Data-Driven Nutrition in the Digital Age

Danielle Nierenberg, Alicia Powers, Sarah Papazoglakis
The Refresh Working Group, USA

Key messages

- There are more than 325,000 health apps available in app stores, which consumers are using to monitor and evaluate their individual health outcomes.
- New innovations, such as Farmwave's pest and pathogen diagnosis app, are being applied across the food supply chain to support the growth, distribution and affordability of healthy, nutrient-dense foods.
- Independent and locally based mobile markets and online shopping platforms are cropping up to improve food access by delivering groceries directly to food-insecure communities.
- Machine-learning algorithms are being used to aggregate data from supermarket loyalty cards in order to generate coupons for nutritious foods and to offer personalized diet recommendations based on consumers' shopping habits.
- Data-driven technologies are being employed across the entire food system both to influence individual behavior change and to address inefficiencies across the food supply chain.

Introduction

Today, data-driven technologies are being used to improve nutrition and health outcomes at the individual level and on a global scale. For individuals, there are now hundreds of thousands of mobile health (mHealth) apps available for download in global app stores related to fitness, diet or medical health.[1] While more research is needed to evaluate their overall effectiveness, these diet and nutrition apps are playing a growing role in supporting individual health-related behavior change.[2] In an effort to address nutrition and health at scale, emerging technologies are being adopted to transform the entire global food supply chain to ensure nutritious food is grown more sustainably and distributed more equitably.

> "Diet and nutrition apps are playing a growing role in supporting individual health-related behavior change"

From image-recognition tools that can identify plant diseases and pests within a matter of seconds and traceability technologies that increase transparency across the food supply chain, to data-driven nutrition apps that employ machine-learning algorithms to track dietary intake and make personalized recommendations to support better individual health outcomes, emerging technologies are being adopted to improve nutrition in the USA and around the world. With the world's population expected to reach nearly 10 billion by 2050, these technical solutions may play an important role in helping to solve some of the most pressing global environmental and agricultural challenges. To better understand how agriculture, food and nutrition data can be leveraged more effectively in the US food system and spur innovations in data-driven technologies across the food supply chain, Google recently brought together more than 35 experts working across the US food system to form the Refresh Working Group. The group is dedicated to ensuring the positive application of new technologies and artificial intelligence (AI) systems with the goal of nourishing the nation and, ultimately, the planet. In this article, we explore how innovations in digital technologies are being applied to change eating habits and address nutrition problems in the USA.

Technological solutions to nutrition and food security

The recent Global Nutrition Report finds that "malnutrition is responsible for more ill health than any other cause."[3] The report notes that the diversification of farming systems to include a greater variety of crops that offer a wider range and density of nutrients is key for addressing malnutrition and making healthier diets more readily accessible and affordable. Optimizing post-

Emerging technologies that are powering data-driven nutrition

Machine-learning algorithms

Computer software programs that can automatically find patterns in volumes of data so large that it is difficult for humans to compute them. Machine-learning algorithms power many of the digital applications that we use online every day. They are used to rank websites in search engines, make recommendations and predict outcomes.

Computer vision and image recognition

Advanced computer programs that can 'read' images and use that visual data to identify the object or image that is being 'seen.'

Farmwave is an AI-powered app that helps farmers to identify plant pathogens and pests, and to produce field reports

Harvesting peppers and preparing them for packing and processing at Santa Cruz Farm in Española, NM, USA

Wholesome Wave program activation at a farmers' market in Miami, FL, USA

harvest processing and distribution networks to reduce food waste is also an important factor in improving nutrition because, as researchers note, "postharvest losses are also nutrient losses."[4] According to the FAO, fruits and vegetables account for the largest percentage of food loss stemming from inefficiencies in the food supply chain.[5] These inefficiencies include preharvest problems, such as pest infestations, and postharvest processing and transportation conditions that impact the quality of perishable foods that must be stored at specific temperatures in order to maintain freshness.

