

Explorable Explanation of the Vegan Diet

Pravika Joshi, Patrice Power, Ava Robinson

Figure 1: An outsider's perspective of the Vegan diet.



Abstract

This paper discusses and analyzes how visualizing the Vegan diet might better equip readers with information about the diet and its global impact. To answer this question, we compiled nutrition and environmental datasets and leveraged tools for data-driven documents including Idyll and D3 to create animations and data visualizations with interactivity. Our use of these tools and datasets resulted in an explorable explanation of the Vegan diet. It offers engaging and interesting graphics to visualize the diet's environmental impact as well as provides interactive animations to explore the diet in practice and its nutritional benefits. This explorable explanation emphasizes the importance of understanding the impact of dietary decisions on one's health and the environment. Click this text to view the visualization.

Keywords: vegan, carbon footprint, dietary restrictions

1 Introduction

The Vegan diet is often viewed by outsiders as overly complex and intimidating. Its overwhelming list of restrictions often presents an intimidating barrier to many individuals beginning to discover plant-based diets. Because the purpose and benefits of the Vegan diet are unknown to so much of the general public, Veganism's positive impact on the environment and one's physical health is largely undervalued or overlooked.

Interested in attempting to decrease the informational barrier caused by a lack of single comprehensive resources for new Vegans, our team set out to provide a well-rounded understanding of the core features of the Vegan diet, including its impact on human health and our environment. We began with the guiding question, how might we create a visual and explorable explanation of the Vegan diet, its characteristics, and its global impact that will help readers make more informed decisions about their diet composition?

2 Related Work

There are a number of sites and infographics for exploring global diets and nutrition that we found prior to creating our explorable explanation. These related works helped our team understand what informational and interactive gaps existed in current explanations of diets and provided us with opportunity areas for our visualization to include.

Simple Happy Kitchen is a website and online resource for current Vegans or individuals exploring plant-based diets [Mottes 2019]. The site offers pages of information about Vegan superfoods and substitutes with quirky graphics. Figure 2 provides an example of their graphics showing Vegan sources of iron. It also includes a food blog for Vegans to share recipes, hear from doctors, or stay up to date on Vegan-related news. While we found this site to be the most comprehensive explanation of the Vegan diet that exists, it turns out that many of the important infographics relating to nutritional deficiencies and the Vegan food pyramid are only available for purchase. As a result, although this site is well researched and designed, it is not accessible to all.

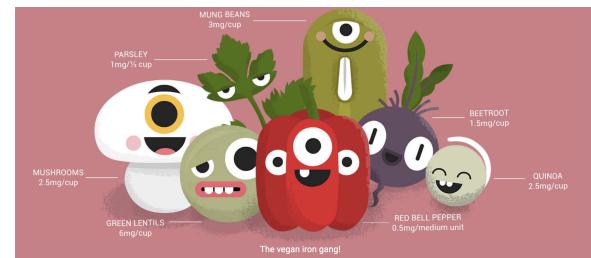


Figure 2: Iron-rich Vegan foods shown on Simple Happy Kitchen.

Our team found some useful infographics including one from Emerson College which touches on all the major aspects of the Vegan diet, including information on common Vegan substitutes, how to ensure proper nutrient intake, and statistics about health effects and environmental impact of the diet [Bethune 2015]. This infographic provides readers with visually interesting graphics to explain common questions or concerns with the Vegan diet; however, it provides no interaction or exploration of the data shown.

Our World in Data is another site which we found had useful information about dietary patterns and their effects on the environment [Our World in Data]. The page on Meat and Dairy Production provides readers with datasets and accompanying visualizations for in-

formation about animal product consumption and resulting carbon dioxide emission and land use from each animal product produced. This page offered preliminary visualizations for our team to start creating our own. An example of their data visualizations is shown in Figure 3. While the graphs created by Our World in Data were well-made, the page fails to build a story or explanation around all the data shown. Moving forward, our team was convinced it is necessary to create an explorable explanation that guided users through the data rather than just display the numbers and visuals.

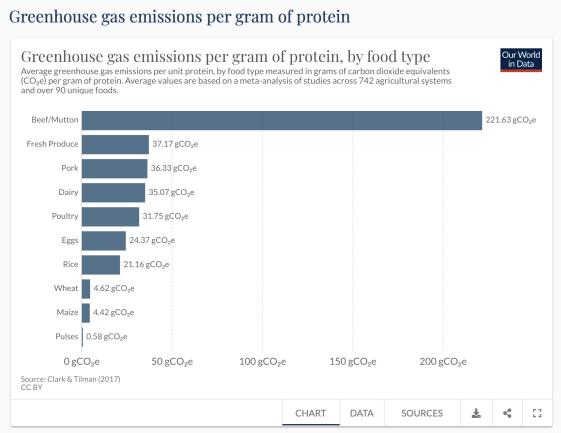


Figure 3: GHG emissions by food type from Our World in Data.

