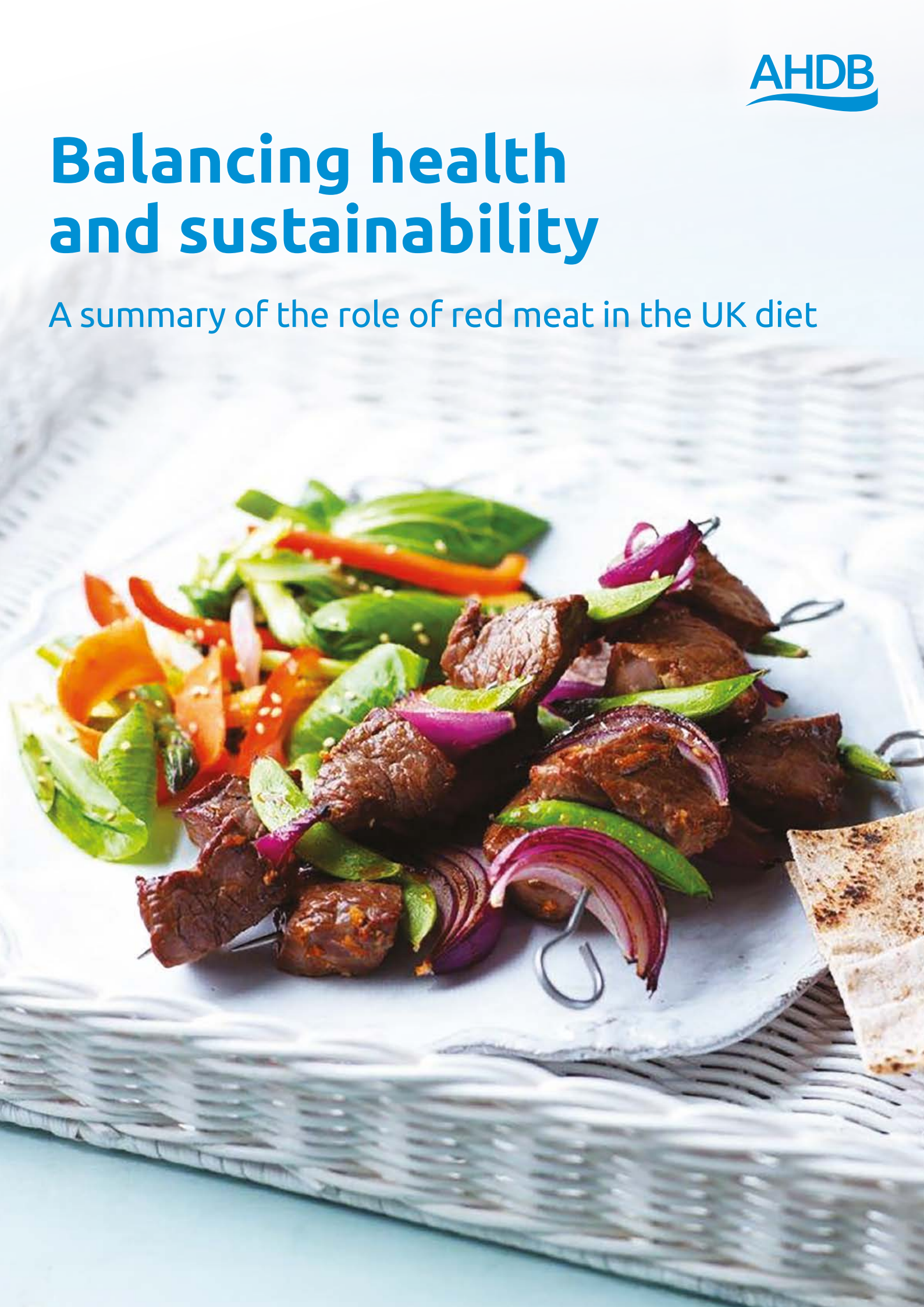
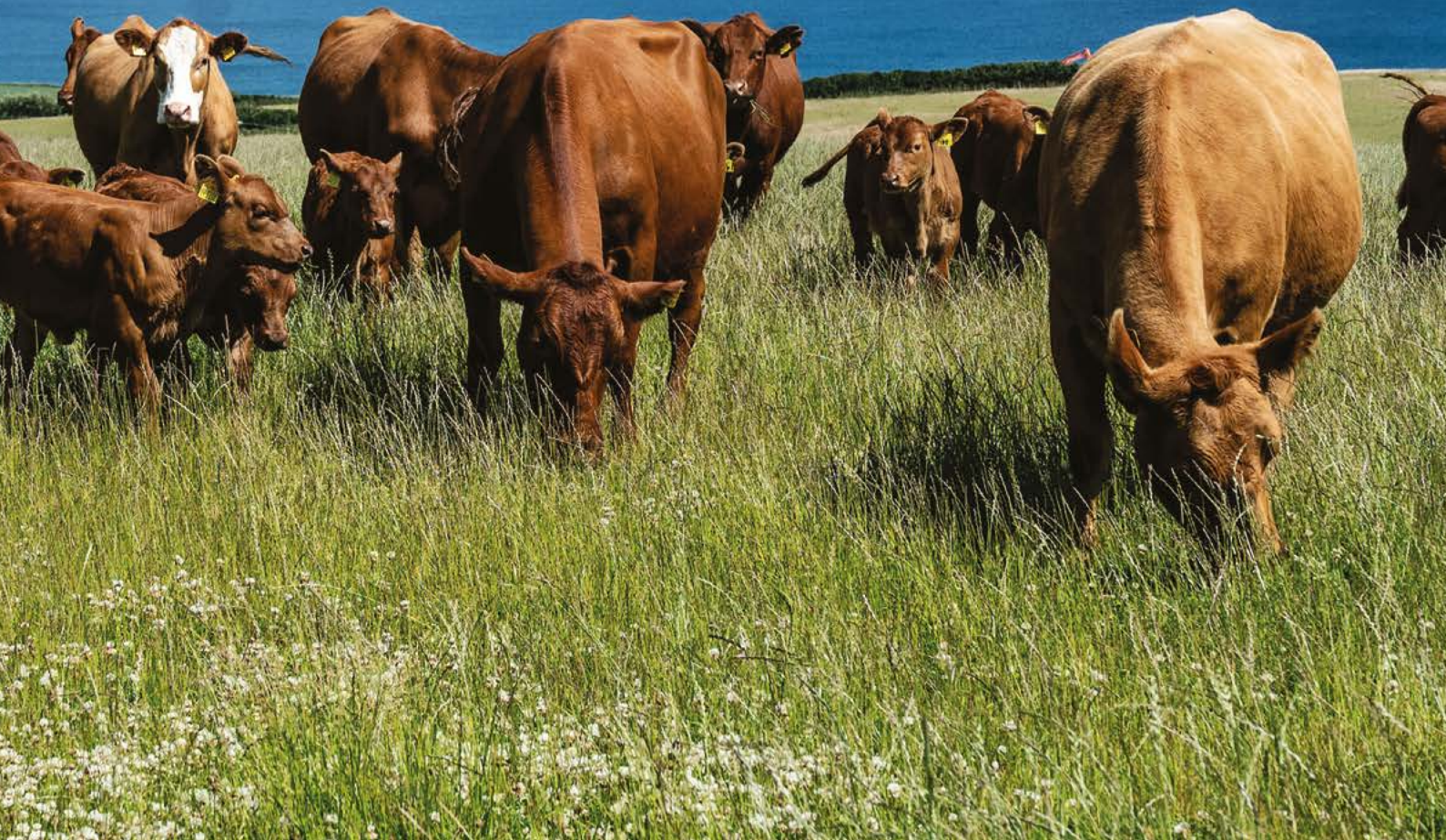
Balancing health and sustainability

