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July 13, 2016

Dear Campus Community Book Project Committee,

In the 2012 edition of Stuffed and Starved: The Hidden Battle for the World Food System, the 2016 Campus Community Book Project selection, Raj Patel makes a number of sometimes misleading, and occasionally simply incorrect, statements regarding genetic engineering. As scientists we are concerned that many of his arguments reiterate the inflammatory rhetoric of anti-biotechnology groups and individuals which have been repeatedly discredited by the scientific community and the large volume of available scientific literature. He cherry picks the data presented and frequently ignores the weight of scientific evidence to present proven inaccuracies as scientific fact. This is not helpful in promoting a constructive discussion around this controversial breeding method nor about world food systems. We feel compelled to address the most egregious errors and support our comments with peer-reviewed scientific papers that were available prior to the 2012 publication data of the book.

We list the major concerns we have around biotechnology, our area of expertise. We hope that the Campus Community Book Project committee acknowledges these concerns and allows an open discourse about these issues during the discussion of this non-fiction book on campus.

p. 5 (Preface): ***"Even if a growing number of studies show little to no improvement of GM over conventional crops, the corporations behind the technology have friends in high places in government and civil society."***

Contrary to Patel's assertions, which he backs by citing a 2011 report from the Center for Food Safety, a 2010 report from the National Academies of Sciences Engineering and Medicine (NAS) found that "the majority of U.S. farmers who grow soybean, corn, or cotton have generally found GE varieties with herbicide-resistance and insect-resistance traits advantageous because of their superior efficacy in pest control; their concomitant economic, environmental, and presumed personal health advantages; or their convenience." A list of NAS reports on these topics, spanning from 1987 to 2010, can be found at: http://nas-sites.org/ge-crops/category/resources/. All would have been available at the time that this version of Stuffed and Starved was written, yet the author chose to only cite an established anti-GMO group that is known to misrepresent facts and contradict the consensus of the scientific community.

Also available at the time of writing was a comprehensive study of GM crop impact from 1996 to 2009 which concluded that, "GM technology has had a significant positive impact on farm income derived from a combination of enhanced productivity and efficiency gains. In 2009, the direct global farm income benefit from biotech crops was $10.8 billion. This is equivalent to having added 5.8% to the value of global production of the four main crops of soybeans, maize, canola and corn. Since 1996, farm incomes have increased by $64.7 billion.” (Brookes and Barfoot 2011, PG Economics Ltd, http://www.pgeconomics.co.uk/pdf/2011globalimpactstudy.pdf)

Numerous studies have similarly described the benefits of GM crops in terms of higher yields, cost savings in agricultural production, and welfare gains for adopting farm households. A few of these prior to 2012 include:

1. Pray CE, Huang J, Hu R, Rozelle S (2002) Five years of Bt cotton in China - the benefits continue. *The Plant Journal* 31: 423–430. doi: 10.1046/j.1365-313x.2002.01401.x View Article
2. Qaim, M, Zilberman D (2003) Yield Effects of Genetically Modified Crops in Developing Countries. *Science* 299(5608): 900-902. Doi: 10.1126/science.1080609 View Article
3. Morse S, Bennett R, Ismael Y (2004) Why Bt cotton pays for small-scale producers in South Africa. *Nature Biotechnology* 22: 379–380. doi: 10.1038/nbt0404-379b View Article
4. Qaim M, Traxler G (2005) Roundup Ready soybeans in Argentina: farm level and aggregate welfare effects. *Agricultural Economics* 32: 73–86. doi: 10.1111/j.0169-5150.2005.00006.x View Article

Similarly, the recently released 2016 NAS report “Genetically Engineered Crops: Experiences and Prospects” (https://nas-sites.org/ge-crops/) reiterated these findings, concluding that the available evidence indicates that GE soybean, cotton, and maize have generally had favorable economic outcomes for producers who have adopted these crops, but outcomes have been heterogeneous depending on pest abundance, farming practices, and agricultural infrastructure. Essentially what their analysis is saying is that GMOs have been a useful tool to increase profits for farmers and can be very beneficial to the environment, but they have to be used correctly and are not a panacea.

