AT A GLANCE

THE LIVESTOCK SECTOR TODAY

Livestock plays an important role in our food systems today, providing **livelihoods** for millions globally, but faces challenges such as **environmental impact**, **animal welfare**, and **human health.** Managing these impacts is crucial for shaping a **sustainable future.**

Livestock farming contributes to **14.5%** of human-caused **greenhouse gas emissions** [1]

Agriculture, especially livestock due to **land clearing**, threatens 86% species at risk of extinction [2]

Around **three-quarters** of land livestock are **factory-farmed** [3]

At any one time globally, there are:

27 billion

1.6 billion

1.3 billion

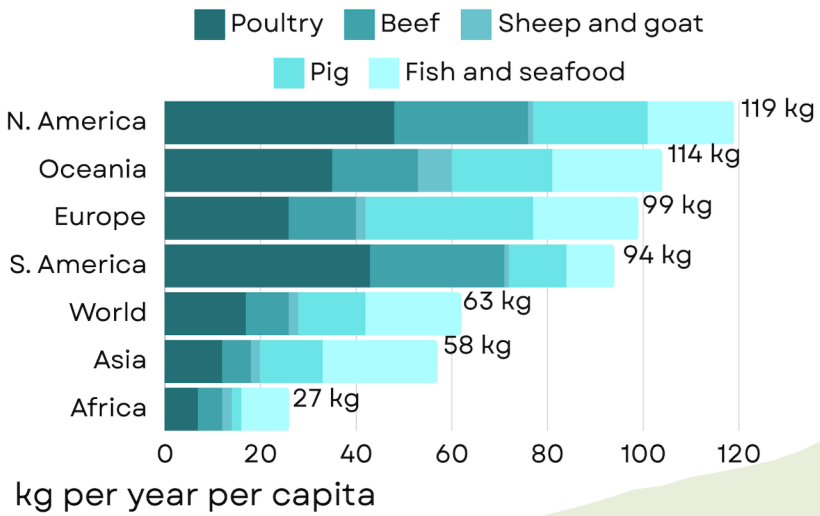
970 million

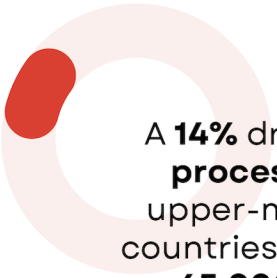
[5b]

That's nearly **4 times more** than people

Chicken bones are a **key marker** of the **Anthropocene era**, signifying humanity's profound impact on Earth's biosphere [4]

Per capita meat consumption by type, 2021 [5a]





A **14%** drop in **red and processed meat** in upper-middle income countries, **could prevent 65,000 deaths** [6]

Did you know?

Global meat production has **more than tripled** over the past 50 years [5]

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- [1] Food and Agriculture Organization of the United Nations. (2017). Livestock Solutions for Climate Change. Technical paper. Available at: https://openknowledge.fao.org/handle/20.500.14283/i8098en.
  - The FAO estimated this figure based on 2004-2005 data. However, more recent studies suggest a broader range of 11.1% to 19.6%, highlighting significant uncertainties and the evolving understanding of livestock's carbon footprint. However, reducing emissions from livestock remains crucial.
  - For ruminants, the largest contribution to production emissions is from enteric methane (>40%), and for monogastrics, it is from indirect emissions related to feed production (>50%) (Wirsenius et al., 2020).

- [2] United Nations Environment Programme. (2021). Our global food system is the primary driver of biodiversity loss. Press Release. Available at: https://www.unep.org/news-and-stories/press-release/our-global-food-system-primary-driver-biodiversity-loss.

- [3] Ritchie, H. (2023). How many animals are factory-farmed? Our World in Data. Available at: https://ourworldindata.org/how-many-animals-are-factory-farmed
  - The term 'factory farm' lacks a precise definition but is often equated with 'concentrated animal feeding operations (CAFOs)' in agricultural research and by the US Department of Agriculture (USDA). CAFOs confine animals for 45 days or more annually without outdoor access, with criteria varying based on animal type and facility size. This confinement often leads to crowded and uncomfortable conditions, particularly for smaller animals like chickens, which are densely housed relative to their size, restricting natural behaviors.

- [4] Bennett, C.E., Thomas, R., Williams, M., et al. (2018). The broiler chicken as a signal of a human reconfigured biosphere. *Royal Society Open Science, 5*(12), 180325. Available at: https://doi.org/10.1098/rsos.180325
  - This study highlights that chicken bones, due to the extensive breeding and population growth of broiler chickens by humans, are poised to become a significant geological marker of the Anthropocene, symbolising humanity's profound impact on Earth's biosphere.

