Terra Preta

Magic Soil of the Lost Amazon

by Allan Balliett

Photo: Cornell, Crop and Soil Science

Photo: Eprida/UGA Bio-conversion

Terra preta soils are manmade, generally 2 feet deep, created by pre-Colombian AmerIndians through the incorporation of charcoal and unfired ceramic pieces (note sherds in photo at right) into the earth.

It's like finding a lost chapter from Peter Tompkins and Christopher Bird's *Secrets of the Soil — terra preta* (literally "black earth") is a manmade soil of prehistoric origin that is higher in nitrogen, phosphorus, potassium and calcium than adjacent soils. It controls water and reduces leaching of nutrients from the rhizosphere. Rich in humus, pieces of pre-Columbian unfired clay pottery, and black carbon, it's like a "microbial reef" that promotes and sustains the growth of mycorrhizae and other beneficial microbes, and it has been shown to retain its fertility for thousands of years. In university trials, *terra preta* has increased crop yields by as much as 800 percent. It regrows itself when excavated. It is even possible to produce carbon-negative useable energy (such as diesel or hydrogen) while making the major input (bio-char) for *terra preta* on the farm.

If these amazing properties haven't convinced you that *terra preta* is important to eco-agriculture, then consider this: experts say that *terra preta* sequesters carbon at such a high rate that, in the near future, farming with this technique could be eligible for lucrative carbon credits.

Perhaps most amazing, though, is the fact that, unlike many if not most of the eco-ag technologies reported in *Secrets of the Soil,* the incredible properties of *terra preta* are *not* denied by myopic academics. In fact, almost everything we know about *terra preta* is coming from university studies!

Much is still unknown about *terra preta* and "Amazonian Dark Earths," but as the key component of a proposed agricultural system that would both feed starving populations and solve global warming, grant money is coming in to fuel university investigations of the technology. For every unanswered

question on *terra preta*, there appears to already be a funded study underway.

TERRA PRETA DEFINED

Terra preta do indio is a black, earth-like, anthropogenic (manmade) soil with enhanced fertility due to high levels of soil organic matter (SOM) and nutrients such as nitrogen, phosphorus, potassium, and calcium embedded in a landscape of infertile soils. *Terra preta* soils occur in small patches averaging 20 hectares (50 acres), but 350 hectare (865 acre) sites have also been reported. These 2,000-year-old manmade soils occur in the Brazilian Amazon basin and other regions of South America. *Terra preta* soils are very popular with the local farmers and are used especially to produce cash crops such as papaya and mango, which grow about three times as rapidly as on surrounding infertile soils.

South American *terra preta* soils are also full of pieces (sherds) of unfired pottery. It is generally believed that the pottery was introduced into the soil much as modern growers add perlite or sand to potting mix, as a way of keeping the soil from baking completely tight under the tropical sun before a cover of vegetation could grow over it. Much is made of these sherds as "proof" that *terra preta* deposits are really prehistoric trash piles, but Charles C. Mann asserts there are indications that much of this pottery was actually made specifically for incorporation into the soil.

Associated with *terra preta* is *terra mulata,* soils which are lighter than *terra preta* and tend not to contain cultural artifacts but are said to have similar qualities. *Terra preta* soils are found near historic settlements, while *terra mulata* soils are found where agricultural fields were once located. It is assumed that the village-related *terra preta* is darker because it received continual inputs of household wastes (including humanure), and that *terra mulata* fields were amended chiefly with bio-char, which was initially created by burning forest cover and later by slow-burning brush, weeds and crop wastes. Because of their overall similarities, *terra preta* and *terra mulata* are often grouped under the title "Amazonian Dark Earths" (ADE).

William Devan, a geologist from the University of Wisconsin who is prominent in *terra preta* research, offers these comments: "The black *terra preta* is associated with long-enduring Indian village sites, and is filled with ceramics, animal

Terra Preta Q&A

Why did production of terra preta stop after European contact?

