

# Biochar: A Great Solution for Global Food Waste and its many, Nasty Consequences

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## Abstract

In today's world, one third of global food production goes to waste, despite our failure to talk much about it in the broad context of sustainability. While we waste a cool \$ trillion and 1.3 billion tons of food annually, enough to feed more than twice as many people as are hungry today (800 million), we seem too seldom to put this problem in the context of climate change, water availability, or land use, offer practical solutions or solutions that normal citizens can take on. This brief article attempts to outline the many sustainability challenges posed by food waste, from greenhouse gas (GHG) and PM2.5 emissions to water and land wastage. It also explores the wide range of "solutions" to the food waste problem, behavioral and engineered, explains their limits and offers the bio charring of food waste as a feasible, cost-effective, commoner-inclusive way of approaching the many aspects of the food waste problem, environmental, social and practical.

**Keywords:** Food Waste, Biochar, Climate Change, CSS, DAC, Food Security, Greenhouse Gas, Global Warming, Behavior Change, Civic Action, Politics, Refugees, PM 2.5.

## Introduction

### The Problem

We seem to face a hot, stormy future. All of us hear daily warnings about the nasty consequences of climate change and global warming. If we cannot manage to hold the average rise in the global temperature at or below 1.5° C above pre-industrial levels, we will face extreme heat, terrible storms, great droughts, massive coastal flooding, climate refugee waves and more [1]. In what must politely be called the climate change "discussion," much is said about these nasty consequences and about the immense, global efforts that are required to avert climate disaster. (Note: at issue today is less that of stopping climate change but rather mitigating its effects. What is lost in this "discussion" of both stopping climate change and mitigating its effects are myriad ways that we, mere global citizens, can do to slow maybe even stop or at least mitigate the effects of our fall into chaos. What is also lost are other big problems confronting us today, food insecurity, water shortages, land and forest loss. Some eight hundred million people already suffer from hunger and malnutrition – and we will welcome another two billion people to the global population by 2050, most in the developing world, people who will require the growing of at least 60% more food than we produce today [2]. Is there anything to be done?

Of course, there is. Stop wasting food. We, the peoples of the world, waste (toss out or allow to rot) 1.3 billion tonnes of food annually, fully a third of the food we ought to eat and more food

than is produced annually in sub-Saharan Africa. This waste accounts for about 30% of total greenhouse gas emissions (GHG) or 3.3 gigatons (billion tonnes) of CO<sub>2</sub> annually. (The IPCC estimates that if we could reduce or withdraw six gigatons of CO<sub>2</sub> from the atmosphere annually, we could forget about climate change) [3]. How big a problem are we talking about? Well, in addition to the GHG emissions of growing, making, processing, transporting and cooking food, and fertilizer and pesticide production and transportation, there is the problem of waste itself. Let us put it this way, if wasted food were a country, it would be the third biggest emitter of GHGs in the world. Wasted food alone produces more than seventy million tonnes of CO<sub>2</sub> daily.

What of the other problems beyond "just" feeding a growing global population? Consider water, the lack of which is already an issue in much of the developing world. (India, for example, is one of the most "water stressed" countries in the world. (Water.org, nd)) Food waste also wastes approximately four gigatons of water annually not including traded "virtual" water. It also wastes a great deal of land. In fact, today food waste wastes an area equivalent to the combined areas of the US, India and Egypt and is a major cause of deforestation. (Cutting some twenty-seven billion hectares of forest annually to pasture cattle and grow corn for animal feed is undoubtedly a major cause of falling water supplies in many places.) And then we have the touchy issue of refugees. Already, the fear of refugees from the South

is a major issue in both the US and Europe, but as the IPCC predicts, (with “high confidence”) the total number of climate change refugees could easily exceed three billion, swamping the tiny number seen today [1].

Oh, and then there is the economic cost of food waste, estimated by the UN to be at least \$750 billion a year or a full trillion dollars if we include fish and other maritime resources.