3 Methods

To begin development of our explorable explanation, we researched details of the Vegan diet including the diet's composition, demographics of Vegans in the world, and the environmental effects of Veganism globally. Consulting numerous research papers and online dataset providers in conjunction with general publications about Veganism and its health effects, we clarified our objective to focus on the impact of a Vegan diet on both the individual and global scale.

After finding that environmental impact stood out most prominently as the greatest motivation for individuals converting to Veganism, we decided to focus our description of the global impact of Veganism on its environmental effects. Beginning with a focus on big-picture environmental issues, we found a plethora of sources describing and analyzing the impact of nutrition on our environment. Three environmental indices stood out as key measurements by which we can compare the Vegan diet to others and assess its sustainability: The Carbon Footprint, The Water Footprint, and The Ecological Footprint. Naturally, we used these indices as the subsections within the environmental impact section of our visualization.

After researching and wrangling data regarding environmental concerns, we turned our focus to finding details of the Vegan diet and its nutritional impacts. Recognizing a lack of sufficient information about nutrient-rich Vegan foods and an incomplete understanding of the Vegan food pyramid among related works, we searched for data regarding common Vegan meals and their nutritional values. We began by identifying commonly absent nutrients in the Vegan diet and researched what actions Vegans might take to consume more nutrient-rich meals. Through aggregation and organization of data, we narrowed the focus of our second section, Nutritional Impact, to descriptions of the Vegan diet's composition, common Vegan substitutes for nonVegan foods, and commonly deficient nutrients in a Vegan diet.

Given our objective of creating a well-rounded explorable explanation of the Vegan diet and its impact, it was necessary to make use of development tools for data-driven documents that could support animation and interaction. After exploring the capabilities of Idyll, a popular tool among explorable explanations, we decided to use it for creating the framework when building out our exploratory explanation; it provides clean layouts, easy-to-use built-in components, and complimentary publishing. Through further experimentation and reading Idyll documentation, we discovered Idyll's custom component feature which allows the embedding of D3 elements into Idyll documents. This allowed us to leverage our prior D3 knowledge in the development process. We combined the use of Idyll's built-in components, including the Scroller, Buttons, and VegaLite charts, with multiple D3 custom components to create dynamic graphs, animations and interactive graphics for our exploratory explanation. Our team also made use of Idyll's Github-hosted chat room to discuss documentation questions not covered explicitly in Idyll's documentation.

4 Results

Our exploratory explanation tells the story of the Vegan diet and its impact on individuals and our world through textual explanations, animations, and interactive graphics. We intend to provide our readers with a general yet simple understanding of why nutrition is a major focus with regards to improving both our health and our environment. The final product is split up into two major sections: Environmental Impact and Nutritional Impact.

The first major section, Environmental Impact, describes the carbon, water, and ecological footprint of the Vegan diet. Leveraging the power of Idyll, SVG, and D3, we used a stacked scroller to navigate between the three subsections. Each subsection includes a ring chart and an animated graphic, both of which are accompanied by text to further assist explanation. The ring charts display the breakdown of the sectors contributing to each environmental footprint, one of which being agriculture. The encoding of area through the use of a ring chart allows for comparisons between the contributions of each sector. Due to largely incorrect assumptions about the contributions of each sector to the three indices of environmental impact, it was important to highlight the relative comparison between sectors. For example, it may be surprising that urbanization and built-up land comprises only 1% of all habitable land, while agriculture amounts to 50%.

