

# Will Lab-grown Food Really Save the Planet?

Claire Robinson of GMWatch and others take a critical look at George Monbiot's vision of farm-free food

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*The environmental campaigner and journalist **George Monbiot** has created a huge controversy by predicting that farmers and farming as we know them will soon be made redundant by the massive expansion of lab-grown food. This, he argues, is largely a good thing (though he adds that it is not without its own dangers), because agriculture is the key driver of the major environmental catastrophes that we face: climate breakdown, maxed-out water use, agrochemical pollution, soil erosion, and Insectageddon (the mass die-off of insects).*

Monbiot set out his case in an article that he wrote for The Guardian, [Lab-grown food will soon destroy farming - and save the planet](#) and a documentary for Channel 4 TV in the UK, called [Apocalypse Cow: How Meat Killed the Planet](#).

We at GMWatch hugely respect and admire George Monbiot for his tireless and courageous work over many years highlighting environmental issues and exposing corruption in power structures, including the corruption of science. We have also been proud to cooperate with him on a series of major investigative pieces that he has written drawing on our research, where we have seen the care he takes over getting things right. But sadly, we believe he is seriously mistaken in his latest intellectual venture, for reasons we explain below.

## Monbiot's arguments

Monbiot's key message is summed up by this excerpt from his article in The Guardian:

"We are on the cusp of the biggest economic transformation, of any kind, for 200 years. While arguments rage about plant- versus meat-based diets, new technologies will soon make them irrelevant. Before long, most of our food will come neither from animals nor plants, but from unicellular life. After 12,000 years of feeding humankind, all farming except fruit and veg production is likely to be replaced by ferming: brewing microbes through precision fermentation. This means multiplying particular micro-organisms, to produce particular products, in factories. I know some people will be horrified by this prospect. I can see some drawbacks. But I believe it comes in the nick of time."

Much of the food revolution that Monbiot anticipates will require the use of genetically modified bacteria that will "create the specific proteins needed for lab-grown meat, milk and eggs". Monbiot believes that while fruit and veg will continue to be grown on farms-as-we-know-them, we will rely on bioreactors to manufacture meat, dairy, palm oil, and long-chain omega-3 fatty acids.

In his documentary, Monbiot visited a Finnish factory in which a company called Solar Foods is using a bioreactor to manufacture a flour-like substance that is intended as a protein-rich food-like substance. The bioreactor uses hydrogen extracted from water as its energy source. Monbiot gets them to make him a pancake from the flour. He eats it and states his verdict that it tasted “just like a pancake”. Solar Foods’ venture has given rise to a BBC News headline claiming that [Food ‘made from air’ could compete with soya](#).

Comparing this process with growing food plants in fields, Monbiot says,

“The hydrogen pathway used by Solar Foods is about 10 times as efficient as photosynthesis. But because only part of a plant can be eaten, while the bacterial flour is mangetout, you can multiply that efficiency several times. And because it will be brewed in giant vats the land efficiency, the company estimates, is roughly 20,000 times greater. Everyone on Earth could be handsomely fed, and using a tiny fraction of its surface. If, as the company intends, the water used in the process (which is much less than required by farming) is electrolysed with solar power, the best places to build these plants will be deserts.”

Monbiot concludes,

“Farmfree food will allow us to hand back vast areas of land and sea to nature, permitting rewilding and carbon drawdown on a massive scale... Farmfree food offers hope where hope was missing. We will soon be able to feed the world without devouring it.”

## **Counter-arguments**

Monbiot’s ideas have come in for heavy criticism from a variety of sources. We’ll give just a taster of these below, but anyone who is interested in these issues should read the articles we cite in full, as they are wide-ranging and make a multitude of points.

### **Oxford Real Farming Conference**

Monbiot reiterated his argument for doing away with farming at the Oxford Real Farming Conference in early January. The gist of the debate has been summarised by [Food Navigator](#).

Monbiot was booed by some in the audience, which included a large number of farmers who aim to manage their land and livestock sustainably. He was also strongly challenged by the other panel members – who, however, voiced their deep respect for him as a person and an environmental campaigner. These included Patrick Holden and Richard Young from the Sustainable Food Trust, who believe that locally sourced meat from grass-fed animals makes up an essential part of a sustainable food system, and Joanna Blythman, the food writer and broadcaster.