Although the decimation of the Amazonian population and the collapse of the elaborate social systems that supported terra preta creation (to make all that pottery and to make all that charcoal and incorporate it up to 2 feet in the ground really does take a village) was a contributing factor, it was undoubtedly the introduction of the steel axe by the Spanish that, in combination with the impact of contact, led to slash-and-burn by small bands replacing slash-and-char by large groups. When clearing land with a stone axe, a conservation of all biomas and an intensification of soil production becomes a necessity. Steel axes — and, later, chainsaws — contributed to exploiting the very short-term benefits of ash. It must be remembered that traditional methods can die out in a single generation, and that in Amazonian social structure, the elders were responsible for all technical knowledge. It makes sense that the elders were the hardest hit by epidemics, and the loss of their cultural knowledge combined with social disruption would lead to the replacement of a deeply effective technology with an less-effective mimicry.

Did natives use special microbial brews to innoculate the soil to create *terra preta?*

There is no proof that a "mother" culture was used for starting terra preta. Current research indicates that the incorporation of charcoal of certain qualities (created in relatively low heat, for example) in combination with appropriate initial fertilization (often, in university tests, with conventional fertilizers that are damaging to soil life) will produce a substantial increase in yields. It is assumed that the char provides such an effective habitat for microbes that effective communities will rapidly develop within most soils. What we don't know yet is whether the simulated terra preta will have the ability to maintain its fertility for as long as the ancient form.

Has *terra preta* been discovered outside of the Amazon?

Yes, high-carbon terra preta-like dark soils have been discovered in Holland, Japan, South Africa and Indonesia and are currently being studied.

Can carbon inputs other than charcoal be used?

The Japanese are extensively investigating the use of coal dust for promoting field fertility. Coal dust does seem to reproduce many of the positive effects of wood charcoal. The research of Siegfried Marian on the benefits of carbon incorporation, as reported in Leonard Ridzon and Charles Walters' *The Carbon Connection* and *The Carbon Cycle,* led to the development of Ridzon's NutriCarb product (no longer being produced), which claimed agricultural benefits very similar to those claimed for terra preta . Those who want to use coal dust for soil fertility need to make certain that the dust is from brown coal, which is more humic, and that the coal does not contain toxins.

Why is *terra preta* often linked to alternative energy and climate change?

Terra preta is a carbon sink, as is most carbon in the soil. Slash-and-burn agriculture contributes greatly to global warming. If terra preta technologies were applied to tropical farming, less land would have to be cleared for farming, and if farmers in temperate zones such as the Midwest incorporated charcoal or other chars into their soil, more carbon could be sequestered. If this char is produced by appropriate technology, such as pyrolysis, both fuel and a "restorative, high-carbon fertilizer" can be produced. This process does not require wood — it is just as effective when agricultural wastes, such as

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Terra Preta *Q&A (cont.)*

peanut shells, are used as input. A good place to learn about this technology is at *www.eprida.com.*

How much charcoal needs to be incorporated?

In published reports on pot tests of the effect of charcoal on plant growth, incorporation at 20-30 percent by weight tended to consistently produce the most benefit. In row crops, this would translate to 30 percent by weight of the top 6 inches.

Are there benefits for plant health from *terra preta* ?

Better plant growth and health is evident with the use of native terra preta. Current investigations are primarily being conducted by archaeologists, geologists and soil scientists. There is no evidence of terra preta studies by an agriculturist, but positive reports from growers suggest that eco-farmers would be well advised to investigate terra preta technology.

and fish bones, and other cultural debris. The brown *terra mulata*, on the other hand, is much more extensive, generally surrounds the black midden soils, contains few artifacts, and apparently is the result of semi-intensive cultivation over long periods. Both forms are much more fertile than the surrounding highly weathered reddish soil, mostly oxisol, and they have generally sustained this fertility to the present despite the tropical climate and despite frequent or periodic cultivation. This is probably because of high carbon content and an associated high microbial activity which is self perpetuating."

Ironically, information about the agricultural value of *terra preta* is only emerging now because of a paradigm shift among archaeologists that has re-evaluated the role of indigenous people (AmerIndians) in the pre-Columbian Americas. Put simply, before contact, there were heavy populations of indigenous people in the Americas, in fact, until the mid-16th century, some of the world's largest and most sanitary cities were in the Americas. Pre-Columbian Indians made great achievements in architecture, art and agriculture. Not only did they breed many of the economically important plants of today's world (corn, sunflower, beans, potato, sweet potato, tomato, peanut, avocado, tobacco and cotton), but they also developed incredibly productive methods of agriculture such as raised beds and "three sisters." As Jerry Brunetti has pointed out, the rate of production of calories by Iroquois agriculture at the time of the New England settlement was unimaginable to Europeans. Not only did the Iroquois Nation produce high-value foods, they were also able to produce enough of it to ensure two to three years' worth of food in storage at any given time!

