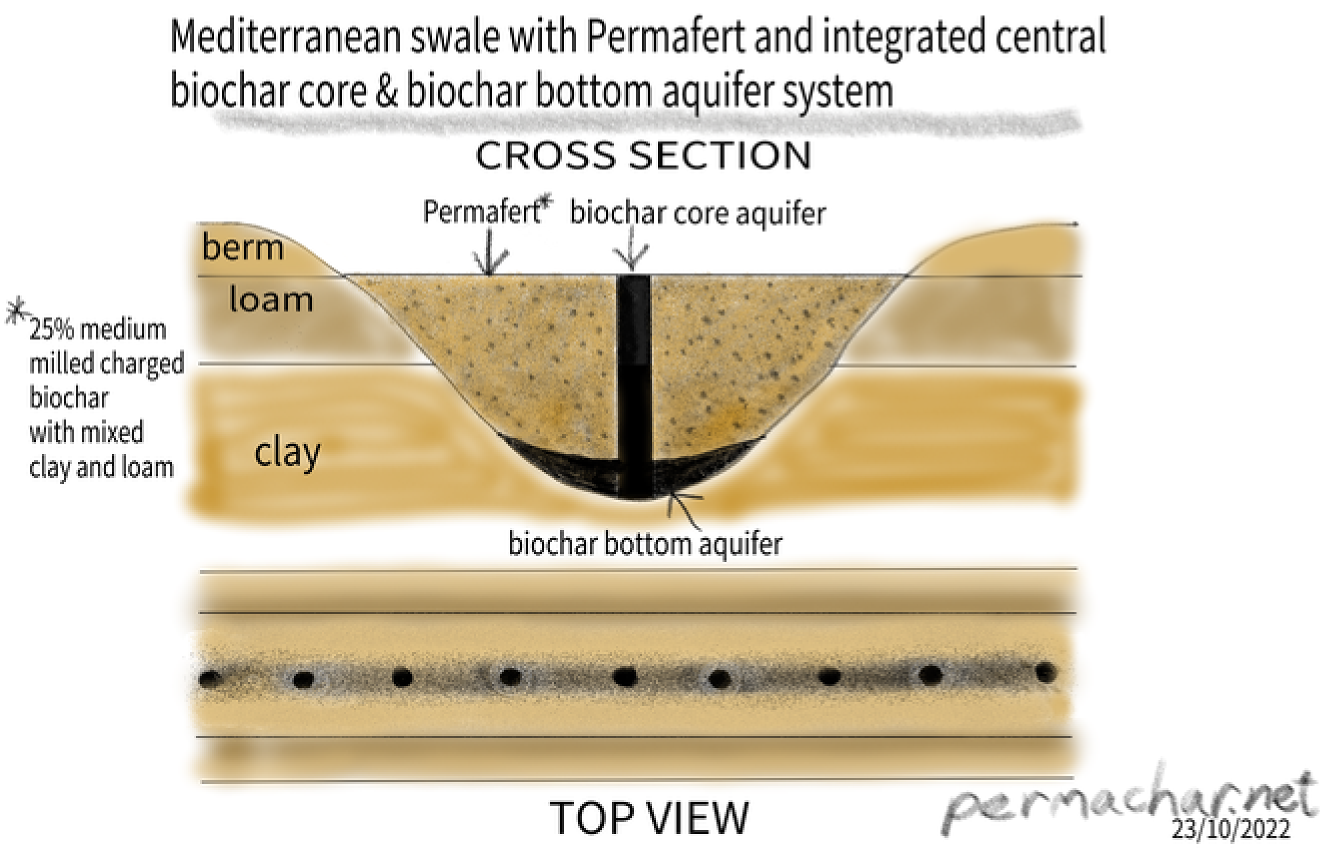
A regenerative agroforestry system (RAS)
Circular Zai pit
Pit
berm
Biochar core
Mulch
H2O
Side view of Zai pit
H20
Permafert midden
Hawaiian 'Lu'au' biochar pit
8/4/2022
permachar.net

7. The terrace permafert swale, biochar aquifer and biochar core system



8. Mediterranean swale with Permafert and integrated central biochar core and biochar bottom aquifer system

-A pump free and battery free system, which makes me happy as I have broken 4 water pumps.



UPDATE - ditched the bottom aquifer for easier building and decrease the amount of biochar needed. Also, proposing a shallower swale with less width for easier access to plants

MAKING THE BIOCHAR

Using a Kon-Tiki 'Essential' (KTE) biochar kiln

-A burn is quenched in the KTE with a water siphon from a header tank (bore) or rainwater tank plumbed from a shed, house or bore. A 20 litre bucket from a water vessel eg.IBC can also be used.

-pH adjustment with food grade Phosphoric acid to suit eg.7 is neutral which is good for most plants.

-Leave overnight

-Bucket out as much 'smoke water' as possible to reduce the weight for tipping and use for irrigation or if using an IBC, add the smoke water to that for reuse

-Empty the kiln

MILLING THE BIOCHAR

Mill 80% of the biochar in a bucket with sledgehammer or solar electric mill to particles less than 10mm in size if needed (milled biochar can be used for the Biochar Mineral Complex (BMC) and unmilled biochar (20%) for composting and the vertical biochar cores in the swale

MAKING THE BMC

Inoculate the milled biochar in a 2 IBC system for BMC eg. liquid sea kelp (sea minerals and nutrients), microbes eg. Plant & Soil Food, POPUL8 etc., organically produced liquid NPK etc

COMPOSTING THE BMC

Co-compost the BMC with manure eg.poultry, which is full of nutrients and minerals, and additional biomass if available + Enhanced rock weathering (ERW) rock dust eg.basalt (more minerals) in a Johnson-Su or modded Johnson-Su compost bioreactor with possible multiple units operating at once

Keep the compost watered/wet and wait roughly a few months (which will vary) and 'voila' - the perfect compost for permafert!

