The McDougall Intensive Advanced Study Conference:
"Plant-food based nutrition and conservative medical care"
Santa Rosa, California
September 6-8, 2013

Happier Meals, Eating Greenfully, and Chomping Climate Change

by Robert Goodland[1]

Introduction

There's an accidental environmental aspect to the location of this conference. That is, it's taking place near Silicon Valley, which is largely responsible for revolutionizing the world by replacing brick and mortar with digital and virtual processes. That replacement can dramatically reduce the use of natural resources and energy, and thereby reduce greenhouse gas (GHG) emissions and help to slow climate change.

The digital and virtual revolution is ongoing. For example, just five years ago, when young people moved to a new urban area, a key concern was where they'd park their car. But now, they often want to know whether the new city has both Zipcar and Car2Go. These competing car-sharing services allow you to reserve a car anywhere at any time using your smartphone's connections to satellites, cellphone towers, and data centers. All of that enables five people to share one car and one parking space where five cars and five parking spaces were formerly needed. That entails a momentous savings of natural resources and energy, thanks to digital and virtual processes.

The person most often identified with the growth of Silicon Valley, and with digital and virtual processes, now spends most of his time thinking about how to improve the world more generally. I'm talking about Bill Gates. Last year, speaking in Silicon Valley, he started talking about going beyond replacing bricks and mortar – and replacing animals raised for food with what we might call "virtual" meat, dairy, and egg products, made with no animals. If someone misses having a piece of an actual chicken or cow or pig on their plate, then they can look at a virtual version on their smartphone while they eat their vegan beef, vegan poultry, or vegan pork. Such change in the world of food and agriculture might even more impressively reduce natural resource and energy use and GHGs than the change we've seen in communications.

I'll quote Bill Gates from a video of him that you can find on YouTube: "All these companies that are taking the animal products, the milk, the egg, the chicken, the beef and actually coming up with a way of using largely plant-based materials – soy, peas and a variety of things – to make these products that are both cheaper, probably more healthy, less cruelty involved, less greenhouse gas emissions, it's quite a phenomenal thing… I think it's a huge thing… It's completely not part of the mainstream dialogue. Five years from now when these products will get out there… [people] will see what exactly the innovation will cause."

Bill Gates then went further. According to an article in the New York Times (NYT, 2013a), he, along with other Silicon Valley investors, are now betting money on his vision of how food is ripe for innovation. In fact, "Food is Ripe for Innovation" is the title of an article by Bill Gates published in May of 2013 (Gates, 2013). That article cites the 2009 article that I wrote with Jeff Anhang on the topic of livestock and climate change. I'll summarize that article that I co-authored, but first let's examine Bill Gates' statement last year. For me, the key points are that he says taking animal products and making them with plant-based materials involves less GHG emissions, among other things, and that's extraordinary, and while it's not mainstream now, it will be in 2017.

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Now, here is what Jeff Anhang and I have written. We estimate that the lifecycle and supply chain of livestock products are responsible for at least 51% of human-induced GHGs, which means that the only pragmatic way to reverse climate change by 2017 as needed is to replace at least 25% of today's livestock products with better alternatives. Our assessment began when we analyzed some significant gaps that we found in a 388-page report by the UN Food and Agriculture Organization, or FAO. That FAO report was called Livestock's Long Shadow, and it estimated that 18% of human-induced GHGs are attributable to livestock products – much less than our figure of 51%, but still a significant amount.

Climatic Tipping Points

GHG reductions have conventionally been sought in the replacement of fossil fuel infrastructure with renewable energy infrastructure. That replacement is surely desirable, yet it has long and complex product-development cycles and capital-intensive requirements. Indeed, sufficient renewable energy infrastructure to stop climate change is projected to take at least 20 years and US$18 trillion to develop, according to the International Energy Agency (2011). Both that agency and the Intergovernmental Panel on Climate Change (Spotts, 2011) project that climatic tipping points may be reached by 2017, making later GHG reductions ineffective.

Climatic tipping points are fearsome. For example, last month, the National Academy of Sciences published a new study that 1,700 American cities – including New York, Boston, and Miami – will be locked into some amount of submersion from rising sea levels as a result of climatic tipping points, unless expensive new dykes and levees can hold back the rising waters (The Guardian, 2013). Those 1,700 cities include Silicon Valley itself; and for some of those cities, the point of no return may come before 2017.

Flooding is only one dire adverse impact expected from climate change. Another is drought – as a key aspect of climate change is that volatility will increase, so swings between one adverse impact and another will become increasingly wide. Increasing swings between flooding and drought can be expected to affect agriculture more than any other industry, as agriculture is worked on outdoors to an extent that's unique among all industries.

Another dire impact of climate change is global warming. For example, a one degree Celsius rise in temperature above optimum in a growing season causes a 10% decline in grain yields (Brown, 2011). This is already happening in some regions. Yet as conservative an organization as PriceWaterhouseCoopers has warned of a possible six degree Celsius rise in global temperature this century (PWC, 2012) – that's a 10.8° Farenheit rise – which implies a 60% decline in agricultural outputs.