A summary of the role of red meat in the UK diet



Contents



Introduction

This summary of the report ‘Balancing Health and Sustainability: The Role of Red Meat in the UK Diet’ examines how UK agriculture can contribute to improved nutrition, public health, environmental sustainability and global food security.

Red meat often provokes polarised discussions, but this report advocates for a balanced, evidence-based perspective on its role in the diet. While much attention has been given to its potential health implications, current research supports the inclusion of moderate amounts of unprocessed lean red meat within a balanced, plant-rich diet as a valuable component of a healthy lifestyle.

Beyond its role in human health, this report delves into the broader context of red meat production within food systems, including its environmental implications. Agriculture occupies a pivotal position in the sustainability conversation, with the ability to not only reduce greenhouse gas (GHG) emissions and store carbon, but also to deliver a raft of other public goods. With effective management, sustainable agricultural practices present an opportunity to achieve net-negative emissions, demonstrating the potential to support both human and planetary health.

“Beyond its role in human health, this report delves into the broader context of red meat production within food systems, including its environmental implications”

Food systems: The role of sustainability and nutrition

Growing concerns about climate change, malnutrition, non-communicable diseases and food insecurity have fuelled the push for healthy and more sustainable diets, leading to ongoing discussions about the environmental, health and ethical implications of red meat. Considering where our food comes from and how it is produced is of huge importance when it comes to the impacts on the environment and our health.

A plant-rich, nutritionally balanced diet benefits both our health and the planet. To achieve this in practice, we need to carefully consider several key factors: the nutritional value, bioavailability and health effects of including red meat in our diets; consumer behaviour and purchasing trends; as well as the environmental impacts of farming systems.