### **Failed Ideas about what can be done to Change these Terrible, Environmental Losses Behavior Change “Solutions”**

Let’s change people’s behavior and so, stop or mitigate climate change. Maybe people could stop eating meat, since meat production is a huge part of agriculture’s impact on the environment. (Producing meat – 325 million tonnes this year - requires some eighteen times as much energy as vegetable proteins (beef requires 250 times as much per gram of protein equivalent), leads to deforestation for pasture and feed production and uses in the order of 2.5 billion tons of water.) (For all the statistics above, see The World Counts, 2023) Personally, this sounds appealing, but it strikes both me and the meat industry as highly unlikely. In fact, the rapid growth of the world’s “middle class,” and wealthier people’s desire to eat meat, ice cream and other dairy delicacies, have led Statista to project a growth of meat industry revenues from \$838 billion in 2020 to one trillion dollars in 2025. (Statista estimates that world meat consumption will stabilize at \$35 per person but that the world will add two billion people by the time it does. (Statista, 2022) Furthermore, even if achieved, the elimination of meat or a reduction in its consumption would not entirely solve the problem.

Even less likely is the hope that everyone can be convinced to go vegan. Well, this would obviously make a dramatic difference as a step toward stopping or mitigating the effects of climate change, but let’s consider the consequences. Soy is the best example. We already have soy in everything from meat alternatives to shampoo. Its ubiquity is legend. The problem is that like most crop wastes in the developing world, soy hay is burned after production, generating huge amounts of climate change gases and PM2.5 [4]. Unfortunately, today a huge portion of soy is grown on land once covered by Amazonian rainforests, an area the size of Texas. Burning this much soy crop waste over five years is just as bad for the climate as burning the rainforest in the first place. And then there is the big problem How to convince the poor that they do not deserve – nor should even want – to eat meat? There is no free lunch [5].

### **Engineered “solutions”**

This simple observation applies, too, to the hope that we can “phase out” oil and gas production quickly enough to meet the 1.5° C deadline in 2050 or at least sharply decrease its effects. The recently concluded COP28’s acrimonious collapse over this question and decision to “soften” the reference to fossil fuels (complicated by over 1,600 oil and gas industry lobbyists) and the President of OPEC’s letter to the conference make clear the problem. We do not only drive with oil and gas, but also produce plastic, pharmaceuticals, fertilizers, pesticides and lots of other critical things from oil and gas [6]. I personally find it hard to believe that the world will do without sippy-cups and plastic wrap soon and without a fight and cannot imagine a world of nine billion food secure people if we cannot replace petrochemical derived

fertilizers and pesticides. And then there is the big issue of what alternatives are or will be available. Bigger and much, much better batteries? Thousands more recharging stations? A whole new generation of vehicle manufacturing equipment – and auto workers? As I learned in graduate school, in the world of politics, the only question that matters is ‘who gets and who pays?’ Apparently, despite technological possibilities, big oil and gas have declared that they will not pay but intend to keep getting [7].

But what about grabbing CO<sub>2</sub> as it is produced at power plants, steel mills and cement factories and sequestering it deep underground (CSS)? Here is a great idea with a potential future and clay feet today. Leave aside technical questions such as how long highly compressed liquid CO<sub>2</sub> will remain “sequestered” in the heat of underground boreholes in fracked rock. The immediate problems are much more pressing. How will and why should companies with existing facilities be forced to pay for such costly systems? How many people will happily accept high pressure liquid CO<sub>2</sub> pipelines snaking across the land (let alone their land)? Certainly, in the world’s largest GHG producer, the US, I find it hard to believe that “Not In My Back Yard” (NIMBY) will not sink any long-term, large-scale CSS effort.

OK, but what about Direct Air Capture (DAC), currently the hottest technology in the carbon removal space? Again, DAC is evolving fast and may have a great future, but today still has clay feet. How best to extract CO<sub>2</sub> from the atmosphere where it is just 0.4% of total volume, remains a big issue not likely to be resolved soon. For better or worse, the only funded versions of DAC are inefficient, highly costly and a long way from commercialization. A critical question, therefore, is whether it can be brought to scale in time. And again, DAC has a huge NIMBY problem [8]. It involves, after all, immense vacuum cleaners all over the world hoovering up millions of tonnes of air. This is not a matter of spoiling the view from Martha’s Vineyard with windmills; this is strictly NIMBY anywhere in the democratic world and more broadly, too. (Grubert) [9].

Besides the problems raised by each failed solution, there remain two common underlying issues: political and civic. On the one hand, all these “solutions” require large-scale political action by sovereign actors. Where will the “political will” come from when countries’ entire budgets are at stake (consider oil and gas in the Gulf and Africa) (Domoseke, 2023) or in which controlling the actions of MNC players is beyond the reach of local governments (consider Borneo and Brazil where a key signatories to forest saving measure are now burning forest in the next country over)? On the other hand, all these solutions make unlikely assumptions about the motivations and abilities of common citizens. Why should a Nigerian commit to giving up to possibility of development with oil dollars or anyone believe that folks around the world will give up meat? Civic movements built on individual altruism generally do not achieve their ends, so why here? [10].

