

IOWA STATE UNIVERSITY

College of Agriculture and Life Sciences

Sustainability Implications of a Global Shift to a Plant Based Diet

T.Awokoya¹, C. Dawson¹, M. McGarry¹, J. Sterle¹, R.Wilgenbusch¹, E. Huff-Lonergan¹, S.M. Lonergan¹, T.P. Robinson²

Background

The world's population is expected to grow to 9.8 billion people by 2050, with much of the growth expected to be in the developing world. During this period, there will be a need for a 70% increase in food production, and a greater demand for animal source foods. Because of the expected increase in global population, the intersection between adequate healthy diets and sustainability is more important than ever. Plant-based diets have been proposed as a solution. In contemplating this shift, there will be synergies and tradeoffs associated. This review aims to evaluate the sustainability implications of a global shift to a plant-based diet using the four domains of the Global Forum for Food and Agriculture.

Methods

Our team conducted a literature review, interviewed scientists, and summarized our findings in a document, power point presentation, and an annotated bibliography.

Results

Our results are summarized using the four domains of the framework outlined by the Global Forum for Food and Agriculture (GFFA).

GFFA Framework

Food and Nutrition Security	Animal Health	Livelihoods and Economic Growth	Climate and Natural Resources
<ul style="list-style-type: none">Obesity and Non-Communicable DiseasesProtein & Nutrient QualityFood Loss & WasteFood vs. Feed	<ul style="list-style-type: none">Impact on human healthZoonotic & Non-Zoonotic DiseasesRisk of Plant Production Intensification	<ul style="list-style-type: none">Economic DevelopmentRole of GovernanceMarket Access & SmallholdersByproducts of Livestock Production	<ul style="list-style-type: none">Inputs of ProductionsGreenhouse Gas EmissionLand Use Change & DegradationWater Use & Quality

Food and Nutrition Security

With climbing rates of obesity, plant-based diets combined with appropriate lifestyle changes can reduce the prevalence of both weight concerns and non-communicable diseases. The tradeoff is in the adequacy of available micronutrients and risk of nutrient deficiencies. Many nutrients found in animal source foods cannot be easily replaced with those found in plant sources due to varying bioavailability or nutritional composition especially in vulnerable populations such as: pregnant women, young children and older adults who have specific nutritional needs. Specific nutrients of interest are iron, zinc, calcium, vitamin B12, vitamin A, and vitamin D. Animal-derived protein provides a higher-quality source of protein and nutrient density. Plant-based diets also bring challenges in food security through food waste increases. Meat is commonly not wasted due to high value and taste preference, but at all levels of the food production system, plant-sourced foods are wasted often because they are less expensive and less preferred by much of the developed world. In the discussion about food vs feed, a balance to achieve efficiency of production of livestock and availability of food for humans must be sought.



Figure 1: Share of global food loss and waste by commodity from World Research Institute, (2013)

Animal Health and Welfare

The use of antibiotics in the livestock sector has been heavily debated in recent times. If antibiotics are overused, or not used correctly, they can lead to resistance in bacteria and be a threat to human health. Intensification of the livestock sector can lead to more "production diseases" in livestock such as bacterial and viral diseases of the respiratory and/or digestive tracts. Reducing livestock production might lead to lower prevalence of zoonotic diseases. However, just like livestock, plants can get their own diseases that can lead to food insecurity, human health concerns, and economic stress. With global temperatures warming, pathogens, hosts, and the interactions between them are changing in ways researchers have just begun to study. Livestock and people can move and adapt, but plant life is stationary. Understanding the interactions between pathogens and hosts, as well as the impacts human intervention has on crop agriculture systems, will be critical to creating safe diversified farming systems to supply the population with secure, reliable sources of food in a plant-based diet system.

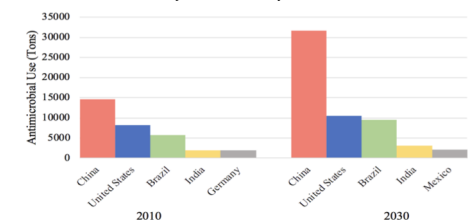


Figure 2: The graph depicts the use of antimicrobials of the top five countries, graph modified from Van Boeckel *et al.*, (2015).

