FEEDING 10 BILLION

background reading | food and agriculture unit

EARTH matters

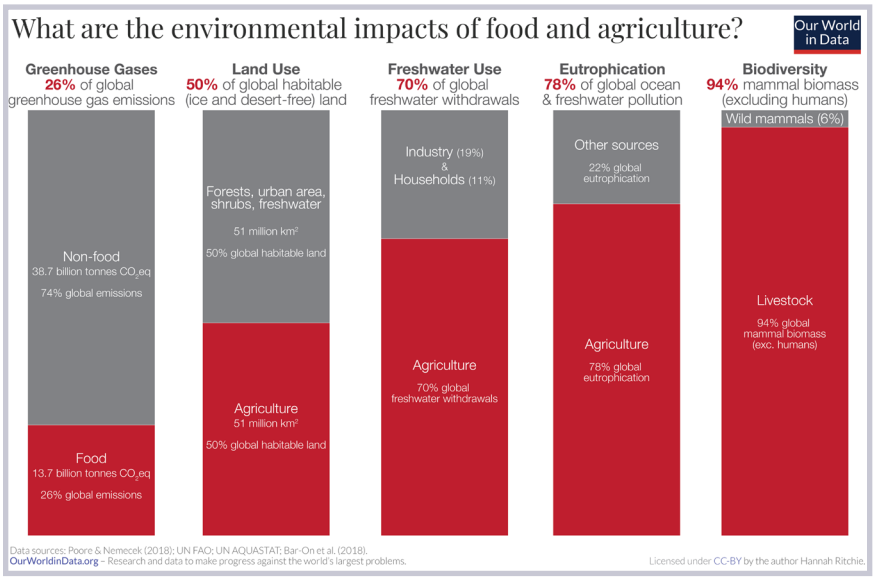
Studies For Our Global Future

One of the greatest challenges facing our growing population is how we will feed the nearly 10 billion people expected by the middle of this century. As our global family expands by 2 to 3 billion in less than 30 years, experts anticipate food production will need to increase by at least 50 percent.[1] This would be to accommodate both the growing number of people and their changing diets across the globe. At the same time, climate change is beginning to affect every aspect of food production, creating a lot of uncertainty about the world's ability to meet future food needs.

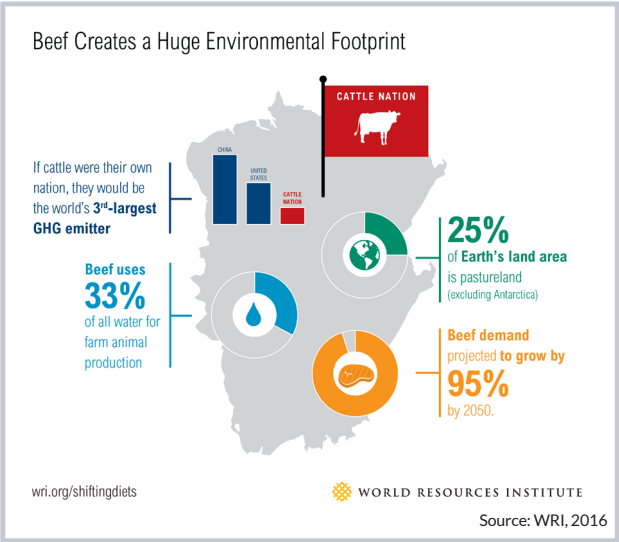
Food insecurity – the state of being without reliable access to a sufficient quantity of affordable, nutritious food – is not just a potential problem for the future. In 2020, the **UN Food and Agriculture Organization (FAO)** reported that close to 800 million people were chronically hungry and over 2 billion suffered **micronutrient deficiencies** (a lack of essential vitamins and minerals required for proper growth and development).[2] The reasons for food insecurity are varied and most often tied to poverty. While there is sufficient food grown globally to feed the current world population, it is not distributed evenly. Access to sufficient, nutritious food is a problem for people who live in areas with civil conflicts, unstable economies or where changing weather patterns have impaired crop production. In some parts of the world, food insecurity has reached crisis levels, as in Ethiopia, Madagascar, South Sudan and Yemen, now at risk of **famine**. Food insecurity is also a fact of life for the millions of the world's refugees, displaced from their homelands.

