Right Now The expanding Harvard universe

THE BEEF ABOUT BEEF

Eating for the Environment

HEN Gidon Eshel sits down for a meal, his plate holds a full agenda. There's the food, of course—plantbased, in his case. But beyond the barley and snap peas spills a cornucopia of environmental, social, and political considerations. "When you make a choice between any two competing ingredients or any two competing meals," Eshel said in a December lecture (on

"Rethinking the American Diet"), "you are making a whole cascade of important choices that you may or may not be aware of. For example, in that choice you determine...the nature of rural communities" in terms of structure, land use, and population density; the quantity of greenhouse gases emitted "on your behalf" for food production; the biodiversity of rangelands; the likelihood of species extinctions; and the health of waterways and coastal ocean fisheries, where massive die-offs are one consequence of agricultural pollution. "You even get to take sides in things that we don't often associate with food choices, like societal strife," he said, citing the example of a water-rights dispute pitting alfalfa farmers against a Native American tribe in Oregon's Klamath basin. And finally, of course, nutritional choices "determine your health as powerfully as genetics or exercise."

Eshel is a geophysicist; a research professor of environmental science and physics at Bard College, he spoke at the Radcliffe Institute, where he is a fellow this year. His field was conventional climate science when he was a professor at the University of Chicago, until a lunch conversation about the geophysical implications of food production led him to a new focus: environmentalgeophysical consequences of human diets. Since 2006, he has examined the effects on the planet of various diets, from vegan to lacto-ovo to the mean American diet (MAD, in which about a quarter of the calories come from animal-based products). His findings have given him a strong message to deliver: lose the beef.

Beef represents only about 7 percent of the calories consumed by Americans, but the hamburger habit has outsized effects. Beef production, Eshel's research has shown, uses in aggregate 28 times more land—91 million acres of high-quality land to grow crops for use as feed, and 771 million acres of rangeland used as pasture for cattle—as well as 11 times more irrigation water than



Illustration by Pete Ryan

HARVARD MAGAZINE 11

Reprinted from Harvard Magazine. For more information, contact Harvard Magazine, Inc. at 617-495-5746

the average of other livestock categories such as pork and poultry. Beef production also creates five times the amount of greenhouse gases and six times as much waterpolluting reactive nitrogen.

"Farmers do a bunch of things" to the earth's surface to affect the rate at which hydrobiogeochemical processes occur, Eshel told his audience. Most importantly, they add nitrogen as fertilizer and they modify drainage so irrigation water leaves the soil almost as quickly as it arrives, to speed plant growth and keep roots from rotting. But these chemical and physical modifications have an unintended consequence: they degrade the ability of soil biota to neutralize reactive compounds. Such microorganisms require soil that retains water to do their work, which takes place slowly and steadily, he explains. By speeding up surface and soil hydrology, "You basically degrade an ecosystem's ability to render those otherwise dangerous compounds harmless." Ultimately, the reactive-nitrogen-laden runoff reaches the coastal ocean, where it severely depletes levels of dissolved oxygen, leading to massive fish kills in places like the northern part of the Gulf of Mexico "near the Mississippi River mouth."

Beyond its contribution to water pollution, agriculture is a significant source of greenhouse-gas emissions: nearly 10 percent of the total in the United States for agricultural production, rising to roughly a quarter when the entire food chain, from farm to plate, is considered. But the vast majority of those emissions are attributable to livestock. Almost half of the total land area in the lower 48 states (1.9 billion acres) is devoted to agriculture: various pasturelands represent about a third of that, while corn, hay, and other feed crops account for almost all the rest. By comparison, all the lettuce, tomatoes, fruits, and nuts people eat (including apples, citrus, and almonds) are grown in less than one-half of 1 percent of the agricultural lands: "a minuscule fraction of the total," Eshel pointed out. Switching to a plant-based diet, his research has shown, would eliminate about 80 percent of greenhouse-gas emissions attributable to agriculture in the United States, because most of that comes from ruminant livestock emissions, and growing their feed grains.

Beef production also threatens biodiversity in Western rangelands. By the time grasslands have been moderately or intensively used for grazing cattle, research shows, more than half the species once native to the landscape have been lost.

Although Eshel has for the past decade emphasized the benefits of switching to a purely plant-based diet (in which foods such as peanuts, soy, and lentils play a prominent role), he recognizes that veganism is not for everyone, despite the clear health benefits. Now he's calculated what would happen if all the national resources required to produce the beef Americans consume annually (about 65 grams per person per day) were devoted to poultry production instead. The number of useful calories produced would increase fivefold. Such a diet would also deliver four times the amount of protein, enough to meet the dietary needs of an additional 140 million people. Given the resources required to produce it, the idea that beef is indispensable, Eshel said, "just doesn't make sense."

But if people demand beef, how much can be grown sustainably? Eshel calculates that by combining feed that originates as an industrial byproduct (orange peels from juice production, for example) with the best half of all the pastureland in the country, 33 percent of the current beef supply could be maintained. Using all the pastureland, including arid, minimally productive Western rangelands, would affect more than 370 million acres and produce only 5 additional percent of the current supply, at the great environmental costs enumerated above. The high-quality cropland used to grow cattlefeed—if repurposed for crops that people eat-would deliver nine times the supply

Explore More

For more online-only articles on research in progress, see:

A Breakthrough in High-**Pressure Physics?**

Metallic hydrogen could revolutionize energy use, space exploration, and more. harvardmag.



A Robotic Fix for Heart Failure

An experimental device could someday restore the ability to pump blood in patients with heart failure. harvardmag.com/heartsleeve-17

of protein if planted with wheat or spelt.

When making their dietary choices, Eshel said in summing up his research, individuals "get to tip the scale of environmental, social, and political contests," as well as improve their personal health. Eating healthy foods that use less land, therefore, "is one of the callings of our time...." ~JONATHAN SHAW

GIDON ESHEL E-MAIL: geshel@gmail.com GIDON ESHEL WEBSITE: www.radcliffe.harvard.edu/people/ gidon-eshel

THE X FACTOR

Why Is Cancer More Common in Men?

NCOLOGISTS KNOW that men are more prone to cancer than women; one in two men will develop some form of the disease in a lifetime, compared with one in three women.

But until recently, scientists have been unable to pinpoint why. In the past, they theorized that men were more likely than women to encounter carcinogens through

factors such as cigarette smoking and factory work. Yet the ratio of men with cancer to women with cancer remained largely unchanged across time, even as women began to smoke and enter the workforce in greater numbers. Pediatric cancer specialists also noted a similar "male bias to cancer" among babies and very young children with leukemia. "It's not simply exposures over a lifetime," explains Andrew Lane, assistant pro-