Young [called](#) lab-grown meat a “fools’ gold”, adding that “the very last thing we need is more processed food”. He also took issue with Monbiot’s data, showing several slides in which he cited figures that are at odds with Monbiot’s statements.

Citing the examples of imported jackfruit and banana blossom as “unconvincing” plant-

based substitutes for meat, Joanna Blythman [said](#), “I really feel that we’ve lost the plot when arcane imports and genetically modified fake meat burgers dreamed up by venture capitalists in Silicon Valley are portrayed as more acceptable than a lamb chop from a British hillside.”

The new technologies promoted by Monbiot, she said, have “huge problems”: “The doctrine of high-tech inevitability is propaganda. We should see it for what it is: those who claim to know the future are trying to own the future.”

### **Techno-optimism run amok?**

An anonymously authored article on the Regenetarianism blog, called [Techno-optimism run amok... George Monbiot’s latest delusion](#), draws attention to the ‘elephant’ in this vision of our food future – the fact that bioreactors are extremely resource- and energy-hungry. The article opens:

“In George Monbiot’s techno-optimistic scenario.... proteins and carbs are created via precision fermentation in brewing tanks requiring infrastructure, blue water [water taken from surface or groundwater resources] and energy. These proteins and carbs (plus some additional minerals, antibiotics and growth factor) will be used in place of amino acids and carbs from industrial crops (soy, corn, etc) to feed growing stem cells in bioreactors that also require a lot of blue water, non-intermittent energy, and infrastructure. The fermentation tanks and bioreactors will also need to be contained in sterile conditioned spaces requiring infrastructure (made of CO2 emitting concrete and steel) and energy. All this energy infrastructure will also need a lot of raw materials and energy to build.

“So first, it certainly would be interesting to see a life cycle analysis [LCA] of this above techno-fix at scale for both energy and blue water use. And then compared that LCA to a LCA of AMP managed [AMP is a global renewable energy infrastructure manager and owner] solar power head of cattle turning non-edible to human grasses watered by green water into beef, leather and a number of other by-products. Does George have such a LCA for his fermented/cell Ag solution to compare to this recent LCA done of White Oak Pastures beef cattle that was carbon negative? Doing any sort of techno-fix at scale is a lot different than doing a small batch ‘proof of concept’ in a petri dish.”

### **Vast amounts of energy, vaster amounts of nutrients needed**

The Regenetarianism article is aggressive in tone, which we do not condone. However, we cannot fault the facts presented in the article, including the apparent absence of life cycle analysis for lab-grown food and the difficulties of scaling up the technology to the extent needed.

These views are very much in tune with comments offered to GMWatch by the London-based molecular geneticist Dr Michael Antoniou. Dr Antoniou is familiar with smaller-scale bioreactor technology from his work in medical research, which has included the manufacture of therapeutic proteins in these giant fermentation vats.

Dr Antoniou says that bioreactors of the scale that would be required – 20,000 litres or more – require large amounts of materials and energy to run them (as for the ‘food out of thin air’ notion of Solar Foods, the process of splitting hydrogen from water (electrolysis) is

extremely [energy-hungry](#)).

He explains that large-scale bioreactors would require vast amounts of nutrients and other inputs that make up the culture medium for the bacteria or yeast that produce the desired proteins. The culture of animal muscle cells in particular to produce synthetic meat requires a huge quantity of nutrient and other inputs. There are dozens of ingredients, including minerals, vitamins, amino acids, glucose and growth factors – as listed in a report by the Good Food Institute, a nonprofit group promoting cell-based meat.[1] Many of these ingredients, especially the growth factors, in turn need to be manufactured from genetically engineered bacteria or mammalian cells – in other bioreactors. Infrastructure will be needed to create the supply chain that will enable one bioreactor to be ‘fed’ by others, as well as to transport raw materials to the bioreactors and dispose of the waste.