BUILDING THE SWALE

Once the compost is ready, dig/build one swale at a time, separating the loam for permafert and clay (if it exists) for berms and placed in piles adjacent to and along the length of the swale on the clear side with no swales

Add the compost (50%) to the loam piles (50%) and mix together = permafert! (25% BMC plus unmilled biochar from the bioreactor vertical cores and bottom aquifer = roughly 1/3 total biochar)

Fill the swale up to the ground surface level with permafert from the permafert piles

Water in the permafert if water is available

Add vertical biochar cores 500mm apart using a 150mm Cyclone post hole digger to remove permafert

Fill the void with unmilled biochar

Repeat along the swale

Spread the permafert obtained from the cores along the swale between the cores

Plant cow pea/other Nitrogen fixer along the swale for additional N fixation

Build the clay berms

Start the next swale and repeat

PLANTS

Once cow pea/other Nitrogen fixer is mature and biochar has 'aged', chop at base and drop for mulch

Seeds or seedlings eg.annuals and/or perennials planted directly into swale

Finely milled biochar can be used to cover the seeds in a thin layer, roughly the same depth as the width of the seeds being planted.

IRRIGATION OF THE SWALE

Irrigate the biochar cores as needed with 20 litre stainless steel buckets filled up with water or a garden hose (or microdrippers).

A Reotemp 'Moisture meter' is needed. The meter probe can be inserted into the base of the cores for moisture measurement and the meter will tell you when you have reached the optimum moisture level after calibration to 'healthy plants'.

Optional micro-irrigation with an Unpowered Measured Irrigation Controller. https://www.measuredirrigation.com/

NOTES

The above swale system is untested. Anyone willing to experiment with it please contact me so we can share results after I build my experimental system too.

If the quality of the loam/other soil type is higher then less BMC is needed in the permafert and vice versa. In my salad greens trial, 25% BMC seems to be the right amount added to good quality clayey brown loam. The quality could take into account water retention, nutrient retention, mineral retention, soil structure and porosity, cation exchange capacity, soil biome and ultimately fertility (and more).

The biochar cores could be inoculated with additional microbes, either before or after building them. Since the biochar cores are the main irrigation points and would be regularly monitored with a moisture meter, they will always be moist to a variable degree. This could be perfect for microbe housing in the 3D biochar matrix. The system should self-regulate aka if the moisture content is too high in the core, the microbes will enter the permafert and if the permafert becomes too dry they will re-enter the biochar core. The only problem I see is if the pit or swale is flooded for an extended period of time, some microbes might die. The only way I can think of to check this would be taking permafert and biochar core samples before and after extended flooding events, to a lab and comparing the microbe colony numbers.

Samples of the permafert probably need to be taken from time to time after flooding events to check nutrient, mineral and microbe levels and determine if direct top-ups are needed in the swale.

Compost from the Johnson-Su bioreactor/donut chicken wire system could be added to the top of the permafert as a mulch in swale when needed. This will reduce water evaporation/increase water conservation and also enter the biochar matrix within biochar pieces in the permafert providing additional nutrients and minerals for soil biota and plant roots plus providing additional microbes. For interest, check out in google images 'Terra preta de Indio' to get some nice Terra preta 'soil profiles'. The modded idea is that over time the soil is replenished and maintained with additional layers of biochar/compost/permafert/Biochar Mineral Complex (BMC, Professor Stephen Joseph) inputs - or even with Terra preta if that's what you want to make.

BEAM extract is worth investigating too. Contact Dr Paul Taylor for more information.

If the clay is too deep to access, there's a possibility of making char-crete lined swales which, if made permeable, might retain water over similar time scales to clay. There are recipes on the internet for this.

If using bore water for irrigation, research can be done to determine the effectiveness of the biochar filtering out the Total Dissolved Solids (TDS) to an acceptable level for a given plant variety.

Latest photographs


BASIL
EDEN SEEDS
EDEN SEEDS
EDEN SEEDS
QUITTING WILL IMPROVE YOUR HEALTH
Select Organic
CORN MAIZE HOPI BLUE
SMOKING
GANGRENE

Seeds

Salad greens trial in the top of an IBC with 25% BMC and 75% loam = Permafert!

Zai pit with mound and central integrated vertical biochar core connected to a bottom biochar aquifer

Permachar Kitchen Garden (PKG) herbs grown in 10% BMC after 3 years

PKG after 3 years

Zucchini in The Permafert Swale with 15% unmilled biochar (built 5 years ago)

A new material experiment. 95% BMC (biochar inoculated in situ with microbes, nutrients and minerals) plus 5% Bentonite clay, growing chili and tomatoe seedlings plus directly seeded perennial basil and cow pea.

Equipment for small-scale biochar application in a garden

Square Zai pits

Sunchokes and zucchini in The Permafert Swale (built 5 years ago)

Conclusions

Any thoughts about how we can improve the hardware-software integrated systems
please send me a message on the contact page at permachar.net
All feedback welcome!!!

END OF DOCUMENT!