p.144 (Ch.6: Better Living Through Chemistry): ***“Like the software industry, the pesticide industry has gone to great lengths to prevent its property being stolen. Just as software has ‘copy protection’, the pesticide industry has developed ‘terminator technology’, a series of genetic modifications designed to make the seeds produced by one of its plants sterile. Like the software industry, the pesticide industry is also prepared to track down and sue people who don’t comply with it.”*** **(no references given)**

In the U.S., the Plant Patent Act was passed in 1930 and the Plant Variety Protection Act that included seed propagated crops was passed in 1970. The first GMOs came on the scene in 1996. Obviously, the protection of intellectual property as it pertains to the seed industry was in place long before modern biotechnology. Companies hold plant breeders’ rights and/or utility patents on organic and conventional varieties as well as GM varieties.

The protection of intellectual property in the plant breeding industry is found worldwide, and has been commonplace for decades. It is in no way specific only to GM crops. The International Union for the Protection of New Varieties of Plants (UPOV), an intergovernmental organization headquartered in Switzerland, was established by the International Convention for the Protection of New Varieties of Plants in Paris in 1961 (revised 1972, 1978, 1981). “UPOV’s mission is to provide and promote an effective system of plant variety protection, with the aim of encouraging the development of new varieties of plants, for the benefit of society.” (http://www.upov.int/portal/index.html.en)

It is true that the pejorative term “Terminator Technology (TT)” has been applied by anti-GMO organizations to methods that would restrict the viability of seeds to prevent their germination; it was originally patented in 1998 by the USDA and the Delta & Pine Land Company (US patent No. 5,723,765, "Control of Plant Gene Expression"). While it would enable enhanced intellectual property protection, it was also considered to be a method to prevent any unwanted spread of GM varieties. However, it is not, and never has been, used in any commercially-available GM crops. Delta & Pine Land Company was acquired by Monsanto several years later in 2007 but TT has never been used in any commercialized Monsanto products. On the other hand, many potentially beneficial uses of the underlying technology unrelated to intellectual property protection have been thwarted by the negative associations promoted by anti-GM groups.

Tangentially, the existence of TT is really a moot point, as modern day farmers do not regularly save seeds anyway since the most desirable seeds are hybrids and would not reliably produce the same desirable traits in the next generation (an excellent video explaining where farmers get their seeds – developed by **UC Davis graduate students and postdocs** – can be found at: https://www.youtube.com/watch?v=zI_lwy8KfHI).

Additional resources reporting on TT include:

1. Genetic use restriction technologies: a review, Luca Lombardo, *Plant Biotechnology Journal* (2014) 12: 995-1005 (http://onlinelibrary.wiley.com/doi/10.1111/pbi.12242/pdf).
2. Terminator technology temporarily terminated, Eric Niller, *Nature Biotechnology* 17:1054. 1999. - http://www.nature.com/nbt/journal/v17/n11/full/nbt1199_1054.html
3. In the Aftermath of the 'Terminator' Technology Controversy: Intellectual Property Protections For Genetically Engineered Seeds and the Right to Save and Replant Seed, Jeremy P. Oczek, *Boston College Law Review* 627-658. 1999. - http://heinonline.org/HOL/Page?handle=hein.journals/bclr41&div=24&g_sent=1&collection=journals#
4. *Epistemic brokerage in the bio-property narrative: contributions to explaining opposition to transgenic technologies in agriculture*, Ronald J. Herring, *New Biotechnology* 27(5): 614 – 622. 2010. - http://www.sciencedirect.com/science/article/pii/S1871678410004528

On the last point in Patel's argument, Monsanto has taken legal action against a proportionally small number of farmers who knowingly, illegally saved seeds, a practice which clearly violated the legal agreements that the farmer signed with the company when they purchased the seeds. The vast majority of these patent infringement cases are settled out of court and all proceeds go to rural communities through scholarships and programs such as FFA and 4-H. Despite the popular myths, Monsanto has never sued farmers for *inadvertently* growing patented crops (i.e., due to accidental pollen drift).

