The Future of Protein: Nourishing the World Sustainably

Policy and Information Package

BRIEF No.2
Feeding the World

Written by Anil Arora and Ryan Katz-Rosene
University of Ottawa, Ottawa, Canada

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Introduction

This brief discusses the theme of **'feeding the world'** as it pertains to the future production and consumption of protein foods. The FAO tells us that by 2050 we will have **34%** more people on this Earth than a decade ago, and humanity will be richer and more urbanized.[1] Given that the demand for ASPFs correlates closely with income levels, it is expected that demand for meat will grow tremendously. Moreover, the FAO asserts that the world will in fact have to produce **70%** more food than it did in 2009 in order to feed everyone in 2050. This, of course, is an enormous and complex challenge, in part because the world is already stretched for farmland; presently about half of the world's habitable land surface (so 51 million square kilometers of 104 million square km total) is used for agriculture.[2] Brief 2 considers this "wicked problem" and various proposed solutions.

As noted in Brief No. 1 (Introduction), we make an important distinction between Animal-Sourced Protein Foods (**ASPFs**), Plant-Sourced Protein Foods (**PSPFs**), and Novel Protein Food Products (**NPFPs**), and we track the discussion surrounding each theme as it is primarily tackled by three main pathways addressing the future of protein (see Brief No. 1 for further details):

a. The **REPAIR** pathway aims to 'fix' existing problems relating to the protein agri-food subsystem, primarily through an approach prioritizing technological innovations and improvements.

b. The **REPLACE** approach seeks a broader overhaul of the protein subsystem, prioritizing the replacement of ASPFs with PSPFs as the dominant protein source in the human diet, in addition to the introduction of new food commodities and consumption practices.

c. The **RESTORE** 'school' aims to address the problem by 'restoring' a holistic balance between humans and nature within the protein subsystem. This includes an emphasis on maximizing biodiversity, biomimicry, natural resilience in the production process, as supported socio-economically through consumption practices.

In this brief, we tackle the following core questions:

- *Can we produce enough food to meet the protein demands of a growing population without overwhelming planetary boundaries and finite natural resources?*
- *How much protein do we really need? Does global food security require an increase in total food production or can it be achieved by addressing the losses and inefficiencies of the current food system?*

Equitable and Sustainable Food Security

Each pathway accepts that growing human populations, rising incomes and urbanization will require significant changes in the way we produce, distribute and consume food. However, proponents of each pathway disagree about the current food system's ability to produce enough protein to achieve global food security in 2050. Moreover, they have differing opinions about what 'feeding the world' means: Does it simply entail producers expanding production to feed the market, irrespective of the nutritional, environmental or social consequences of the food system? Or, does feeding the world demand these latter dimensions be given considerable attention? Relatedly, what sort of diet can be sustained at a population of 9.7 billion in 2050? This latter interpretation appears to be more appreciative of the overnutrition epidemic, food access inequalities and the climate emergency. These are different futures being envisioned, with different consequences for human and planetary health.

The **REPAIR pathway** largely interprets the challenge as being about **meeting consumer demand**, suggesting that improved **conventional agriculture is necessary** to feed the world. It focuses primarily on achieving global food security through **technological innovation and efficiency improvements** at the production level. **Intensification** of agriculture, particularly in developing countries whose yields are significantly lower than their industrial counterparts, will be necessary to meet the growing demand for ASPFs and ensure a stable supply to healthy protein foods. **Bioengineering** will increase productivity, enhance nutritional quality and improve agricultural resilience to the impacts of climate change.

The **REPLACE camp** emphasizes the **inefficiencies of livestock production** in supplying protein **as compared to plant-based protein foods** and **novel proteins** on the cusp of disrupting the food system. This pathway suggests that **consumers play a critical role** in our ability to feed the world, particularly within high-income countries with abundant food supply. Since PSPFs and NPFSs require less land for production, it is seen as essential to replace the ASPFs in order to feed the world in the future.

Finally, the **RESTORE pathway** is primarily focused on breaking down the **misconception that small-scale farming cannot produce enough food to feed the world.** To the contrary, regenerative agricultural practices can ensure land productivity well into the future, and appeals to a natural variation of 'intensification' of production based on the large amounts of biomass seen in resilient biodiverse ecosystems. Moreover, by **addressing the inefficiencies of the current system**, namely **food waste** and **inefficient grain-fed livestock production**, small-scale farming can produce enough food to feed the world—as they arguably already do.