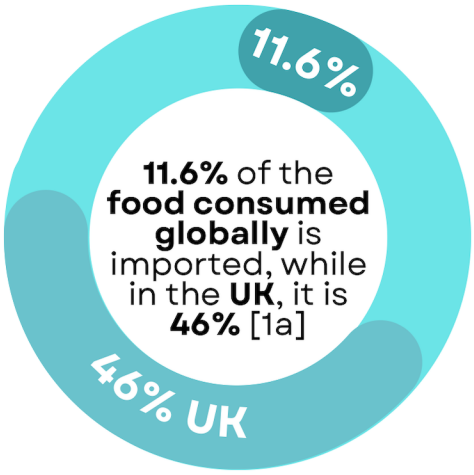
- [5] Ritchie, H., Rosado, P., Roser, M. (2023). Meat and Dairy Production. Available at: https://ourworldindata.org/meat-production
  - [a] The figures presented represent per capita meat consumption for various types in 2021, based on data from the Food and Agriculture Organization of the United Nations (2023). Actual consumption may vary from availability due to food wastage.
  - [b] The figures cited refer to total livestock numbers as live animals at a specific point in each year, distinct from figures for animals slaughtered or used for meat annually.
  - According to the UK government, in the UK, there are approximately 163m animals in livestock production systems, with respect to cattle, pigs, sheep and poultry. These populations sustain the weekly slaughter of approximately 33k cattle, 170k pigs, 240k lambs and 22m poultry, and the production of 220m eggs and 230kt cow's milk. In 2021, these outputs were worth approximately £16bn, almost half of the UK's total income from farming.

- [6] World Health Organization. (2023). Red and processed meat in the context of health and the environment: Many shades of red and green: Information brief. Available at: https://www.who.int/publications/i/item/978-92-4-007482-8
  - A reduction of 14% in the consumption of red and processed meat in upper-middle income countries, associated with an increase in plant-based food sources, might result in 65 000 fewer attributable deaths.

ROUTES TO SUSTAINABILITY

NAVIGATING FOOD TRANSPORT AND LOCAL SUPPLY CHAINS

Understanding the **environmental impact** of **food transportation** and **local supply chains** is vital in our **globalised economy**, shaping both **sustainability** and **food security.**



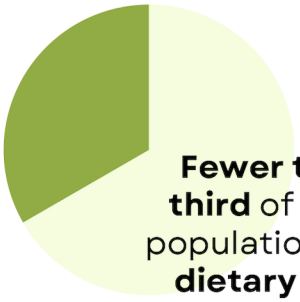
11.6% of the **food consumed globally** is imported, while in the **UK**, it is **46%** [1a]

The **emissions reduction potential** of **localising food** is **relatively small** [1b]

Some of the **highest carbon-intensive supply chains** are associated with **red meat consumption in China** [1c]

Vegetables, **fruit** and **dairy** have **high food-mile emissions** due to transportation needs e.g. temperature control [1]

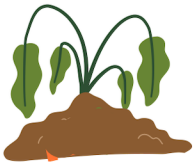
High-income countries account for **46% of international food-miles** and associated emissions despite comprising just **12.5% of the population** [4]

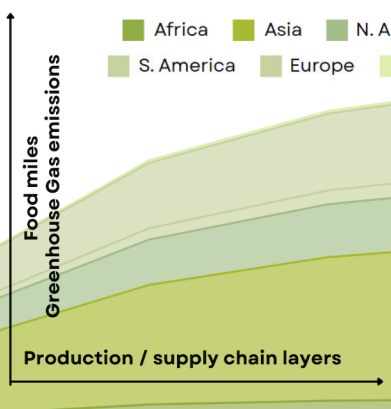


Fewer than one-third of the global population **can meet dietary demands from local crop production alone** [2]

Short supply chains offer direct **consumer-producer connections**, but **may not universally enhance food security or affordability** [2]

Localising production may require **intensive farming practices** that **stress ecosystems and biodiversity** [2]





Did you know?

Indirect supply chain emissions, e.g. including transporting fertilisers and machinery, **more than double** the direct emissions from food transport alone [1]