UK agriculture is responsible for 12% of total GHG emissions in 2022, with 7% of total emissions resulting from livestock farming. This is significantly lower than emissions from the energy (19%) and transport (25%) sectors.[1,2,3] Achieving net zero in the UK by 2050 requires improving agricultural practices and accurate measurement of the environmental impacts. This is also vital to ensure our food security and to provide high-quality nutritious food.

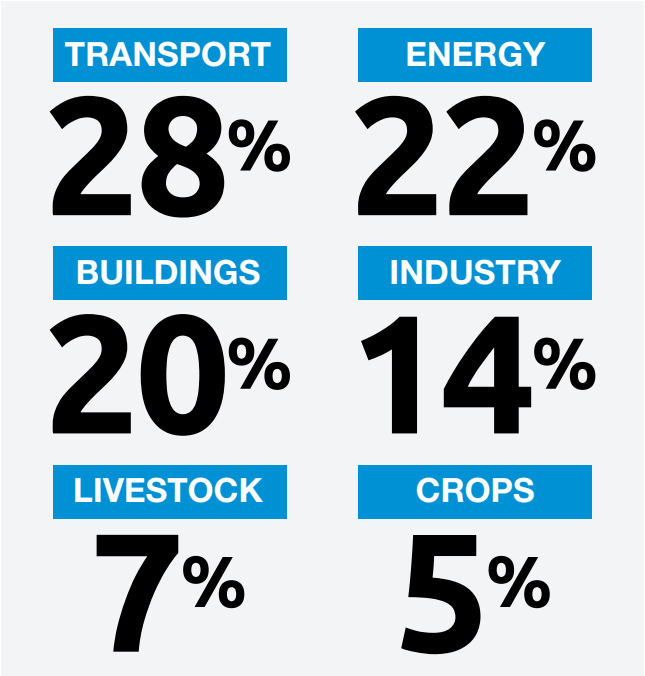


Figure 1. Carbon dioxide equivalent emissions of seven greenhouse gases from within UK borders

What is a healthy, sustainable diet?

"Sustainable, healthy diets are dietary patterns that promote all dimensions of individuals' health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable. The aim of sustainable healthy diets is to achieve optimal growth and development of all individuals and support functioning and physical, mental and social wellbeing at all life stages for present and future generations; contribute to preventing all forms of malnutrition (i.e. undernutrition, micronutrient deficiency, overweight and obesity); reduce the risk of diet-related non-communicable diseases (NCDs); and support the preservation of biodiversity and planetary health. Sustainable, healthy diets must combine all the dimensions of sustainability to avoid unintended consequences." (FAO 2019)[4]

Global food-based dietary guidelines are increasingly advocating reduced red and processed meat consumption for health and sustainability.

The UK's Eatwell Guide outlines a framework for a more sustainable, healthy diet, recommending a balanced diet that includes a diversity of whole plant-based foods, such as fruits and vegetables, legumes, whole grain carbohydrates, nuts and seeds, while still allowing the inclusion of animal-sourced foods, including meat, fish, eggs and dairy products.

How red meat is defined and why it matters?

Unprocessed red meat includes beef, lamb and pork (including fresh, minced and frozen). Processed red

Eatwell Guide's dietary recommendations

Less than 1% of the UK population currently follow the Eatwell Guide's dietary recommendations.[5] If everyone in the UK followed these dietary recommendations, diet-related disease would be significantly reduced and overall health would improve.[6] Greenhouse gas (GHG) emissions would also be reduced by a third, suggesting that aligning our diets to these guidelines would benefit both individual and planetary health.[7]

