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Why not Artisanal Biochar? A Biochar Life, PBC Case Study

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Abstract

Today's biochar market is booming as the IPCC and other major organizations publish their support for biochar as the best available, long-term means to slow climate change by removing CO2 from the atmosphere. Unfortunately, the only large purchases of biochar carbon removals credits (CDRs) have been from industrial biochar production companies. Why is this? Buyers such as Microsoft shy away from biochar made by smallholder farmers (artisans) because they cannot measure actual CH4 emissions and are uncertain about its quality [1]. This misunderstanding reinforces the barriers to artisans and the market's bias toward Western, high-tech producers. What is the problem? Western (OECD) companies get all the money and poor artisans are left out. Given the small size of the OECD population relative to the huge population of the developing world, this seems unfair and backward looking. After all, with less than 20% of the world's population in the OECD and well over 80% in the developing world, who will be the key players in climate change mitigation in the future when population growth buries the people of the OECD even deeper? Moreover, the criticisms of artisanal biochar are largely wrong and so stop the annual removal of gigatons (billions of tons) of carbon from the atmosphere. This brief article looks at doubts about the value of artisanal biochar in the form of a case study of a leading proponent, Biochar Life, PBC.

What is Biochar?

Biochar is "super charcoal" made by heating any biomass (e.g., crop waste) in the near absence of oxygen. Biochar is carbon negative (meaning it removes carbon from the atmosphere) and is inert (making sequestration possible). As Marlena Geça et al note [2].

Biochars are obtained by biomass pyrolysis, whereas activated carbon is a biochar that has undergone chemical or physical activation. Owing to the large surface area and easy surface modification both solids are widely applied as adsorbents. They [biochars] are low-cost materials, they [can] be regenerated, and their disposal is not troublesome. Adsorption of heavy metals, dyes, pharmaceuticals on the surface of biochars and activated carbons, are described extensively in the literature. (2022)

The bottom line is simple: biochar is a low-cost, well understood and well-researched material.

Why do Biochar Life Care about Artisanal Biochar?

It cares, in part, simply because the developing world really is the world and will be more so by 2050. It cares because everyone talks as if the West were the world. No question, the OECD is important both because it is responsible for our climate problems and its concentration of scientific and engineering capacities. Even today, however, the OECD is not the world, but instead is a small and shrinking portion of global population, just 16.6 percent of 7.8 billion people today and by 2050 just 13.2% of 9.5 billion. Where is the rest of the world in the biochar debate? It suffers worse from climate change than the OECD and, is already most of the people on the planet, people whose children – several billion of them – will inherit this world by 2050. Can we afford to ignore so much of the global population, assume that they have nothing to say about climate change and nothing to contribute to slowing it? Biochar Life thinks not.

Biochar Life cares about smallholders because there are so very many of them who do so much damage. After all, 570 million smallholder farms today produce some 10 gigatons (billion tons) of crop waste annually, (FAO stats and as modified in Shafer, 2021 through the elimination of minor producing states, the oil rich countries and the old USSR) of which experts suggest 50 to 90% is burned. (Commonly cited figure) [3, 4]. Even if we assume that only 25% is burned, this is 2.5 gigatons annually. Converted to biochar, this 0.5 gigatons able to remove 1 gigaton of CO2 eq annually. (At a conversion rate of 20%, likely in the developing world, 2.5 gigatons of waste converts to 0.5 gigatons of biochar. If this biochar sequesters two units of CO2 per unit of biochar, 0.5 gigatons of biochar removes one full gigaton of CO_2 annually, one sixth of the total amount the IPCC declares must be removed from the atmosphere annually until 2050. Smallholders collectively, some 600 million of them, therefore, constitute a major threat to the environment and a major potential for carbon removal, to say nothing of the food that they actually grow (approximately 30% of the global total) [5, 6]. By the same token, the PM2.5 generated by burning 2.5 gigatons of waste is equally huge. At 6.26 kg per tonne of waste burned, this much burning produces 1.57 trillion kg of PM2.5, each kg of which is the equivalent of the smoke from 71,429 cigarettes [7]. (The industry puts smoke per cigarette at 14 micrograms.)

This article uses Biochar Life, a single artisanal biochar focused company as a base. Biochar Life cares about smallholders for several reasons, all expressed in its tag line: Cool the climate, clean the environment, improve public health and reduce rural poverty.