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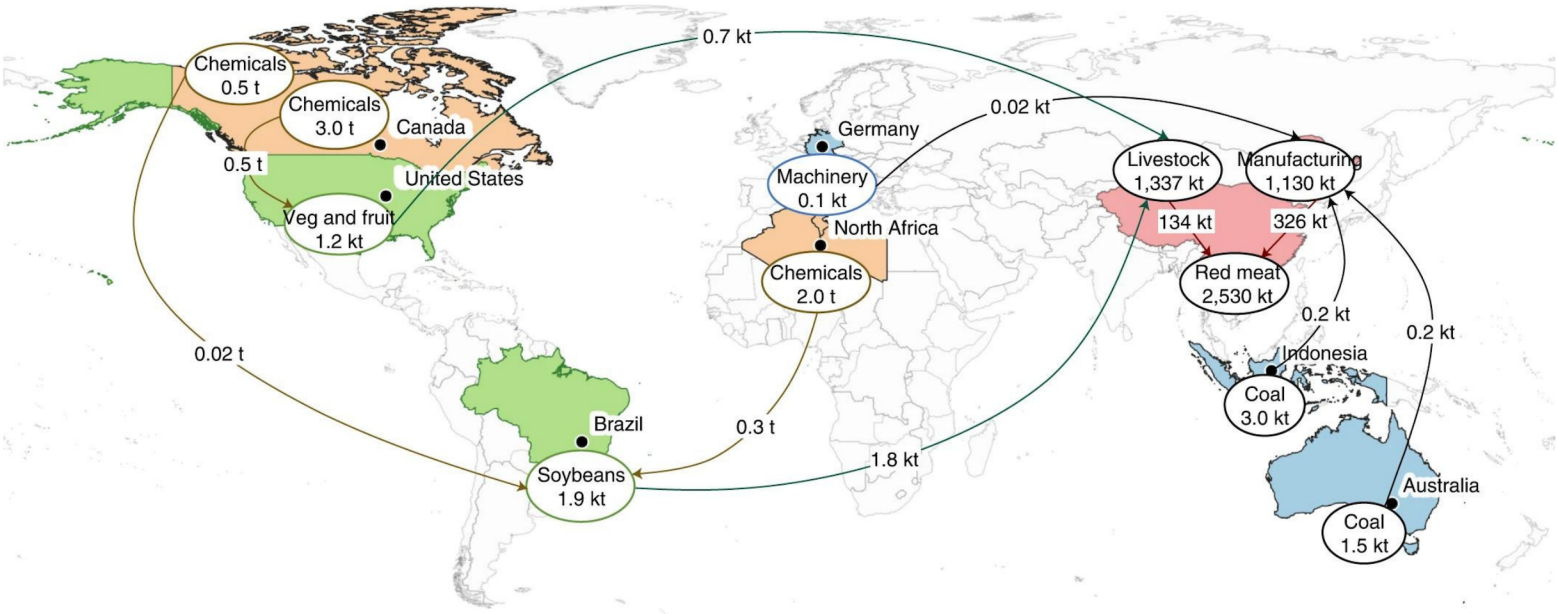
- [1] Li, M., Jia, N., Lenzen, M. et al. (2022). Global food-miles account for nearly 20% of total food-systems emissions. *Nat Food 3*, 445–453. Available at: https://doi.org/10.1038/s43016-022-00531-w

  - [a] 11.6% of foods consumed globally are imported. In terms of emissions, transport represents 20% when accounting for the whole supply chain for example including inputs. According to the Department for Environment, Food & Rural Affairs, the UK imports 46% of its food. United Kingdom Food Security Report 2021: Theme 2: UK Food Supply Sources. Available at:

  - [b] Switching to local food supply reduces emissions from long-distance transportation, primarily maritime shipping, which emits about 0.01–0.02 kgCO2e per tonne-kilometer (tkm). However, local supply increases emissions from domestic transportation, predominantly road transport, which emits significantly higher at 0.2–0.66 kgCO2e per tkm. Overall, the potential for emission reduction appears limited due to the varying emission intensities associated with different transportation modes and distances, influenced by refrigeration requirements and transport logistics.

  - [c] The global meat sector is a major contributor to food-production emissions, with China emerging as a significant meat importer due to dietary shifts. Consequently, some of the highest carbon-intensive supply chains are associated with red meat consumption in China. Road transport, with emission intensities ranging from 0.2 to 0.66 kgCO2eq per tonne-kilometer (tkm), contrasts starkly with maritime shipping, which emits only 0.01 to 0.02 kgCO2e per tkm.

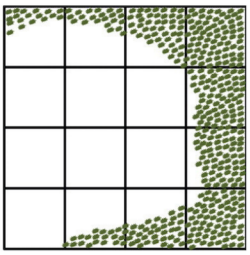


- [2] Stein, A.J., Santini, F. (2022). The sustainability of “local” food: a review for policy-makers. *Rev Agric Food Environ Stud 103*, 77–89. Available at: https://doi.org/10.1007/s41130-021-00148-w

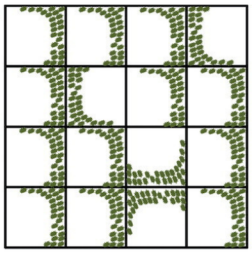
FARMING FOR TOMORROW

LAND SHARING VS. SPARING

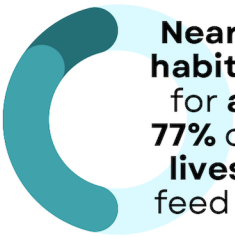
Land use and land use change are major drivers of **greenhouse gas emissions** and **biodiversity loss,** making effective land management essential for feeding a growing population and reducing environmental impact. Two strategies emerge: **land sparing** (intensive farming separate from nature), and **land sharing** (integrating farms with natural habitats).