It is further evident in Patel's characterization of plant breeding companies as "pesticide" companies that he seeks to attach negative connotations to genetic engineering, despite the fact that it is a breeding method that can be used to produce crops that use no pesticides (e.g. virus-resistant papaya), and that one of the two major GM traits (insecticide resistance) has actually dramatically reduced pesticide use. Similarly, his comparison with software companies who seek to protect their intellectual property suggests that he also rejects the application of patents to those products of intellectual invention. Patents, and their vigorous protection, are standard practice in the computer industry for both hardware and software, yet this has not stymied dramatic advances in delivering enormously useful products to consumers (e.g., the internet and cell phones).

Additionally, in all but a few cases, all contemporary conventional plant varieties developed by private breeders are protected by patents, and most public varieties are protected as well. This is not unique to genetically engineered varieties. Intellectual property protection for living organisms is not a novel or recent phenomenon. According to "Intellectual Property and Plants" chapter available at https://www.princeton.edu/~ota/disk1/1989/8924/892407.PDF, "*Proprietary protection specifically for plant varieties has evolved in the United States over the last 60 years. Plants are the sole life form for which the U.S. Congress has expressly permitted intellectual property protection*".

p.144 (Ch.6: Better Living Through Chemistry): ***"One informant told me of discussions at the Monsanto Corporation to engineer traits into its plants such that their leaves would reflect light in a characteristic way and be visible from an appropriately positioned low Earth orbit satellite. This wasn't a trait that would benefit farmers. It would simply make it easier for the company to survey its property rights from space, and chase up farmers who hadn't paid."*** **(no references given)**

These statements are not backed by any evidence, are admittedly anecdotal, and reflect a lack of understanding of modern agricultural tools and methods.

In 2003, in the journal *Nature*, Jonathan Knight discussed an evolving EPA proposal that hoped to determine if subtle differences in the way leaves reflect the sun's rays could be used to distinguish transgenic from conventional maize, thereby allowing them to monitor GM crops from space. The author discusses the fact that satellite imagery in agriculture is nothing new. At the time it was already a well-established tool (http://www.cell.com/trends/plant-science/pdf/S1360-1385(98)01213-8.pdf) for quickly spotting stressed plants, thirsty crops, pest infestations and plant diseases over large areas. (http://www.nature.com/nature/journal/v425/n6954/full/425112a.html)

In 2005, scientists from the U.S. Environmental Protection Agency (EPA) filed a patent (US 7715013 B2) for "optical system for plant characterization" "to monitor targeted pest populations, disease, presence of transgenic and non-transgenic plants, or targeted pest population in a transgenic crop using remote imagery to discern differences in crops along with pest infestation in all crop varieties".

Pioneer (Du Pont) had a pilot program in 2013 on the "Use of Remote Sensing Imagery for Improving Crop Management Decision", but this program was not specifically aimed at GM crops.

Even if Monsanto were to engineer such a trait into its crops, the assertion that it would have no benefit to farmers shows ignorance of current and historical farming techniques in which farmers widely use such technology to gather information about their crops.

p.146 (Ch.6: Better Living Through Chemistry): re: Golden Rice/Vitamin A – ***"But children will have to eat an awful lot. Estimates of quite how much they'd have to eat range from the biotech industry's two bowls figure to independent assessments of nearer fifty bowls per day to get their daily allowance of vitamin A. And all this to 'save a million kids' as Time Magazine put it in 2000, the majority of whom live in countries that already have food surpluses."*** **(exact reference not given, but assume http://content.time.com/time/magazine/article/0,9171,997586,00.html).**

In a 2002 paper describing the introduction of the β-carotene biosynthesis pathway into rice, the authors state that, "Golden Rice is not expected to provide 100% of vitamin A in the diet but to add to present intakes to reach vitamin A sufficiency." (Beyer et al. 2002 The Journal of Nutrition: http://jn.nutrition.org/content/132/3/506S.long). In 2005, a paper describing 'Golden Rice 2', the next generation of the crop, reported an increase in total carotenoids of up to 23-fold compared to the original Golden Rice and a preferential accumulation of β-carotene (Paine et al. 2005: http://www.nature.com/nbt/journal/v23/n4/full/nbt1082.html). A 2009 paper in the American Journal of Clinical Nutrition reported on a clinical trial that determined "β-carotene derived from Golden Rice is effectively converted to vitamin A in humans" and estimated that 50% of an adult's vitamin A needs could be met by consuming about one cup of Golden Rice a day (Tang et al. 2009: http://ajcn.nutrition.org/content/89/6/1776.long).

