Terra Preta Research History

Throughout the world intensive agriculture often has resulted in soil physical and chemical degradation, to due erosion and higher output than input rates of nutrients and OM. In contrast, the intentional and unintentional deposition of nutrient-rich materials within human habitation sites and field areas has in many cases produced conditions of heightened fertility status (Woods 2003). Biochar was also used in agriculture in the past (Allen 1846; Ogawa 1994; Ogawa 2008), but Terra Preta soils in the Amazon are among the most prominent examples of human enriched soils. Sustainable soil fertility management is a major constraint in the humid tropics and is probably one reason for Terra Preta’s high degree of public awareness. Further the difference between Terra Preta and ordinary soils in its vicinity is striking. In contrast to yellow or reddish Ferralsols the Terra Preta is dark (black). Terra Preta is rich in calcium and phosphate. These two elements are scarce in the Amazon basin and its presence alters fertility and ecology of the landscape distinctly. Terra Preta has an elevated pH in comparison to the surrounding soils (Ferralsols, Acrisols, and Arenosols) which are acidic with toxic levels of exchangeable aluminum (Glaser and Birk 2012). Current major environmental threats such as deforestation and global warming contribute to Terra Preta’s wide public perception. Its existence proofs that long-lasting soil fertility improvements and carbon sequestration is possible, even under the most unfavorable circumstances (fast mineralization and leaching) and gives rise to hope to overcome these environmental challenges. Terra Preta may offer an opportunity to learn from the past and improve our current wasteful material flow management (Steiner and Taylor 2010).

Due to the Terra Preta’s distinctiveness to the surrounding soils, it is not surprising that early explorers of the Amazon noticed its existence. However, it is not clear if the first reports made by Francisco de Orellana describe Terra Preta or if they are accurate or exaggeration. He described large cities, roads and fertile land, a landscape and society which disappeared. Remaining is Terra Preta and today it is clear that Terra Preta is of cultural origin (Glaser and Birk 2012). Whether Terra Preta was made intentional or unintentional remains unknown and the size of a pre-Columbian sedentary population necessary to create these soils is discussed (Heckenberger et al. 2003; Meggers 2003; Stokstad 2003). Glaser and Birk (2012) suggested both, intentional soil creation for home gardens as well as unintentional deposition of materials like bones, feces, ashes and incomplete combusted organic materials and other waste. Charcoal is frequently used to create an appropriate growing media (soil) for herbs and vegetable in the region today (Steiner et al. 2008; Steiner et al. 2004). In the long-term, such activities may lead to the formation of Terra Preta.

Charcoal is frequently used in these vegetable gardens. Foto Gilvan, Embrapa Charcoal residues used in the elevated gardens

Although early descriptions (for a review see Woods and Denevan 2008) clearly mention the anthropogenic genesis of Terra Preta, geogenic hypotheses such as volcanic (Hilbert 1968) and fluvial (Zimmermann 1958) deposition were still discussed. Charles Brown and William Lidstone recognized the human origin at the sites of settlements in bygone days. They assume that: “Villages must have stood upon these spots for ages, to have accumulated such a depth of soil about them; and probably their original founders were of a race that has now completely vanished” (Brown and Lidstone 1878). Similar observations were made by Charles F. Hartt, a pioneer of Brazilian Geology and his assistant Herbert H. Smith. They explained the Terra Preta’s fertility by the accumulation of “the refuse of a thousand kitchens for maybe a thousand years” (Smith 1879). The Austrian Friedrich Katzer conducted pioneering analytical work on these soils and was apparently the first scientist noticing that Terra Preta contains charred plant material. In contrast to Chernozems, where the charred residues are of natural origin, the Terra Preta soils are manmade (Katzer 1903). Wim Sombroek correlated soil organic carbon (SOC) with the soils to retain nutrients and concluded that SOC in Terra Preta has superior quality (Sombroek 1966). Since the 1980 Terra Preta received intensive scholarly attention (Woods and Denevan 2008). Glaser et al. (1999; 1998), confirmed and quantified the presence of carbonized organic matter. His research showed that charcoal is a key factor for the stability of SOC and enhanced nutrient retention. Based on this research, the first field experiment with the intention to replicate Terra Preta and study the effects of charcoal (biochar) on soil fertility was established in the Brazilian Amazon in the year 2001. As a result slash and char was described as an alternative to slash and burn agriculture by Lehmann and Steiner (Lehmann et al. 2002; Steiner 2007; Steiner et al. 2004). The carbon sequestration potential of Terra Preta soils was also recognized by Wim Sombroek (Sombroek et al. 2003). Independently, carbon sequestration by the burial and landfilling of charcoal was suggested by Seifritz (Seifritz 1993). However this proposal neglects the removal of essential nutrients contained in the biomass and the beneficial effects of carbon on soil fertility. Seiftiz did not know about the beneficial effects of charred plant material on soil fertility and that a significant proportion of SOC in Chernozems or Mollisols consists of such carbonized plant matter (Skjemstad et al. 2002). The recalcitrance of carbonized plant matter makes it needless and therefore wasteful to protect this form of carbon in ocean sediments or landfills. Ogawa (1994) proposed the use of charcoal as soil amendment to improve soil fertility, particularly in the humid tropics. Terra Preta served as an example that both long-lasing carbon sequestration and soil fertility improvements are possible and raised international awareness. In 2002 the BCC broadcasted “The Secret of El Dorado” and with that Terra Preta and the potential of carbonized organic matter received worldwide attention. In the same year the Terra Preta Nova workshop was held in Manaus, Brazil. In 2004 a groundbreaking conference on charcoal was organized by an energy system developer (Eprida) and the University of Georgia. This conference brought energy producers and policy makers together with agricultural ecologists, soil scientists, engineers, archeologists and private-sector companies from around the world.

In 2006 the International Biochar Initiative was formed with the mission to promote the development of sustainable biochar systems. Since then the number of biochar research, conferences, workshops and symposia sky-rocketed. Today there are biochar initiatives on almost every continent and biochar samples in most soil labs worldwide.