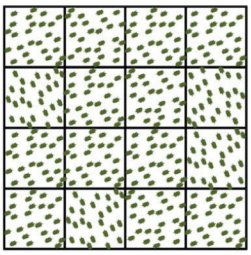
Land sparing across multiple farms [1]



Land sparing with each farm [1]



Nearly half of Earth's **habitable land i**s used for **agriculture**, and **77%** of that is used for **livestock** (including feed production) [2a]



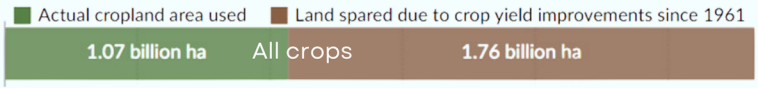
Land sharing [1]

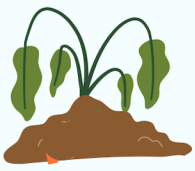
Land sparing

Concentrates agriculture on **minimal land** to **preserve native vegetation** [3]

Can benefit **generalist species that have adapted to our landscapes** [4]

Yield increases due to **breeding and management improvements** have already spared vast areas of land [2b]





Intensification can cause **soil erosion**, **fertility loss**, and **pollution** [3], requiring **sustainable management** to **preserve productivity** and **prevent degradation**.

Benefits primarily the **affluent,** potentially exacerbating **social inequalities** and **conflict** [3]

Land sharing

Integrates agriculture with biodiversity conservation to **enhance ecosystem functions** and **support wildlife** [3]

Can benefit **habitat specialists** (including rare species) **that fill niches outside of human adapted landscapes** [4]

Increased biodiversity improves **primary productivity**, **decomposition**, **carbon storage**, **pollination**, and **water retention** [3]

Surrounding **crops** with **trees**, **hedges**, and **natural predators reduce pests and plant diseases** [3]

Can **reduce productivity => expansion of agricultural areas** unless consumption patterns change (e.g., less meat).

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Did you know?

Agriculture is a **major driver of global land-use change**, impacting about **75% of Earth's land surface** [2]

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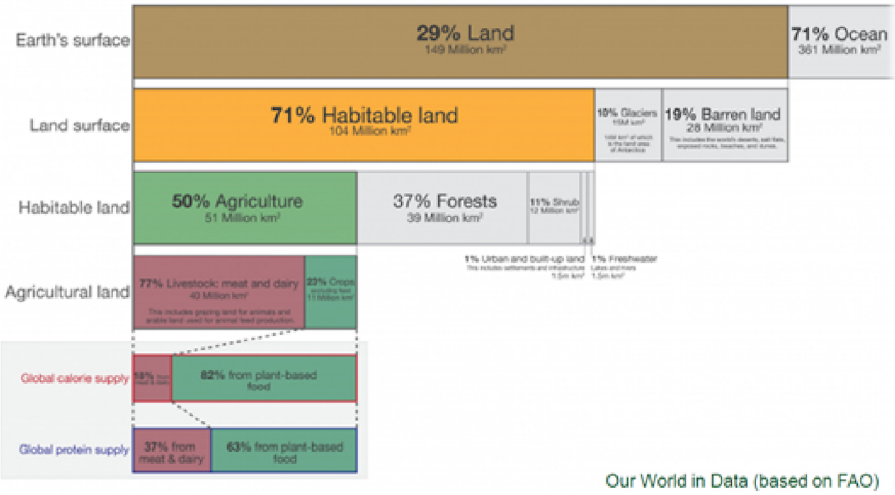
- [1] Balmford, A., Green, R., Phalan, B. (2012). What conservationists need to know about farming. *Proc. R. Soc. B. 279*, 2714–2724. Available at: https://doi.org/10.1098/rspb.2012.0515
    - In each figure, the same total area (denoted by the green shapes) is given over to wild nature, but recent evidence suggests that its value for other species and for ecosystem services might increase from right (land sharing) to left (land sparing across multiple farms) raising the question of whether certification could be realigned towards incentivising high-yield farmers to collectively set aside adjacent areas of land for conservation.
- 2) Ritchie, H., Roser, M. (2019). Land Use. Our World in Data. Available at: https://ourworldindata.org/land-use#all-charts
    - [a] Ritchie, H., Roser, M. (2019). Half of the world's habitable land is used for agriculture. Our World In Data. Available at: https://ourworldindata.org/global-land-for-agriculture
    - The figure below illustrates the current distribution of global land area. Approximately 10% is covered by glaciers, with an additional 14% comprising deserts and other barren land. The remaining portion, termed 'habitable land', is where human activities predominantly occur. Nearly half (44%) of the world's habitable land is utilised for agriculture, amounting to a vast area of 48 million square kilometers, roughly equivalent to five times the size of the United States. This agricultural land is divided into croplands, which make up one-third, and grazing lands, which account for the remaining two-thirds.