The Issue in Brief

Throughout the 20th century, steady progress in agricultural productivity—predicated by industrialization and globalization—has enabled unprecedented expansion of the global food supply and per capita food availability. Looking ahead, population growth, increasing affluence and urbanization all stand to boost agricultural demand, necessitating an increase in protein availability. Is the food system capable of meeting the protein demands of a growing and more affluent population without overwhelming planetary boundaries or exhausting a finite supply of natural resources? There are a number of issues pertinent to challenge of feeding the world sustainably:

- By 2050, we will need to feed an additional two billion people. On current trajectories of consumption, such levels of growth will require global food production to increase 25 to 70 percent by mid-century.[3]
- As global per capita income increases alongside economic development in the developing world, diets will continue to shift to include greater amounts of ASPFs. In response, global meat supply will need to reach 460 million tons by 2050.[4]
- At current capacity, our food system is failing to achieve food and nutritional security. More than 820 million people are undernourished and do not have enough food to eat, while over two billion people suffer from overweight or obesity, increasing their risk for diet-related non-communicable diseases.[5]
- Food security is defined by a multitude of qualities. These include nutritional and energy requirements, cultural appropriateness, affordability, accessibility and stability, all of which must be appreciated in food security objectives.
- Despite an abundance of food in high-income countries, food insecurity remains an ongoing challenge due to unequal distribution and income inequality. In Canada, one in eight households struggle with food insecurity.[6]
- In the current system, one-third of all food grown for human consumption is either lost or wasted.[7] Furthermore, grain-fed livestock production is a relatively inefficient means of producing protein for human consumption[8] when considering that the croplands which produced the animal feed could have produced PSPFs. Further, a considerable amount of agricultural lands are dedicated to non-edible crop production.[9]
- The food-climate relationship is reciprocal. Food production is one of the leading causes of biodiversity loss, climate change and natural resource depletion.[10] Conversely, the impacts of climate change threaten global food supply stability.[11] However, agri-food sector has perhaps the greatest potential to become fully sustainable.

In short, the complex challenge of feeding the world includes: meeting the increasing and changing demands of a larger and more affluent population; doing so without expanding the environmental footprint of production; eradicating hunger and malnutrition; and ensuring food supply stability.

Background

Defining and Measuring Food (In)Security

Food Security

> *"*a condition that exists when "all people, at all times have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"
>
> ***FAO, 1996, Rome Declaration on World Food Security[12]***

According to the FAO, there are a number of dimensions that contribute to food security: [13]

1. **Availability** – physical presence of food, including aspects of production, food reserves, markets and transportation, and wild foods.
2. **Access** – sufficient access to the above-mentioned food supply.
3. **Utilization** – sufficient energy and nutrient intake by individuals.
4. **Stability** – ensuring consistent and uninterrupted household food security.

Severe food insecurity applies to individuals who have likely run out of food, experienced hunger and, at the most extreme, gone days without eating.[14] However, food insecurity extends beyond just hunger and providing individuals with a sufficient amount of food.

Moderate food insecurity exists when an individual lacks consistent access to an adequate quantity of nutritious food. Resource constraints may challenge the certainty and stability of the quantity and quality of food they consume.[15]

More Mouths to Feed, Growing Appetites

An increasing global population, rising incomes, and urbanization will conjointly necessitate an increase in global food supply to the tune of 25 to 70 percent.[16] The **food gap**—the difference between the amount of food produced in 2010 and that necessary to meet projected demand in 2050—is estimated to be 7,400 trillion calories.[17] Notwithstanding improvements in agricultural productivity, it is hard to imagine the food system will have the capacity to feed the projected world population in 2050.