The FAO estimates that healthy diets are unaffordable for 3 billion people around the world, including those living in low-income and low-access areas in some of the world's wealthiest countries. In Northern America (U.S. and Canada), nearly 30 million people are considered to be food insecure, many of whom reside in **food deserts**, locations with limited access to grocery stores.[3] The COVID-19 pandemic has exacerbated food insecurity in nearly every country due to lost income and disruptions in food supply chains.

Our agricultural footprint



Feeding present and future generations requires a balancing act of producing more food, but doing it sustainably in a way that doesn't cause environmental harm. Our agricultural footprint is already large. We've cleared an area the size of South America to grow crops and an area the size of Africa to raise livestock.[4] That amounts to about 40 percent of all the ice-free land on the planet, and this agricultural expansion over the decades has often come at the expense of entire ecosystems, like North American prairies and tropical rainforests. In fact, agriculture is the dominant driver of tropical **deforestation,** and thus, a major cause of wildlife extinction. Agriculture is also a thirsty industry, accounting for 70 percent of all the water that is withdrawn from lakes, rivers and aquifers.[5] Groundwater sources are being rapidly depleted in an effort to grow more food.

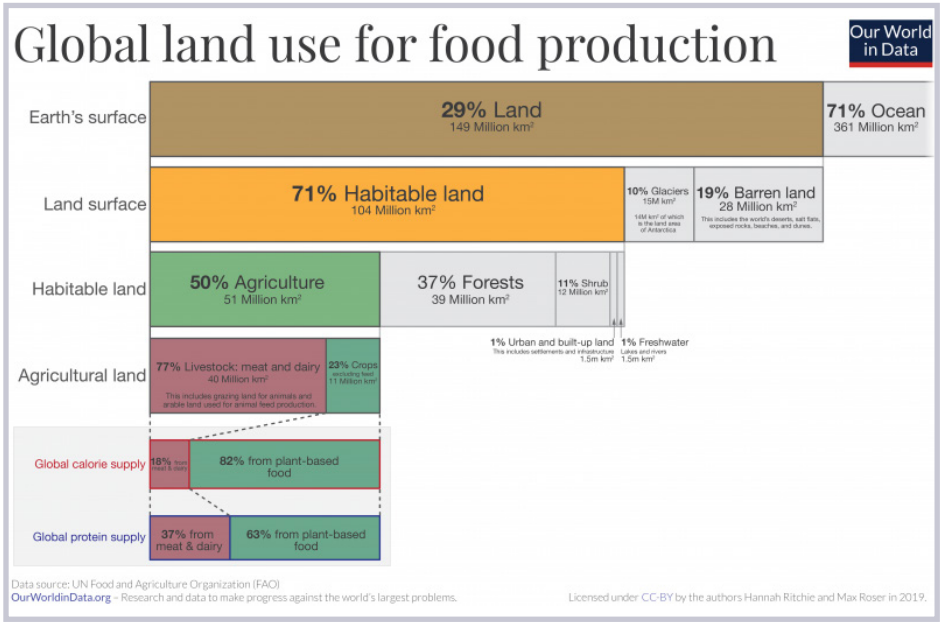


Agriculture's ecological footprint extends beyond the water used and the land converted. The byproducts of mass producing food also impacts the environment. One-quarter of all greenhouse gas emissions – more than those pumped out of all the world's cars, trucks, trains and planes – are generated from agricultural production.[6] That's a combination of methane released from cattle and rice farms, nitrous oxide from fertilizers used on fields and carbon dioxide from clearing rainforests for cropland and grazing areas. The runoff from croplands – chemical fertilizers, pesticides and manure – wash into lakes, rivers and coastal waters, further disrupting sensitive ecosystems.

A growing demand for chemical-free produce in the United States and the European Union has led to a rapidly expanding business in organic farming. Although the definition of "organic" varies from country to country, use of more sustainable farming practices has increased across the globe. Between 1999 and 2019, the amount of agricultural land used for **organic farming** grew more than six-fold, as has the global market for organic produce.[7] Though still a small share of all global agriculture, organic farming has shown steady growth in most parts of the world.