    - [b] Land spared = [Area that would have been needed without yield improvements] - [Actual crop land area in a given year]. The data is sourced from Food and Agriculture Organization of the United Nations (2023).
- [3] Alkemade, R., van Bussel, L.G., Rodríguez, S.L., Schipper, A.M., 2022. Global biodiversity assessments need to consider mixed multifunctional land-use systems. *Current Opinion in Environmental Sustainability*, 56, 101174. Available at: https://doi.org/10.1016/j.cosust.2022.101174
- [4] Green, R.E., Cornell, S.J., Scharlemann, J.P., Balmford, A. (2005). Farming and the fate of wild nature. *science*, *307*(5709), 550-555. Available at: https://doi.org/10.1126/science.1106049

SOWING CHANGE

ALTERNATIVE APPROACHES TO SUSTAINABLE FARMING

From **organic agriculture** to **agroecology**, **rotational grazing, integrated crop-livestock systems,** and **agroforestry**, these methods aim to protect our **environment,** and nurture **healthier ecosystems.**

Organic standards vary globally with certifications predominant in **N. America, Europe,** and **Australia.**

Generally bans **GMOs**, **synthetic nitrogen**, and most **synthetic pesticides**, limits **antibiotic use**, promotes **soil quality, crop rotation, biodiversity**, and **animal welfare.**

Agroecology focuses on regenerative use of natural resources and ecosystem services.

Not standardised like organic farming; principles include **enhancing biodiversity** and **soil health.**

Yields average **8 to 25% lower** than conventional systems, varying by crop type [2]

Could **lower external costs** of agricultural production in the UK by **75%,** from £1,514 million per year to £385 million [2]

Virtually eliminates synthetic **pesticide pollution and reduces chemical exposure for farm workers.**

Rotational Grazing

Prevents overgrazing, promotes grassland regeneration, and soil health.

Integrated Crop-Livestock Systems

Combines crops and livestock to enhance productivity and sustainability.

Agroforestry

Integrates trees and shrubs to support livestock, sequester carbon, and increase biodiversity.

Did you know?

Around **39% of consumers** are **willing to pay** a 30% premium for **organic food** [3]

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    - Several studies comparing organic and conventional farming systems found that organic yields are typically 8 to 25% lower than conventional yields. Different crops and farming practices show varying differences; for instance, rice, soybeans, corn, and grass-clover yield about 6 to 11% less in organic systems compared to conventional, while fruits and wheat yield around 27% to 28% less.

- [2] Pretty, J. N., Ball, A. S., Lang, T., Morison, J.I.L. (2005). Farm costs and food miles: an assessment of the full cost of the UK weekly food basket. *Food Policy 30*, 1–19. Available at: https://doi.org/10.1016/j.foodpol.2005.02.001

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Navigating Change

Redirecting Agricultural Subsidies for Public Goods

Agricultural subsidies profoundly influence **how food is produced and distributed globally**. Efforts to **reform these policies** aim to enhance sustainability, addressing **environmental**, **health**, and **social equity** concerns in farming practices.

Global agricultural subsidies amount to **USD 540 billion annually,** projected to increase significantly by 2030 [1]

These subsidies often **distort food prices, harm human health**, and **contribute to environmental degradation** [1]

Reform or **reorienting** of agricultural subsidies is needed to **better aligned prices towards less environmentally damaging and healthier foods**.

Emphasis on investing in **public goods** such as **research, development**, and **sustainable infrastructure** [1]

EU and UK Policy

The EU's **Common Agricultural Policy** (CAP) has shifted from production incentives to **support tied to environmental practices like biodiversity protection** [2]. But it **lacks robust indicators** for assessing **biodiversity**, **ecosystem services**, and **land-use changes** [3].

England and Wales' **Environmental Land Management scheme** (ELMs) replaces the Basic Payment Scheme. It **pays farmers for public goods** like **biodiversity** and **climate resilience** [4]. But, it faces criticism for **complexity**, **insufficient funding**, potential to **undermine food production**, and unclear **success metrics** [5].

The Scottish Parliament propose a **tiered agricultural support model** to start in 2025 [6]

Tier 1	**Base payments to support farmers and food producers.**
Tier 2	**Enhanced payments for businesses reducing greenhouse gas emissions and enhancing nature.**
Tier 3	**Elective payments for nature restoration, innovation, and supply chain support.**
Tier 4	**Complementary support for skills, training, advisory services, and climate change measurement tools.**

$1.8 trillion

Did you know?

Under current trends, global agricultural subsidies could rise to **USD 1.8 trillion by 2030** if not redirected towards more sustainable investments [1]

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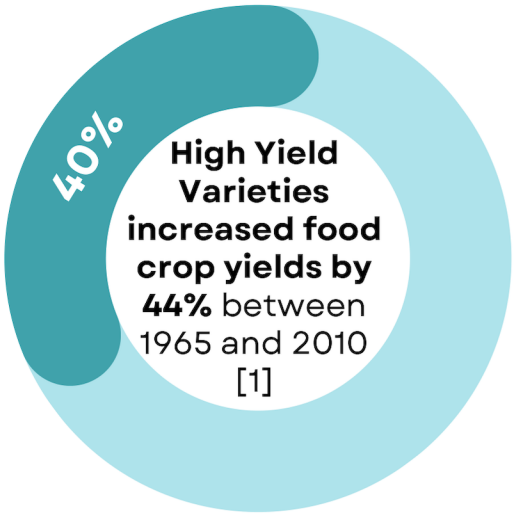
- [6] Brand, A. (2023). The Agriculture and Rural Communities (Scotland) Bill. Scottish Government. Available at: https://bprcdn.parliament.scot/published/2023/11/24/39b120ec-5b30-4af2-8633-3665d5902cbf/SB%2023-44.pdf