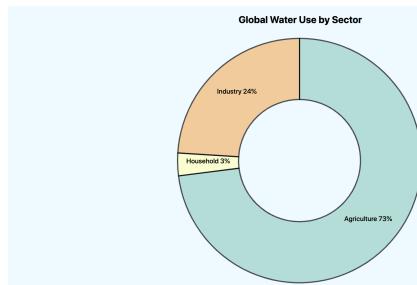


Figure 4: Ring chart displaying global water use by sector

Graphical animations were used to illustrate the differences between a standard, meat-eating diet and a Vegan diet for each of the three subsections. In each case, quantitative research results concluded that a Vegan diet reduces the environmental strain from food production. Each animation consists of graphics showing the differences in the impact of a standard diet, based on a 2,000 kcal omnivore diet, and a Vegan diet. The usage of value, position, and area encodings for the animations of greenhouse gas (GHG) emissions, water usage, and ecological impact respectively provide ef-

fective visual encodings that support easy comparisons. The animations focus on leveraging preexisting perceptions of GHG emissions, water use, and land use. For example, as shown in Figure 4, the GHG footprint animation visualizes emissions as an image of the world clouded by an atmosphere of grey gases. Accompanying these graphics are quantitative data on the average differences on a daily per-person basis between the standard diet and Vegan diet. The combination of animated graphics and numerics allows for reduced cognitive overhead during comparison and effectively portrays the great differences in the environmental footprints of the Vegan diet.



Figure 5: Animated graphic of carbon emissions for Vegan and standard diets

The second major section of this exploratory explanation, Nutritional Impact, describes the details of Veganism and its health effects. This section begins with a written explanation of the main features of the Vegan food pyramid accompanied by an interactive animation. Because food pyramids are well-known structures for understanding diets, a food pyramid is used as the underlying structure for this section of explanation. The food pyramid animation allows users to click through the steps of converting a traditional omnivore food pyramid into a Vegan food pyramid, beginning with identifying restricted foods and ending with substituting with Vegan alternatives. With included functionalities for replaying and pausing after each step, this feature provides users with a step-by-step process for comprehending the composition of a Vegan diet.

After explaining the Vegan diet composition, our explanation describes possible drawbacks to the diet by offering an explanation of common nutritional deficiencies among Vegans. Daily recommended intakes are commonly used for quantifying adequate nutrition in one's diet. The average percentages of DRI targets met by Vegans and non-Vegans for the eight most commonly deficient nutrients are plotted in a chart. We used y-position to encode met DRI percentages and hue to encode Vegan versus non-Vegan datapoints. This visualization gives readers an overview of what nutrients the Vegan diet tends to lack and how those compare to a more common non-Vegan diet. Because Vitamin B12 is the only mentioned nutrient that cannot be found naturally in any plant-based foods, a separate section was added to describe the effects of a Vitamin B12 deficiency. A small abstract animation of one's cells accompanies this explanation to visualize how energy levels and overall health is affected by a diet with little to no Vitamin B12.

Lastly, this exploratory explanation includes an interactive visualization of how Vegans might alter their diets to better meet their commonly deficient DRI targets, as shown in Figure 5. A clickable 'food bank' of Vegan superfoods allows users to explore how each food or a combination of foods contributes to each of the eight nutrients commonly lacking in Vegan diets. As users choose foods from the food bank, a bar chart animates with an aggregate percentage of DRI targets met for each nutrient. A table to the side also updates with the number of servings of each food selected so



Figure 6: Food pyramid after substituting with Vegan alternatives

far. This portion of the exploratory explanation gives users useful examples of nutrient-rich Vegan foods and the freedom to test out possible snacks and meals while exploring how these meals might affect their nutrient intake.

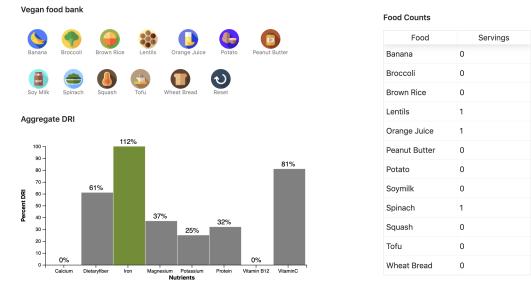


Figure 7: Interactive dynamic bar chart for exploring nutrition of Vegan foods

5 Discussion

In developing our exploratory explanation of the Vegan diet, our team encountered a few interesting problems and grappled with important design decisions.

Initially, our main concern when approaching this project was our limited knowledge of Idyll and D3. We understood the power of these tools to assist in creating engaging and effectively communicated exploratory explanations, but with only a beginner's understanding of the two tools, creating a clean-looking and complete explanation with interactivity and animation proved quite difficult. With each additional component added, our team grew more comfortable with Idyll and D3 and could better make decisions about scaling our project. With three team members, we were able to learn new features of the tools individually and share our findings in meetings. Solidifying our technical abilities was our first challenge, which once at least partially overcome, we could focus on making design decisions that resulted in a more cohesive and comprehensive exploratory explanation about the Vegan diet.