Cool the Climate
Biochar Life believes that making biochar from artisans' crop wastes will remove large amounts of CO_2 eq from the atmosphere and sequester it permanently in the ground.

Clean the Environment
One of the biggest global threats to human life is PM2.5, the killer component of smoke. Much of the world's harvest season smoke comes from artisans burning their agricultural waste [8]. If this waste was pyrolyzed and not burned, the amount of smoke in the air would be dramatically reduced.

Improve Public Health
Cleaning up huge quantities of PM2.5 will improve the health of artisans, reduce national public health costs and raise labor productivity.

Reduce Rural Poverty
Eight hundred million people in the world are starving today and many millions more live in the shadow of food insecurity. Making biochar offers employment to farmers during the dry season when there is no agricultural work [9]. Using crop waste biochar will improve yields and feed millions.

Unfortunately, not everyone is interested in the Biochar Life mission. If one's sole focus is the bottom line, Biochar Life's concerns about the climate, environment, public health and rural poverty make little sense.

What are the Supposed Problems with Artisanal Biochar?

In a world where the ICPP's best estimate requires removing at least 6 gigatons of CO_2 annually from the atmosphere and biochar prices are soaring (There are few ways of permanently sequestering carbon, the best of which currently is biochar production and sequestration). Unfortunately, big buyers' view artisanal biochar with skepticism. Most refuse to consider, open field burning, the alternative to pyrolysis by smallholders and its huge CH_4 emissions [10]. Some doubt the quality of the biochar because they doubt the way in which it is measured while being made. Others doubt that there will be enough biomass to sustainably make biochar. (Personal communication 2020) Still others doubt that there will be enough land to apply biochar to. Still others are betting on technological solutions such as Direct Air Capture (DAC) to end climate change soon enough.

Quality Biochar: Companies Fear Buying a Pig in a Poke.
Perhaps the biggest problem smallholder biochar producers face is that most big buyers refuse to consider the GHG emissions savings of pyrolysis v. open field burning. As a result, they look only to CH_4 emissions from smallholder pyrolysis and do not consider that CH_4 emissions from open field burning. According to S. Akagi et al., the open field burning of one tonne of biomass generates 25.8g/kg of CH_4 while even field pyrolysis produces only 3-9 g/kg. This limit is highly prejudicial to smallholders and essentially discounts entirely the climate (CO_2 eq) and health (PM2.5) consequences of open field burning [11]. (A recent study by Mahidol University suggests that 41% of all corn stalks are burned, a figure that does not include the burning of cob and husk.) Since estimates about the amount of corn waste burned around the world range from 50% to 90%, it is clear to us that smallholder pyrolysis is a boon to the climate. (One low estimate asserts that corn waste equals 2.9% of all vegetable waste in the world. G. Howarth, 2023) Unfortunately, few big buyers do not consider the problem a problem and instead hold smallholders' pyrolysis to the same standard as high-tech OECD machines.

Many buyers also doubt the quality of artisanal biochar. For them, scientific articles attesting that its quality is equal to that of industrial (machine made) biochar. (This view is not universal. See, for example) are largely irrelevant and not read. The problems come down to measurement or the constant monitoring of production [12]. This is quite easy with industrial machines that produce large amounts of biochar at the same time. Here the sustained heat of production at or above 450° C, the humidity of feedstock, greenhouse gas (GHG) emissions from production, the actual carbon content of the biochar, exactly how much biochar is made. Generally undiscussed by big buyers is the apparent contest between cooking and forests and other energy requirements that may overextend smallholder biochar.

As for the pig in a poke, many big buyers entered the scene early and bought millions of tonnes of carbon emissions reduction credits (CER) for hundreds of millions of dollars, only that are now labeled as "worthless." P. Greenfield. (9.15.2024) [13]. Rainforest carbon credit schemes misleading and ineffective, finds report The Guardian.) In a major study prepared by the Oko-Institute v.V, and adopted by European Union notes that

Overall, our results suggest that 85 percent of the projects covered in this analysis and 73 percent of the potential 2013-2020 Certified Emissions Reduction (CER) supply have a low likelihood that emission reductions are additional and are not over-estimated," said the report, which was prepared by the Öko-Institut v.V., a German research group. "Only 2 percent of the projects and 7 percent of potential CER supply have a high likelihood of ensuring that emission reductions are additional and are not overestimated [14].