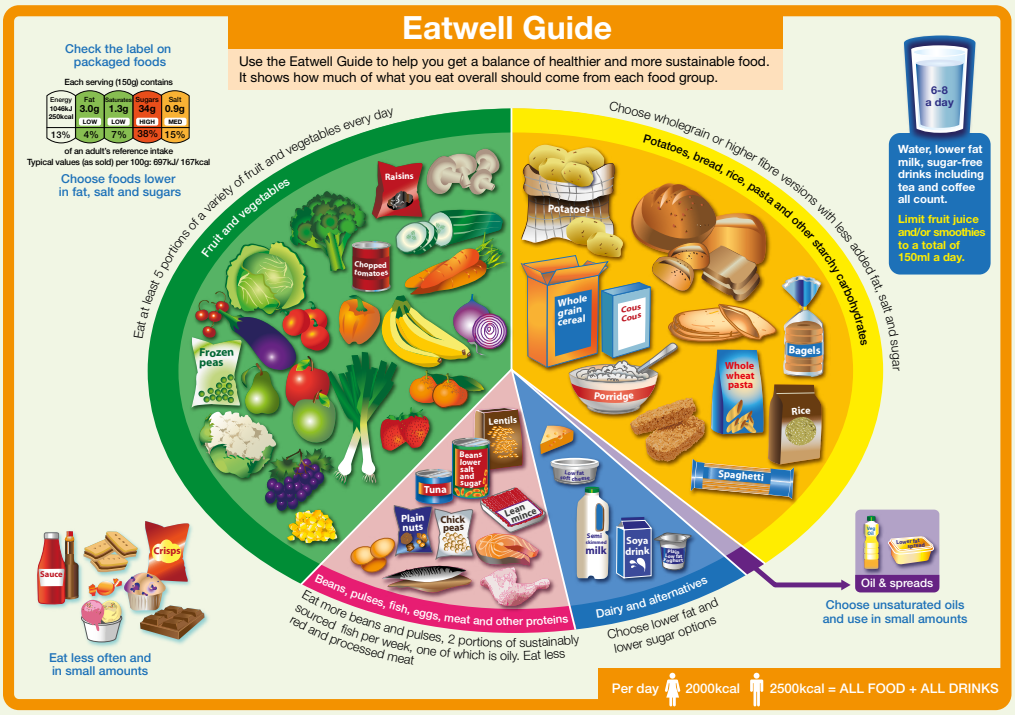


Figure 2. The Eatwell Guide – The UK government's healthy eating recommendations. The UK's food-based dietary guidelines are represented by the Eatwell Guide, which is a pictorial representation of government healthy eating advice. The guide represents a balanced diet and is applicable to children over five years, adolescents and adults. It does not apply to children under two as they have different nutritional needs

Source: Public Health England, in association with the Welsh Government, Food Standards Scotland and the Food Standards Agency in Northern Ireland.

meat refers to meat preserved by methods other than freezing, such as salting, smoking and marinating.

Definitions of unprocessed and processed red meat are often used inconsistently, and often grouped together in dietary guidelines, national surveys and research studies. For example, the UK Eatwell Guide and the National Diet and Nutrition Survey do not differentiate between unprocessed and processed red meat, despite their distinct definitions, processing methods, nutritional attributes and associated health risks.

To improve clarity, separating processed and unprocessed red meat in national surveys would enable comprehensive analysis of consumption patterns, nutritional contributions, health risks and benefits, as well as environmental impacts.

According to the Eatwell Guide, lean unprocessed red meat is a valuable source of key nutrients in the diet, especially for vulnerable population groups, like children, women of childbearing age, pregnant and breastfeeding women and older adults. UK dietary guidelines should focus on advocating high-quality lean unprocessed red meat as part of a healthy, balanced diet.

> "Being able to clearly distinguish between unprocessed and processed red meats is crucial as their nutritional profiles and associated health risk differ. Making this distinction would improve dietary messaging and help consumers make better-informed food choices"

Red meat's place in UK dietary guidelines

The UK's Eatwell Guide recommends less red and processed meat while eating more beans and pulses and including two portions of sustainably sourced fish a week.

More specifically, it recommends no more than 70 g a day or 500 g per week of unprocessed and processed red meat. Those who eat more than 90 g of unprocessed and processed red meat a day are advised to reduce their intake to 70 g or less to lower the risk of colon cancer linked to high meat consumption.[8]

It is important to avoid unintended consequences, such as health issues or nutrient deficiencies resulting from reduced meat intake. In 2010, the UK's Scientific Advisory Committee on Nutrition examined what the impact would be of reducing red meat intake on key micronutrients such as iron and zinc.[8] They found that reducing high red meat intakes down to 70 g a day would have little effect on iron deficiency risk, but it would slightly increase the proportion of adults at risk of zinc deficiency from 3.7% to just over 5%.

More recent analysis in this area has been conducted by Food Standards Scotland (see section: Targeting the eat less meat message, see page 10).

Recommendations from expert and academic groups

For the past few decades, global organisations have recommended upper limits for unprocessed and processed red meat. In 2003, the World Health Organization (WHO) and the Food and Agriculture Organization (FAO)'s expert report concluded that diets high in red meat are associated with certain types of cancer and recommended moderate consumption.

However, no United Nations (UN) agency has set specific targets for red meat production or consumption. Instead, the FAO/WHO guidelines recommend a healthy sustainable diet including "moderate amounts of eggs, dairy, poultry and fish; and small amounts of red meat."