One important design decision made early in the process was the decision to exclude a visualization of the data regarding Vegan demographics. Although we had collected a handful of statistics on this topic, we decided not to include these data in our exploratory explanation as the datasets we found were not conclusive or complete enough to make assumptions about global Vegan demographics. Additionally, the demographic data we found did not enhance a user's understanding of the Vegan diet's impact on both a personal and a global scale. As a result, our team pivoted the objective of our exploratory explanation to only include the Environmental Impact and Nutritional Impact sections, in which we demonstrate how diets can affect both our world and our health respectively.

Due to the rising concern for the state of our environment, finding dataset regarding agriculture's role in global warming and use of limited resources was anything but difficult. Where the challenge lies is in compiling and filtering these data into the appropriate handful of statistics worth mentioning in this explorable explanation. Moreover, since users continuously scroll through the three environmental subsections, we emphasized using consistent units for data across subsections in order to demonstrate the connection between the three. We initially struggled with finding data in the unit of per person per day for The Carbon Footprint, The Water Footprint, and The Ecological Footprint, but after much digging, our team was able to find data identifying daily diet contribution to each environmental footprint.

Through our explorable explanation of Veganism, users can better understand both the environmental and health impact of this diet. In terms of the environment, users can learn about unsustainable agriculture practices and understand how following a Vegan diet could reduce their carbon footprint, save water, and free land. In terms of nutrition, users can learn what foods are not allowed under a Vegan diet and what foods they can be substituted in. Additionally, users can understand what nutrients Vegan diets often lack and what nutrient-rich foods can compensate for those deficiencies. With this knowledge, our explorable explanation provides a description of the environmental benefits and nutritional implications of the Vegan diet to allow users to decide with themselves whether plant-based diets could be right for them.

6 Future Work

While our current explorable explanation is complete enough to give users a holistic introduction to Veganism's impact on our world, there are a number of additions and alterations we would be interested in implementing in the future.

First, for the sake of simplicity and given our time constraints, this explorable explanation focused on a singular diet. However, it would be interesting to provide similar visualizations for other popular diets, including Keto, Vegetarian, Pescatarian, Paleo, etc. This could allow users to explore the differences in diet composition and environmental impact of each diet. Additionally, while Veganism proves to be one of the most restrictive long-term diets, providing information about less extreme diets could offer a more gradual immersion into an entirely plant-based diet.

Our team is also interested in discovering how to quantify overall health in a diet. We intend to equip readers with enough dietary information to make informed decisions about their own diets. This objective would suggest that more information about the nutritional quality of a variety of foods within each food group could help paint a more complete and objective picture of one's food choices.

Lastly, our team would hope to include a third section to this explorable explanation about the financial impact of the Vegan diet. While Vegan diets are more sustainable from an environmental perspective and tend to be healthier due to a natural increase in consumption of fresh and organic foods, it also tends to be less financially accessible. Fresh produce and plant-based meat and dairy substitutes are often more expensive than deli meats or regular milk due to the size of the meat and dairy industry in the United States. It is important for our future iteration of this explorable explanation to explore this aspect of Veganism's impact to give users a realistic expectation of the attainability of an entirely plant-based diet.

References

2010. Assessment of greenhouse gas emissions and mitigation potential: Global livestock environmental assessment model 2.0. http://www.fao.org/fileadmin/user_upload/gleam/docs/GLEAM_2.0_Model_description.pdf.
- BETHUNE, M., 2015. The vegan diet. <http://word.emerson.edu/dataviz/2015/01/29/the-vegan-diet/>.
- COTTLE, D., AND LEWIS, K. Chapter 3: Beef cattle production and trade. collingwood, vic. csiro publishing.
- DiMARINO, A., 2013. https://kb.osu.edu/bitstream/handle/1811/54564/Vegan_Thesis_DiMarino_2013.pdf?sequence=1&isAllowed=y.
- ELLIS, E. C., GOLDEWIJK, K. K., SIEBERT, S., LIGHTMAN, D., AND RAMANKUTTY, N. 2010. Anthropogenic transformation of the biomes, 1700 to 2000. *Global Ecology and Biogeography* 19 (December), 5.
2018. Environmental protection agency: Greenhouse gas emissions from a typical passenger vehicle. <https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle>.
- FAO, 2006. Livestock a major threat to environment. <https://www.truthordrought.com/water>, November.
2018. Food's big water footprint. <https://www.watercalculator.org/water-use/foods-big-water-footprint/>.
2019. Food's carbon footprint. <http://www.greeneatz.com/foods-carbon-footprint.html>.
2018. Global emissions: Center for climate and energy solutions. <https://www.c2es.org/content/international-emissions/>, January.
- HARRABIN, R., 2019. Plant-based diet can fight climate change - un. <https://www.bbc.com/news/science-environment-49238749>.
- Healthy eating. <https://www.safefood.eu/Healthy-Eating/The-Food-Pyramid-and-The-Eatwell-Guide/The-Food-Pyramid.aspx>.
- How would a vegan shift save water? <https://www.truthordrought.com/water>.
- MANGELS, R. Protein in the vegan diet - vegetarian resource group. <https://www.vrg.org/nutrition/protein.php>.
- MEKONNEN, M., AND HOEKSTRA, A., 2010. The green, blue and grey water footprint of crops and derived crop products.
2018. How much fiber is found in common foods? <https://www.mayoclinic.org/healthy-lifestyle/nutrition-and-healthy-eating/in-depth/high-fiber-foods/art-20050948>, November.
- MOTTES, M., 2019. Simple happy kitchen, the illustrated guide for your plant-based vegan life. <https://www.simplehappykitchen.com/>.
- Nutritional values for common foods and products. <https://www.nutritionvalue.org/>.
2019. National institutes of health: Strengthening knowledge and understanding of dietary supplements - calcium. <https://ods.od.nih.gov/factsheets/Calcium-HealthProfessional/>.