These assertions have been upheld, with a recent paper reporting, "The latest version of golden rice produces enough beta-carotene in the endosperm of the rice plant to provide 50-60% of the daily recommended allowance of vitamin A from as little as 72g of golden rice grains, which is equivalent to one serving of rice. The daily rice consumption of a child who eats rice as a staple food is averaged about 300-400 g depending on the age of the child." (Moghissi et al. 2015 http://www.tandfonline.com/doi/full/10.3109/07388551.2014.993586). Patel's repetition of earlier criticisms of Golden Rice while ignoring the subsequent development of Golden Rice 2 and confirmation of its effectiveness as a source of vitamin A seems to reflect either willful ignorance or purposeful misrepresentation.

p.147 (Ch.6: Better Living Through Chemistry): ***"The experiment had a terrible human cost: 90 percent of farmers who had committed suicide in Andhra Pradesh and Vidharba had been growing genetically modified cotton."*** **(Shiva 2006, The Pseudo-science of Biotech Lobbyists: The Baseless Barfoot-Brookes Claim that Farmers and the Environment Have Benefited from GMO's. http://www.ourworldisnotforsale.org/en/article/pseudo-science-biotech-lobbyists-baseless-barfoot-brookes-claim-farmers-and-environment-have)**

This issue of Bt cotton causing Indian farmers to commit suicide is a notorious recurring motif for Vandana Shiva, the Indian-born environmentalist that Patel cites; she featured it in a 2009 op-ed in the *Huffington Post*. There are many problems with this accusation, not the least of which is that in the period between 2002 (when Bt cotton was first grown in India) and 2009, the adoption of Bt cotton *increased significantly* from 0.05 million hectares (Mha) to 7.6 Mha, or 80% of the 9.4 Mha national cotton crop, a 168-fold increase in eight years. In the same time period, the number of Bt cotton farmers in India *increased significantly* from 0.05 million to 5.6 million, indicating that farmers adopted, and continued to use, the technology at a rapid rate (Choudhary and Gaur, Bt Cotton in India: A Country Profile, ISAAA Series of Biotech Crop Profiles, 2010) . These numbers have also continued to increase since 2010 (ISAAA 2014 Biotech Cotton in India, 2002 to 2014).

In 2008 the International Food Policy Research Institute released a discussion paper (https://www.ifpri.org/publication/bt-cotton-and-farmer-suicides-india) reviewing the evidence for the role of Bt cotton in farmer suicides in India. They concluded:

"We first show that there is no evidence in available data of a "resurgence" of farmer suicides in India in the last five years. Second, we find that Bt cotton technology has been very effective overall in India. However, the context in which Bt cotton was introduced has generated disappointing results in some particular districts and seasons. Third, our analysis clearly shows that Bt cotton is neither a necessary nor a sufficient condition for the occurrence of farmer suicides. In contrast, many other factors have likely played a prominent role. Nevertheless, in specific regions and years, where Bt cotton may have indirectly contributed to farmer indebtedness, leading to suicides, its failure was mainly the result of the context or environment in which it was planted."

Another paper on the same topic was available in 2011 "Bt Cotton and Farmer Suicides in India: An Evidence-based Assessment" (The Journal of Development Studies Volume 47, Issue 2, 2011) in which the abstract reads "Available data show no evidence of a 'resurgence' of farmer suicides. Moreover, Bt cotton technology has been very effective overall in India. Nevertheless, in specific districts and years, Bt cotton may have indirectly contributed to farmer indebtedness, leading to suicides, but its failure was mainly the result of the context or environment in which it was planted."