### **Politics**

As noted above, I have always been taught that politics is about ‘who gets and who pays?’ The problem is, in part, about money. Big oil and gas have it, few others do – except for governments and intergovernmental organizations such as the EU and UN. Here, the EU is the outlier, in which countries were driven together by the fear of another war and willing to forego some sovereignty in return

for binding the hands of other EU members. It is not surprising, therefore, that in the EU non-salient issues such as the environment and rules of the road have advanced far further than monetary and employment policies or national security [11]. The UN, on the other hand, embraces everyone at the cost of agreeing to a sort of “unanimity solution,” in which every state maintains its sovereignty and so right to say no. (Consider the US’s veto of a sanction of Israel for not ending the war in Gaza or the US’s and Israel’s refusal to accept the all but unanimous vote in the General Assembly.) It is not surprising that that UN has not succeeded in clipping the wings of any country yet, nor that it is unlikely to do so soon.

This is not all about sovereignty or money, per se, i.e., the ability to hire lobbyists. It is also about expertise. Until recently, who could challenge the findings of the only big labs studying the issue in the world that all asserted that CO<sub>2</sub> emissions and climate could not possibly be linked. Besides, who could serve credibly on government and INGO committees investigating climate change except for industry experts? [12]. The media driven rise of public fear about climate change has today begun to foster new research and a loud enough voice to provide space for alternative views. The problem remains, however, what are you and I going to do about all this? There are very few people in the world who possess the means to pay for countervailing data. (Indeed, who but Bill Gates, Jeff Bezos and a few others?) This being the case, while many are today frightened by climate change, most believe that the only workable solutions must cost lots of money and come from on high as in, “this is so big that they will have to do something about it.”

### Civics

This is a very depressing conclusion for those interested in civic action., Just what is a reasonable vision of the future of our planet? Here, increasingly, people have risen up screaming that the sky is falling, but unless your democracy works extremely well, who will listen if you are not organized for action? I may fear climate change or want to mitigate its consequences, but without a leader and a program, how much will my voice contribute to change? Not much. Why? Traditional collective action problems. We autoworkers, for example, may not want to see a shift toward electrics, but who will walk out first? (The recent victory of the UAW was striking, but heavily context dependent.) So, if we lack a strong leader, a program and the ability to coerce others to join in the cause, what chance do we have against a small, well organized and very wealthy oil and gas companies which share a common interest in money (an infamous k-group)? Again, this situation leaves most of us wondering “but what can I do?” (A 2023 Gallup/MITRE Corp survey found that among Americans food waste as an issue ranked only third, far behind cost and healthiness, and that few American know what they can do about it) [13, 14]. We may be as scared as we like, but unless we are able to do something, who cares?

### Is there anything to be done?

Of course, there is. If just one half of the world’s food waste was dried and biocharred, many problems would fall away.

### What is Biochar?

Biochar is “super charcoal” made from any carbon containing biomass heated very hot (550° C, as opposed to normal charcoal which is seldom made at more than 350° C) in the near absence

of oxygen. Making biochar requires no energy inputs and converts at least 40% of the carbon contained in the biomass into an inert form that will not return to the atmosphere. Making biochar is thus carbon negative, sequestering carbon removed from the atmosphere by plants through photosynthesis forever. Making biochar also eliminates smoke and, therefore, PM<sub>2.5</sub> and most smog precursors that together kill seven million people per year, mostly in the developing world [15]. (The World Health Organization estimates that 4.2 million people die annually for PM<sub>2.5</sub>, making it the fifth biggest killer in the world, ahead of the combined mortality caused by Hepatitis A, HIV, malaria and TB) And why biochar? Because anyone who wastes food can make biochar – easily [16]. Anyone can make biochar if they have a hoe and a space big enough to dig a small hole in the ground.

