Flaws in the Feedlot Diet Study: Scientific Commentary on 'Nutritional and greenhouse gas impacts of removing animals from US agriculture'

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Executive summary

In "Nutritional and greenhouse gas impacts of removing animals from US agriculture," White & Hall imagine a future without animal agriculture but make the odd and unrealistic assumption that without livestock, Americans would continue to produce animal feed and incorporate it into human diets (White & Hall, 2017). Feed crops take up roughly 75% of US cropland (USDA NASS, 2018), and commodity corn, the primary crop grown for feed, is both unpalatable for humans without processing and notoriously demanding of nutrients (Stewart et al., 2005). Without livestock, the 240 million acres currently used for feed production would likely be used to grow a much wider variety of much healthier and more palatable crops for human consumption, as well as biofuel crops and food for export, all while setting aside critical habitat for endangered species. These shifts would be beneficial, because they would not require the high fertilizer loads and other farming practices used to maximize corn yields, which are the primary drivers of biodiversity loss in American streams and recurring dead zones in the Gulf of Mexico and elsewhere (NOAA, 2000). Many studies have shown that such shifts from animal agriculture to plant-based systems have concomitant benefits to total food production, health, and environment (Behrens et al., 2017; Peters et al., 2016). In fact these were precisely the findings of the US Dietary Guidelines Committee, which in 2015 concluded on the basis of a broad scientific review that a transition to healthy, animal-free diets could reduce the adverse environmental impacts of agriculture (USDA, 2015).

The Good Food Institute is a 501(c)(3) nonprofit organization dedicated to creating a healthy, humane, and sustainable food supply. GFI's team of scientists, entrepreneurs, lawyers, and lobbyists are laser focused on using markets and food innovation to transform our food system away from industrial animal agriculture and toward plant-based and clean meat alternatives.

Introduction

Providing food for a growing population without further degrading the environment is a crucial global challenge. Already, agricultural practices and the extent of land use for cropland and livestock grazing are pushing Earth's systems to their limits (Rockstrom et al., 2009). Many scientists have sought to address the environmental problems associated with agriculture, studying the potential for more productive or ecologically sound farming systems and the relationship between diet and land use. In their November 2017 paper, White & Hall apply a highly simplified model of the connections between food production and diet. You can take the title of their paper literally – they model what would happen if you took animals out of our agricultural system without changing any of the other factors that would necessarily shift, such as which crops farmers choose to plant. White & Hall's overly simplistic assumption that Americans will eat crops we currently use for animal feed (commodity corn and soybeans) instead of switching to crops that are more appealing and nutritious (wheat, sweet corn, beans, vegetables, etc.) leads to dubious environmental and nutrition conclusions.

In addition to this fatal flaw, the paper is not carefully written - the authors misreport information from their sources in several places and interpret results selectively, as addressed in detail below. Their use of irrelevant economic information in the abstract,[1] unrelated to the design of their study or any of their findings, shows evidence of bias in favor of the livestock industry.

Modeling flaws

By modeling a system where animals are removed but all other factors stay constant, the authors erroneously assume that removing the primary market for feed crops will have no effect on what farmers choose to plant. This is the key flaw of the paper. Unlike the sweet corn available at the supermarket, commodity corn and other feed crops must be processed to be palatable to human consumers. Eliminating the major market for these crops (livestock) would disincentivize farmers from planting them and would drive a transition to a wider, healthier, and more environmentally friendly variety of grains, legumes, vegetables, and fruits. To defend their lack of consideration of changes in crop production in the absence of animals, White & Hall make the unsupported claim that climatic rather than economic factors restrict vegetable production in the US. This assumption is contrary to the experience of farmers, scientists, and agencies nationwide. Farmers are market-driven business people whose planting decisions are influenced by access to markets and to government risk-reduction programs, such as crop insurance. Vegetables and other so-called specialty crops grow well throughout the Midwest and would be planted more widely if crop insurance policies did not restrict their planting (Balagtas et al., 2013; USDA, 2018); and of course, if commodity crops were no longer being fed to farm animals, there would be no incentive for such narrowly focused economic policy. By assuming that supply will lead to consumption even where there is no demand, White & Hall ignore the basic economic principle that if consumers don't want something, no one will produce it.

Environmental Impacts

A) Changing crop production would allow the US to feed more people, reduce emissions, and ameliorate many other environmental harms.