While some of the components of culture medium are cheap to buy or manufacture, others are extremely expensive – such as the growth factors that are required to make the animal cells multiply. For example, to supply the growth factors insulin and transferrin has been estimated by the Good Food Institute to cost \$131,920 and \$85,600 respectively, for a single production batch in a 20,000 litre bioreactor.[1] The costs for the growth factors FGF-2 and TGF- $\beta$  are far higher: an eye-watering \$4 million and \$3.2 million. And remember, that’s only for one batch: each successive culture will require fresh culture medium.

Bioreactors are complex structures with miles of pipework. The materials to make the thousands of bioreactors needed to ‘feed the world’ will have to be mined, adding to the damage that extractive mining already does to the planet.

When the bioreactors are up and running, they will need maintenance, including a constant supply of energy. There is also the problem of the waste culture medium once a batch has been harvested: it will require treatment with toxic disinfectants before disposal. Also, between production runs, the whole system will need to be disinfected and the resulting waste will need to be disposed of somehow. Thus the potential for environmental pollution is high. Bioreactor systems are also not immune from contamination. Although relatively rare, contamination would shut down a facility for months.

### **Need for immortalised cell lines**

Dr Antoniou adds that the proponents of synthetic meat production through the culture of muscle cells also face yet another major biological limitation. Muscle cells isolated from, say, a cow or bull have a limited growth capability in culture: that is, the muscle cells grow well for a while, but then senesce (age) and die, just as they would in the body of the animal from which they were derived. This makes it very unlikely that normal muscle cells isolated from an animal will have the growth capacity to fill a 20,000 litre bioreactor, unless vast numbers of cells were initially isolated from a large number of animals, which is impractical.

Thus the [claim](#) by Maastricht University in the Netherlands that cells from a single cow can produce 175 million quarter-pound beefburgers, while you would need 440,000 cows from traditional farming, is disingenuous.

To try to overcome this limitation, proponents of lab grown meat are being forced to consider using genetically engineered “immortalised” animal muscle cell lines, which are akin to cancer cells and have a much greater lifespan in culture than normal muscle cells isolated directly from an animal. The potential safety problem with immortalised muscle cell

lines is that they have been generated by the introduction of growth regulator genes, which can be carcinogenic. This raises major concerns, as eating synthetic meat containing large quantities of cancer-causing oncogenes is an obvious safety risk. It will be interesting to see how regulatory agencies respond to requests from industry to approve the use of immortalised muscle cells in food production. If normal safety rules are applied, such requests should be rejected.

Bioreactors also need a large number of highly trained staff to run them.

As for 'sparing' land with this system of food production, the large number of bioreactors needed will take up large tracts of land.

And if by some miracle in this dystopian world, some land is spared, then who decides what will happen to it? Will it be rewilded, as per Monbiot's wish? If so, who will compensate the landowners for the lost income they otherwise would receive by allowing it to be farmed? Or will the landowners retain some say over what happens to their land? In which case they will doubtless prefer to sell it for housing or other development, which would make them far greater profits.

### **Real costs not assessed**

The Good Food Institute report concludes optimistically that "it is likely that cell-based meat is capable of ultimately being cost-competitive with conventional meat production at scale". But tellingly, the report states that it excludes from its estimates the costs of labour, energy, and the expenditures necessary to build the facility. In other words, the real costs of this industry have not been realistically assessed and would likely prove prohibitive at the large scale needed.

### **Corporate consolidation**

Permaculture expert and critic of capitalism Rebecca Ellis also believes that Monbiot is on the wrong track - from the point of view of corporate control of the food supply. She [writes](#),

"The type of high-tech, venture capitalist-backed lab foods advocated by Monbiot represents an intensification of the industrial capitalist food system and a move towards further consolidation of power in the hands of a few corporations. Monbiot realizes this is a risk and advocates for a decentralization of this new system of lab foods. However, in the actually-existing world, this is not what is happening or will happen. This is because lab-based foods will require a huge amount of capital investment. Food will essentially be created in lab-factory hybrids which, to build at a scale to feed 7 to 9 billion people, will be incredibly resource intensive.