Population Growth

By mid-century, the global food system will need the capacity to produce enough food to feed a global population of 9.7 billion people.[18] The overwhelming majority of this growth—92 percent—will occur in Asia and Africa.[19]

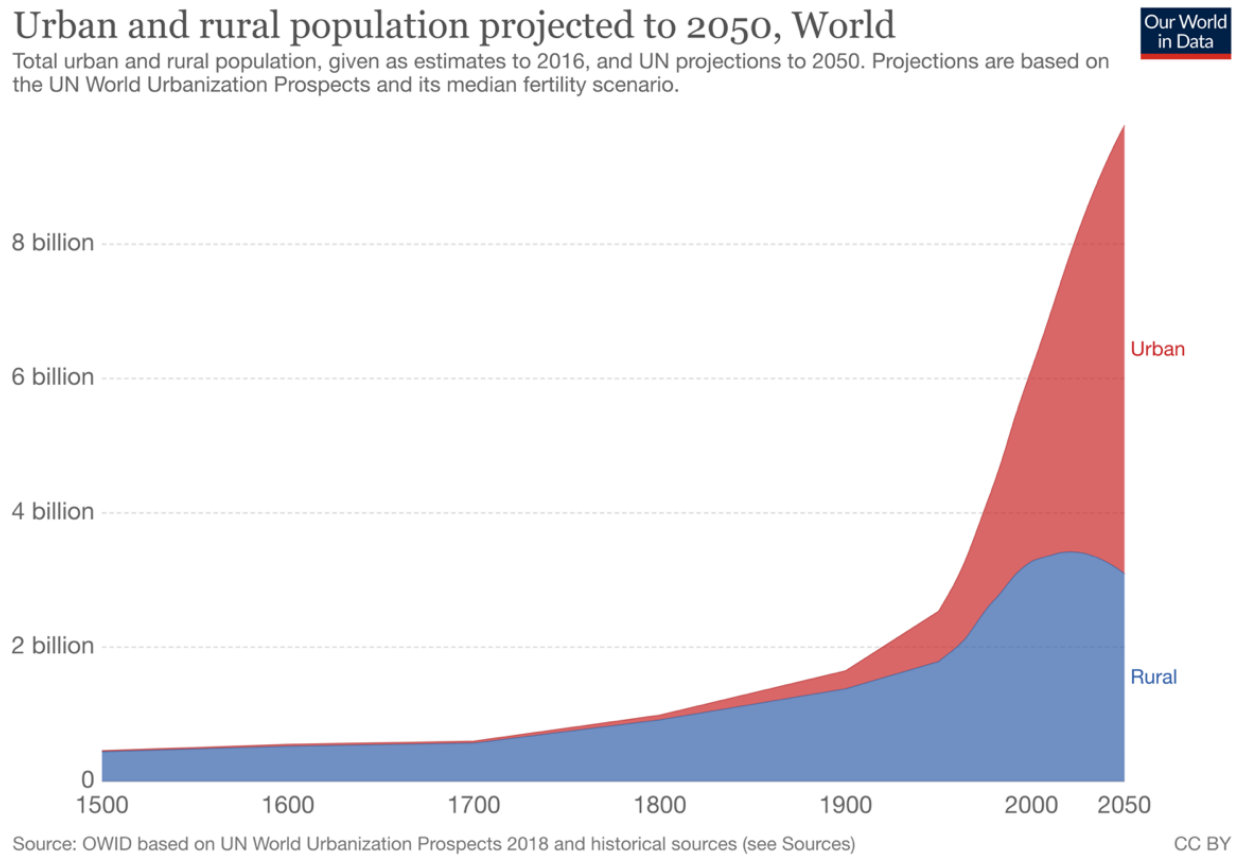
Rising Incomes

Global per capita income is expected to increase over the next few decades as the economies of developing countries grow at twice the rate of those in industrial countries.[20] It is well-documented that as people become wealthier, they tend to shift to a diet richer in meat and dairy, a trend observed throughout the latter half of the 20th century.[21] Countries having undergone strong economic transitions have experienced the greatest increases in per capita ASPF consumption.[22] Meat production is poised to increase 76 percent—reaching an all-time high of 455 million tonnes in 2050.[23]

Urbanization

Urbanization will see 68% of the world's population live in urban areas in 2050.[24] The link between urbanization and economic growth is well-documented.[25] Moreover, urban food environments are characterized by greater access to animal-sourced and processed foods.[26] Consequentially, total calorie consumption and the share of animal-source foods is usually greater in urban areas.[27]

Figure 2.1. Urban and Rural Population Projections to 2050



Credits: Produced by Hannah Ritchie and Max Roser, "Urbanization", *Our World in Data*.[28]

The State of Global Hunger and Food (In)Security

Taking a step back, a more pressing issue is the food system's inability to achieve food and nutritional security at current levels of demand. After a decade of steady decline, the prevalence of undernourishment (PoU) has been increasing since 2015, hovering at a level slightly below 11 percent of the global population.[29] According to the most recent estimates, more than 820 million people do not have enough food to eat and suffer from hunger.[30] The situation is most dire in Africa, where 20 percent of the population is undernourished.