CROPS AND CONSEQUENCES

ENVIRONMENTAL FALLOUT FROM THE MID-20TH CENTURY AGRICULTURAL REVOLUTION

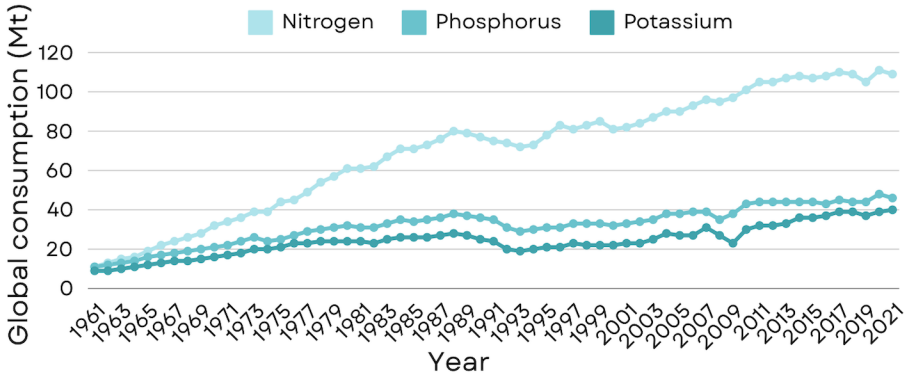
The mid-20th century **Agricultural Revolution**, driven by **high-yield crop varieties**, increased **mechanisation** and **intensive fertiliser use**, vastly increased food production but also raised challenges like **environmental sustainability**, **soil health**, and **global food security**.



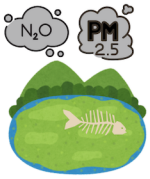
Mechanisation historically **displaced rural labour**, but using machinery also enabled the **expansion of cultivation**, **timely operations**, and **reduced physical strain** [2]

Intensive use of fertilisers contributes to substantial **nitrogen** (40–70%), **phosphorus** (80–90%), and **potassium** (50–70%) **losses** to the environment [3]

Global annual consumption of nitrogen, phosphorus and potassium for fertiliser production [4]



More than **50% of the global population** was fed with crops grown using **artificial fertilisers** as of 2015 [3]



Nitrogen fertilisers contribute to environmental issues like **nitrous oxide production**, **PM2.5 formation**, **biodiversity loss**, **water eutrophication**, and **air pollution** [5]

The challenge for the future lies in **balancing the benefits of increased productivity** with **sustainable practices that mitigate environmental impact**, **preserve soil health**, and **ensure long-term food security.**

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Did you know?

By 2050, the world will need to produce **double** the amount of crops to feed over nine billion people [6]

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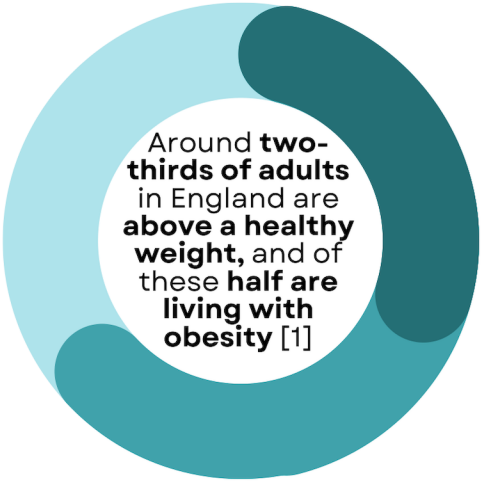
BUILDING HEALTHY DIETS, ONE BITE AT A TIME

Diet plays an important role in shaping **health** and **well-being**, impacting everything from **disease risk** to **energy levels**. A **balanced diet** rich in nutritious foods can promote longevity and vitality, while **poor dietary habits can increase risk of developing health issues.**



1 in 3 children leaving primary school are **overweight** [1]

Almost **one-in-ten** people in the world **do not get enough to eat** [5]

Three billion people cannot **afford** a **healthy diet** [6]

