Making Terra preta.

Terra preta is a type of soil with long-term fertility, apparently created by early Amazonian civilisations. The soil has a high charcoal content, appears to promote the growth of mycorrhizal fungi, and is said by the locals to “grow”. The reasons why it is so fertile, and whether this fertility can be replicated today, is the subject of a great deal of modern scientific research.

Exactly how early Amazonian civilisations created terra preta is still unclear. Aside from the obvious charcoal, which often extends to a depth of half a metre or more, broken pieces of clay pottery are also commonly found in terra preta. In my opinion, pieces of pottery may not contribute much to soil fertility (inert stones, for all intents and purposes, but this may turn out to be wrong), and may just be incidental. This is just speculation in the absence of hard scientific facts, but perhaps the Amazonians defecated into clay pots or shallow clay pans, which could have had air-tight lids. When full, these could have been placed amongst the trees that had been felled, and smashed before the trees were burnt (or they could have just cracked in the fire). The heat of the fire would sterilize the human manure, (they could well have added various animal manures as well) and probably increase its phosphorus availability. In a trial growing annual ryegrass in subtropical Australia, growth increased with incorporated charred cow manure “feedlot manure”, compared with charred chipped tree branches and leaves “municipal greenwaste” (which would equate quite well with slashed rain forest), which produced results much the same as the control (no treatment). A combination of feedlot manure biochar and NPK fertilizer gave the best results (Watson 2009).

Over time, earth worms are likely to ingest the fine particles of charred cow, goat, horse or sheep manure, and increase nutrient availability still further. Mycorrhizal fungal populations may also proliferate in time, resulting in increased efficiency in water and nutrient uptake, and increased glomalin should improve soil structure.

Repeated additions of charred manure, wood, wood ash, and burnt animal bones over time would build up a soil of high and long-lasting fertility. Coupled with this, the forest would probably have been allowed to grow back occasionally, and been cut again (or today, a mixed, improved fallow could be grown, producing more biomass in less time). Trees on the outside of newly cleared areas may also have been felled into the clearing, concentrating the organic matter and nutrients in the cleared area. It is worth remembering that about 60% of the nutrients in a tropical rain forest are in the tree trunks, rather than the soil.

Highly productive soils of concentrated fertility would also have eliminated or at least reduced the need to clear more forest for more slash-and-char agriculture (a great deal of hard physical work, especially with stone axes - it is possible that the Amazonians girdled the big trees with axes, allowed time for them to die and dry out, and then burnt the bases of the trees to fell them more easily).

Around the world today, there are examples of using charred materials in agriculture, and an apparently less well-known traditional shifting cultivation system is still practiced on swelling, cracking clays in Ethiopia. Dried cow manure is mixed with clods of soil into piles and then burnt (Donahue in Troeh et al, 1980). The burnt or charred soil/manure mixture is then spread over the fields. The mixture is improved, changing from swelling, cracking clay to a loamy sand texture, like brick dust, with an increase in available phosphorus and pH, which results in better crop growth.

In order to reproduce Terra preta today, or at least something similar, it seems that the inclusion of livestock manure (and potentially human manure) is important, providing higher nutrient biochar, and producing a Terra preta with increased phosphorus availability.

A possible way of making Terra preta today.

If human manure is used, it could be deposited in clay pots with lids, or in paper bags/newspaper lining a plastic bucket. A deckchair toilet could be made (see www.kernowrat.co.uk/) to go over the top of the bucket or pot, and the faeces covered with wood ash, soil, rice hulls, dry leaves or sawdust, and possibly the top of the bucket could be covered with a plastic shower cap when not in use.

Terra preta could be made in circles/mounds, rings or strips. To make a terra preta circle or strip, soil could be collected into a pile (scraped or dug up) from a circle of one or more metres diameter, or if in a strip, on the contour and one or more metres wide, and as long as desired. The soil could be dug to a depth of around ten to twenty centimetres, and separate piles made of the good topsoil, and the less good subsoil.

A large quantity of crop wastes (eg. maize stalks and cobs, rice hulls, coconut shells and fibre, bagasse, manioc peelings), dried stalks of Napier grass and *Tithonia*, thin wooden twigs from *Sesbania sesban* or bamboo for example, dried animal manure, dried water plants eg. *Eichhornia, Pistia, Salvinia*, dry grass, bark, leaves etc. could be piled onto the circle or strip, all distributed evenly. On top of this, animal bones (burning bones increases the availability of the already high phosphorus, Bennet 1995) and fish heads and skeletons should be placed on top, where they will receive more heat. If available, feathers, shells from crustaceans, reptiles (Amazonians used turtle shells) molluscs and any other animal waste could also be added.

Large plant leaves (eg. coconut and other palm fronds, banana, *Alocasia* leaves) should be used to cover the pile (otherwise most of the soil will fall into openings), and then subsoil used to cover the pile, leaving two or three approximately 10 cm holes at each end. To get the fire started and burning thoroughly through all the material, more air would be drawn through if the hole at one end is larger than the hole at the other end, or if there are holes made on top as well, especially for longer strips. The fire would then be lit at both ends and initially allowed to burn evenly through the pile. Methylated spirits or similar may be needed to get the fire going. When it appears that the fire is burning well throughout the mix, the holes should be covered with subsoil to create a low oxygen environment (to induce pyrolysis) and produce charred material (rather than material which is burnt through in a high oxygen environment, which would leave mostly ash). The fire would then be allowed to slowly smoulder and burn out. A curved sheet of corrugated iron could be used for strips, with the ends covered with large leaves and soil mounded against them.

When it has cooled down completely, a “tea” of human urine (20 – 50%) plus good topsoil should be thoroughly mixed with water in a bucket or watering can (with the head/rose removed) and applied evenly throughout to introduce nutrients, micro-organisms, and food for micro-organisms.