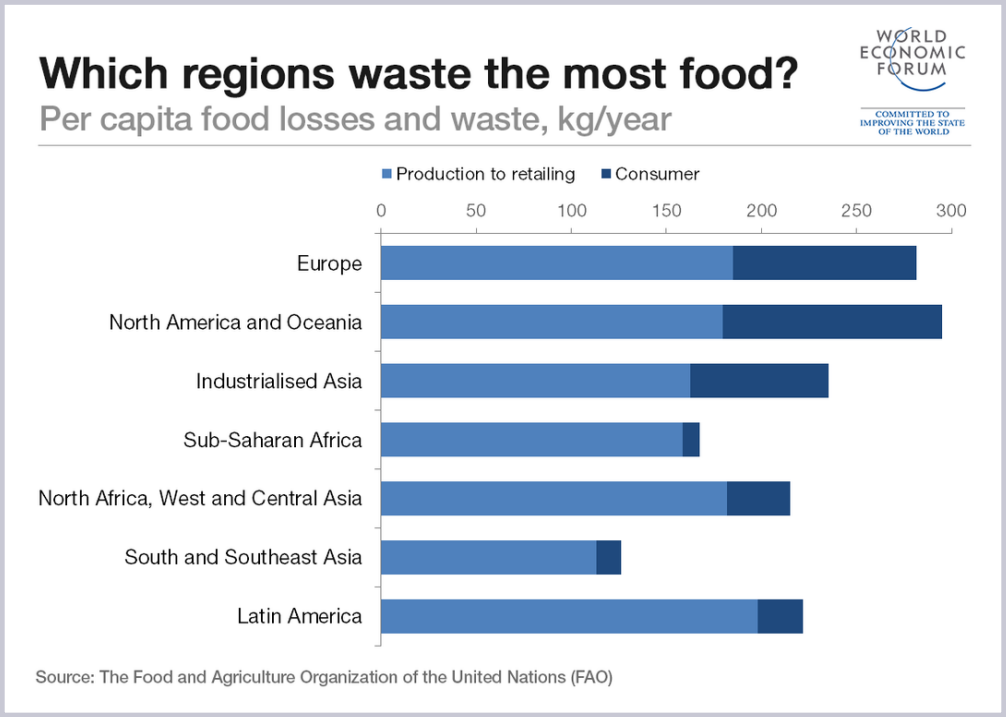
Much of the agricultural expansion we've seen in recent decades has been in response to changing diets around the world, rather than in an effort to promote food security. With the increased wealth of consumers in rapidly developing economies, like China and India, has come a greater demand for meat and dairy products. As a result, more land is being converted for grazing livestock and for growing animal feed. In fact, over one-third of the global grain production is fed to animals.[8] Only a fraction of the calories in that animal feed actually winds up on people's dining tables. According to Jonathan Foley, Executive Director of Project Drawdown, "for every 100 calories of grain we feed animals, we get only about 40 new calories of milk, 22 calories of eggs, 12 calories of chicken, 10 calories of pork, or 3 calories of beef."[9] Because of this inefficient feed-to-food conversion, more people could be fed eating lower on the food chain (more fruits, vegetables and grains) and with smaller portions of animal proteins. "The world's farmers currently produce enough calories to feed 9 billion people a healthy, mostly vegetarian diet," writes environmental journalist Joel Bourne.[10] Unfortunately, these calories are not produced in a way to make them accessible to our current 7.8 billion people.

In addition to feeding livestock, an increasing amount of our cropland is now used for growing **biofuels**. This adds to the world's acreage that is already devoted to non-nutritional crops, such as coffee, tobacco and cotton, that are of important economic value but don't contribute to feeding a growing population.



Gone to waste

According to the UN Environment Program, roughly 30-40 percent of food grown globally is lost to waste. In less developed countries, this is mainly due to a lack of adequate storage to keep food fresh before it gets to consumers. In India, for example, up to 40 percent of fresh produce goes bad because neither the wholesale nor retail outlets have cold storage. [11] Even crops that don't need cold storage, like rice, can be lost to pests and spoilage.