"Technological innovation can play an important role in helping to optimize agriculture, food and nutrition infrastructures"

Technological innovation can play an important role in helping to optimize agriculture, food and nutrition infrastructures in order to support abundant harvests, improve logistics and distribution networks, reduce food and nutrient loss, and enable greater global food security now and into the future. For example, Farmwave is an AI-powered platform that was designed to help farmers identify plant pathogens, bugs and weeds by simply tapping an app. "A process that normally takes a couple of days or even weeks to get an answer from a pathologist or entomologist, we've narrowed down to about 10 seconds," says Craig Ganssle, Farmwave's founder and CEO. Trained on high-quality agricultural datasets from land-grant universities, Farmwave's algorithm is over 95 percent accurate.[6] This precision is important in order for these tools to have an impact on farm efficiency and sustainability.

It is not only undernutrition that threatens global health; overnutrition is also a primary concern, especially in developed countries. In fact, obesity is the number one cause of prevent-

able death in the USA, where nearly 40 percent of the population suffers from the condition, according to the Centers for Disease Control and Prevention (CDC).[7] One contributing factor to the obesity epidemic in the USA is the high cost and inconsistent availability of healthy, nutritious foods. More than 15 million American households – about 12 percent of the national population – are food-insecure. The United States Department of Agriculture (USDA) defines food insecurity as "households [that] were uncertain of having, or unable to acquire, enough food to meet the needs of all their members because they had insufficient money or other resources for food."[8] In a country defined by its abundance and prosperity, the so-called food-insecurity obesity paradox has come to refer to conditions in which access to nutritious food is unreliable, thereby rendering communities more vulnerable to hunger, obesity, type 2 diabetes and other associated health risks.[9] Recent digital innovations in e-commerce, online grocery shopping, and food and meal delivery services are helping to address food and nutrition insecurity by bringing fresh foods into communities that have a dearth of brick-and-mortar grocery stores or else experience other food access issues.[10]

Enabling and expanding social safety nets through technology

Government-supported healthy-eating incentive programs are among the most impactful technology-based, national programs to increase consumption of nutrient-dense foods, such as fresh fruits and vegetables. The USDA's Supplemental Nutrition Assistance Program (SNAP) is helping to close the food gap by providing financial assistance for families living below the poverty line so that they can purchase fruits, vegetables, breads, cereals, meats and dairy products.[11] Within SNAP, the Food Insecurity Nutrition Incentive (FINI) program goes a step further by using SNAP data to provide incentives for healthy purchases.[12] Specifically, the FINI program incentivizes the purchase of fruits and vegetables by doubling the amount of SNAP benefits, based on the value of the eligible fruits and vegetables that are bought.

> "Impoverished communities have not had the same level of access to online options as affluent communities"

Online SNAP redemption is an additional technology-based innovation currently being piloted. The online SNAP redemption pilot program enables program participants to use e-commerce tools to shop for groceries online. While online grocery shopping is not new for most, impoverished communities have not had the same level of access to online options as affluent communities. The online SNAP redemption pilot program is, for some participants, the first time they have ever ordered products online, especially food products. Many low-income individuals are unbanked or underbanked and, therefore, use cash for all purchases, which prohibits online ordering.[13] SNAP users are given a debit card that gives them access to the funds that the government program provides for food purchases. Having the ability to order online with the SNAP debit card helps SNAP participants enter the digital economy in a way they have not been able to before.

Not only does the online SNAP redemption pilot program have the potential to improve access to foods; some researchers suggest this shift may improve access to nutritious foods for food-insecure communities, where packaged foods in gas stations make up a disproportionate amount of the food consistently available within the community.[14] While a brick-and-mortar grocery store may not be a sustainable solution in rural communities in the USA, grocery stores that take advantage of digital technologies for shopping and delivery services can increase access to nutritious foods in rural, food-insecure communities.