2019. National institutes of health: Strengthening knowledge and understanding of dietary supplements - iron. <https://ods.od.nih.gov/factsheets/Iron-HealthProfessional/>.
2019. National institutes of health: Strengthening knowledge and understanding of dietary supplements - magnesium. <https://ods.od.nih.gov/factsheets/Magnesium-HealthProfessional/#h3>.
2019. National institutes of health: Strengthening knowledge and understanding of dietary supplements - potassium. <https://ods.od.nih.gov/factsheets/Potassium-HealthProfessional/>.
2019. National institutes of health: Strengthening knowledge and understanding of dietary supplements - vitamin b12. <https://ods.od.nih.gov/factsheets/VitaminB12-HealthProfessional/>.
2019. National institutes of health: Strengthening knowledge and understanding of dietary supplements - vitamin c. <https://ods.od.nih.gov/factsheets/VitaminC-HealthProfessional/>.
- POORE, J., AND NEMECEK, T. 2018. Reducing food's environmental impacts through producers and consumers. *Science 360*, 6392, 987–992.
- RAMMOHAN, A., AWOFESO, N., AND ROBITAILLE, M.-C. 2012. Addressing female iron-deficiency anaemia in india: Is vegetarianism the major obstacle? . *ISRN Public Health*.
- RITCHIE, H., AND ROSER, M., 2013. Land use. <https://ourworldindata.org/land-use#note-2>.
- RITCHIE, H., AND ROSER, M., 2019. Meat and dairy production. <https://ourworldindata.org/meat-production>.
- ROSI, A., MENA, P., PELLEGRINI, N., TURRONI, S., AND NEVIANI, E. FERROCINO, I. E. A. 2017. Environmental impact of omnivorous, ovo-lacto-vegetarian, and vegan diet. *Scientific Reports 7*, 1.
- ROSS, A. C., TAYLOR, C. L., AND YAKTINE, A. L. E. 2011. *Dietary reference intakes for calcium and vitamin D*. National Academies Press, Institute of Medicine (Us) Committee to Review Dietary Reference Intakes for Vitamin D and Calcium. Washington, DC.
- SCARBOROUGH, P., APPLEBY, P. N., MIZDRAK, A., BRIGGS, A. D. M., TRAVIS, R. C., BRADBURY, K. E., AND KEY, T. J. 2014. Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the uk. *Climatic Change 125*, 2, 179–192.
2019. Sources of greenhouse gas emissions. <https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>, September.
- THOMAS, L. 2019. Environmental impacts of a carnivorous diets vs. vegan diets.
2018. Water friendly food choices. <https://www.watercalculator.org/water-use/water-friendly-food-choices>, December.
- WEBBER, J., 2018. Going vegan could free up 75 percent of land, says new oxford study. <https://www.livekindly.co>this-is-why-a-vegan-diet-is-better-for-the-environment/>.
- WEBBER, J., 2019. This is why going vegan is better for the environment. <https://www.livekindly.co>this-is-why-a-vegan-diet-is-better-for-the-environment/>
- WILLS, L., 2018. Vegan diet uses 5 times less water than a meat-based diet, study finds. <https://www.livekindly.co/vegan-diet-less-water-than-meat/>.