In more developed countries, food waste mostly occurs at homes and at the retail level (grocery stores, restaurants and other food services). Because food is relatively cheap in countries like the U.S., there are fewer incentives to prevent waste. As a result, stores discard produce that is edible but not perfect (like bruised fruit), and restaurants often serve overly large portions which encourage waste. If the food waste was composted for fertilizer or fed animals, it could still be put to good use in the food chain. But more often, this food waste winds up in the regular garbage, headed toward the landfill.

Losing farmland

At the same time that we look to increase crop yields and reduce food waste, we have the added challenge of preserving valuable farmland that is being lost to urban growth and **soil erosion**. As global population grows by over 80 million people each year, there is increased demand for all sorts of infrastructure that requires land – homes, industry, commercial areas, roads, utilities, and more. The planet is rapidly urbanizing and some of this urban growth is taking farmland out of production.

Soil degradation also reduces the area of land available for agriculture. The most common cause of soil degradation is erosion, the carrying away by wind and water of the thin layer of topsoil which holds all the nutrients necessary to grow crops. It is estimated that one-third of the world's **arable** land was lost to soil erosion and pollution from 1975 to 2015.[12] **Overgrazing**, deforestation, **agricultural mismanagement**, and **overharvesting** of fuelwood frequently cause erosion. These activities, in turn, are frequently the result of poverty and the unequal distribution of land. As population growth increases the demand for land, poor farmers are forced to work marginal land, such as hillsides and land cut from tropical forests, which erodes easily. Researchers at the University of Sheffield report that erosion is occurring at a pace of up to 100 times greater than the rate of soil formation.[13] It takes about 500 years to create just one inch of topsoil.

Increased **irrigation**, which has allowed for greater crop production in past years, is also a cause of cropland damage. Whereas rainwater is essentially distilled, irrigation water contains salts which are left in the topsoil upon evaporation. This process, called **salinization**, reduces crop yields on 50 percent of the irrigated land area worldwide.[14]

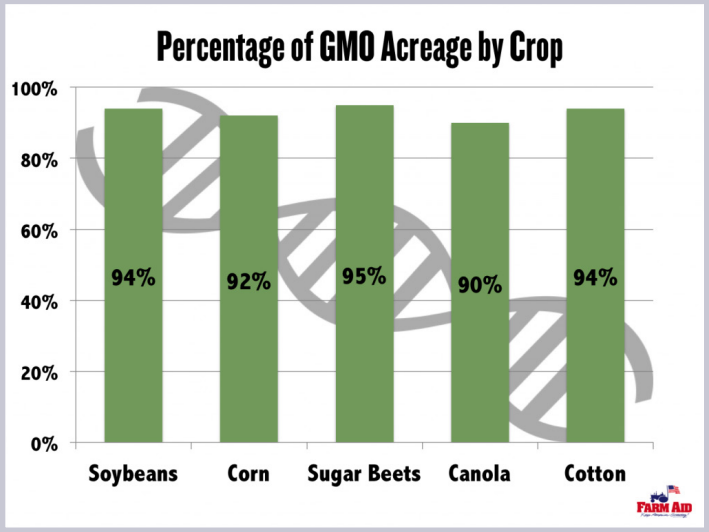
Will technology save us?

Tomatoes grow in a greenhouse in the Netherlands.

So how will we feed 10 billion people? Many look to breakthroughs in agricultural science and technology to save the day. Historically, they point to the **Green Revolution** of the 20th century as a model. In the 1960s, world population was growing at its fastest rate in human history and there was concern that the food supply wouldn't keep up in this race for humanity's future. An all-out effort to increase food yields, especially in Asia where population was growing the fastest, mobilized scientists.

Norman Borlaug, an American biologist, was one of the heroes of the Green Revolution. He developed hybrid varieties of common grains to use water and nutrients more efficiently and to resist disease. For these achievements, he was awarded the Nobel Peace Prize in 1970. From the 1960s through the 1990s, yields of rice and wheat in Asia doubled, creating food security for hundreds of millions of people. The Green Revolution also heralded an age of intensive use of chemical fertilizers, pesticides and irrigation. We have since witnessed the downside to these practices – toxic runoff in waterways, wildlife endangerment and the unsustainable use of water.