Unfortunately, climatic tipping points can no longer be avoided by constructing the amount of renewable energy infrastructure that would be required. The amount of renewable energy infrastructure needed to avert climatic tipping points projected to be reached by 2017 could have been constructed in time – if construction had started when the Kyoto Protocol was adopted in 1997. That was supposed to happen through the process that required each country that subscribed to the Kyoto Protocol to reduce GHG emissions in each year after the protocol came into force in each country. Instead, with only a few exceptions, GHG emissions ended up rising each year in each country that signed the Kyoto Protocol.

Future Food Scenarios

Now, there seems to be only one remaining pragmatic way to reverse climate change before it's too late – and that's by taking quick and large-scale actions in the realm of food, agriculture, and forestry. If analysis by Jeff Anhang and me is correct in estimating that at least 51% of human-induced GHGs are attributable to livestock, then

replacing 25% of today's livestock products with better alternatives by 2017 could almost fully achieve the objective of the Kyoto Protocol and avert catastrophic climate change.

In contrast, if the FAO was right to say that 18% of human-induced GHGs are attributable to livestock, then it would take replacing about 67% of today's livestock products with better alternatives by 2017 to achieve the same objective, and avert catastrophic climate change.

So let's say that the world needs to replace between 25 and 67% of today's livestock products with better alternatives in order to avert climate catastrophe. Yet the FAO's Livestock's Long Shadow contemplates actions to manage a projected doubling in livestock production to feed the projected 9 billion people who will be alive in 2050. Specifically, Livestock's Long Shadow projected that "the production of meat will double between now and 2050" (Steinfeld et al., 2006).

Let's examine a few parameters of the FAO's projections to understand whether they can be justified. First, let's examine the FAO's assertion that we should expect livestock production worldwide to double by the year 2050. The Soil Association uses unusually harsh language to critique that projection, calling it a "big fat lie"; it says that the FAO's projection assumes "high meat" growth in developing countries, which would generate "massive land use change" that would exacerbate climate change rather than slow it (Soil Association, 2010).

Conversely, a report by the International Food Policy Research Institute projects that consumption of livestock products could decline through at least 2030 (Rosegrant and Msangi, 2011). That institute co-published a report 14 years ago that kicked off what was called at the time the "Livestock Revolution," which was said to be a recognition of a sort of inevitable increase in factory farming (Delgado et al., 1999). So it's particularly striking to see the International Food Policy Research Institute now projecting such a different future.

Yet neither the International Food Policy Research Institute nor the FAO has explicitly drawn any scenario by which disruptive climate events might force shrinkage of the livestock sector. The need to draw such a scenario seems apparent as large-scale die-offs of livestock, feed crops, and grasses for grazing started to be seen in every region of the world in 2009. In some regions, such die-offs reached unprecedented proportions this year – and climate change threatens to make them increase further.

Now, let's examine the FAO's projection that 9 billion people will need to be fed in 2050. That projection comes from what the UN Population Division calls its medium-variant projection for 2050. The UN Population Division also publishes a low-variant projection, which is for a human population in 2050 of 8.1 billion. That low-variant projection would yield 14% more people than today in 2050, while the medium-variant projection would yield 28% more people than today. Neither one comes close to justifying a doubling in livestock production.

Moreover, none of the UN Population Division's projections factors in the possibility of a reduction in human population forced by climate change, which would mean that less food than is produced today may be required in the future. In any event, any switch from a livestock product to an alternative means that less crops need to be grown, which is equivalent to saying that less food may need to be grown in the future than is grown today.

How could the FAO go so wrong? Well, let's start with the FAO report that I've mentioned, namely Livestock's Long Shadow, published in 2006. Activists often use that FAO report to support advocacy for vegetarian foods. But Livestock's Long Shadow actually prescribes more factory farming: "The principle means of limiting livestock's impact on the environment must be... intensification" (Steinfeld et al., 2006, p. 236). That report's lead author and a co-author later wrote to confirm that prescription (Steinfeld and Gerber, 2010). Yet those authors are livestock specialists, not environmental specialists.

International good practice is to have any activity with major environmental impacts be assessed by environmental specialists, and my co-author Jeff Anhang and I are longtime environmental specialists employed by two UN specialized agencies, the World Bank and International Finance Corporation.

Why it matters who performs environmental assessment becomes clear when reviewing the report Livestock's Long Shadow, written by livestock specialists rather than environmental specialists. The report examined land degradation, climate change and air pollution, water shortage and water pollution, and loss of biodiversity. It asserted that those risks and impacts must be balanced with benefits available from raising livestock. Yet the report failed to measure livestock's various risks and impacts in any relative ranking, a basic element of environmental assessment. For example, the report failed to separate livestock's lesser risks and impacts, such as those involved in water pollution, from livestock's highest risks and impacts – that is, those that are diverse, irreversible, and unprecedented, which are certainly involved in climate change.

In fact, Livestock's Long Shadow failed to identify any climatic tipping points, even though they're actually the #1 risk of continuing to expand livestock production. That failure in Livestock's Long Shadow led to its fatal flaw of projecting a doubling in livestock production, and pairing that with only minor prescriptions for mitigating greenhouse gas, implicitly asserting that benefits available from producing livestock products outweigh their risks. Also, the report assessed only livestock products and included no analysis of alternatives, another basic element of environmental assessment.