These figures are likely conservative estimates, only inclusive to the most severe form of food insecurity and giving no due consideration to individual energy requirements. When moderate food insecurity is included, the prevalence of global food insecurity is 26 percent—equal to two billion people.[31] In Africa, half of the population suffers from severe or moderate food insecurity.[32]

The recent rise in hunger is a consequence of multiple factors, among them:

- climate change and extreme weather events;
- price volatilities;
- political and social conflict/insecurity; and
- economic slowdowns and downturns

These influences not only interact, but the latter three have bi-directional relationships with hunger. Food shortages are likely to increase food prices, ignite social and political unrest and hurt the financial stability of agricultural economies.

The Double Burden of Malnutrition

A sizeable proportion of the world's population is malnourished in one way or another. Malnutrition research has historically been compartmentalized, focusing on either hunger (undernutrition, micronutrient deficiencies) or overnutrition (overweight, obesity, noncommunicable diseases).[33]

Undernutrition is typically found in lower-income countries due to insufficient food supply and lasting hunger. It makes individuals more vulnerable to disease and death; 45 percent of deaths amongst children under the age of five are linked to undernutrition.[34] There are four forms of undernutrition:

1. **Stunting** (low height-for-age) – stunted growth has decreased 10 percent in the last six years; however, 149 million children remain stunted, nine of 10 residing in Africa or Asia.[35]
2. **Wasting** (low weight-for-height) – 50 million children (7.3 percent) under the age of five are wasted; nine of 10 reside in Africa or Asia.[36]
3. **Underweight** (low weight-for-age) – 462 million adults are underweight[37] and one in seven live births suffered low birthweight in 2015.[38]

4. **Mineral and Vitamin Deficiencies –** anaemia affects roughly one-third of the global population and half of these cases are due to iron deficiency.[39] These deficiencies are exacerbated by malaria and other infectious diseases in resource-poor areas.[40]

A growing concern pertaining to the challenge of feeding the world is the detrimental health effects of overnutrition.[41] **Overweight** and **obesity**, often the result of poor nutrition and a lack of exercise among other factors, are major risk factors for **noncommunicable diseases (NCDs)** including cardiovascular disease, diabetes and some forms of cancer.[42] In 2017, an estimated 11 million deaths were attributable to dietary risk factors and each year, and obesity is now killing more people than hunger/undernutrition.[43]

- Most recent estimates suggest that one-third of the global population is obese or overweight. Of these, roughly two billion are adults, equal to ~40 percent of the adult population.[44] In 2018, 63% of Canadians 18 and older were classified as being overweight or obese, an increase from 61.9% three years prior.[45]
- The worldwide prevalence of **obesity** nearly tripled between 1975 and 2016 and its relative rate of increase has outpaced that of overweight. Roughly one-third of overweight adolescents and adults, and 44 percent of overweight children aged five to nine are obese.[46]

This form of malnutrition was previously assumed to only exist in high-income countries. Lamentably, globalization of the food system and urbanization have spread the overweight and obesity epidemic to all regions of the world by making unhealthy foods cheaper and more accessible. Many low and middle-income countries are now facing the **double burden of malnutrition,** defined as the co-existence of undernourishment and obesity in the same country.[47] More than one-third of low and middle-income countries are affected by this burden.[48]

Food (In)Security in the West – Unaffordability and Inaccessibility

Food insecurity remains a persistent problem in high-income countries. Predominantly residing in the moderate food insecurity classification, eight percent of the population in North America and Europe are food insecure. In Canada, one in eight households, or four million Canadians, struggle to put food on the table.[49] Rates of food insecurity are disproportionately high amongst Canada's Indigenous population with nearly half of Indigenous families being food insecure.[50]

