### Traditional Crops and Gardening Practices Developed for Tropical Regions, Co-Evolved and Adaptable to Use in New Zealand’s Very Different Cool Temperate Climates

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**Constituted Wetlands, Irrigation and Raised Bed Gardens of Australasia and Pasifika**

- gardens are fundamentally important to the health and survival of communities. Climate change is already demanding adaptation of both aesthetic and productive gardens to new conditions. This is an account of dramatic and effective adaptation of gardening practices developed in one climatic region transposed to a very different zone.

- Eastern Polynesian agricultural practices were well-established when migration to Aotearoa occurred. The people who became the Māori brought tubers of important food crops with them, but faced a far colder climate and different soils. They developed many adaptive gardening practices.

- Unlike the Amazon River case, where we are left only with archaeological evidence of intriguing ancient gardening practices with no cultural remnants to explain them, pre-colonial gardening heritage of New Zealand is conserved by Te Reo Māori (Māori language); and customary values, practices and conventions (Tikanga).

- Customary gardening practices enabled New Zealand’s first gardeners to adapt to a different environment, growing crops brought from warm tropical conditions, by modifying cool garden soils using raised beds, pathways, and soil amendments of charcoal, sand, pumice and gravels to assist soil heating, aeration, drainage, soil-water holding capacity and nutrient retention.

- Aerial photographs and physical evidence remains of borrow pits and hundreds of hectares where Māori modified garden soils (Anthrosols).

- Other soil amendments: Gravel, Black iron-sand mulch, and porous Pumice sand.
  - Improve soil structure and porosity - reduced soil bulk density of heavy clay soils
  - Increased soil moisture infiltration rates (drainage)
  - Increased soil temperatures

- Interestingly, some Māori traditional practices such as charcoal / biochar amended soils, afa “umu” serve not only adaptation but also mitigation of climate change

- **EVALUATION** - The survival of any species / technology / behaviour / or attitude by a process of natural selection favoring an adaptation / ecological fitness in response to changing environmental circumstances. and

- **CREATION** - The action or process of bringing something into existence

### Ancient Origins of Biochar Production and Use in Garden Soils of Australasia and Pasifika

- **Charcoal**: is made by heating up organic matter in the absence of oxygen. Heat “boils off” or “distils” gases & or liquids contained in solid wood or anything that once lived.
  - Charcoal surfaces act like a filter, it ‘binds’ or ‘adsorbs’ stuff in similar effect to how Velcro attracts fluff.
  - Charcoal also acts like a sponge, it ‘soaks up’ or ‘absorbs’ liquids including water.
  - Soil micro-organisms, including bacteria and fungi can inhabit tiny pores within charcoal.

- **Biochar**: is defined here as charred organic matter (charcoal) that was created for and specifically used as a soil amendment.
  - Simply put, biochar makes things grow better by creating a better plant root environment. Here’s what gardeners and farmers can expect biochar to do:
    - Increase supply of soil organic matter.
    - Improve soil structure and porosity - improve soil aeration and soil permeability.
    - Increase soil moisture infiltration rates
    - Reduce bulk density of heavy clay soils, and decrease soil erosion and runoff.
    - Improve the moisture holding capacity of light sandy soils – improve soil moisture retention
    - Reduced nutrient leaching – improved nutrient availability to plants and soil microbes.
    - Improve the cation exchange capacity (CEC) of soils
    - Aid the proliferation of soil microorganisms - supply micro-habitats of beneficial microorganisms to soils and growing media.

- **Pit kilns** or ‘trench kilns’ may be used to make ‘earth ovens’, the indigenous peoples cooking methods in Chile, Peru, and Pacific Island cultures of Melanesia, Micronesia, and Polynesia.
  - Charcoal embers are a by-product of earth oven cooking methods.
  - The Māori name for an earth ovens is “umu”, and the name for dark coloured charcoal modified soils is “para umu”, (i.e ‘scraps’ of “umu”).

- **Operation of an Australian Aboriginal Cooking Oven**

- **Optimal Placement of Biochar in Root Soil Zones or “Rhizospheres”**

  - Intensive tillage methods including rotary hoes or mould-board ploughs are destructive to soil structure, aeration, drainage, and soil biology food-webs including mycorrhizal fungi networks. In contrast, no-tillage technologies including direct seed drills, foot-ploughs, soil corers and chisel ploughs produce minimal soil disturbance effects.

  - Biochar placement adjacent to plant root zones enables plant roots, rhizobacteria and mycorrhizal fungi close access to nutrients, soil water and micro-organisms contained in biochar.

  - Plant root exudates, Carbon and nutrient rich organic matter, create soil bio-diversity & energy “Hot-Spots” including soil aggregates, rhizosphere soils and biochar