We know one of the authors of Livestock's Long Shadow, Cornelius De Haan, from when he worked at the World Bank. He was lead author of the World Bank's 2001 livestock strategy, which pegged livestock's adverse impacts at a lower level than in the 2006 "Livestock's Long Shadow" – yet the World Bank strategy correctly recommends that institutions should "avoid funding large-scale commercial, grain-fed feedlot systems and industrial milk, pork, and poultry production" (De Haan et al., 2001).

Why would Cornelius De Haan move from being lead author of a report that prescribed avoiding factory farming to co-authoring a report that prescribed expanding factory farming? Maybe it's at least partly because the FAO, unlike the World Bank, has formed a formal partnership with: (a) the International Meat Secretariat, (b) the International Dairy Federation, and (c) the International Egg Association. My assessment of that partnership was published last year by the New York Times (Goodland, 2012), and it's on our website, Chomping Climate Change.

Our website includes links to many prominent citations of our analysis, including by UNESCO, NBC News, the Washington Post, Forbes Magazine, Canadian government climate scientists, and the Sierra Club. The website also has links to a number of universities' syllabi that include our analysis, including Harvard and the University of California.

In fact, worldwide interest in our analysis started to unfold the day it was first published, when Jeff Anhang and I got requests for interviews from all over the world. Worldwide interest in our analysis is important not for our sakes, but because climate change is one of a relatively small number of environmental issues that are transboundary. This means that GHG emissions and atmospheric carbon don't respect borders – so a molecule of carbon dioxide emitted in China can affect someone in the Bay Area just as much as it will affect someone in Beijing.

The transboundary nature of climate change means that everyone in the whole Bay Area could go vegan with virtually no climatic benefit if the consumption of livestock products continues to increase in China and elsewhere. In other words, it's as important to be concerned about what happens with food and climate change elsewhere as it is to be concerned about what happens with food and climate change here in California.

The FAO also projects that improvements in managing methane and nitrous oxide attributable to livestock will achieve most of the GHG reduction from livestock that is needed. Yet according to an article in Nature (Petherick, 2011), such improvements can achieve only 4% of global agricultural mitigation potential to 2030. That's much less GHG reduction than all other industries are being called upon to achieve, and indeed is a trivial amount relative to what the food industry should be called upon to achieve (as published in my response to Petherick, Goodland, 2013a.)

In any event, the FAO also projects that minimizing food waste will significantly help with GHG reduction from agriculture (Gustavsson et al., 2011). Minimizing food waste is surely desirable. Yet the FAO's best-case scenario for minimizing food waste would account for a small fraction of the GHG reduction that is needed. In fact, it might yield no GHG reduction at all. For example, it could mean that parents, instead of cooking less food for their children, will instead increase their insistence that children clean their plates, which some scientific studies have associated with increased obesity (NYT, 2013b). Or it could mean that more animal fats will be incorporated in consumer products instead of being discarded, and this would have no beneficial effect on climate change.

Insanity versus Better Alternatives

Indeed, minimizing food waste has been an objective of humanity for centuries, during which food waste has only increased. It's been said that failing at the same thing over and over and expecting a different result constitutes insanity.

Yet virtually all efforts that have focused on reducing GHG emissions have failed over and over, and are nevertheless being tried again. What we really need is some sort of action that will yield a large-scale reduction in GHG emissions and at the same time will massively capture atmospheric carbon in a stable place, otherwise known as carbon sequestration. We need such a grand dual action because the average global concentration of atmospheric carbon continues to increase after it recently rose above 400 parts per million – far above the safe level of 350 parts per million; and once carbon is in the atmosphere, it normally stays up there for at least 100 years. Some of it stays up there for thousands of years.

But there are ways to draw atmospheric carbon down to earth. The only known way to sequester atmospheric carbon on a large scale is by growing more trees. In recent decades, work to reforest land has been an overwhelming challenge, as policymakers and industry have both acted in various ways to do the opposite, namely to expand deforestation.

Simply proposing for the umpteenth time that we should grow more trees and expecting a different result could be considered insanity. Instead, Jeff Anhang and I propose that replacing a substantial amount of today's livestock products with better alternatives will both massively reduce GHG emissions and free up a vast amount of land to permit large-scale reforestation and GHG sequestration at the same time. The effect of this would be so enormous that it could actually be the only pragmatic way to reverse climate change. That's because livestock and feed production is estimated to occupy 45% percent of all land on earth,[2] according to Thornton et al. (2011) – that's all land, both arable and non-arable, not excluding ice caps or mountaintops or anything else. Much of that land was once forested, and could be forested again.

In fact, there is documented potential for agricultural change to bring atmospheric carbon to pre-industrial revolution levels within five years. Some of the relevant literature deals with remineralization

[2] Before Thornton co-authored the 45% estimate, he co-wrote with other authors an article that contained a 55% estimate (Kruska et al., 2002). According to that article's Table 2, livestock systems worldwide occupy 80.8 million km^2 of land, compared with the Earth's surface area of 149 million km^2, which means that livestock systems occupy 55% of all land on earth. Thornton is a livestock specialist employed by the International Livestock Research Institute, which generally promotes expansion of livestock and feed production.

(remineralize.org/research/the-potential-of-remineralization), while other relevant literature uses terms such as afforestation, reforestation, forest regeneration, and rewilding.