The Cost of Being Food Secure

In countries with abundant food supply, food insecurity is tied to **poverty**. Households with lower incomes are at a much higher risk of being food insecure and employment no longer appears to be a safety net; 60 percent of food insecure households in Canada have employment-sourced income.[51] A recent survey finds that 87 percent of Canadians perceive food prices to be increasing faster than household income.[52] Moreover, despite a stated interest in doing so, many Canadians lack the financial capacity to buy healthy, sustainable and ethically-sourced foods.[53] A nutritious basket of food for a family of four can cost up to $900 in major cities and with food prices expected

to go up next year, it is not going to get any easier; the average Canadian family will pay an additional $487 to feed themselves in 2020.[54]

Food Access Inequality

The ability to purchase healthy and sustainable foods is also challenged by **food access inequality**. Low-income, urban neighbourhoods across North America have a higher prevalence of fast food establishments and a lower prevalence of grocery stores, limiting access to healthier foods. These neighbourhoods are often referred to as **food deserts**—residential areas with limited access to affordable and nutritious food.[55] For many people living in these marginalized communities, private transportation is a luxury few can afford, further challenging their ability to purchase affordable fruits and vegetables. According to Freeman, the race and class-based health disparities perpetuated by food access inequality constitute 'food oppression'.[56]

Hunger in the Arctic

Northern communities are particularly vulnerable to higher rates of food insecurity due to higher rates of poverty, the Arctic climate and geographical isolation.[57] Country foods remain central to Inuit food security, nutritional and local economies.[58] However, commonly harvested wildlife species are being threatened by the impacts of climate change and many Inuit are transitioning towards Western diets. Non-traditional food sources must be transported infrequently over long distances and are therefore more expensive in the North. In 2014, the yearly cost of groceries for a family of four was almost $20,000 in Nunavut.[59]

Distribution Inequities, Production Inefficiencies

Food Loss and Waste

Food loss and waste refer to decreases in quantity or quality of food along the entire food supply chain.[60] The former includes any food that is discarded along the supply chain from harvest/slaughter/catch up to, but not including, the retail level. In contrast, food waste refers to losses that occur at the retail and consumption level. Reasons for food being wasted by retailers include food not meeting aesthetic standards (i.e. shape, colour, etc.) and nearing their best-before dates. For consumers, food waste is often the result of excess purchasing, poor meal planning and confusing best-before dates as meaning date of expiration.[61]

The severity of food loss and waste, as well as its potential role in achieving sustainable food security, is often underappreciated. According to the FAO, one-third of all food produced for human consumption is either lost or wasted.[62] These losses amount to 1.3 billion tonnes of food annually, enough food to feed an additional two billion people.[63] In Canada, more than half of all the food produced is either lost or wasted.[64] The average consumer in Europe and North America wastes more than 100 kg of food each year—more than 10 times the average person in some of the developing world.[65] Recent research sheds light on the culpability of industry, finding that 86 percent of food loss and waste in Canada takes place prior to the consumer stage of production.[66]

Agricultural Inefficiencies

Notwithstanding the multi-dimensional benefits of animal food sources, namely their contribution to global nutrition and economic security in rural areas, they are relatively inefficient sources of calories and protein. On a global scale, 36% of the calories produced by crops are fed to animals, an amount that only stands to grow.[67] Furthermore, the caloric and protein conversion efficiencies of US livestock production are on average, 7-8%.[68] Beef is by far the least efficient; compared to the production of edible PSPFs, including beans, peas and lentils, beef production requires 20 times the amount of land per unit of edible protein.[69]

Beyond the inefficiencies of growing crops for animal feed, there is also the issue of non-edible crop production. Increasingly, grains are being utilized for biofuel production such as ethanol and biodiesel.[70] Corn is considered to be a highly productive crop in the United States. Nevertheless, 40 percent of US corn is used for ethanol.[71] Combining this with the amount used for animal feed and export, only a tiny fraction serves the purpose of feeding people. Like animal feed, biofuel production occupies valuable agriculture resources that could in theory be used to instead to grow food for human consumption.