Some expert groups are calling for food-based dietary guidelines to be reviewed and made more sustainable. For example, the EAT-Lancet Commission's Planetary Health diet advocates cutting global meat consumption by more than 50% by 2050, limiting intake to less than 98 g per week while still meeting nutritional needs.[9] However, concerns have been raised about the ability of this diet to provide adequate essential micronutrients such as iron, vitamin B12, calcium and zinc, as well the affordability.[10] Some scientists have emphasised the need to reassess the Planetary Health diet to include more animal-sourced foods (specifically beef and pork) to prevent micronutrient deficiencies, especially iron deficiency among women of childbearing age.[11]

Meat	Grams	Method
Lean beef mince	100	Use in a Bolognese sauce
Lean beef rump steak	130	Cut in strips and use for fajitas with plenty of peppers and mushrooms
Two pork sausages (grilled)	90	For a weekend brunch with poached eggs, tomatoes and mushrooms
Lean diced lamb	100	In a lamb kebab with pitta, salad and herby yogurt dressing
Pork chop (edible portion)	75	Use in a tray bake, with roasted vegetables
Total for the week	495	

Table 1. Example of how meat portions can be included in healthy balanced meals across the week

How much red meat are we eating in the UK?

Overall, meat consumption in the UK has been steadily decreasing since 2008.[12] Average red and processed meat consumption in the UK is currently within the recommended limit of 70 g per day:

> Average adult red meat intake is 56g/day, highest in men (19–64 yrs) at 69g/day and lowest in adolescent girls (11–18 yrs) at 46g/day[12]

The figures above are calculated by considering all adults, whether they eat meat or exclude meat from their diet. When we look at only those who eat meat, the average red and processed meat intake is 63 g a day for adults (aged 19y+), with 64% consuming no more than 70 g a day, equating to 53% of men and 73% of women.[13]

Younger adults generally consume more red and processed meat than older adults. For instance, men aged 19–39 years average 86 g a day, with amounts ranging from 13 g to 196 g per day. This group is also the most likely to exceed the 70 g a day threshold for red and processed meat (54% of 19–39 year-olds) (Figure 3).[13]

There is also a segment of the population that does not consume red and processed meat at all. Women aged 40–64 years were the group with the highest figure (of 16%) who did not eat red or processed meat.[13]

Over the last 40 years, unprocessed lean red meat consumption has notably declined, while the consumption of poultry and processed meats has increased.[14] Consumer preference for more processed foods is reflected by the data, showing that purchases of processed and other meat products are, on average, more than double that of red and poultry meat[15] (Figure 4).

Interestingly, there is an almost equal split between the average consumption of red meat versus processed meat by adults aged 19+ years (40 g vs 36 g a day). In adults aged 19–39 years, the split is the same: 40 g vs 40 g a day on average of red and processed meat.