While Jeff Anhang and I have identified the unique dual benefit of reducing GHG emissions and increasing GHG sequestration from the single action of replacing livestock products with better alternatives, the FAO strategy for GHG mitigation from livestock involves a relatively small amount of GHG reduction through methodological tweaks. So we weren't surprised when the lead author of FAO's Livestock's Long Shadow and a co-author participated on a team of livestock specialists who wrote a critique of our analysis, and they were able to get their critique published only as a "commentary", not a regular article, even by the cattleman-friendly journal Animal Feed Science and Technology (Herrero et al., 2010).

Animal Feed Science and Technology then published our response, and provided the other team a chance to respond in turn, which they declined to take up (Goodland and Anhang, 2011). This can be seen on our website (chompingclimatechange.org), and it can help people to decide whose analysis is more authoritative.

One of the mistakes that we've identified in Livestock's Long Shadow is that it doesn't count carbon dioxide in livestock respiration at all, as the FAO considers that carbon dioxide to be balanced perfectly by photosynthesis. Indeed, the perfect balance of exhaled carbon dioxide with carbon captured by vegetation via photosynthesis is something that most children learn in school – namely, the carbon cycle.

However, reality no longer reflects the old model of the carbon cycle, in which photosynthesis balanced respiration. That model was valid as long as there were roughly constant levels of respiration and photosynthesis on Earth. In recent decades, respiration has increased exponentially with livestock production, which has risen from less than 10 billion land-based animals worldwide in 1945, up to more than 70 billion land-based animals worldwide this year[3] – while intensified livestock and feed production has been accompanied by large-scale deforestation and forest-burning, huge increases in volatilization of carbon, and a dramatic decline in both Earth's photosynthetic capacity and its GHG sequestration capacity (Goodland, 2013a).

200 tons of carbon per hectare are typically stored in forest, and are at risk of being released through deforestation. Yet more than 200 tons of carbon per hectare are typically stored in the soil beneath, and are at risk of being released when the forest above it is degraded. It's estimated that each year between 2000 and 2010, an area larger than England was deforested (FAO, 2010).

As a result, either carbon dioxide in livestock respiration – or its reflection in carbon absorption forgone on land used for livestock and feed production – should be counted as emissions. When that is done, it seems clear that a priority for governments is to provide incentives for reforesting a significant amount of the land used today for livestock and feed production.

Jeff Anhang and I aren't the only environmental specialists to suggest that the carbon cycle has changed, and that carbon dioxide in livestock respiration should be counted. For example, our analysis references an estimate that carbon in livestock respiration exceeds 8 gigatons per year, about 8 times the volume of carbon dioxide from human respiration (Calverd, 2005). A lower estimate that relies on FAO data is available, but it similarly concludes

[3] The worldwide terrestrial livestock population in 2010 included 1 billion cattle, 1.8 billion sheep and goats, 1.5 billion pigs, and 68.8 billion poultry. These are not standing inventories (animals alive on a particular day) but the total number of animals alive in a year, which is particularly important for poultry where most commercial broiler chickens are slaughtered after 42 days. This data is for terrestrial livestock, so it excludes farmed fish and other farmed seafood. Half the fish consumed worldwide is projected to be farm-raised by the year 2025. As the definition of livestock is limited to animals raised by humans, data on livestock will always exclude non-farmed seafood, although there are major environmental impacts created in catching and processing such seafood, as indeed there are in farmed fish [After: ifahsec.org/wp-content/files_mf/ifahfactsheet0112fin.pdf].

that carbon dioxide in livestock respiration can no longer be considered offset by photosynthesis (Prairie and Duarte, 2007).

In contrast, some scenarios for future food production recommend that beef and dairy production should be prioritized on grassland. That's contrary to the FAO's recommendation for more factory farming. In fact, it seems clear that the FAO is correct in its assessment that beef and dairy cattle produced on grassland emit much more methane than intensively-produced ones and they take up much more land, leaving much less forest available to absorb atmospheric carbon (Eshel, 2010).

Scenarios involving more grass-fed livestock fail to account for the urgent need for reforestation. In any event, meat promoters can be seen spinning recommendations for more grass-fed livestock as if they apply equally to factory farmed meat (Murphy, 2013). Yet it's no new trick to promote factory farmed meat as grass-fed. A grassland producer has himself noted that well over 90% of meat sold in the United States comes from feedlots, and most marketing of "grass-fed" beef is a hoax (www.americangrassfedbeef.com/grass-fed-hoax.asp). Beef marketed this way commands a 200-300% price premium, so the incentive for producers and sellers to cheat is overwhelming (Goodland, 2013b).

Yet halting climate change is an urgent task. In fact, the only real choice may be whether to look at replacing livestock products with better alternatives as a voluntary opportunity – or to deal with it involuntarily if large-scale die-offs of livestock, crops, and grasses continue to increase due to climate disruption.

As most livestock products worldwide are now produced on a large scale, all of the replacement of livestock products with better alternatives that's needed can happen in ways that would allow livestock populations in poor rural communities to remain intact. If those poor pastoralists continue to suffer from livestock die-offs due to disruptive climate events, then rather than assist them to reestablish livestock, only to be imperiled in the next disruptive climate event, assistance should be provided to improve their livelihoods. Alternative livelihoods are now much more widely available than previously as a result of the dramatic growth in use of computers, mobile communications, mobile banking, microfinance and off-grid electricity (Sullivan, 2007).