Environmental Sustainability and Climate Change Disruptions to Global Food Supply

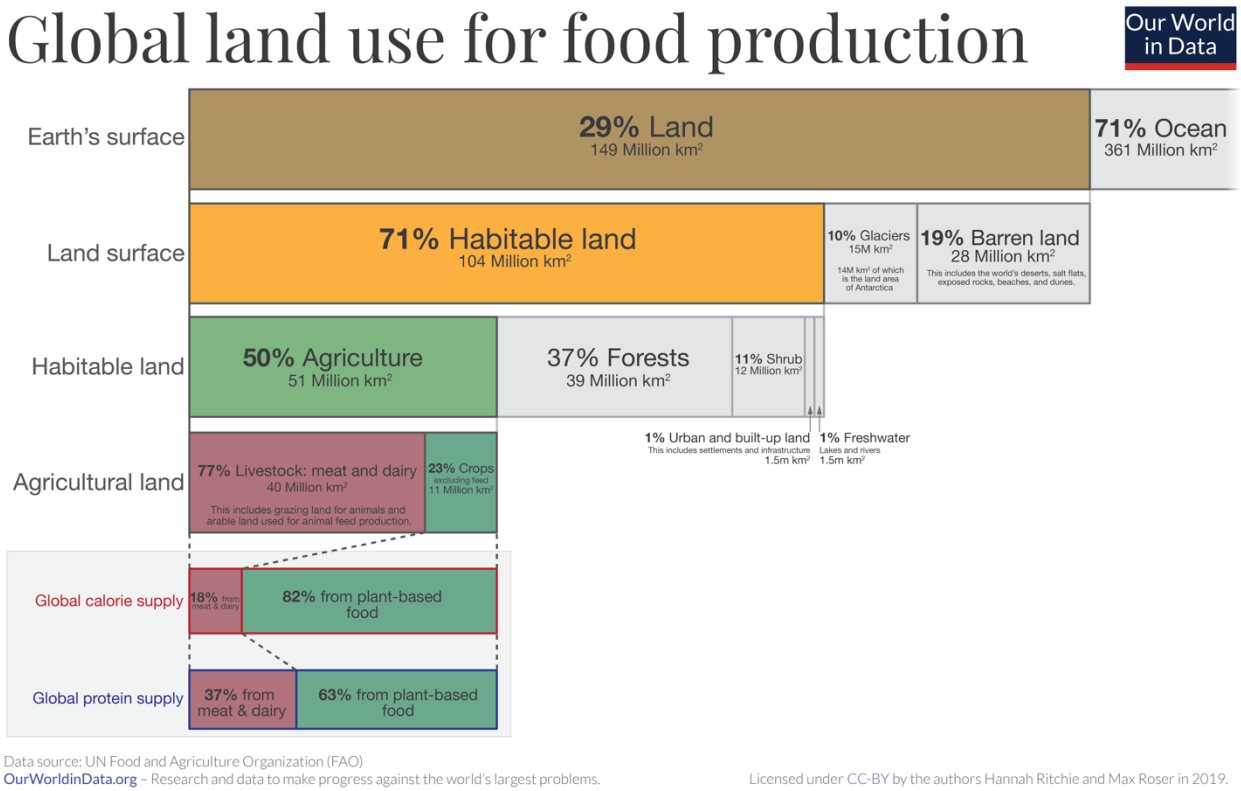
Feeding the World with Environmental Sustainability in Mind

In a vacuum, the solution to feeding a growing population might seem obvious—allow agri-food production to occupy more land and water resources. The reality is that we are in the midst of a climate crisis and the natural resources we exploit are finite. Presently about half of the world's habitable land surface (51 million square kilometers of 104 million square km total) is used for agriculture, the overwhelming majority of which is dedicated to livestock production (see Figure 2.2). Satisfying a growing appetite for meat and dairy would not only require agricultural expansion of an estimated 593 million hectares—an area twice the size of India—it would also come at the expense of critical ecosystems and increase the food system's contributions to global warming. Minimizing the environmental impacts of food production is therefore paramount for sustainable food security [see **Brief 6: Climate Change and Biodiversity**].