Companies are doubly doubtful of artisanal removal credits since the tree planting/carbon emissions reducing credits (CERs) had been verified by one the biggest and best accreditation operations in the world. Once bitten, twice shy, companies are understandably interested in the quality of the credits they buy. For better or worse, the only way to know this is through quality of production monitoring or of the MRV (Monitoring, Reportable and Verifiable, MRV) platform used. Having been burned by the misapplication of one standard, when turning to the newer, carbon-removal credit schemes and platforms they are shy about adopting anything that cannot be monitored throughout, credibly reported on (continuously) and easily verified after the fact [15]. Unfortunately, while it may be easier to apply MRV to biochar production in an industrial plant, it is much more difficult in a dispersed production setting where tens of thousands of artisans are making tiny batches of biochar.

How can these doubts be alleviated? The best way, of course, would be to develop a credible MRV platform or through the denial of artisanal char. Because the latter is already so much in evidence, let us focus on the former. At base, the question is one of the standards to which producers are held and their application. Many standards target only industrial production in the developed world (OECD) (e.g., Gold Star) and do not apply. And all standards can be circumvented (even, for example, the extremely detailed Verra standard so flouted in Zambia by South Pole, but much is to be said about the care taken by the standard writers to accommodate the characteristics of artisanal producers. This is exactly what the Carbon Standards International (CSI) Global Artisan Standard does. It is based on scientific knowledge, but recognizes the limitations imposed on artisanal farmers by poverty. It starts with the lowest-tech equipment, not industrial equipment. Low-tech-equipment does not have the capacity to monitor pyrolysis temperatures and emissions. Here, recent studies have proven that flame cap kilns operate at 450° C and emit only tiny amounts of methane (CH_4) Likewise, laboratory tests of Kon-tiki biochar flam cap) demonstrate its high carbon content [16]. To measure the production and biomass used, CSI requires multiple GPS and time stamped photos of both.

The CSI Global Artisan Standard addresses the humidity of biomass, but only as a caution to artisans, insisting that the biomass be dry. Schmidt) Recent studies, however, have demonstrated that the higher the moisture content of the biomass, the greater the methane emissions. (e.g., Emery and Mosier, Cornelissen) How to verify and provide continuous and permanent reporting? Biochar Life believes that companies and those interested in CH_4 emissions will take seriously the risk of pyrolyzing moist biomass as explained in the scientific literature and require proper verification [17-11]. Biochar Life itself is planning to require that field verifiers measure and permanently record biomass moisture just prior to pyrolysis. This figure and the continuous, data logged burn temperature and CH_4 emissions will be captured and recorded with photos of the feedstock, pyrolysis and the ultimate use of the biochar, a time and GPS stamped image of which will be attached permanently to the Carbon credit certificate. (Personal knowledge)

Biochar Life is in a particular position. Its focus is on the artisan only and therefore it very conscious of both what artisans can afford and buyers' MRV requirements. The Biochar Life system reports according to the CSI standard, but goes further by requiring that a paid, independent verifier witness the farmer making and using his/her biochar appropriately. Indeed, if the screening tool addition can be made cost-effectively, Biochar Life will provide graphs verifiable moisture content, as well as time and GP stamped photos of the data logger tracks of pyrolyzer temperatures and methane emissions (throughout production).

How Much Biomass can be Turned into Biochar?

The lack of data makes this a difficult question. Original estimates (for example, an early EU publications) largely ignore the production of agricultural crop waste in the developing world. Based on FAO statistics, smallholders around the developing world (not including the ex-USSR) produce almost 10 billion tonnes of agricultural waste annually. In addition, others estimate that 60+% of global construction waste is wood that can be pyrolyzed. Needless to say, the global supply of sewagr, wet food and construction waste is always renewed [19]. Taken together, these suggest that it will be a long time before the world's supply of biomass is exhausted. Indeed, the vast potential production of biochar suggests a different problem: How to use it all productively.

How Much Biochar can be used for Agricultural Purposes? Or Everything else Biochar can do.