> "Grocery stores that take advantage of digital technologies can increase access to nutritious foods in rural, food-insecure communities"

The benefits of digital innovation in the food industry influence not only those needing access to food, but also grocery stores implementing these innovations. The effect on the stores is currently being studied. In Opelika, AL, a rural, southern town of about 30,000 residents, Auburn University's Hunger Solutions Institute teamed up with independent grocer Jimmy Wright of Wright's Market to solve food-insecurity issues through a unique mobile market called Fresh Mobile. Fresh Mobile serves the Opelika-Auburn area and its surrounding rural areas of Lee County, an area that covers about 600 square miles. Fresh Mobile is testing the effectiveness of combining FINI, online SNAP redemption and centralized delivery as mechanisms through which to increase access to nutritious foods in rural areas while maintaining a sustainable business model.

Leveraging data to improve nutrition

In 2007, 7 years before the establishment of the FINI program, which formally incorporated healthy food purchases into the USDA's food assistance program, Michel Nischan founded

Wholesome Wave as a nonprofit organization dedicated to addressing food insecurity. Wholesome Wave was created to expand access to fresh produce in communities that would not otherwise have access. In communities across the country, Wholesome Wave began doubling SNAP benefits spent on fruits and vegetables at farmers' markets and grocery stores. At the Saturday market in City Heights, San Diego, CA, for example, Somali refugees are growing native pumpkin leaves and lablab beans and selling them to their community for deep discounts through the program.

Based on the program's success, Wholesome Wave launched a card-based reward system to support its Fruit and Vegetable Prescription Program.[15] The rewards card is powered by NutriSavings, a platform that has been described as "the first measurable nutrition benefit solution that is designed to change shopping behavior."[16] NutriSavings' scoring algorithm draws upon nutrition research that shows that diets high in fiber, protein, vitamins and minerals and low in fats and sugars lead to optimal health outcomes.[17] The algorithm produces ratings for each shopping trip based on the items purchased, and uses that information to make purchase recommendations and provide coupons to support and enable healthy food purchases.

By partnering with grocery store loyalty card programs to synchronize their point-of-sale systems with rewards for buying fresh produce, Wholesome Wave's program is improving health outcomes for individuals and their communities. Sixty-eight percent of participants in the program stay with the program through to its conclusion – about 6 months on average. And 40 percent of families reported that they will continue to eat more fruits and vegetables even after the program ends. Healthy eating incentives also grow the demand for produce from regional farmers and increase profit margins for farmers' markets and grocery stores. The program is one example of how technological applications can support multifaceted programs that target both individual behavior change and market conditions by helping to increase demand for unprocessed, nutrient-dense foods.

> "Healthy eating incentives also grow the demand for produce from regional farmers"

The future of data-driven nutrition

From facilitating individual behavior changes to addressing inefficiencies across the national and global food supply chains, machine-learning algorithms and computer vision programs are among the emerging technologies being mobilized to grow more food more efficiently and empower consumers to make the best decisions about their individual health. These tools are helping to drive innovations in food distribution and food delivery that offer the potential to address food insecurity by bringing fresher food at lower cost to more people.

The Refresh Working Group's nearly 40 farmers, small business owners, researchers, corporate partners, nonprofit leaders, educators, nutritionists, decision-makers and advocates are committed to identifying sustainable and equitable ways of leveraging data-driven technologies to improve the US food system. We recently hosted a series of public conversations to explore this topic in depth, including a livestream discussion with the former US Secretary of Agriculture, Tom Vilsack, (available on the Refresh website) and a series of panels on the impact of AI on food production, distribution and consumption at the annual South by Southwest Conference. By convening conversations that break down silos through bringing different stakeholders together and evaluating policies that support social and technological innovations as a collective, the Refresh Working Group is helping to advance a data-driven future in which healthier food is produced, distributed, accessed, afforded and consumed by everyone, everywhere.

Our work is just getting started. To learn more, please read the Refresh: Food + Tech, from Soil to Supper report, and visit the website (refreshfoodandtech.com).