Livelihoods and Economic Growth

Gross Domestic Product (GDP) of livestock production comprises 50% of all agricultural GDP in developed countries and 33% in developing countries. Initiatives designed to advance a global shift toward plant-based diets would largely reduce the livestock sector of many developed countries in which the industry makes up a substantial portion of the economy. In the United States alone, the livestock sector was valued at over \$150 billion in 2017 (USDA, 2017). Fruits and vegetables are primary exports, so a plant-based diet would likely be more beneficial to fostering growth in developing economies. However, fruit and vegetable production does not carry the same market value as meat production.

Since not all land area and climate types are sufficient for food crop production, this means there will not be a scenario in which all livestock and meat industry workers will be able to find work in a plant-based diet landscape—a shift that results in "many losers, but also some winners". Global partnerships will be an essential component of reducing inequalities between developed and developing nations through equitable trade agreements.

Climate and Natural Resource Systems

Reducing livestock emissions and shifting to a plant-based diet could increase emissions of carbon dioxide and nitrous oxide, both potent GHGs, from cropping systems. Additionally, not all of the land made available by reducing livestock production would be suitable for crop growth. Even land that is suitable could be more heavily degraded by cultivation and increased need and application of synthetic fertilizer. Further, livestock play a critical role in nutrient cycling through consumption and excretion of carbon-containing plants and waste. This cycle cannot be adequately replaced by plant processes. In water use, no definitive conclusion can be drawn regarding which system would consume more water—crops or livestock as each commodity uses water in different ways.

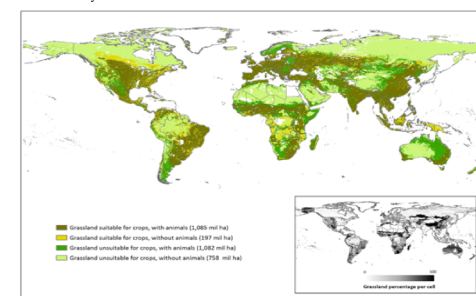


Figure 3: Grassland distribution, from Motet *et al.*, (2018)

Conclusion

Using the GFFA provides a guide to further research into the feasibility of plant-based diets. An increase in the consumption of plant-based diets at the expense of reducing livestock production does not account for all of the assets provided by livestock in supporting sustainable development. Regional considerations should guide a plant-based diet shift, globally, when taking into account all necessary cultural, nutritional, and environmental factors.

References

- Alshin, A., G.B.D.D. 2019. Health effects of dietary risks in 195 countries, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet (London, England)*. doi: 10.1016/s0140-6736(19)30041-8.
- Figure 1: World Research Institute. 2013. Share of global food loss by commodity. <https://www.wri.org/publication/reducing-food-loss-and-waste>
- Mottet, A., de Haan, C., Falucci, A., Tempio, G., Opio, C., & Gerber, P. (2017). Livestock: On our plates or eating at our table? A new analysis of the feed/food debate. *Global Food Security*, 14, 1-8. DOI: 10.1016/j.gfs.2017.01.001
- Schönfeldt, H. C., & Hall, N. G. 2012. Dietary protein quality and malnutrition in Africa. *British Journal of Nutrition*, 108(S2), S69-S76. DOI:10.1017/S0007114512002553
- UNFAO, 2018. Shaping the future of livestock, <http://www.fao.org/publications/card/en/c/18384EN/>
- Van Boeckel, T.P., Brower, C., Gilbert, M., Grenfell, B.T., Levin, S.A., Robinson, T.P., Teillant, A., & Laxminarayan, R. 2015. Global trends in antimicrobial use in food animals. *Proceedings of the National Academy of Sciences of the United States of America* 112 (18):5649-5654. doi: 10.1073/pnas.1503141112.
- ¹Iowa State University College of Agriculture and Life Sciences
- ²United Nations Food and Agriculture Organization-AGAL