If available, soaked *Tithonia* leaves and fresh livestock manure (especially the nutrient rich manure of pigeons or chickens) would also be valuable additions to the tea, as well as molasses, compost, vermicompost, seaweed, and fish emulsion. Appropriate beneficial micro-organisms may become

commercially available, and should be added if affordable. Better quality tea should be produced if the water is aerated using an aquarium bubbler, if this is practical/possible (see the work of Dr. Elaine Ingham).

For earth worms to act on them, a major proportion of the biochar should consist of fine particles, as would be the case with livestock manure. If most of the charcoal pieces are large, produced from large diameter wood for example, the bigger pieces of charcoal could be trampled and crushed into smaller pieces by livestock confined to the area, which would also add fresh manure and animal urine.

Good topsoil (preferably containing earth worms of a few different species) would then be spread evenly over the pile, and then mulch on top of that (preferably containing some fresh green materials to provide food for earthworms). To keep the earthworms flourishing, it would be advisable to frequently add fresh green material as a mulch. Plants should be grown specifically for this purpose. A mixture of leaf material from repeatedly cut fast-growing grasses such as *Pennistum purpureum* or *Panicum maximum*, *Phalaris* spp., and small-leaved legumes such as *Gliricidia sepium*, or lucerne/alfalfa (depending on the climate) would be ideal for this. Mulching also reduces the need for weeding and watering.

The perimeter of the circle should be planted with the desired plants. If a strip is made, plants should be grown along both edges. Buckets of topsoil enriched with compost/vermicompost could be placed into holes dug within the circle or strip, to provide a pocket of around ten litres of good topsoil for trees/crops. The plants will get a good start in improved soil, and should then grow into the Terra preta as it "matures". In theory, the roots of all the plants will grow into and proliferate in the burnt manure/bone/biochar/ash mix, with superior growth and health from the additional nutrients, nutrient availability, organic matter, increased water holding capacity, increased cation exchange capacity, and mycorrhizal fungal growth. The plants could also be watered with human urine, at a 5% to 20% solution of urine to water, to provide additional NPK and trace elements.

A bucket load of good topsoil in the centre of a circle/mound of Terra preta should prove to be a good place to grow a *Faidherbia albida* tree, *Prosopis cineraria*, or perhaps *Parkia* spp., *Inga* spp., *Paulownia* spp., *Morus* spp., *Gleditsia triacanthos*. Concentric rings of Terra preta could be made around the tree, in which to grow crops, especially in the case of *Faidherbia*.

Trees and other plants that have grown well in arborloos are likely to grow well in Terra preta circles or Terra preta strips. Fertile Terra preta strips and circles could also be useful in reforesting areas with degraded soils.

Terra preta circles or strips should greatly increase food plant productivity. In time, additional Terra preta could be made on top of existing circles or strips, building up a depth of topsoil with greatly increased long-term fertility. Additional benefits include long-term carbon sequestration (probably thousands of years), recycling various waste materials, and if it is used, recycling the organic matter and nutrients present in human manure, sterilizing human manure, and not wasting drinking water in its disposal.

The greatest productivity increases are likely to occur in infertile, acidic, coarse sandy soils, and in infertile, acidic, heavy clay soils, including swelling, cracking clays with little or no structure.

Some have expressed concerns about possible problems with biochar in the future, and it is wise to exercise some caution. Various chemicals can be produced during the manufacture of biochar, which could possibly have implications for human health and have impacts on soil life. If problems occur in the future, small quantities of biochar spread extensively in soils will be there for thousands of years, and may be difficult to deal with. It should be borne in mind though that every year huge forest fires blaze across Africa and Australia for example, producing enormous amounts of charcoal, and multiple chemicals in the smoke (in fact, the seeds of many sclerophyllous plants in the South Western Cape in South Africa, and in South Western Australia, appear to require smoke in the soil before they will germinate). Nevertheless, in case there are problems in the future, it may be wiser to apply larger quantities of charred materials, concentrated into small areas. This means that only small areas are affected, and so only small areas would need treatment/management if there is a problem. To date though, it seems that early Amazonian civilisations and modern day South Americans and Ethiopians, were not, and are not, stricken with chronic illnesses due to incorporating charred organic materials into the soil. On the contrary, for subsistence farmers in developing countries, a greater variety of foods, and foods which are more plentiful, nutritious, and reliable, means healthier and wealthier people. This is something that Terra preta should be able to deliver.

Another concern is that if too much organic matter is converted to biochar, there may not be enough fresh and decomposing organic matter available to feed the types of soil life that depend on these fresh and decomposing materials. However, since high biomass plants are likely to be grown, and since plant growth is increased by biochar/Terra preta, then even greater quantities of fresh organic material, as well as root exudates, would become available to feed the soil life.

It should be possible to make the cake bigger, and eat it too.

David Clode, 9 February 2012.

+++

References

Bennet, P. (1995). Organic Gardening. National. ISBN 1 86436 043 7. Pgs. 100, 133, 201.

Troeh, Frederick R. (1980). Soil and water conservation for productivity and environmental protection. Prentice hall. ISBN 0-13-822-155-3. Pgs 670-672.

Watson, L. (Dec. 2009) “Feedlot manure biochar stands out”. Australian Farm Journal, vol 19 No 10, pg. 43.

Just a few internet resources:

http://www.anzbiochar.org

www.news.cornell.edu/stories/Feb06/AAAS.terra.preta.ssl.html

http://www.merfield.com/research/2011/Biochar-the-need-forprecaution-2011-Merfield.pdf

www.en/wikipedia.org/wiki/Biochar

http://terrapreta.bioenergylists.org/

www.biochar.org

www.biochar.info

www.fungi.com/