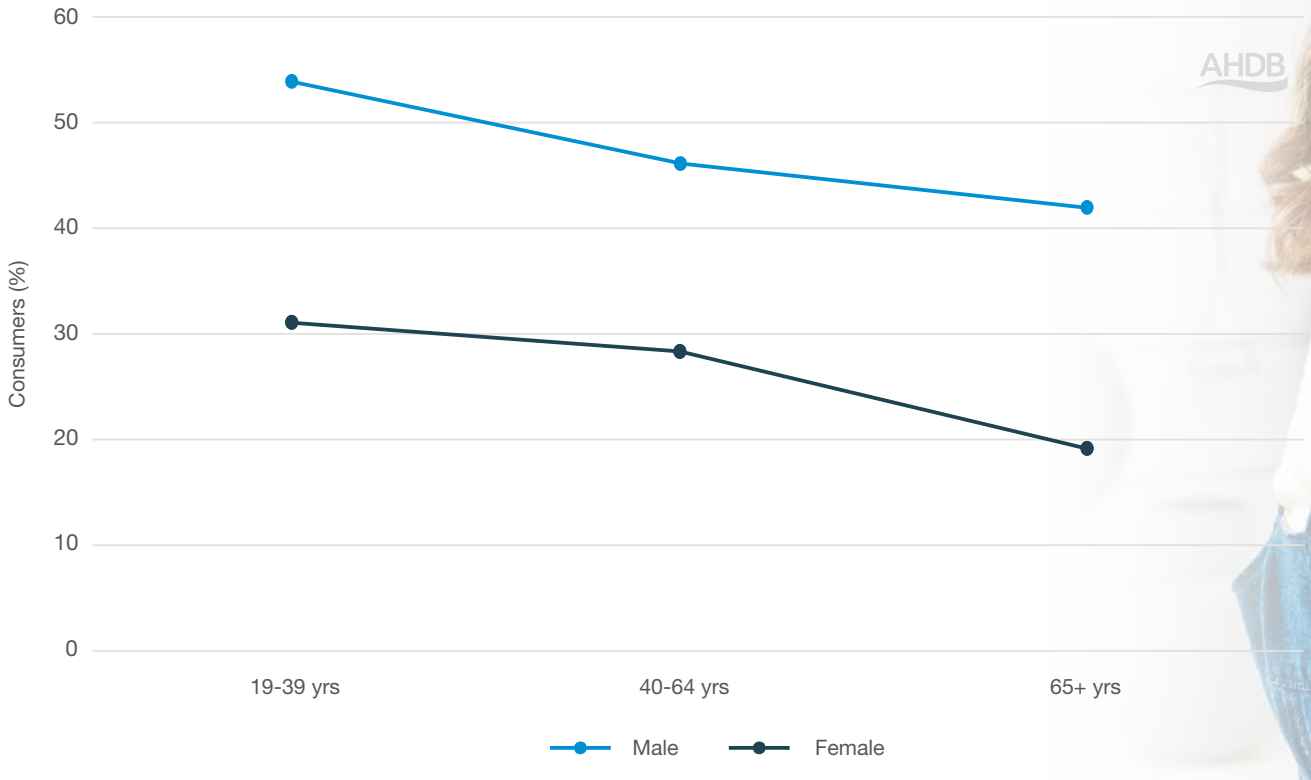


Figure 3. Males and females who eat more than the 70 g a day threshold for red and processed meat

Source: Secondary Analysis of NDNS Data [Years 9–11 (2016/17–2018/19) conducted by the British Nutrition Foundation][13]

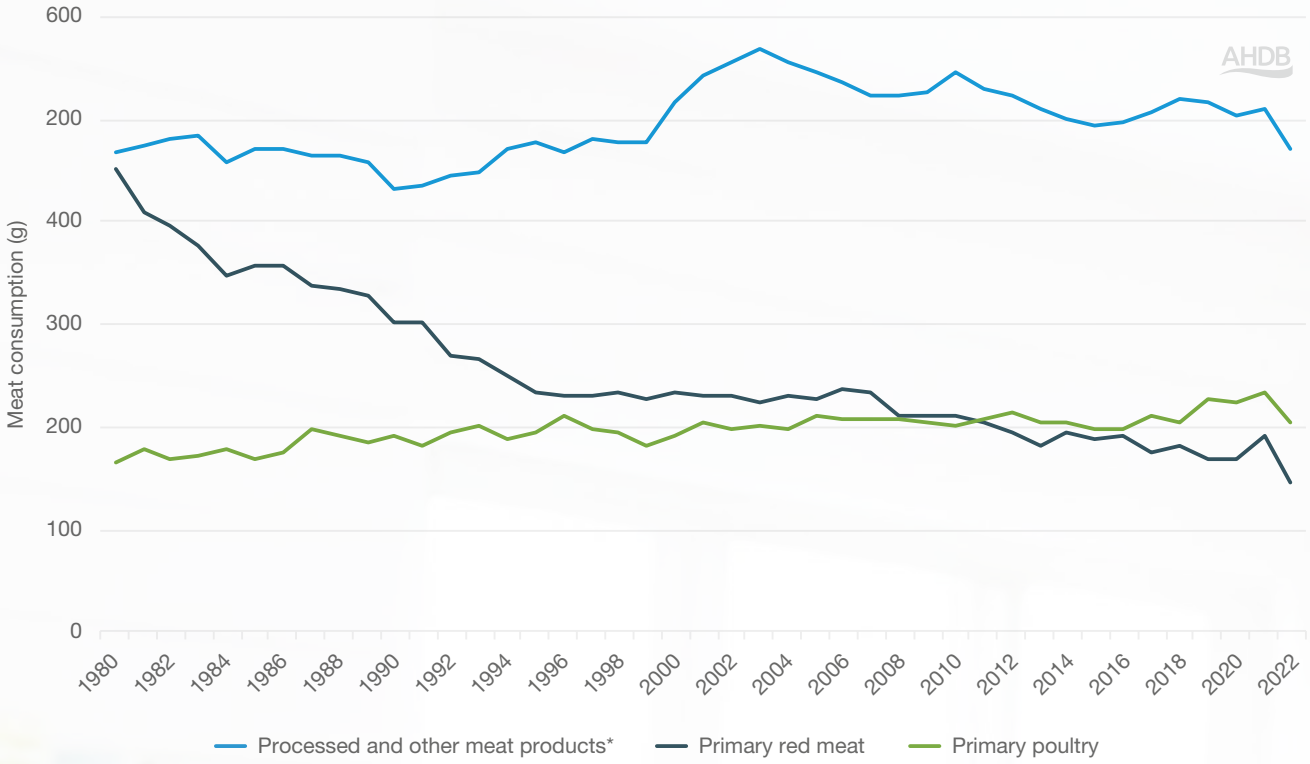


Figure 4. Comparison of household purchases (average grams per person per week) of red meat, poultry and processed and other meat products (1980–2023)

Primary red meat includes beef joints, beef steaks, minced beef, veal, mutton, lamb joints, lamb chops, pork joints, pork chops, pork fillets and steaks and all other non-processed beef, lamb and pork. **Primary poultry** includes uncooked chicken and other uncooked poultry. **Processed and other meat products** include bacon and ham, cooked meat, canned meat, sliced meat, corned meat, sausages, meat pies, sausage rolls, burgers, ready meals and convenience meat products, meat pastes and spreads, and other fresh, chilled and frozen meat.