A careful investigation by the journalist Keith Kloor in 2014 (Issues in Science and Technology, Winter 2014, pp. 65-70) demonstrated the falsity of claims that GM cotton was a significant factor in Indian farmer suicides. He further questioned the motivations of those who make and promote such claims: "Blaming farmer suicides on Bt cotton thus seems not only to be incorrect but also a distraction from the real causes of a tragic problem. One is left wondering what problem Vandana Shiva and other like-minded activists are actually interested in solving, since it does not seem to be the livelihoods of Indian farmers."

p.152 (Ch.6: Better Living Through Chemistry): regarding the assertion that Chapela was more of an activist than a scientist and refutes that "it is possible, as Einstein was, to be both" and p. 155: *"Chapela isn't the only scientist flayed by the biotechnology industry's PR firms: Tyrone Hayes and Arpad Pusztai are other names to note."* (Smith 2003 – Seeds of Deception)

The scientists mentioned here have all been repeatedly discredited by the scientific community. It is very easy to find documentation of retracted or withdrawn papers, improperly-conducted experiments, and irreproducible results.

Additionally, the source cited by Patel, Jeffrey Smith, is not a scientist, and has no scientific training or background (he is credited as a flying yogic instructor) and is widely criticized by the global scientific community. His anti-GMO tomes Seeds of Deception and Genetic Roulette are soundly contradicted by the vast amount of available data and scientific publications.

The 2001 Quist and Chapela *Nature* paper (Quist, D, Chapela, IH, 2001 Nature 414:541-543) reporting that GM corn had contaminated traditional Mexican landraces was subsequently withdrawn by the journal after a scathing editorial by a group of reputed scientists appeared in *Transgenic Research* (Christou, P 2002 Transgenic Research 11:iii-v) and other researchers demonstrated how Quist and Chapela's results were likely due to errors in their methods. In 2005, Ortiz-Garcia and colleagues showed that GM corn had not spread to native Mexican maize crops despite a thorough and widespread search, (Ortiz-Garcia, S, Ezcurra, E, Schoel, B, Acevedo, F, Soberon, J and Snow, AA, 2005 PNAS: Absence of detectable transgenes in local landraces of maize in Oaxaca, Mexico (2003-2004). PNAS Aug 30;102(35):12338-43. Epub 2005 Aug 10. Erratum in: Proc Natl Acad Sci U S A. 2005 Dec, http://www.ncbi.nlm.nih.gov/pubmed/16093316), effectively putting an end to the debate.

Tyrone Hayes is a researcher at UC Berkeley who is known for claiming a link between the herbicide atrazine and developmental problems in frogs. He claims that Syngenta is essentially out to get him as a result of his findings. Both his home institution and Syngenta have repeatedly publicly denied his allegations of conspiracy. The EPA has declared his work to be methodologically flawed and his results have not been replicated by other scientists. In fact, two identical studies conducted in separate labs in

Germany failed to establish the effects claimed by Hayes, showing no harmful effects on frogs over an even larger dose range than Hayes reported.

References refuting Hayes's claims include:

Office of Prevention, Pesticides and Toxic Substances Office of Pesticide Programs Environmental Fate and Effects Division Washington, D. C. 2003, White Paper on Potential Developmental Effects of Atrazine on Amphibians. https://archive.epa.gov/scipoly/sap/meetings/web/pdf/finaljune2002telconfreport.pdf

Anne F. Lindsay testimony before the Agriculture and Rural Development Committee of the Minnesota House of Representatives, 2005, http://academicsreview.org/wp-content/uploads/2014/03/anne-lindsay-testimony.pdf

US EPA, Decision Documents for atrazine, 2006, https://archive.epa.gov/pesticides/reregistration/web/pdf/atrazine_combined_docs.pdf

Hosmer, A., Kloas, W., Lutz, I., et al. 2007. Atrazine: response of larval Xenopus laevis to atrazine exposure: assessment of metamorphosis and gonadal morphology. Leibniz Institute of Freshwater Biology and Inland Fisheries (IGB), Wildlife International, Ltd., and Experimental Pathology Laboratories, Inc. Unpublished. (MRID 47153501)