Dealing with food waste biomass ought to be neither difficult nor costly. A key problem with all food waste is moisture. Making biochar, however, releases lots of heat that can be used to dry feedstock [17]. And, because the feedstock is free (garbage is valued only by rag pickers and is already collected in many areas), costs should be low. Rather than going to all the effort of making compost (which releases fluxes of CO<sub>2</sub>, methane and often NO<sub>x</sub>, why not just dry and char waste? Yes [17]. You can do it, in your back yard or on your apartment porch and help to make yourself and your town part of the solution, not the problem [18].

### What can be done with Biochar?

Making biochar should not be considered as a fix only for the problems caused by food waste. Biochar has tremendous possibilities. As a soil amendment, biochar will restore degraded soils, improve fertility, increase soil porosity and water retention, reduce acidity and vitalize soil life. In animal feed, biochar will improve animal health and increase productivity whether through weight gain, milk production or egg laying [19]. Biochar also adsorbs to its surface heavy metals, industrial and agricultural chemicals, reducing contamination of the food chain [20]. As an industrial product, biochar can be added to concrete and asphalt, improving strength and lowering weight [21]. Biochar also makes an excellent replacement for carbon black used especially in tire production [22]. The list goes on and on, often replacing products made with fossil fuels [23].

### Biochar and Food Waste, Back to the Big Problem

How exactly can biochar help in the battle against climate change? Imagine that one half of the world’s “wet garbage” was biocharred instead of tossed, no huge behavioral change required. Imagine that nothing changes but the drying and charring of garbage. The immediate benefits would be huge. Not least, by reducing GHG emissions by approximately 40%, this effort would remove a quarter (1.3 gigatons) of the carbon required to meet the IPCC 1.5 ° C annual requirement, and save 2 gigatons of water, one half the lands currently committed to food production (maybe the equivalent to acreage of the US and all the associated 13.5 billion hectares deforested annually that destroys habitat, biodiversity and watershed. Naturally, even if biocharing does not stop climate change, it will certainly mitigate the consequences [24].

But these are the gross statistics. Let us look at the eight hundred million people who are today starving or food insecure and the problem of feeding another two billion people by 2050. Many

of the food insecure are tiny farmers who cannot afford to buy synthetic fertilizers especially now that price have tripled since the start of the war in Ukraine [25]. and perhaps quadrupled in Africa. Likewise, many of the two billion newcomers will also be smallholders at the bottom of the food chain. By making and using biochar-based fertilizer, these smallholders ought to be able to reduce costs considerably and produce much more, permitting them to feed themselves and increase gross food production. (A recent meta-analysis by Joseph et al., suggests that the simple use of biochar can increase production 42%. (2022)) Furthermore, by retaining water, biochar can mitigate the impact of climate change droughts.

### But what about the Cost?

This will not be a costless project, but ought to be one able to pay for itself. Consider New York City, for example, that in 2017 spent millions of dollars to landfill the remains of dead or pruned trees. (Landfills account for 36% of US methane emissions. And this does not consider the carbon footprint of garbage trucks and out of state transportation of wood chips. ----- (2023)) Imagine the savings if the city had, instead, invested just once in a biochar operation. Likewise, take Phenom Phen, where the massive city dump grows daily, spews lethal smoke across the city and generates millions of tonnes of CO2 eq. Here the issue is not cost saving, but revenue making. What if the city or country built a combined composting and biochar making facility, and produced and sold a million tonnes of biochar-compost fertilizer annually? Think of the annual foreign exchange savings (More than \$300 million annually (Observatory of Economic Complexity, 2023), reduced dependence, increased food production and lowered health care costs. In short, converting to the production of biochar from food waste can be hugely beneficial for individual farmers, the state and the global climate [26, 27].

### And what about the Little People?

I am interested in the world's poorest and simply in you and me.

### Conclusion

There is no question that we face a grim climactic future. Most of our discussion about climate turns, however, on actions so big and costly that we, individual citizens, feel left out. They also tend to avoid discussion of the big, unobvious issues that lie behind climate change such as, for example, food waste. In this brief article [1]. I have attempted to consider the consequences of food waste for the world and to suggest a possible, low-cost solution, biochar. From this analysis, biochar emerges ahead of the highly unlikely contenders to solve climate change, both because of its efficacy and individuals' access to it. Unlike CSS, DAC, and massive landfills, biochar does not exclude the rest of us because we lack the billions of dollars necessary to play. Unlike giving up meat or becoming vegan, biochar does not require massive society wide behavior change. Instead, biochar has the potential to reduce many climate change drivers and to permit each of us to play a significant role.

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