Scientists are continuing to experiment with cross-breeding crop varieties to get desired traits like tolerance to droughts, floods or pests, or to increase their nutrient value. Since the 1990s, **agronomists** have also been using **genetic modification (GM)** to produce crops with desired traits. With GM, genes identified in one species can be transferred directly to an unrelated species, giving it an entirely new trait, such as resistance to a pest or higher nutritional value. For example, scientists have developed a nutrient-enhanced rice using genes from corn. This "golden rice," as it is known, was developed to produce beta-carotene (the vitamin found in many yellow vegetables) to combat Vitamin A deficiency, which causes over one million deaths each year and half a million cases of blindness in less developed countries.



Most of the corn, cotton and soybeans grown in the United States today are GM crops. A study from the U.S. Department of Agriculture makes the environmental case for planting GM varieties, showing that pesticide use has been reduced significantly since the introduction of Bt corn which contains genes from a bacterium that help it ward off pests.[15] The use of GM crops is not universally accepted around the world, though. In Europe and much of Africa, debates on the potential safety of GMs for human health and the environment have deterred their use. At present, only a handful of countries – U.S., Brazil, Argentina, Canada, and India – grow 90 percent of the world's GM crops.[16] Arguments against GM crops focus on the potential threats to public health including the production of new allergens and antibiotic resistance.

The climate wild card

Even with the potential for new technologies to grow more food, we are still facing an uncertain future for farmers in terms of our changing climate. We are already seeing more evidence of weather patterns affecting agriculture – prolonged droughts, damaging floods and heat waves. According to researchers at Cornell and the University of Maryland, global farming productivity is 21 percent lower than it could have been without climate change over the past 60 years.[17] Recent droughts in some of the world's largest grain-producing countries, including the United States and Brazil, have diminished yields and sent food prices soaring.

Spikes in food prices disproportionately affect the poorest people, those who already live in food-insecure regions. Regions where population is expected to rise the most this century, especially Sub-Saharan Africa, are also the most vulnerable to the effects of climate change on food supply. "Increased hunger is likely to be one of climate change's most savage impacts on humanity," cautions Oxfam International, a nongovernmental organization that has been working to alleviate poverty and hunger around the world.[18]

A sustainable future

If we hope to feed present and future generations, we must commit ourselves to **sustainable agricultural practices**. Sustainable agriculture means using the land in such a way as to safeguard its natural productive capacity for generations to come. It is not enough to focus on the most efficient and profitable way to grow food today. Ensuring that an ample amount of land will remain for tomorrow's food supply must also be our concern. For example, destroying rainforest to create cropland provides productive land for only a few years before topsoil erodes. Leaving the rainforests intact and harvesting renewable products, such as fruits and nuts, insures a steady stream of produce indefinitely.

With such finite cropland, we must use this precious resource judiciously. **Crop diversification**, moderate irrigation and responsible land management are just a few ways to produce food more sustainably. Eating a wide variety of foods and not depending heavily on animal products will allow us to use land more efficiently to feed more people. Better distribution of available food is also essential in preventing mass starvation in low-income countries.

Among the top priorities for the UN's Sustainable Development Goals is "Zero Hunger by 2030" (SDG #2). In addition to supporting sustainable agricultural practices, the UN hopes to meet that goal by supporting small-scale farmers and allowing equal access to agricultural lands, new technologies and markets. This will also require an investment in the infrastructure that enables reliable agricultural production, such as sustainable soil and water management.[19]

Example of multiple cropping: fava beans and grapes planted in alternating rows in a vineyard in Tasmania.

And, of course, steps to meet the world's food needs are made more difficult the larger the human population grows. Demographers now expect global population to grow to 10 to 11 billion before leveling off sometime in the next century.[20] Stabilizing population size sooner – through education and access to modern family planning – could buy humanity more time to produce enough food for all.

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