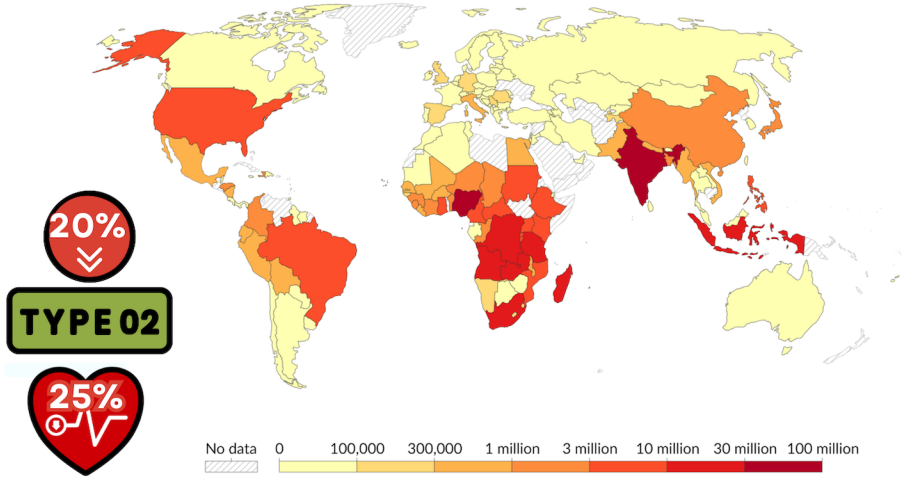
In 2022, **hunger** affected between **691 and 783 million people**, about 122 million more than in 2019 [7]. Additionally, **282 million people** faced acute **food insecurity** due to conflict, weather extremes, and economic shocks [8].

People who consume **red and processed meat ≥ 4 x per week** have a **20% increased risk of colorectal cancer** compared with those who consume it **< 2x a week** [2]

Increased consumption of meat **increases risk for many health conditions** [3]

Replacing **animal-based foods** with **plant-based foods** may **reduce the risk** of **type 2 diabetes** by **20%** and **cardiovascular disease** by **25%** [4]

Number of people globally that cannot afford a calorie sufficient diet, 2017 (a diet is deemed unaffordable if it costs more than 52% of a household's income) [6]



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Did you know?

On average, just **one-third of adults** in England had **5 or more portions of fruit and vegetables a day** ('5 a day') [9]

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  - Papier et al. (2021) examined associations of meat intake with the risk of 25 common health conditions, finding increased consumption resulted in increased risk for all conditions except iron deficiency anaemia; animal source food (ASF) consumption is an important modifiable risk factor.
  - According to Crowe et al. (2022), The processing of meat may cause its carcinogenic properties.
  - Although ASFs are often credited with supplying essential macro- and micro-nutrients, e.g. calcium, iron and iodine, these are almost never synthesised by the animals themselves, but taken from their own feed and vitamin/mineral supplements, or exist as an artefact of the production process, though the bioavailability is higher from ASFs (Beal et al., 2023).

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GREEN CUISINE

TOP TIPS FOR A HEALTHY AND SUSTAINABLE DIET

By making simple changes to your **eating habits**, you can contribute to your **well-being** and the **health of the planet**. Here are our top tips and flavourful ideas to reduce meat consumption and explore the diverse world of plant-based proteins.

It can take **30 bathtubs** of water to produce just **one beef burger** [1]

More than **three-quarters** of **global soy** is **fed to animals** [2]

Beef requires **55 times more land** to produce 100g of protein compared to 100g of protein from **peas** [3]

Food production methods affect emissions [4], but your **dietary choices have a much greater impact** [5]

Start Small
Begin by substituting one meat-based meal per week with a plant-based alternative.

Experiment with Flavours
Explore different cuisines that traditionally use less meat and more plant-based proteins.

Explore New Ingredients
Try cooking with ingredients like lentils, chickpeas, quinoa, and edamame to add variety and protein to your meals.

Get Creative with Recipes
Look for recipes that feature alternative proteins as the main ingredient, such as bean burgers, lentil curry, or tofu stir-fry.

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Did you know?

Skipping meat once a week can cut your yearly carbon footprint as much as **not driving for a month** [6]

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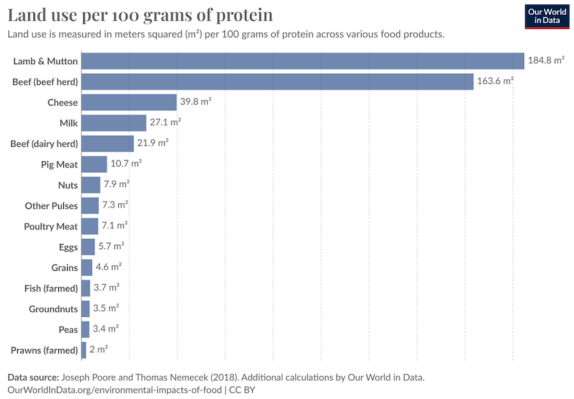

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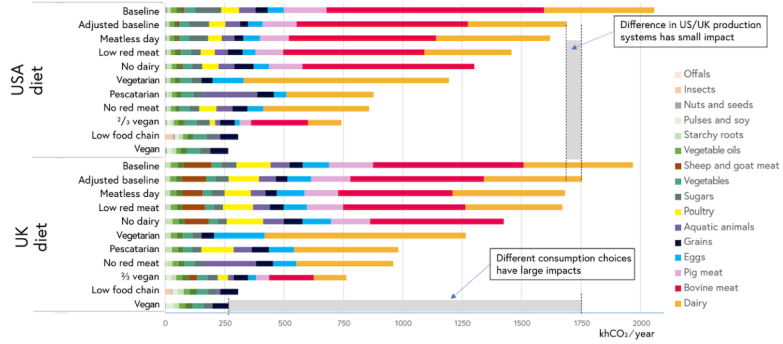