In fact, the best development assistance for poor pastoralists would be to get them involved in reforestation. This would be more economical than building dykes and levees, as preventing adverse environmental impacts is almost always less expensive than adapting to adverse environmental impacts once they've occurred. More important, it has a chance to stop climate change – whereas large-scale dykes and levees would be practically a concession that there's no longer a chance to stop climate change. Indeed, if climate change would become unstoppable, then eventually sea levels could overwhelm any practical scale of dykes and levees.

Poor pastoralists who live in arid grasslands (as in Mongolia) would have to want to move to reforestable land, but such cases would be exceptional. Most poor pastoralists live in places that used to be forested and can be reforested. Reforestation may be easiest of all in parts of Sub-Saharan Africa, where forest must be constantly burned to maintain pasture.

Reforestation can be an enormous source of sustainable employment, with jobs in seed collection, planting, nurseries, fire prevention and conservation. Many non-governmental organizations specialize in reforestation, although their efforts haven't been nearly well-enough known or well-funded.

Indeed, in poor and well-off countries alike, there is a long history of passionate champions advancing the cause of reforestation. Yet it's been 200 years since the work of history's most notable champion of reforestation, Johnny Appleseed. The world could hugely benefit from the rise of a modern-day Johnny Appleseed championing the restoration of the carbon cycle to its former steady state. So if you know any young, ambitious person who wants to

change the world, perhaps you could suggest to such a Jane Doe or John Doe that they change their name to Jane Appleseed or John Appleseed and become the change they want to see, to paraphrase a famous saying.

Technical GHG Assessment

So far, this presentation has mixed bits of technical assessment into more general analysis; but now it will focus directly on some technical GHG assessment of livestock products versus better alternatives. Doing so requires consideration of the GHG Protocol, the most widely-used methodology for GHG accounting (www.ghgprotocol.org). The GHG Protocol recommends counting GHGs as either Scope 1, Scope 2, or Scope 3 emissions. Scope 1 emissions are direct emissions from owned or controlled sources, while Scope 2 emissions are indirect emissions from purchased inputs, and Scope 3 emissions are indirect emissions other than those from purchased inputs, such as emissions attributable to disposal of food waste by consumers.

In food and agriculture, a first step is to pick which entities should be considered the key owners or controllers. It's commonly accepted that farmers are the key ones – rather than anyone else along the supply chain, such as processors, grocers, or consumers. Then, the key Scope 1 emissions are understood to be emissions from within a farm's boundaries – that is, emissions from plants and animals themselves, including emissions from their waste products.

If a farmer owns both livestock and the plants that feed them, then livestock feed – and all the emissions attributable to that feed, including emissions attributable to deforestation – will be counted under Scope 1; otherwise, it will be counted under Scope 2 or 3. In the realm of Scope 1 emissions, a key question is whether or not to count carbon dioxide in animal respiration or its reflection in carbon absorption forgone in land used for livestock and feed production. The FAO says no, while analysis by Jeff Anhang and me says yes.

When it comes to indirect emissions, they should be counted only when something can realistically be done to reduce them, according to guidance in a report by the World Resources Institute (Putt del Pino et al., 2006).

If we consider that there's no way to feed humans with a lower GHG footprint than by growing plants to feed humans directly, and we consider that farmers can't control emissions for transport, refrigeration, and packaging of foods once they leave the farmer's hands, then we can consider that the only emissions for transport, refrigeration, and packaging of foods that merit counting are any emissions over and above those required for plant-based foods. That's because farmers can control these emissions by choosing to produce higher-emission animal products or lower-emission alternatives.

Now, the GHG footprint of growing plants can be understood to depend principally on two factors: (1) the farmer's purchases of energy and fertilizer; and (2) whether the farmer's planting methods either (a) degrade soil and thereby cause soil carbon, or (b) improve soil and thereby yield net carbon absorption in the soil and the plants themselves.

Chemically-fertilized large-scale production of plants will generally degrade soil. In contrast, small-scale organic production will generally improve soil, so it can even yield more or less a zero-GHG operation for an organic farm producing alternatives to livestock products. The GHG footprint of a non-organic farm producing alternatives to livestock products is likely to have a measurable GHG footprint – but it is likely to be small, since after all, it includes no carbon dioxide from livestock respiration, and no methane attributable to livestock, while the farm's plants are likely responsible for net absorption of GHGs from the atmosphere.

Ultimately, not only will every farm have a GHG footprint that differs from every other farm, but each different planting of the same plant on each farm is likely to have a unique GHG footprint. However, given all of what's

explained above, it's possible to say that generally, the GHG footprint of alternatives to livestock products that are grown on appropriate lands (not recently deforested) is small, and barely merits counting. As an analogy, when renewable energy is promoted over fossil fuels, it's commonly accepted that the key GHGs to count are those relating to fossil fuels – as they're understood to drive catastrophic levels of atmospheric carbon – while renewable energy infrastructure is simply understood not to be such a driver.