What the AmerIndians lacked, unfortunately, was resistance to European diseases. Hard to believe as it is, pre-contact Amerindians apparently had no human-to-human diseases, with the possible exception of syphilis. According to Charles C. Mann, they didn't even have the common cold until Europeans arrived. Several waves of deadly diseases (such as small pox and measles) swept through the Americas after Columbus' first visit, spread not only by subsequent European explorers, but, after contact, by the AmerIndians themselves through their well established, hemisphere-wide, socially motivated trade routes.

By the mid-1500s, most of the indigenous Americans had died as a result of epidemics. Undermined by pain, suffering, superstition and loss of leadership (many important Incan leaders died of European diseases, including the most powerful, which opened the door for Pizarro's conquest of this powerful empire), AmerIndian society began to collapse. Urban populations could not be fed, and cities were abandoned. In the stone-free Amazon, this meant that metropolises built of wood and soil were absorbed by the jungle at such a rate that areas reported by the first explorer as heavily populated with massive structures were, just 50 years later, reported as jungle wildernesses populated by small bands of scraggly natives.

Photo: Eprida/UGA Bio-conversion

Corn trials at Dr. Danny Day's Eprida biofuel (pyrolysis) experiment in Georgia. Corn on the left is bio-char plus fertilizer, corn on the right is fertilizer alone, corn in the center is unimproved soil. The program produces biodiesel from ag waste (peanut shells) with 50 percent of the input becoming bio-char for use a very effective "terra preta nova" soil input.

The bottom line for mainstream archeological interpretation of the history of the Amazon was based on the assumption that the area was a "counterfeit paradise," with all of its nutrients locked into its canopy, leaving soils poor, acidic and toxic. Although *terra preta* was described to academic America as early as 1870, rich soils in the Amazon were considered to be an anomaly, the result of prehistoric lakes or hydrological accidents. (An enjoyable period view of the value of Amazon agricultural land can be found in an 1867 book entitled *Brazil, the Home for Southerners,* by Confederate expatriate Ballard S. Dunn, which lauds the high fertility of Brazil's Amazonian dark soil among other aspects of "planter life" in Brazil; it is available online in its entirety through Google Books, *www.books.google.com).*

Caught in a "believing is seeing" syndrome, archeologists assumed that because typical Amazonian soils were thin and infertile, large populations could never have existed there. Accepting this assumption, they saw no point in looking for evidence of settlement. Betty J. Meggers, the Smithsonian archaeologist, said, "The apparent lushness of the rainforest is a sham. The soils are poor and can't hold nutrients — the jungle flora exists only because it snatches up everything worthwhile before it leaches away in the rain. Agriculture, which depends on extracting the wealth of the soil, therefore faces inherent ecological limitations in the wet desert of Amazonia."

Views are changing, however, and a new school of archaeologists, geologists and soil scientists have asserted that the Amazon was in fact heavily populated and that the fertility of *terra preta* was what made feeding these large groups of people possible. Although many questions remain unanswered, this new school of Amazon investigators feels that there is substantial physical proof that not only was the Amazon rainforest home of very large populations supported by an effective agriculture based on the robust fertility of the manmade *terra preta* soils, but also that the Amazon forest itself is better thought of as a manmade landscape.

It is important to note that the good news about *terra preta* is not the news about the physical soils in Brazil. Although soils are illegally mined and sold as potting mix and soil amendments in Brazil and Bolivia, native *terra preta* is not accessible to U.S. growers. Because they are filled with pre-Columbian artifacts and because they are associated with archaeological sites that have yet to be fully investigated, *terra preta* cannot be purchased or imported.

The current goal of scientists studying *terra preta* is to learn what it is and how it works so that it can be replicated anywhere in the world. The focus of most of this work, however, is not on benefiting small farm American agriculture, but on how to make more fertile land available in tropical South America and Africa, along with an interest in carbon sequestration. The time is ripe for innovative eco-growers and agricultural researchers to explore the benefits of the magic soil from a lost world.

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