Removing animals from US agriculture would make far more food available for human consumption. White & Hall admit this,[2] but because they neglect to account for changes in crop production that will result from such a shift, their assessment does not realize many of the potential benefits that increased

[1] "The US livestock industry employs 1.6×10^6 people and accounts for $31.8 billion in exports."

[2] Even in their unlikely scenario of humans eating vast quantities of feed crops, White & Hall found that without animals, the US would be able to export enough protein to feed an additional 74 million people each year and enough calories to feed 158 million people each year.

productivity could bring. A recent study found that an agricultural system that reduced meat production and increased fresh fruits and vegetables, consistent with U.S. dietary recommendations, would reduce greenhouse gas emissions, fertilizer pollution, and land use by 25%, 21%, and 18% respectively, even without eliminating emissions-intensive animal agriculture (Behrens et al., 2017). Moreover, domestically producing crops tailored to healthy plant-based diets could allow US agriculture to feed 735 to 807 million people using only 22% to 25% of the land used today (Peters et al., 2016). Under this latter scenario, the US could export food for over 400 million people each year, reducing the harmful environmental impacts of greenhouse gases and nutrient pollution from agriculture around the world. White & Hall do not account for these potential benefits from land sparing or offsets to environmental impacts from increased food exports in their analysis.

Another example of an obvious environmental impact neglected by White & Hall is the pollution associated with feed crop production. Commodity corn, the primary crop grown for feed, is notoriously demanding of water and nutrients. High fertilizer loads used to maximize corn yields, including overapplication of manure from confined animal feeding operations (CAFOs), are a primary driver of biodiversity loss in American streams and recurring dead zones in the Gulf of Mexico and elsewhere (Long et al., 2018; Meehan et al., 2011; Rabalais et al., 2002). These dead zones are estimated to cost coastal US fisheries tens of millions of dollars annually, in addition to impacts on local streams, rivers, and the broader damages to tourism and regional ecosystems (Rabotyagov et al., 2014). Reducing fertilizer pollution from feed crops could have massive long-term benefits for freshwater and coastal ecosystems.

B) Removing animals from agriculture opens up land for other environmentally beneficial uses.

Commodity corn and soybeans for animal feed occupy over 50% US farmland and up to 80% of cropland in the Midwestern corn belt.[3] Expanding conservation measures on even a small fraction of this land could dramatically reduce domestic greenhouse gas emissions and could improve cropland quality by reducing the loss of soil carbon (Lal, 2004).[4] For example, converting just 10% of US cropland used for feed corn to switchgrass for production of second-generation biofuels could reduce US agricultural greenhouse gas emissions by 6% to 12% by building soil organic matter and reducing petroleum use.[5] Already, forestry in the US sequesters nearly 700 million metric tons of CO_2 per year, offsetting more than 10% of all agricultural emissions (USEPA, 2017). Less drastic changes in farm management practices may also reduce emissions. In an animal-free scenario, White & Hall assume that crop residues and processing waste would be burned, but organic wastes are much more likely to be composted or otherwise utilized as a soil amendment. Composting residues would build up soil organic matter, improving crop yields long term and serving as a large carbon sink. Conversion of more cropland to organic agriculture or other ecologically sound farming practices could further improve soil carbon and reduce pollution (Pimentel et al., 2005; Tuomisto et al., 2012).

White & Hall also do not account for changes to range and pasture lands. Without cattle, these 400 million acres could be used for second-generation biofuel crops, renewable electricity, conservation, or developed for uses that would achieve other environmental and economic goals. There are several categories of pasture and rangeland, some of which may also be usable cropland (Nickerson et al., 2011). Restoring native prairie would boost biodiversity and soil carbon sequestration. Producing second-generation biofuels from native North American grasses like switchgrass and prairie cordgrass would offset petroleum use, improving energy security and reducing system-wide greenhouse gas emissions (Dale et al., 2010). White & Hall consider none of these fairly obvious and likely outcomes,

[3] Nebraska, Minnesota, Iowa, Illinois, and Indiana, each of which contributes more than 5% of total US corn production.

[4] The Conservation Reserve Program (CRP) and other land-sparing programs compensate farmers for taking erosion-prone farmland, stream buffers, or critical wildlife habitat out of production, but cannot compete with heavily subsidized commodity feed crops (USDA, 2017; Secchi et al., 2009).