Cultured Meat: There's a theoretical way to produce alternatives to traditional livestock products that's been in the news lately, variously called cultured meat or *in-vitro* meat or lab-grown meat. The base material consists of stem cells from livestock, and the growth medium is made with serum taken from the blood of calf fetuses. Still, some vegan activists had high hopes for this type of meat, especially if the fetal cow serum could be replaced with a vegan medium. However, that hadn't happened in time for a public test held last month, to see if the sample would taste like meat as required. In fact, the sample reportedly failed its taste test, and its proponents subsequently projected that commercializing a viable product would take at least 10-20 years, with no promise that the growth medium might ever become vegan.

Numerous analysts have questioned whether such meat can ever be commercialized (e.g., Timmer, 2011; McLeod, 2011). So last month's proof-of-concept test may turn out to be the high-water mark for cultured meat. While one article has asserted that cultured meat might eventually yield a 78 to 96 percent GHG reduction (Tuomisto and De Mattos, 2011), that seems optimistic. Cell culture in modern laboratories is incredibly energy-intensive, and therefore GHG-intensive, as it requires constant control of temperature and humidity, unlike outdoor livestock production. Also, it's said that cultured meat can gain the required consistency only with stretching machinery, essentially elaborate meat gyms (Agapakis, 2012). Again, that's energy-intensive, and therefore GHG-intensive.

Nevertheless, cultured meat has attracted a lot of media hype. But most media have overlooked the fact that there are plant-based meats that long ago passed the same taste test that the cultured meat sample failed. The proponents of cultured meat by their own account are proposing no reduction in GHGs attributable to livestock for the next 10-20 years. Yet as I've suggested, climate change is likely to cause increasingly more large-scale die-offs of livestock and crops that feed livestock, and possibly a forced 60% reduction in crop production. That would force a large-scale replacement of livestock production with more efficient food production, without the cost and uncertainty of commercializing lab-grown meat. Or people can voluntarily change their diet by buying great-tasting vegan products that have long been commercialized, and are available in abundance on grocers' shelves today.

Consumers commonly see processed vegan products as an important aid to transition from livestock products to better alternatives. Yet many nutritional experts would prescribe whole foods over those processed products, and it seems clear that whole foods are the most perfect foods. However, given the importance of large-scale replacement of livestock products by 2017 in order to avert catastrophic climate change, the best chance for such large-scale replacement to happen is likely to be fulfilled if the required dietary change is as imperceptible as possible. Once that critical transition is made, then health and environmental improvements could and should be pursued over time. For now, we should make sure that the perfect isn't the enemy of the good.

Back to Production: Now, let's move back from consumption to production. If privately-owned farms replace livestock and feed production with the production of better alternatives, they may need no subsidy or other incentives to do so, as they likely will profit more by switching production than by keeping on producing livestock or feed. On the other hand, they may need some sort of fiscal incentive to reforest any amount of their land.

Public lands, on the other hand, are often degraded by ranchers who do not pay the full cost of the adverse impacts caused by their ranching. So if governments would act to reduce or eliminate livestock grazing on any amount of public lands, then governments will lose the relatively small amount of ranching fees paid on that land – but that

loss would be more than offset by the elimination of adverse impacts on that land, and the huge value of carbon capture in forest and other vegetation that could be regenerated even passively, with little or no investment.

For example, eight researchers who studied the productivity of rangelands in the western United States concluded that climate change is causing additional stress to many western rangelands, and as a result land managers should consider a significant reduction, or in some places elimination of livestock and other large animals from public lands (Science Codex, 2012).

Tropical forest is commonly thought of as being the world's most important carbon sink, yet boreal forest may absorb just as much carbon dioxide per hectare as tropical forest, according to Hance (2009; cfs.nrcan.gc.ca/pages/391), and it's possible for forest to regenerate on most sites on which boreal forest formerly grew. Similarly, burning of African forest and woodland-savanna to expand and maintain livestock grazing is even more intense than in the Amazon, and it must be stopped (Russell, 2010). Even if forest isn't regenerated, some plants, such as *Brachiaria*, may capture more carbon than can tropical forest, according to Tarré (2001).

Raising Awareness

Now let's consider some different ways to raise awareness about the need to replace a substantial amount of livestock products with better alternatives. Note that I don't simply say we should consider aspects of replacing "meat" and "milk". That's because vegan food producers often market their products as "meat" and "milk" (e.g., www.fieldroast.com and silk.com). While that may offend some activists, it seems more important that it offends livestock producers, some of whom have filed lawsuits to prevent vegan food producers from using the term "milk" (Robbins, 2010).

In fact, dictionaries define "meat" and "milk" as essential foods that include vegan versions (www.merriam-webster.com/dictionary/meat and www.merriam-webster.com/dictionary/milk). The various names for better alternatives to livestock products include soy milk, nut butters, vegan cheeses, and grain-based meats, and they can fully serve as essential foods. So it may not be the soundest of strategies to cede the terms "milk" and "meat" to livestock producers, and to press people to sacrifice those items.

Perhaps the most popular campaign that presses people to sacrifice meat is the Meatless Mondays campaign. If Meatless Mondays were to be fully adopted by everyone in the world, it could yield a 13 percent replacement of livestock products with better alternatives, which would be significant.

