**Foodprint**

**Understanding Connections Between Food Choices and the Environment**

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**Chapter 5**

**Land Use**

**Section 1. Learning Objectives**

By the end of this chapter, you will be able to:

* Describe the status of the Land Use planetary boundary
* Understand some of the current literature (World Resource Institute, van Dooren et al.) on land use of various dietary scenarios
* Understand results of a study optimizing nutrition while minimizing environmental impact.
* Calculate the estimate land required for various 2000 cal/day diets.

**Section 2. Chapter Overview**

This chapter presents some recent studies that calculate the land requirement for various dietary scenarios. One study used linear program to estimate a nutritionally appropriate substitute for beef that minimized land use, greenhouse gases, and nitrogen use.

**Section 3. Land Required for our food.**

A report from World Resources Institute (Ranganathan et al., 2016) estimated the land requirement for the current US diet, as well as for various scenarios of dietary shifts. The leftmost circular graph shows the calorie distribution of the current US diet, divided into the categories plant, dairy, beef, and other animal products. Moving across the diagram to the right, and onto the second panel, the circular graphs show various scenarios that were modeled for environmental impact. The first two scenarios were focused on reducing overconsumption, and the next six scenarios model decreased animal products, with the last three focusing on reducing beef specifically. Finally, the world average is shown for reference.

The image below each circle shows the land required for the scenario, again broken down by category. In red, you can see the large proportion of land required for beef production compared to the relatively small fraction of the calories due to beef consumption.





Some data from Meier and Christen (Meier & Christen, 2013) can be used for calculating the land use requirements of different foods.



Stehfest et al. 2009 (Stehfest et al., 2009)

* Studied a reference diet and four different dietary change scenarios
  + No ruminant meat
  + No meat
  + No animal products
  + Healthy Diet (recommended by Harvard, applied globally)
* No animal products had slightly less emissions, but all modeled scenarios were much better than control (the reference diet)
* 2700 Mha of pasture and 100 Mha of cropland would be freed up for carbon sequestration as vegetation regrows

**Section 4. Understand results of a study optimizing nutrition while minimizing environmental impact**

Eshel et al. (2016) (Eshel, Shepon, Noor, & Milo, 2016) investigated the environmental benefits of replacing the nutrition that people are currently getting from beef with plant sources. They first made a list of 65 common plant foods. Then, the choose 60 of those foods at random, 500 times. For each of the 500 sets of foods, they did three different optimizations to find the set of foods that would best replace the nutrition people would have gotten from the beef while minimizing land use, greenhouse gases, and nitrogen use, respectively. Nutritionally, replacement foods had to provide less than or equal to the 190 kcal/day they were getting from beef (since most people consume an excess of calories), greater than or equal to 11 g protein/day (since beef is typically eaten as a protein source), and less than or equal to 16 g fat/day (as the saturated fat in beef is generally considered not beneficial. An additional constraint was that the mass of the total of the replacement foods could not be more than double that of the mass of the beef.

The 1500 optimizations (500 sets of food, were then averaged, reflecting equal weighting of the three environmental issues (greenhouse gas production, nitrogen use, and land use). **Peanuts and legumes** figure prominently in the average replacement diet. Notably, these foods are generally considered healthy, and are both readily available and affordable.

**Slide 23 Calculate the estimate land required for various diets.**

Activity: To do in class

Open the Excel file LandUseCalcsWhattheWorldEatsExercise.

Go to the What the World Eats site by National Geographic. Choose a country and a time, and enter the total grams of food per person per day in D8. Then, working down column D, please fill in the % of grams that come from each food group. You may have to hover over a category in order to get the breakdown. For example, if you hover over Meat, you will see how much of the meat is beef, pork, etc.

Use google to find the population of the country you chose, and the area. Put those items in the spreadsheet. You will be able to compare the actual land area of the country to the amount required to grow its food, as estimated by these data.

Eshel, G., Shepon, A., Noor, E., & Milo, R. (2016). Environmentally Optimal, Nutritionally Aware Beef Replacement Plant-Based Diets. https://doi.org/10.1021/acs.est.6b01006

Meier, T., & Christen, O. (2013). Environmental impacts of dietary recommendations and dietary styles: Germany as an example. *Environmental Science and Technology*, *47*(2), 877–888. https://doi.org/10.1021/es302152v

Ranganathan, J., Vennard, D., Waite, R., Dumas, P., Lipinski, B., & Searchinger, T. (2016). Shifting diets for a sustainable food future, (April), 90. https://doi.org/10.2499/9780896295827\_08

Stehfest, E., Bouwman, L., Vuuren, D. P. Van, Elzen, M. G. J. Den, Eickhout, B., & Kabat, P. (2009). Climate benefits of changing diet, 83–102. https://doi.org/10.1007/s10584-008-9534-6