Climate Change and Global Food Supply (In)Stability

Ironically, as the current food production system attempts to grow more at the expense of planetary health, we are negatively affecting our ability to grow more in the future.[72] A recent IPCC report makes starkly clear that stability of global food supply is threatened by climate change.[73] Rising temperatures, changing precipitation patterns and more frequent and intense extreme weather events will negatively affect crop yields in many parts of the world, and evidence suggests they already are.[74] These climate-induced disruptions will lead to more food shortages, higher food prices and increased risk of food insecurity. Vulnerable populations already struggling to feed themselves due to access and affordability barriers will be the ones who are most affected.[75]

Figure 2.2. Limited land use for food production



Credits: Produced by Hannah Ritchie and Max Roser, "Land Use", *Our World in Data*.[76]

Considerations

The discussion surrounding how to feed the world is often portrayed as a face-off between conventional farming and local food systems. Entering the conversation abruptly are novel protein foods with the potential to reimagine the protein landscape, yet much of the discussion about the latter is hypothetical. Nevertheless, the discussion need not be so black-and-white: The respective schools of thought each offer badly needed solutions that could complement each other. If we instead assume them to be mutually exclusive, very little progress will be made in closing the food gap. Action is needed on multiple fronts: consumer demand for ASPFs needs to be moderated, food loss and waste reduced, production efficiencies improved and planetary health and biodiversity promoted. Potential solutions that improve the state of global food and nutritional security while simultaneously reducing the environmental impacts of food production must be explored.

REPAIR:

Sustainable Intensification

According to many subscribers of the repair pathway the answer to feeding the world is to increase production. Accepting this premise presents two options: extensification—bringing more land into agriculture, and intensification—increasing the productivity of the existing agricultural footprint.[77] Extensification is not a viable option; land and water resources are in short supply and further encroachment would contribute additional GHG emissions that the planet can ill afford. Hence, this school of thought promotes sustainable intensification—producing more food from the same area of land while reducing the required environmental impacts.[78] Crop and livestock productivity rates vary considerably across regions, producing a "yield gap" between the developing and developed world. Obtaining higher yields depends on farmer access and use of certain technologies, genetic materials, management practices and knowledge.[79] For the repair pathway, closing the yield gap would substantially increase global food supply and improve access in vulnerable regions where demand is projected to increase the most. This is accomplished by improving crop and livestock yields through a range of technologies (i.e. mechanization, irrigation, feed additives, genetics, precision farming, etc.).

Genetic Engineering

For many, genetic engineering of food is simply the next progression of agriculture. Gene engineering allows scientists to extract a desired gene from one plant or animal and insert it into the genome of another organism.[80] Their application in agriculture, the outputs of which are referred to as genetically modified (GM) foods, will reduce food price, increase yields, enhance nutritional quality and strengthen agricultural resilience to the impacts of climate change. Less intrusively, gene-editing tools such as CRISPR allow undesirable genes to be "turned off".[81] These benefits will help address food scarcity in the developing world and ensure food supply stability.

Uncharted Territorial Expansion

In line with the objectives of sustainable intensification, creative technological innovations present opportunities within the food system to increase global food supply without comprising planetary health. The first-ever floating dairy farm in the Netherlands is a "transfarmation" reimagining what urban farming looks like.[82] Following the same logic, innovators are also looking to oceans as a potential medium for livestock feed.[83] Technological advancements and the depletion of wild fish stocks have sprung a revival of aquaculture. It has gone from being a niche player in the protein landscape, contributing a mere few million tonnes of fish and seafood in the 1960s, to recently surpassing wild fisheries in production.[84] Aquaculture and aquaponics will be key providers of protein moving forward. In short, an neo-industrial revolution in agriculture helped stave off global famine before – and the hope is that ingenuity and technological innovations can do so again.

REPLACE:

The Inefficiencies of Animal Proteins

Those in the Replace camp are steadfast in pointing out that the existing global farmland is capable of producing enough calories and protein to feed the world in 2050, but only if there are major shifts in the types of protein foods we produce. The problem is not our capacity to produce food, rather the fact that much of what we grow serves as animal feed, an inefficient means of producing protein for human consumption. Livestock production occupies more than two-thirds of agriculture's land footprint and is one of the biggest contributors to planetary warming and biodiversity loss.[85] While the repair pathway assumes the inefficient conversion of plant protein to animal protein to be a fixture in future scenarios, the replace pathway appreciates the food availability, health and climate change mitigation benefits of replacing animal protein production with that of plant-based and novel alternatives.[86] This would enable the food system to support a greater number of people on the same area of land.[87] In theory, exclusively growing crops for human consumption could feed an additional four billion people.[88] There may even be potential to cut back on farm land, which could help draw down additional CO_2 and support biodiversity through rewilding projects.[89]