On the other hand, there are a number of ways in which Meatless Mondays could be improved upon. First, the Meatless Mondays campaign should recognize that by touting "meatless" eating in its name, it overlooks the fact that, as mentioned, dictionaries define meat as an essential food that includes vegan versions. Second, the campaign needs somehow to draw attention to the impacts of dairy and egg products – as at present, Meatless Mondays can lead people to switch from something like a salad with chicken to a cheese omelet or quiche, which could actually worsen both public health and climate change.

Moreover, Meatless Mondays' prescription for 13 percent of livestock products to be replaced is far less than the amount of replacement that's actually needed to reverse climate change, which, as mentioned, is somewhere between 25 to 67 percent, depending on whose analysis is used. While the Meatless Mondays campaign publicizes a prescription from medical authorities who say that a 15% reduction in saturated fat is needed for good medical health, which the campaign says can be fully achieved by replacing livestock products one day per week, the campaign should similarly publicize how much livestock products need to be replaced for good climatic health.

Another issue for the Meatless Mondays campaign to consider is that if what's needed is framed as a meatless day, then people may perceive what's needed as a sacrifice – so the needed action may suffer the same fate as everything that promotes sacrifice; that is, people who will sacrifice meat one day may just crave it more the next day. Indeed, the Meatless Monday campaign anachronistically touts its basis in World War I rationing, after which meat consumption exploded (www.meatlessmonday.com/history).

Also, while the Meatless Mondays campaign presses people to consume something other than a livestock product one day per week, it seems that no consumer product is successfully sold by pressing people to use it just one day a week. For example, consumers might be wary of choosing Pepsi Cola at all if its marketing promoted it as a one-day-a-week drink, conceding that Coca Cola remains the drink of choice the rest of the week.

In fact, while Meatless Mondays has expanded around the world since 2003, the worldwide consumption of livestock products hasn't fallen, but rather has risen. This seems especially striking when considering the wave of economic downturns in one region after another since 2007 – as the consumption of livestock products meat-eating has historically dropped during economic downturns (The Afro-American, 1974).

The actual trend of global meat consumption is surely more important than the trend of organizations to adopt Meatless Mondays. Perhaps the organizers of Meatless Mondays could achieve more success by framing alternatives to livestock products as better products, rather than a sacrifice. If alternatives to livestock products might seem hard to promote, well, then consider for example that bicycles may be hard to promote to car-lovers, but bike advocates normally don't frame bike-riding as a sacrifice.

In any event, the Meatless Monday campaign promotes sacrificing meat to reduce health risks, energy and water usage, and carbon emissions. Yet goals for such reductions are common in the production and consumption of many consumer products, and they usually don't motivate action to replace any products. In contrast, emergencies normally motivate major action – and both the UN Intergovernmental Panel on Climate Change and the UN International Energy Agency have warned that major action by 2017 may be the last real chance to reverse climate change before it's too late (Christian Science Monitor, 2012 and International Energy Agency, 2011). That seems a more compelling motivation on which to dwell.

An alternative to the Meatless Mondays campaign is a campaign that has a similar but better name, namely Meat Free Mondays, operated by three members of a famous family, Mary, Stella, and Paul McCartney. By replacing the term “Meatless” with “Meat Free,” they’ve moved from using a term that connotes taking something away – to a term that raises the idea of being free, or obtaining something for free.

The McCartney family is well-known for marketing a line of vegetarian foods named after Sir Paul’s late wife Linda, and they recently published a vegetarian cookbook (Riggs, 2012). Stella McCartney runs a fashion company that is the largest of its type that uses no leather or fur. Paul McCartney has a well-known track record of promoting vegetarianism, veganism, and animal rights. The Meat Free Monday campaign organizes tabling at all of Paul McCartney’s concerts around the world, whereby tables are set up and staffed by local volunteers who distribute literature and engage with concert-goers to promote the cause of meat-free eating.

The type of tabling that Meat Free Mondays has conducted at Paul McCartney’s concerts could be expanded to sporting events and many other concerts. After all, nothing moves people like music, and people tend to open their minds to new possibilities by the very act of walking into a concert venue.

In an expanded version of event-tabling, bids could be solicited from big food companies to be sponsors or advertisers, and to provide new veggie food options to event-goers. The bid process could give explicit preference to any company that would work with the venue's food stands to offer new veggie options on an ongoing basis.

Event-goers could be induced to enter contests that could further raise awareness, with prizes that could include meeting the stars of the events, for whom incentives could be devised to ensure their active participation. Jeff Anhang and I don't have the capacity to do this ourselves; but we're trying to raise money for it. (There's a Donate button on our website).

In theory, the group that might be best organized to expand on Meat Free Mondays' tabling in the United States would be the Meatless Mondays campaign. But as I've explained, there are a number of improvements that the Meatless Mondays campaign should consider making – including changing its name, so that sacrificing meat is not the key focus.

Yet such changes might be too radical to implement in an established campaign such as Meatless Mondays. So it may well take a new group to implement an improved campaign that could compete with Meatless Mondays. As with the need for a modern-day Johnny Appleseed, if you know any young, ambitious people who want to change the world, perhaps you could suggest to them that they contact Jeff Anhang and me about starting a new campaign.