Data does not include offal, fish or takeaways.

Source: Defra (2023)[14]

Targeting the ‘eat less meat’ message

> “Aligning with the Eatwell Guide and current recommendations of a maximum of 500 g of lean red meat weekly (or 70 g/day) as part of a varied, healthy diet would ensure that meat reduction efforts do not compromise micronutrient intakes, particularly among vulnerable groups such as children, pregnant women and older adults”

Food Standards Scotland recently analysed red and processed meat consumption in Scotland to assess the impact on nutrient intakes of achieving the Climate Change Committee’s target of a 20% reduction in meat intake by 2030.[15] They found that if heavy meat eaters (currently 28% of the adult population, primarily men aged 25–34y) reduced their intake to 70 g a day, total meat consumption would drop by 16%, making significant progress towards meeting climate change targets.

Food Standards Scotland advises focusing on wider adherence to the Eatwell Guide recommendations to address health and climate change concerns. However, they caution against reducing red meat intake below current guidelines (from 60–31 g per day). This could lower key nutrient levels, like iron, zinc, selenium and vitamin B12, in a population already at risk of deficiencies. Instead, encouraging heavy meat eaters to cut back while adding more plant-based foods and increasing fibre can support both health and environmental goals.

Additionally, since the consumption of unprocessed versus processed meat is similar among adults, particularly those aged 19–39 years, more targeted messaging is needed to reinforce the advice on processed meats. The recommendation for processed meat is to eat it sparingly or in minimal amounts.[16]

Nutritional consideration of red meat

Red meat packs a lot of nutrients in a small serving, meaning moderate portions are highly effective in meeting nutritional needs.

Maximising nutrition with moderate portions

Red meat is considered a source, or rich source, of 11 micronutrients. These include vitamins and minerals often found to be at low intake levels in the population, such as iron, zinc, selenium and vitamin B2.

Even a small amount of iron from red meat can significantly contribute to iron intake compared to plant-based sources. Animal-based foods like meat, fish and poultry provide haem iron, the most bioavailable form of iron.[17] Haem iron absorption from a Western diet is approximately 25%, in contrast to an absorption of around 8% from plant-based iron sources.[18,19]

> “Due to non-haem iron being absorbed less efficiently, vegetarian and vegans may need to consume nearly twice the amount of iron compared to meat eaters”[20]

Nearly half of adolescents and a quarter of women aged 19–64 years have iron intakes below the Lower Reference Nutrient Intake (LRNI) – a level of intake which meets only 2.5% of the population’s needs. Additionally, NHS hospital admissions for iron deficiency anaemia in England have more than doubled from 2013/14 and 2022/23, rising from 196,685 to 490,005 cases, indicating a significant year-on-year increase.[21]

Babies, infants, young children, adolescents and women of childbearing age have increased iron needs due to growth, menstruation and pregnancy, making them more susceptible to iron deficiency. Over 90% of Scottish women of childbearing age (16–44 years) already fall short of the recommended iron intake.[15] Notably, this is before the climate change committee targets to reduce meat intake by 20% and 30% have been implemented.

Food fortification

Consuming foods fortified with essential nutrients can help boost levels within the body. While fortification of plant-based products can help, unlike animal foods, they do not provide the complex matrix of biological compounds that influence metabolism and nutrient absorption, which may provide additional health benefits.