Renner, R., 2008. "Atrazine Effects in *Xenopus* Aren't Reproducible (Perspective)". *Environmental Science & Technology* **42** (10): 3491–3493. View Article

Kloas, W; Lutz, I; Springer, T; Krueger, H; Wolf, J; Holden, L; Hosmer, A, 2009. "Does atrazine influence larval development and sexual differentiation in Xenopus laevis?". *Toxicological sciences: an official journal of the Society of Toxicology* **107** (2): 376–84. View Article

Australian Pesticides and Veterinary Medicines Authority, 2010, "Chemicals in the News: Atrazine", http://archive.apvma.gov.au/news_media/chemicals/atrazine.php

US EPA, 2010, letter to representative Dave Winters (IL), http://academicsreview.org/wp-content/uploads/2014/03/usepa-response-to-rep-winters-may-2010.pdf

In 1998, Arpad Pusztai famously stated on a British TV show that rats that consumed GM potatoes during experiments he was conducting at the Rowett Institute had stunted growth and suppressed immune systems. He made this announcement prior to the completion of the experiment and before any peer review was done. An audit of his data by his institution found that it did not support his conclusions. A review of the data by six anonymous reviewers of the British Royal Society found that the experiments were poorly designed, with inadequate composition of the diets, too few numbers of animals and improper statistical methods. For both Hayes and Pusztai, criticism by scientists of their results was supported by a strong factual basis, not by a desire to "flay" anyone through public relations.

Relevant citations about "the Pusztai affair" that were available in 2012 include:

Murray, Noreen et al., 1999. Review of data on possible toxicity of GM potatoes The Royal Society, View Article

Kuiper, H. A.; Noteborn, H. P. M.; Peijnenburg, A. A. M, 1999. "Adequacy of methods for testing the safety of genetically modified foods". *Lancet* **354** (9187): 1315–1316. View Article

Enserink, M., 1999. "The Lancet Scolded Over Pusztai Paper". *Science* **286** (5440): 656a–656. View Article

p.163 (Ch.6: Better Living Through Chemistry): *"Monsanto sells its crops worldwide, to large-scale farmers."*

In 2011, biotech crops were planted on a total of 160 million hectares across 29 countries worldwide. Of these countries, 19 were developing and 10 were industrial countries. In 2011 the growth rate for biotech crops was twice as fast and twice as large in developing countries, at 11% (8.2 million hectares), versus 5% (3.8 million hectares) in industrial countries. A total of 16.7 million farmers grew biotech crops in 2011. Of those, 15 million, or 90%, were small-scale, resource-poor farmers from developing countries (ISAAA Brief 43-2011: http://www.isaaa.org/resources/publications/briefs/43/executivesummary/default.asp).

p.164 (Ch.6: Better Living Through Chemistry): *"Now, that said, it could be that GM seed is actually better if you want to grow cotton on dryland. The jury is still out on that: initial yield increases seem to have declined, and adoption rates can be explained for a range of reasons other than crop performance. Less money is spent on pesticides by people who buy GM seed, partly because the seed is much more expensive, and partly because farmers who buy the more expensive GM seed ignore Monsanto's instructions and choose not to spray at all. Given the history of the crop elsewhere in the world, though, it seems unlikely that GM cotton will prove a substantial improvement on its predecessor for small farmers."*