We have several ideas for the name of this new campaign. What we'd want it to frame as ideal wouldn't exactly be a vegan or vegetarian diet, as that will appear to most people as abrupt and radical as if McDonald's were to promote a "meatarian" diet. Instead, McDonald's prospers by marketing Happy Meals. So it may be better to frame as ideal something like "Happier Meals," which would promote climate-friendly and healthful foods as the better ones to choose every day of the week or year.

Advocates of climate-friendly and healthful foods may see McDonald's as an opponent; but sometimes the best way to beat one's opponent is to improve on a tactic that they've used to win. Other potential campaign names could include a couple of names that we incorporate on our website, namely Chomping Climate Change and Eating Greenfully.

We also want to use any funds that we raise to work on drawing out the scenario that I've mentioned remains to be drawn out regarding the implications of increasing large-scale die-offs of livestock, feed crops, and grasses that are grazed by livestock. While it's never easy to raise funds, we've become confident in the value of our analysis – particularly since we saw Chris Mentzel, the CEO of a solar power company, calculated that our analysis showed him how a replacement of just 1% of today's livestock products with better alternatives could yield the same climatic benefit as $3 trillion of his solar panels (Mentzel, 2010).

Another area in which we'd like to do more work is in the field of environmental health, and this might be of interest to public health specialists in the audience today. Environmental health is a somewhat obscure field, but it may well grow a lot as climate change unfolds, as the purpose of this field is to explore the effects of the natural and built environment on public health. There's a small amount of literature in this field that has so far focused on climate change and public health. Jeff Anhang and I welcome collaboration with public health experts to focus in particular on food, climate change, and public health.

More Pitfalls to Avoid: There are a couple of other approaches that I'd recommend avoiding. You may have heard a popular way to recommend more vegan foods is to cite a 2006 University of Chicago study, which found that switching to a vegan diet is more environmentally friendly than switching from a Hummer to a Prius (Eshel and Martin, 2006). Yet this comparison was devised when Hummers were popular, hybrid Priuses had just appeared, and some people thought hybrid cars were sure to become widely used, and a feasible solution to climate change. That hasn't happened, and it's now anachronistic to suggest that people are calculating whether they should replace a Hummer with a Prius. As I mentioned earlier, Prius owners may well now be thinking about replacing their Prius with a car-sharing service. Moreover, the 2006 University of Chicago study estimates that livestock are responsible

for only about 6 percent of human-induced GHGs, far less than even the FAO's 18 percent estimate, let alone our 51 percent estimate.

Another approach that I'd caution against using is to copy some activists' assertion that the UN recommends veganism. In fact, they're citing a report that wasn't published by the UN, but rather by UNEP, a UN agency. That UNEP report actually says that agricultural production "accounts for... 14% of the world's greenhouse gas emissions," which is less than the FAO's 18% figure (Hertwich et al., 2010). Moreover, the UNEP report doesn't specify dietary change all the way to veganism. That suggestion actually came from a newspaper that apparently thought it made sense to hype that UNEP report (The Guardian, 2010).

The lack of interest by many consumers in vegan foods sometimes provokes activists to add elements to their activism, so their activism will encompass as much reasoning as possible for people to choose vegan foods. Indeed, activists sometime promote 100 or more reasons for people to go vegan, framing what's needed as a sort of culture change.

Yet culture change is normally generational at best. It seems anachronistic to promote generational change in the age of climate change, when there's a strong case for people to change their food habits in only a few short years. The best way to make this case may be for activists to exclude from their messaging many dozens of reasons for people to go vegan, which may dilute the key message that tipping points for catastrophic climate change may be reached by 2017. After all, if people won't change their diet to help avoid the destruction of much of life on earth, then it's hard to think that they'll change their diet to save some water, or even to save the estimated 2,700 animals that each person will otherwise eat in their lifetime.

The best messaging on food and climate change may actually be quite simple, as it can simply involve framing livestock products as being obsolete in the age of climate change. After all, if we think of alternatives to livestock products as analogous to digital communications, then we can consider how tube TVs, for example, were completely replaced within 5 years by rather simply framing them as being obsolete in the age of digital technology.

Conclusions

I'll wrap up this presentation by reminding you of what Bill Gates said: "All these companies that are taking the animal products, the milk, the egg, the chicken, the beef and actually coming up with a way of using largely plant-based materials – soy, peas and a variety of things – to make these products that are both cheaper, probably more healthy, less cruelty involved, less greenhouse gas emissions… I think it's a huge thing."

Yes it's a huge thing, and it's huge that Bill Gates has promoted it. But I'll also remind you that it's not just about cheaper, healthier products involving less cruelty or less GHG emissions. Goals to produce such products have long been promoted, yet they've achieved little success. In contrast, emergencies normally motivate major action – and as mentioned, both the Intergovernmental Panel on Climate Change and the International Energy Agency have warned that major action by 2017 may be the last real chance to reverse climate change before it's too late. Indeed, there's surely no more compelling motivation for action than that replacing livestock products with better alternatives may be the only pragmatic way to stop catastrophic climate change from imperiling much of life on earth.

Acknowledgements

I want to acknowledge the inspiring partnership of my dear friend, co-author and colleague Jeff Anhang through the years.

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