[5] Calculated based on USDA cropland data, agricultural emissions data from White & Hall, soil carbon data from Liebig et al., 2008, and life-cycle analysis of switchgrass ethanol from Wang et al., 2012.

choosing instead to imagine a world in which nothing at all happens with hundreds of millions of acres of land that are freed up by a shift away from farm animal production and consumption.

Nutrition

As noted, White & Hall assume that Americans will consume feed corn rather than more nutritious and palatable alternatives. Even so, they find that the plants-only agriculture system would yield more food, including more protein and fiber, than is currently produced in the United States.[6] This finding is consistent with other studies (Behrens et al., 2017; Peters et al., 2016). However, the authors conclude that the food produced by the plants-only system would meet "fewer of the US population's requirements for essential nutrients" (p. 1), in direct contradiction to the overwhelming consensus of nutritionists, doctors, and scientific evidence, which the 2015 Dietary Guidelines Advisory Committee summarized in its finding that "plant-based diets would promote health" (USDA, 2015).

White & Hall ignore the overwhelming weight of the evidence and science on plant-based diets, use the wrong metrics to project population-level nutrition needs, and cherry-pick the nutrients they model to ignore several nutrients of public health concern while focusing instead on relatively unimportant nutrients.

A) White & Hall ignore the overwhelming evidence that plant-based diets promote health, and overestimate nutrition requirements.

What makes White & Hall's nutritional conclusion so surprising is that it is inconsistent with the scientific consensus that a shift toward plant-based diets would improve health. That finding is supported by many studies, including a 2016 study also published in PNAS, the Academy of Nutrition and Dietetics' position paper on plant-based diets, and, as the authors themselves state, the findings of the 2015 Dietary Guidelines Advisory Committee (DGAC) (Melina et al., 2016; Springmann et al., 2016; USDA, 2015). Importantly, the Academy's work represents a complete scientific review, as does the recommendation of the DGAC. Not only does the Academy conclude that plant-based diets are appropriate for all stages of life, but also that plant-based diets reduce risk of certain health conditions, including "ischemic heart disease, type 2 diabetes, hypertension, certain types of cancer, and obesity" (Melina et al., 2016). Notably, heart disease and cancer are the top two causes of death in the United States, and obesity and diabetes are at epidemic levels.

Calcium and vitamin A are the only nutrients of public health concern that the authors project to be low under the plants-only system that are not already low in the present system. However, plant-based foods rich in both calcium and vitamin A are commonly consumed by vegetarians and vegans. Fortified orange juice and soy milk are both rich in calcium,[7] and red and orange vegetables, whole grains, and fortified soy milk are rich in vitamin A (USDHS and USDA, 2015). Moreover, vitamin A deficiency is rare in the United States, so focus on this deficiency while ignoring epidemics like obesity and diabetes is unjustifiable.

Additionally, it is impossible to know from White & Hall's study whether a plant-based agricultural system would provide sufficient quantities of calcium and vitamin A, because White & Hall do not model a plant-based agricultural system—but rather an animal-based agricultural system where humans are assumed to eat the feed crops we currently grow for livestock. Nonetheless, even in the odd world that finds humans consuming unpalatable feed crops, White & Hall's approach is still wrong. They project that the plants-only system would be deficient in these nutrients by modeling the amount

[6] On p. 3, White & Hall state that "Removal of farmed animals from the US agricultural system resulted in a 23% increase in total amount of food available exclusive of current exports (Fig. 3). Grain comprised the majority of the increase, of which corn grain accounted for 77%...." Figure 2 shows that the plants-only system would produce more than twice the protein as the present system does, including sufficient quantities of all amino acids White & Hall evaluated, and more than three times the fiber.

[7] The Dietary Guidelines for Americans list these as two of the top four "Food Sources Ranked by Amounts of Calcium." They are also the lowest in calories among the top ten sources.

of these nutrients that the plants-only system would yield and then comparing it to the Recommended Dietary Allowances (RDA) for the U.S. population by age and sex (table S11). The problem with this approach is that the RDAs are inappropriate for this kind of model.[8] In fact, the authoritative body that sets RDAs—the Institute of Medicine—explicitly warns, "do not use [RDAs] to assess intakes of groups" (IOM, 2000). Using RDAs to estimate the needs of a group is inappropriate because they are intended to be used as goals for individual intake and thus overestimate population-level dietary requirements. The "best measure of population adequacy of nutrient intake," according to both the IOM and the very document White & Hall cite for the required levels, is the Estimated Average Requirement (EAR), which is the level required to meet the median requirement for healthy individuals (because some people need more and some need less) (USDA, 2015).