Cornell University Extension (the gold standard of biochar data) believes that the best amount of biochar to use on agricultural land is 1 kg per square meter and that a higher proportion of biochar to soil than this will stunt growth. There is, therefore, a legitimate reason for doubting that the agricultural application of biochar can be infinite. Luckily, there are many other rapidly growing uses for biochar beyond agriculture, which commanded first attention since the results were so striking and immediate [20]. The research of Kathleen Draper at Rensselaer Polytechnic focuses on how biochar not only can replace sand in cement but is also better than sand. (Sand is rapidly becoming a limited resource. Biochar concrete is lighter, tougher and emits far less CO_2 [21]. Than sand cement. (Senadheera, 2023) Likewise, biochar has a significant role to play in the making of asphalt. With the global rise of cities and road networks, the need for biochar for high temperature use asphalt, there is no reason to worry about finding a place for biochar [15].

The Easiest Solution (with Clay Feet)

Certainly, the most commonly suggested solution to artisans' biochar's use is simply to eliminate it. Here the issue goes far beyond big buyers simply not purchasing artisanal credits to the elimination of artisans as players at all. Why not simply build tougher, transportable high-tech pyrolyzers and spread them across the great barren plains of the developing world? Leaving aside all consideration the human consequences of such a move, the solution's biggest problem is that it will probably not work. Why not? Simple geography. Smallholders generally occupy the worst land; their fields are often extremely steep and rocky. Smallholders tend to live beyond the reach of "development" defined as the number of kilometers of roads built. As a result, smallholders' biomass cannot be collected cost-effectively, leaving them all their agricultural waste to do something with. And, because it is waste, they generally leave it to rot or burn it. It is, therefore, entirely possible to locate an efficient, high-tech pyrolyzer at a central collection point. Stopping emissions GHGs and PM2.5 will not happen because no one can bring it to the center and no one wants that agricultural waste at a market clearing price.

But what if one had the roads and all? What then? Well, from my point of view, the outcome could be bad in an entirely different way. The costlier the equipment, the fewer laborers it requires and the higher the required educational level. Under these circumstances, the likely result of "solving" the MRV problem might well be a marked increase in inequality and the failure of the "solution" to deal with one of the great problems facing much of the developing world: the lack of income producing jobs. This applies not only to the introduction of higher tech pyrolyzers, but also to such very high-tech solutions to the climate problem as a whole: Direct Air Capture (DAC)and Carbon Capture and Sequestration (CSS) solutions. For NIMBY reasons, such facilities are likely to be built in deserts and other non-arable areas. This means that the countries of the developing world can expect to see large DAC facilities built on their soil and we can expect the desert of the Saudi Empty Quarter likewise to fill up with CSS facilities servicing the oil and gas industries. Undoubtedly, these facilities will be heralded as evidence of development and foreign investment. They may do something about the glut of unemployed university graduates, but they will do nothing for the very poor except take up potentially fruitful land [22-25].

Conclusion

Despite the general recognition of climate change, the terrible health consequences of smoke and of growing inequality in the developing world, artisanal biochar has been largely ignored, although it might remove huge quantities of CO2 eq and PM2.5 annually. Why? First, because big buyers measure artisanal pyrolysis against high-tech OECD standards, Second, because the ready availability of industrial biochar and big buyers' concerns about the quality of carbon removal credits both limit demand. The most discerning buyers argue that the problem is the absence of a credible MRV platform to verify the quality and quality of biochar artisans make. Second, others doubt that the is enough biomass available to make biochar continuously. Third, still others believe that there is no place to put the biochar. Fourth, many thinks that investments in super high-technology solutions such as DAC and CCS will solve climate change soon enough.

This article argues the opposite. First, it contends that artisanal biochar represents a large, renewable source of carbon removal from the atmosphere and that standards setting organization such as CSI and companies such as Biochar Life can offer high quality biochar proved out by improved MRV platforms. Second, it argues that such constant sources of biomass as urban garbage and sewage will provide a constantly renewed source of biomass. Third, contrary to the assumption that there is not enough agricultural land to absorb the huge volume of biochar, the ready existence of large industrial markets such as cement and asphalt can easily use biochar effectively. And finally, despite the future potential of DAC and CSS, their current not at scale or commercial application will result in huge, unnecessary quantities of CO2 eq and PM2.5 being emitted as the world waits. Equally important, such very high-tech solutions will not cost effectively collect the widely and thinly dispersed waste of smallholders who will largely unemployed by such efficient technologies and the high educational requirements of those hired.

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