Feedlot diet for Americans that results from a misspecified optimization algorithm

Marco Springmann[a,1], Michael Clark[b], and Walter Willett[c,d]

White and Hall (1) suggest that removing animals from US agriculture would create a food supply incapable of supporting the United States population's nutritional requirements and increase nutritional deficiencies compared with the current food system. However, their analysis suffers from an uncritical use of nutritional values and optimization algorithms, and a highly unrealistic and narrow scenario design.

In constructing their dietary scenarios, White and Hall use a linear-programming algorithm that optimizes diets to meet nutrient constraints at lowest cost. This approach is problematic: since 1945, it has been recognized to result in highly unrealistic and monotonous diets if not properly constrained (2), for example, by realistic serving sizes or deviation from current diets (3). White and Hall's algorithm is particularly nonsensical as exemplified by what they term "plant-based" diet scenarios: an "optimized" energy intake twice that of an average adult (>4,700 kcal/d), with 2,500–3,500 kcal/d (51–74% of energy, 700–1,000 g/d) coming from corn alone and 4,100–4,400 kcal/d (84–93% of energy, ~1,200 g/d) from total grains (see figure 4 and code in supporting information of ref. 1). According to White and Hall's data (figure 3 and code in supporting information of ref. 1), much more diverse diets—for example, including recommended intakes of vegetables (>400 g/d), fruits (>200 g/d), nuts and seeds (>40 g/d), and plenty of legumes—would be possible in their no-animal scenario without trade. However, unfortunately all derived results are based on White and Hall's implausible scenarios, and therefore cannot represent realistic examples of plant-based systems.

The assumptions made regarding the inputs used in the optimization algorithm are similarly problematic. White and Hall assume that the distribution of crops in US agriculture cannot change, despite plentiful examples otherwise (4). That assumption results in a food supply that is significantly higher in corn and other animal feeds, which is not desirable from health and environmental perspectives, given their high carbohydrate content and predominant food use as high-fructose corn syrup and the high fertilizer inputs to corn production. Despite that, the emissions related to fertilizer inputs might be double-counted, as they are commonly included in the life-cycle estimates used.

Furthermore, White and Hall misuse and misinterpret the nutritional reference values. All of the nutrients that they suggest would be deficient in their plant-based scenarios are either not essential [arachidonic acid, eicosapentaenoic acid (EPA) + docosahexaenoic acid (DHA)] or can be readily obtained in sufficient quantities in realistic plant-based diets (calcium, vitamin A) and lifestyles (vitamins B_{12} and D) (Table 1). Contrary to what White and Hall imply, total nutrient supply is actually higher in their plant-based scenarios (figure 2 in ref. 1) at half the price (figure 4 in ref. 1). That said, nutritional adequacy is a poor marker for healthiness. Many nutrient recommendations are old, based on a few short-term studies with few participants, and generally have not been subject to the same academic quality standards as applied to current medical research practices (5). Long-term studies clearly indicate that consumption of red and processed meat is associated with higher incidence of several chronic diseases and total mortality despite its nutritional content (6), and that a higher proportion of healthy plant-based foods is associated with lower risks (7).

[a]Oxford Martin Programme on the Future of Food and Nuffield Department of Population Health, University of Oxford, Oxford OX3 7LF, United Kingdom; [b]Natural Resources Science and Management, University of Minnesota, St Paul, MN 55108; [c]Department of Epidemiology, Harvard T. H. Chan School of Public Health, Boston, MA 02115; and [d]Department of Nutrition, Harvard T. H. Chan School of Public Health, Boston, MA 02115

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[1]To whom correspondence should be addressed. Email: marco.springmann@dph.ox.ac.uk.

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Table 1. Comments on nutrients suggested to be deficient in White and Hall's (1) modeled plant-based diets

Nutrient	Comment
Arachidonic acid	Arachidonic acid is not essential and readily synthesized endogenously from plant-derived linoleic acid.
Omega-3 fatty acids	Out of the omega-3 fatty acids, only the largely plant-derived α-linolenic acid (ALA) is considered essential; ALA can be endogenously converted to EPA or DHA, and DHA can also be obtained from algae.
Calcium	The recommended intake for calcium in the United States (1,000–1,200 mg/d for adults based on very short-term studies) is likely overstated (500 mg/d is considered adequate by the WHO) (8). Furthermore, there is no evidence that calcium intake from milk and dairy lowers or prevents the risk of bone fractures (9). Hip fracture rates are lowest in countries with little or no consumption of dairy foods (8)
Vitamin A	Vitamin A can be fully obtained from carotenoids in plants as part of realistic diets, such as from a cup of carrots, sweet potatoes, or butternut squash, among others (see, for example, US Department of Agriculture nutrient reference values).
Vitamin B_{12}	Vitamin B_{12} is a key nutrient that would be low in all predominantly plant-based diets, but it can be readily obtained from existing fortified foods, such as many nondairy milks (10), or can easily be added by fortification at minimal cost, similar to folate and other micronutrients.
Vitamin D	Food intake, either from plants or animal sources, are not a major source of vitamin D, which is synthesized in sufficient quantities in the skin following sun exposure. In addition, supplements and foods fortified with vitamin D are readily available (10).

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