"Already, this emerging industry is being supported by venture capitalists, and other tech optimists, who believe firmly that high-tech capitalism will save humanity and the Earth. Of course those of us with a critique of capitalism know that the system is about wealth accumulation and private profit, not about feeding people or regenerating the Earth. In fact, we currently grow more than enough food for the world's population. People starve to death and face chronic malnutrition not due to lack of food but due to the cruelty of the capitalist system (for an incisive critique of the industrial-capitalist food system, please see the work of Dr. Tony Weis)."

## The ecomodernist delusion

A witty [takedown](#) of Monbiot's position is offered by Chris Smaje, a social scientist and small-scale farmer.

Smaje writes, "First, historically, getting people out of farming has rarely ended well for the ex-farmers, and there are more farmers in the world than any other single job. And second, making people mere spectators of the natural world is unlikely to do either people or the natural world a long-term favour. George's plan for sparing nature is self-defeating."

The main point of Smaje's article is to explore "why George has ended up where he has". With that aim in mind, he offers a "nature spotters' guide to the ecomodernists", a group of technophiles that Monbiot appears to have joined in his latest venture into farm-free food. Smaje diagnoses Monbiot as a "Last-Chancer", a type of ecomodernist who has "looked long and hard at the future to which we're hurtling and got very, very scared. They've spent a lot of time trying to warn us about this wolf at our door, only to find that not only do we treat their prophecies with indifference but we've actually welcomed the wolf in and installed him in the White House and No. 10. Understandably, they've now given up on prophecies and politics and are desperately clutching at whatever darned thing they think might just conceivably save us in the last chance saloon we now inhabit - nuclear power, lab-grown eco-gloop or whatever."

Smaje doesn't think the Last-Chancer vision will work because after the moment of "ecomodernist salvation", there is never any plan in place detailing how to institute a resilient ecological economy. In contrast, Smaje [believes](#) that the only things that will save us are "two of the oldest human trades: farming and politics".

### Reconnecting with nature by disconnecting from nature?

GMWatch largely shares the views of the critics cited above and we'd like to add a postscript of our own.

Chris Smaje captures something that we all need to be aware of. As the climate and ecological crises worsen and governments continue to fail to take robust action, the allure of simplistic techno-fixes is going to grow ever greater amidst the resulting sense of desperation and despair. And you can be sure that there will be plenty of corporations, venture capitalists and entrepreneurial scientists more than ready to exploit the situation.

But techno-fixes are based on what Monbiot himself has [characterised](#) as a "wildly romantic" view of technology as somehow magically able to solve the complex and difficult problems we face. And worse still, they serve as a distraction from the hard work that needs to be done to heal our relationship with the planet we live on.

That relationship has become largely characterised by abuse and violence (we say "largely" because clearly there are pockets of sustainability). And the only way to heal that damaged relationship is by facing up to what we have collectively done and retracing our steps back to a simpler, more honest, and more accountable stance upon the Earth. But that process is much less likely to happen as long as we settle for distracting ourselves with supposedly magical techno-fixes.

The notion of saving the Earth through farm-free food is no better than the notion (proposed by various experts, including Stephen Hawking) of colonising other planets to save us from

the destruction we are wreaking upon our home planet.

Removing ourselves from the mess we have made of the Earth to refocus our attention on a brave new world of bioreactors will only lead us to recreate the same old problems in our new food-producing environment: the resource-guzzling materials and processes, the pollution, the corporate consolidation and corruption in the search for ever-greater profits.

And there will be another serious problem. Due to our new diet of super-processed food-like substances, the vast majority of the bioreactor-fed population may grow increasingly sick in body and mind. The precise reasons for that sickness will take decades to unravel scientifically. But they may make it well-nigh impossible for us to pull ourselves out of the dystopian construction we have built for ourselves.

We all know what's needed to start to mend the damage we've caused – and it cannot entail turning our backs on the land that feeds us. We have to look our 'victim' in the eye, stop doing the things that damage and destroy, and start doing the things that regenerate. It's quite simple, even if right now it's further away than it's ever been.

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### Note

1. Liz Specht, "An analysis of culture medium costs and production volumes for cell-based meat". The Good Food Institute, February 13, 2019. Table 1.

<https://www.gfi.org/files/sci-tech/clean-meat-production-volume-and-medium-cost.pdf>

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