Patel's prediction that GM cotton would not be a substantial improvement was already wrong in 2012 when this book was published, and there was plenty of data to show this at that time. Since its official adoption in India in 2002, GM cotton has been rapidly embraced in India and has been a breakthrough in reviving the previously ailing cotton sector. In 2014, India became the number one cotton producing country in the world, surpassing the U.S. and China. From 2002 to 2014, India registered a significant increase in cotton area from 7.7 Mha to 12.25 Mha – the highest ever cotton area in the country's history. Also during that time, the number of small and resource poor cotton farmers increased significantly from 5 million to more than 8 million, 7.7. million, or 95%, of which were Bt cotton farmers. "Coincidental with the steep increase in adoption of Bt cotton between 2002 and 2014, the average yield of cotton in India, which used to have one of the lowest yields in the world, increased from 308 Kg/ha in 2001-02 to 567 Kg/ha in 2007-08 (data would have been available to Patel in a 2010 report: Choudhary and Gaur, Bt Cotton in India: A Country Profile, ISAAA Series of Biotech Crop Profiles) and continue to hover close to 500 Kg/ha in 2011-12 before reaching the highest national cotton yield of 570 Kg/ha in 2013-14." (Choudhary, B and Gaur, K 2015, Bt Cotton in India, 2002-14, http://www.isaaa.org/resources/publications/biotech_crop_profiles/bt_cotton_in_india-a_country_profile/download/Bt_Cotton_in_India-2002-2014.pdf)

A 2006 study released by the Indian Council of Agricultural Research (ICAR) reported a net 33.7% increase in yield of Bt cotton hybrids over non-Bt hybrids and a 73.3% increase over open-pollinated cotton varieties. These results from 1,200 plots in 11 cotton-growing states showed significantly higher yields for Bt over non-Bt cotton hybrids and open-pollinated cotton varieties (ICAR, 2006, "Front Line Demonstrations on Cotton 2005-06", Division of Agricultural Extension).

A 2012 report in PNAS found an average increase in profit of $107-$213/acre across the time period 2002-08 (Kathage, J and M Qaim 2012 PNAS: http://www.pnas.org/content/109/29/11652). Also in 2012, the

Indian Society for Cotton Improvement (ISCI) revealed the results of the largest and most comprehensive survey of Bt cotton farmers in India and found that more than 50% of adopters of Bt cotton were small holder cotton farmers. They concluded, "the survey confirmed that Bt cotton is a scale neutral technology that offers similar level of protection to dreaded bollworm irrespective of who cultivates Bt cotton."

p.304 (Ch.10 Conclusion): ***"The livestock industry produces 18 percent of all CO2-equivalent emissions on the planet and contributes more to climate change than driving cars." (Steinfeld et al 2006, Livestock's Long Shadow)***

This statistic has been challenged by a **UC Davis professor and air quality expert**, Dr. Frank Mitloehner, in "Clearing the Air: Livestock's Contribution to Climate Change" in *Advances in Agronomy* in 2009 (http://dels.nas.edu/resources/static-assets/banr/AnimalProductionMaterials/PiteskyClearingAir.pdf), who argues that livestock production in most countries of the developed world has a relatively small GHG contribution, much less than transportation, energy, and other sectors. However, livestock production in the developing world can represent a larger greenhouse gas contribution due to smaller transportation and energy sectors.

In the U.S. alone, this statistic does not hold true. A 2009 EPA report cites 2.8% of GHG emissions associated with livestock and 26% from the transportation sector (EPA. Hockstad, L., and Weitz, M. (2009). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2007. Environmental Protection Agency, Washington DC; 430-R-09-004).

It is also important to note that production efficiencies have resulted in fewer animals producing more animal products. For example, today there are 9 million fewer dairy cows in the U.S. than existed during WWII and they produce 60% more milk. This means that the carbon footprint of a glass of milk is 2/3 smaller today than it was 70 years ago. (Capper, J.L. 2011. The environmental impact of dairy production in the United States: 1944 compared with 2007. J Anim Sci 87(6):2160-2167. https://dl.sciencesocieties.org/publications/jas/abstracts/87/6/0872160)

p.311 (Ch. 10 Conclusion) "Eat agroecologically. In the Global North, the virtues of organic food are increasingly recognized." (no references) and p.312 agroecological farming – developed in Cuba, promises to be able to feed the planet (Halweil 2006)

A number of publications have actually reported a *lack* of evidence to indicate that organic food is superior to conventional or GM foods. Most agree that in order to feed the planet we will need to use a combination of tools, including organic, conventional and GM. Here is a small sampling of the available literature that would have been available to the author prior to 2012:

Woese K, Lange D, Boess C, Bogl KW. 1997. A comparison of organically and conventionally grown foods—results of a review of the relevant literature. *J Sci Food Agric* **74**:281–93. View Article