The difference between the EARs and RDAs for calcium are 200 mg, with the EARs approximately 15-25% lower (depending on age and sex), with a similar difference for vitamin A.[9] In Figure 2, White & Hall show their plants-only system as supplying most of the population level requirements for both calcium and vitamin A. Correcting their analysis by applying the EAR for calcium results in the plants-based system producing 3.72×10^8 human requirement years (HRYs)–more than enough to supply the US population. Applying the EAR for vitamin A reduces the deficiency of the plant-based system by a factor of 4, from 36% to 9% (a 9% deficiency could be eliminated by the average American consuming one small slice of sweet potato a day).[10] Using the correct dietary requirements could also have a much larger effect on the least-cost model White & Hall use as the basis of their conclusions about animal-containing and plant-based diets (such as in Figure 4). Because that model drops any requirement for nutrients that cannot be met at 100% of the RDAs,[11] using the EARs could result in more nutrient-rich foods being selected, and more nutritional requirements being met, across all diets.

B) White & Hall ignore nutrients of public health concern to focus on relatively unimportant nutrients.

White & Hall conclude that the plant-based system they model would underproduce six nutrients, compared to four in the present system, leading them to warn that the removal of animals from agriculture would result in "diets that are nonviable in the long or short term to support the nutritional needs of the US population without nutrient supplementation" (p. 6). They do not explain why these six nutrients are more important than the four nutrients deficient in the current system nor do they lament the deficiencies in the present system.

Not all nutrients are of equal importance, of course. Excessive intake of saturated fat has a significant impact on disease patterns, and ample evidence exists to draw a correlation between plant-based diets and reduced consumption of saturated fat (Melina et al., 2016). Similarly, excessive sodium intake is associated with cardiovascular disease, the number-one killer in the United States, and it is possible that plant-based diets could be lower in sodium than diets emphasizing animal products (CDC, 2017; Melina et al., 2016). However, rather than model whether the plants-only system would reduce production of the excess nutrients that drive disease patterns in America, White & Hall decided to ignore saturated fat and sodium altogether.

On the other hand, one of the nutrients low under the plant-based agriculture projection is a fatty acid called arachidonic acid, which is needed only by infants under 6 months, who get it from breastmilk

[8] *See* Table S11, citing USDA/HHS ref. 26, which is the 2010 Dietary Guidelines for Americans. The calcium and vitamin A requirements that Table S11 reproduces are from Appendix 5 (p. 76) of the Dietary Guidelines, which states that they are taken from the RDA.

[9] Compare White & Hall Table S11 to the EARs (IOM, 2011). For vitamin A, the difference is 90-275 mcg, approximately 40% less.

[10] Corrected assessments for calcium and vitamin A were calculated based on the age and sex distribution of the American population (White & Hall table S12), the EARs for calcium and vitamin A (IOM, 2011), the retinol activity equivalent (RAE) content of common foods (NIH, 2016), and the total U.S. population.

[11] In the model description on page 7, White & Hall state that "When a nutrient requirement could not be met, that specific nutrient was removed as a constraint and the diet was rerun."

(where it is plentiful) and fortified infant formulas, not the food supply (FAO and WHO, 2008; see also White & Hall table S10). Others have no reference level in United States due to a lack of data, such as DHA and EPA fatty acids. In fact, because our understanding of the body's need for DHA and EPA is not based on a sufficiently authoritative statement, the FDA prohibits label claims that certain foods are "high in" or an "excellent source" of those fatty acids (FDA, 2014).

C) White & Hall's conclusions are based on the presumption that production systems determine what people eat—which they concede is erroneous.

White & Hall's nutritional analysis is also flawed because they rely on production as a proxy for consumption. Based on agricultural production data, they draw the widely reported conclusion that removing animals from agriculture would "create a food supply incapable of supporting the US population's nutritional requirements" (abstract). Yet just two pages later they concede that "total domestic nutrient supply does not adequately describe the impact of changes in an agricultural system on the adequacy of diets for meeting a population's nutrient requirements" (p. 3), undermining the credibility of their nutritional analysis.