Consumers' Role in Feeding the World

Rather than framing the challenge of feeding the world as a question of how to feed the market, a more appropriate question is what sort of diet can be sustained at a global population of 10 billion? For those in the replace camp, reducing global meat consumption is critical to increasing food availability on existing farmland while simultaneously limiting global warming below the two-degree Celsius threshold.[90] Consumers shifting toward plant-based and novel protein foods would reduce livestock production, freeing up significant land and water resources that could be repurposed to grow human-edible crops. It is also well-documented that on a large scale, a shift to plant-based diets would lead to considerable reductions in agricultural GHG emissions and provide population health benefits.[91]

The Second Domestication of Plants and Animals

Proponents of the repair and replace pathways may agree on one thing: technological innovation will be critical to closing the food gap. The replace pathway envisions an unprecedented technological disruption that will render conventional livestock production obsolete.[92] Cellular agriculture—the process of growing agricultural products (i.e. meat, milk, etc.) from cultured cells—is right around the corner. Its disruption to the food system has been coined the second domestication of plants and animals. Lab-grown meat, seafood and other food products would enable us to produce far more food on less land, reduce food-related GHG emissions and environmental impacts[93] and safeguard the system against unpredictable climatic conditions. Moreover, by rewilding land formerly used for farming, the natural capital we have lost can be restored and a considerable amount of GHG emissions could be pulled from the atmosphere.[94]

RESTORE:

Small farmers can feed the world

Contrary to what the repair pathway suggests, small-scale farmers can feed the world, and they already do. Of the more than 570 million farms worldwide, more than 500 million are family farms.[95] Aggregately, small-holder agriculture occupies a small share of the world's farmland, yet they produce more than 80 percent of the food we consume.[96] Counter to the narrative promoted by the repair pathway, small farms are actually more productive than big farms, an inverse relationship known as "the productivity paradox".[97] Industrial farms may be cost and labour efficient, but when it comes to food supply, small diversified farms produce more food per hectare overall.[98] For instance, if all farms in Kenya, Central America and Ukraine had the current productivity of their country's small farms, Kenya's production would double, while Central America and Ukraine's would triple.[99]

From an environmental standpoint, it is quite clear that conventional farming practices are unsustainable. Small farms employing regenerative practices utilize and enhance biodiversity, contribute to local economies and can help reverse the climate crisis through soil carbon sequestration.[100] Regenerative agriculture can also restore degraded land, improving our ability to grow food over the long run. Conversely, conventional agriculture practices degrade soil health, undermining our ability to do such.[101] It is important to financially support farmers for their efforts to improve sustainability and welfare standards. Although a shift in agricultural subsidies that typically reward industrial models of production is one option, an alternative that policymakers may be more amenable to is allocating a portion of government support without disrupting existing subsidies. For instance, carbon sequestration credits would incentivize the adoption of regenerative practices, rewarding farmers for being stewards of their land.

Livestock have a role to play

Finally, while many subscribers of this approach agree that consumers should limit the amount of ASPFs they consume, they still consider livestock production to be integral in achieving food security and sustainability objectives. Our ancestors were omnivores and just as they have for thousands of years, ASPFs remain a fundamental source of nutrients, minerals and vitamins. The nutritional benefits of eating plant-based certainly have merit, but they are not a given as many of the meat substitutes on the market are ultra-processed. Livestock also play an important role in reducing poverty, serve as a means of ploughing and transport, a local supply of manure and a vital source of income.[102] From an environmental standpoint, the narrative that all meat consumption is 'bad' is thus overly simplistic, failing to appreciate the nuances of livestock production or the complexity of the food-climate relationship.[103] While it is true that a great deal of meat comes from grain-fed livestock operations, a considerable amount is grass-fed. Much of these grassland areas could not be converted to arable land for crop production without environmental consequence.[104] Rotational grazing of ruminant animals in particular completes the nutrient cycle, improves soil health and provides much needed carbon sequestration.

NOTES

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