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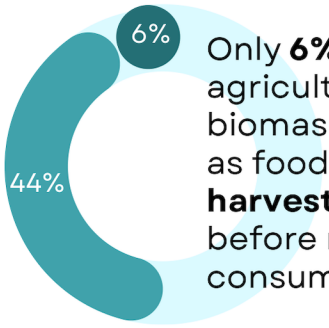
FROM FIELD TO FORK

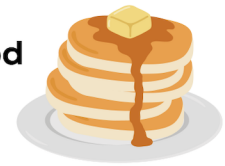
LOSSES, INEFFICIENCIES AND WASTE IN THE GLOBAL FOOD SYSTEM

Food loss and waste are critical issues that **undermine global food security** and **sustainability**. Astonishingly, **almost half of all harvested crops** are lost before reaching consumers, with inefficiencies in livestock production further exacerbating the problem [1].



Only **6%** of global agricultural dry biomass is consumed as food, with **44% of harvested crops** lost before reaching consumers [1]

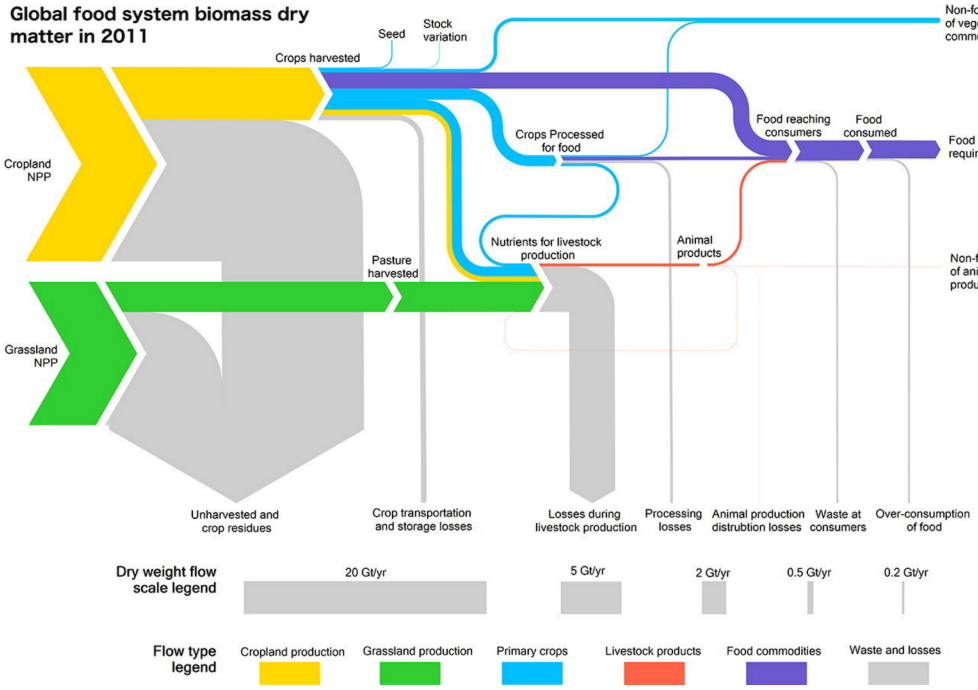
Overeating contributes as much to **food system losses** as **consumer food waste,** highlighting the need for better dietary habits [1]



Addressing **inefficiencies** and **changing consumer behaviour**, such as **reducing meat consumption** and **eating according to nutritional needs**, could significantly improve **global food security** [1]

Food production contributes **26% of global greenhouse gas emissions**, with **food waste alone responsible for 6% of total global emissions** [2] [3]

If wasted food were a country, it would be the **third-largest producer of carbon dioxide in the world**, after the USA and China [4]



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Did you know?

All the food produced but never eaten would be sufficient to **feed two billion people**. That's **more than twice the number of undernourished people** across the globe [4]

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    - The figure illustrates the significant inefficiencies in the global food system from crop production to human consumption in 2011, covering dry matter, energy, protein mass, and wet mass. The figure highlights that a large portion of biomass and energy is lost at each stage, particularly during livestock production. Major losses occur when crops are used for animal feed instead of direct human consumption. Despite improvements in crop yields and livestock efficiencies, substantial losses persist. The future reduction of these losses will depend on advancements in agricultural practices, technology, changes to diets, and responses to climate change.

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    - Food production is a major source of global greenhouse gas emissions, accounting for 26% of the total. Within this, food waste contributes significantly, responsible for approximately 6% of total global emissions. This figure reflects the environmental impact of inefficiencies throughout the food supply chain, where substantial amounts of food are lost due to spoilage, mishandling during transport and storage, and wastage at retail and consumer levels. The mitigation of these losses not only conserves valuable resources such as land, water, and energy but also plays a critical role in efforts to combat climate change on a global scale.

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