To be clear, food production cannot be used as proxy for consumption patterns.[12] White & Hall's model of the current food supply demonstrates how weak the correlation between production and consumption really is. While figure 2 shows that fiber and potassium are abundant in the current food supply, the reality is that both of these nutrients are under-consumed to such an extent that they are considered nutrients of public health concern (USDHS and USDA, 2015); in fact, the average American consumes just 15 g of fiber a day, which is 60% of the recommendation for women and well under half the recommendation for men, and 97% of Americans take in less fiber than recommended (Moshfegh et al., 2005). Unsurprisingly, people who consume primarily plants generally meet the recommended daily intake for fiber (Rizzo et al., 2013). Had White & Hall based their analysis on actual consumption data, they would have had to report that current consumption patterns do not adequately meet the population's nutrient requirements and that shifting diets to include more plant-based foods, such as vegetables, fruits, and whole grains, would improve the population's nutrition.[13]

Of course, one cannot eat that which is not grown, and indeed, the American food supply has historically produced inadequate quantities of vegetables and fruit and excessive quantities of saturated fat, sodium, and calories from solid fats (such as beef fat and butter). In 2010, researchers warned that supplies of dark-green and orange vegetables, legumes, and whole grains were "entirely insufficient" to meet the population's nutrition requirements (Krebs-Smith et al., 2010). A shift to plant-based agriculture would provide an opportunity to address these shortcomings, rather than continuing to grow feed crops for livestock.

Conclusion

White & Hall make unrealistic assumptions about American dietary choices and land use. By keeping crop production static, they neglect market pressures that would transform farmland in the US in the absence of animals. As many other studies have shown, American cropland can provide vastly more food, renewable energy, and environmental benefits when farmers produce food for humans rather than livestock. These benefits are multiplied when we consider the ability of food exports to offset the costs of food production and deforestation abroad.

[12] The American food supply produced 4,000 calories a day per capita in 2010, the latest year for which data are available (USDA, 2014), whereas consumption averaged 2,481 that year (DeSilver, 2016). While the USDA has historically monitored nutrients in food production, the purpose has primarily been to examine trends of nutrient availability over time, rather than to monitor intake (Gerrior et al. 2004).

[13] Indeed, this was the condusion of the Dietary Guidelines for Americans, which advised Americans to eat more of these foods (and dairy) to increase intake of nutrients of public health concern.

Additionally, the authors' diet-building model biases consumption toward unpalatable, nutrient-poor feed grains. The inconsistent focus on individual nutrients and incorrect application of population-level nutrition guidelines amplify the bias in the authors' model. White & Hall underestimate both production and consumption of fruits, vegetables, and legumes, thereby misrepresenting the potential for a plant-based system to improve global health. Readers interested in the environmental and nutrition effects of a transition to plant-based food systems should review some of the many better-designed studies, which have found that reducing or eliminating the production of animal products can simultaneously achieve health and environmental goals (Behrens et al., 2017; Peters et al., 2016; Springmann et al., 2016).

An accurate assessment of micronutrient availability in the absence of animal agriculture would help policymakers simultaneously advance nutrition and environmental goals. Such a study would have to be built on realistic land use scenarios, accurate dietary modeling, and the best available data. White & Hall's analysis does not meet these standards. By assuming that Americans would eat feed crops in the absence of livestock, the authors built their flawed dietary model on a baseless land use scenario. They oversimplify America's complex food system and ignore the crucial influence of markets and land use change on nutrition and the environmental impacts of agriculture. As a result, White & Hall exaggerate the importance of livestock to American diets.

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ABOUT THE GOOD FOOD INSTITUTE

The Good Food Institute is a 501(c)(3) nonprofit organization dedicated to creating a healthy, humane, and sustainable food supply. GFI's team of scientists, entrepreneurs, lawyers, and lobbyists are laser focused on using markets and food innovation to transform our food system away from industrial animal agriculture and toward plant-based and clean meat alternatives. To learn more, please visit GFI.org.

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Jessica oversees GFI's work to create a better future of food through regulatory and statutory reform in Washington. She came to The Good Food Institute from the Center for Science in the Public Interest, where she served as Deputy Director of Nutrition Policy. Before working for CSPI, she worked for the D.C.-based law firm Meyer Glitzenstein & Crystal. She holds a J.D. from New York University School of Law and an M.S. in Animals and Public Policy from Tufts University. She is a member of the bar in New York and Washington, D.C.

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