Worthington V. 2001. Nutritional quality of organic versus conventional fruits, vegetables, and grains. *J Altern Complement Med***7**:161–73. View Article

Bourn D, Prescott J. 2002. A comparison of the nutritional value, sensory qualities, and food safety of organically and conventionally produced foods. *Crit Rev Food Sci Nutr* **42**(1):1–34. View Article

Fillion, L, Arazi, S, 2002. Does organic food taste better? A claim substantiation approach, Nutrition & Food Science, Vol. 32(4): 153 – 157. View Article

Kouba, M, 2003. Quality of organic animal products. Livestock Production Science 80(1-2): 33-40. View Article

Magkos F, Arvaniti F, Zampelas A. 2003. Organic food: nutritious food or food for thought? A review of the evidence. *Int J Food Sci Nutr***54**(5):357–71. View Article

Honkanen, P, Verplanken, B, Olsen, SO, 2006. Ethical values and motives driving organic food choice. Journal of Consumer Behaviour 5(5): 420-430. View Article

Magkos, F, Arvaniti, F, Zampelas, A, 2007. Organic Food: Buying More Safety of Just Peace of Mind? A Critical Review of the Literature. Critical Reviews in Food Science and Nutrition 46(1):23-56. View Article

Kristensen M, Ostengaard L, Halekoh U, Jorgensen H, Lauridsen C, Brandt K, Bugel S. 2008. Effect of plant cultivation methods on content of major and trace elements in foodstuffs and retention in rats. *J Sci Food Agric* **88**(2):2161–72. View Article

Dangour AD, Dodhia SK, Hayter A, Allen E, Lock K, Uauy R. 2009. Nutritional quality of organic foods: a systematic review. Am J Clin Nutr 90:680–5.

Rosen, JD, 2010. A Review of the Nutrition Claims Made By Proponents of Organic Food. Comprehensive Reviews in Food Science and Food Safety 9(3): 270-277. View Article

Even more studies published since 2012 further reinforce that organic or agroecological farming methods have not been able to establish their superiority with respect to either nutrition or sustainability. A large meta-analysis of global studies by researchers at Stanford University (Ann Intern Med. 2012, 157:348-366) found no evidence for nutritional superiority of organic foods relative to conventional foods. Similarly, comparison of conventional and organic crop yields indicate significantly lower yields for organic systems for most crops (Seufert, V., Ramankutty, N. and Foley, A.J. (2012) Comparing the yields of organic and conventional agriculture. Nature 485, 229-232). Similar results were found in a recent study by the Berkeley Food Institute, of which Patel is a faculty member, also confirming that organic crops yield on average 19% less than conventional crops (Ponisio, et al. 2015. Diversification practices reduce organic to conventional yield gap. Proceedings of the Royal Society B: Biological Sciences 282, 20141396). This yield gap is critical, as other studies have shown that a key factor in reducing further increases in CO_2 in the atmosphere is to stop the expansion of farming into currently unfarmed areas (Burney et al. 2010. Greenhouse gas mitigation by agricultural intensification. PNAS 107: 12052-12057). Advocates of the sustainability of organic farming methods have failed to explain how they will meet the growing global demand for food with one-fifth lower productivity and without expanding the area devoted to crop production.

The organization Food First documented the significant challenges to adopting Cuba's agricultural model (M.L. Chan and E.F. Freyre Roach. 2012. Unfinished Puzzle. Cuban Agriculture: The Challenges, Lessons and Opportunities. Food First Books, Oakland, CA). The study notes: "In the last ten years, agricultural production has improved, but remains unstable and insufficient." "Because domestic production has been insufficient to guarantee the island's food security, it has had to import food and suffer all that this entails." "Cuba… depends on imports to feed its 11.23 million people." "Over the period of 1998 to 2009 [when agroecological systems were being implemented], the percentage of food imported by Cuba increased by 112%. By 2009, half of the food consumed in Cuba was imported." These facts clearly do not support Patel's claim that such systems promise to be able to feed the planet.

We look forward to your response.

Sincerely,

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