Correspondence: ***Dr Sarah Papazoglakis,***
Senior Policy & Research Manager, Swell Creative Group,
304 SBroadway, Los Angeles, CA 90013, USA
Email: *sarah@refreshfoodandtech.com*

References and notes

01. Aitken M, Clancy B, Nass D. The growing value of digital health. Parsippany, NJ: IQVIA Institute for Human Data Science; 2017.
02. Schumer H, Amadi C, Joshi A. Evaluating the Dietary and Nutritional Apps in the Google Play Store. Health Inform Res. 2018 24(1): 38–45.
03. Development Initiatives Poverty Research Ltd. 2018 Global Nutrition Report: Shining a light to spur action on nutrition. Bristol, UK; 2018. Internet: https://globalnutritionreport.org/reports/global-nutrition-report-2018/
04. Lauretti-Bernhard R. Postharvest Loss = Nutrition Loss. ADM Institute for the Prevention of Postharvest Loss at the University of Illinois-Urbana-Champaign; December 2015. Internet: http://publish.illinois.edu/phlinstitute/2015/12/04/postharvest-loss-lauretti/
05. Food and Agriculture Organization of the United Nations. Key Facts on Food Loss and Waste You Should Know! 2019. Internet: www.fao.org/save-food/resources/keyfindings/en/

06. Land-grant universities in the USA are public universities that were established in the 19th century with a mandate to teach agriculture and conduct agricultural research. These institutions have some of the richest agricultural datasets because of this.
07. Centers for Disease Control and Prevention. Leading causes of death and numbers of deaths, by sex, race, and Hispanic origin: United States, 1980 and 2016. 2017. Internet: www.cdc.gov/nchs/data/hus/2017/019.pdf
08. Coleman-Jensen A, Gregory CA, Rabbitt MP. Food Security Status of U.S. Households in 2017. United States Department of Agriculture Economic Research Service; September 2018. Internet: www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/key-statistics-graphics.aspx
09. Hilmers A, Hilmers DC, Dave J. Neighborhood Disparities in Access to Healthy Foods and Their Effects on Environmental Justice. Am J Public Health. 2012 Sep 102(9): 1644–54.
10. Cometti M, Fredette D, Panek AE, Radley M. From Markets to Tech: Governmental Initiatives, Solutions, and Responses to Food Insecurity. J Public Affairs [serial online] 2018. Internet: https://doi.org/10.1002/pa.1860
11. Diaz-Granados S. The Food Gap: Income Inequality and Disease Disparity. Harvard Political Review. 2018 March 17. Internet: http://harvardpolitics.com/culture/food-gap/
12. Loveless JC. Food Insecurity Nutrition Incentive (FINI) Grant Program. United States Department of Agriculture National Institute of Food and Agriculture; 2018. Internet: https://nifa.usda.gov/program/food-insecurity-nutrition-incentive-fini-grant-program
13. Federal Deposit Insurance Corporation. 2017 FDIC National Survey of Unbanked and Underbanked Households. October 2018. Internet: www.fdic.gov/householdsurvey/2017/2017report.pdf
14. Karsten J, West D. How the Amazon-Whole Foods Merger Shrinks Food Deserts. Washington, DC: Brookings Institution; August 2017. Internet: https://www.brookings.edu/blog/techtank/2017/08/29/how-the-amazon-whole-foods-merger-shrinks-food-deserts/
15. Wholesome Wave Fruit & Vegetable Prescription Program. Wholesome Wave; 2018. Internet: www.wholesomewave.org/sites/default/files/network/resources/files/FVRx%20Placemat_Revised2-22-18.pdf
16. Venter D. NutriSavings Adds Walmart to List of Participating Retailers for Health Plans That Reward Healthier Purchases. VentureBeat. 2016 May 18. Internet: https://venturebeat.com/2016/05/18/nutrisavings-adds-walmart-to-list-of-participating-retailers-for-health-plans-that-reward-healthier-purchases/
17. Nutrisavings. The Nutrisavings Scoring System. [white paper]. August 2016. Internet: http://media.nutrisavings.com/Print/white-paper-v4.pdf