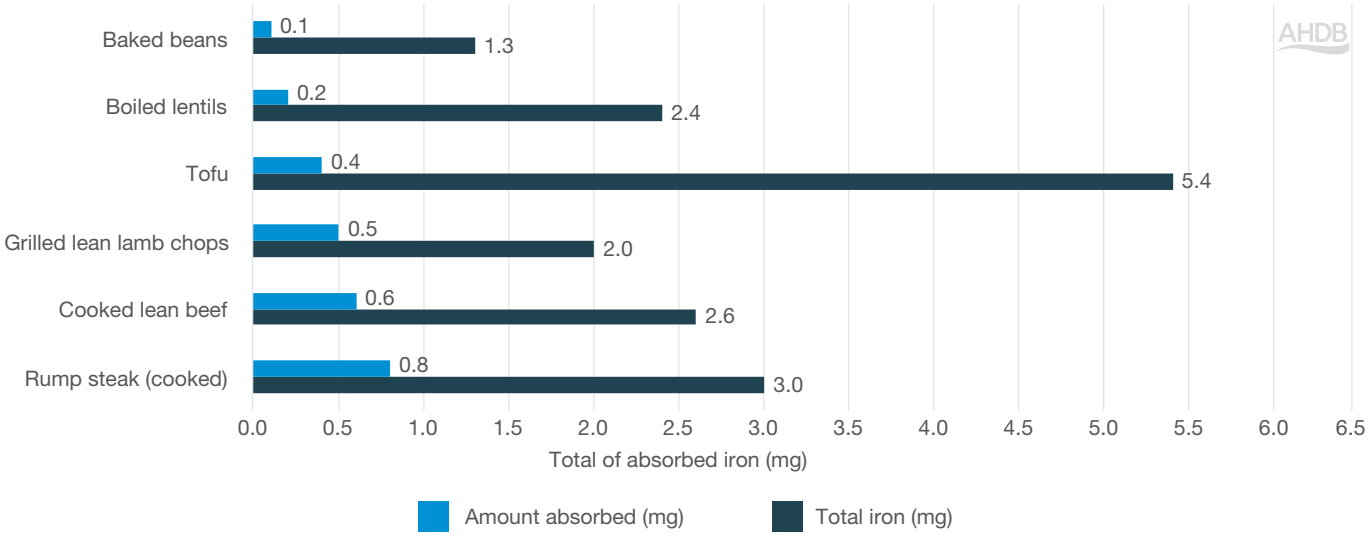


Figure 5. Total iron content and absorption from 100 g of haem (meat) versus non-haem (plant) foods
Source: New Zealand Institute for Plant and Food Research Limited and Ministry of Health (2021)

There remain significant variations in fortification practices, with many plant-based meat and dairy alternatives lacking key nutrients such as vitamin B12, calcium and iodine.[22,23] Consistency and improvements in fortification of plant-based alternative products are necessary to enhance the nutrition provided by such products.

Encouraging a healthy, balanced diet that includes a variety of plant foods and adequately fortified plant-based alternatives is needed. Interestingly, there is a synergistic effect of including some meat in a plant-based diet.

The meat factor and mineral absorption

Adding meat into meals with plant-based iron sources enhances the absorption of non-haem iron, due to the haem iron in meat. This is known as the Meat Factor. This increases the bioavailability of minerals, including iron, from plant-based foods.[20] A UK health claim supports this, stating that consuming 50 g of meat or fish with non-haem iron-rich foods improves iron absorption.[24]

> Consuming 50 g of meat or fish with non-haem iron-rich foods improves iron absorption (approved UK health claim).

Additional ways to increase iron absorption from plant foods

Plant-based foods often contain anti-nutrients, such as phytates in wholegrains and beans, which can reduce mineral absorption, including iron and zinc. Drinking tea and coffee, which have trypsin inhibitors and tannins, also have the same effect.

To improve mineral absorption, it is recommended to avoid drinking tea or coffee with meals and to pair plant-based foods with vitamin C-rich foods. For instance, combining plant-based iron sources with vitamin C can increase absorption by two to threefold. Good combinations include a green leafy salad with orange segments or a citrus dressing, or a chickpea and red pepper salad.

Balancing animal and plant proteins for optimal nutrition

Animal and plant proteins each provide distinct benefits. Red meat provides a higher protein content and a better amino acid profile compared to plant-based foods. Animal proteins have higher digestibility (>95%) compared to plant protein (50–80%), which is mainly due to a better distribution of essential amino acids.[25,26]

Red meat not only provides all nine essential amino acids but it is also rich in branch-chain amino acids, like leucine, which is essential for muscle protein synthesis and preventing muscle breakdown. In contrast, evidence suggests vegans have 47% lower blood levels of amino acids.[27]

Some plant-based foods, such as soy foods, quinoa and mycoprotein/Quorn™, are complete proteins, meaning they provide all nine essential amino acids. However, plant-based foods tend to have a lower protein content and provide fewer essential amino acids and branch-chain amino acids. This means a greater variety of plant proteins, and in greater amounts, are needed to meet nutritional needs. A complete amino acid profile from plant-based proteins requires careful dietary planning.

In terms of the overall nutritional profile, red meat provides essential nutrients, like iron, zinc, vitamin B12 and selenium, but lacks fibre. Plant sources of protein offer fibre and micronutrients, like folate, although they lack haem iron and vitamin B12. Therefore, consuming a variety of both animal and plant-based protein foods, ideally together, can enhance overall nutritional balance.

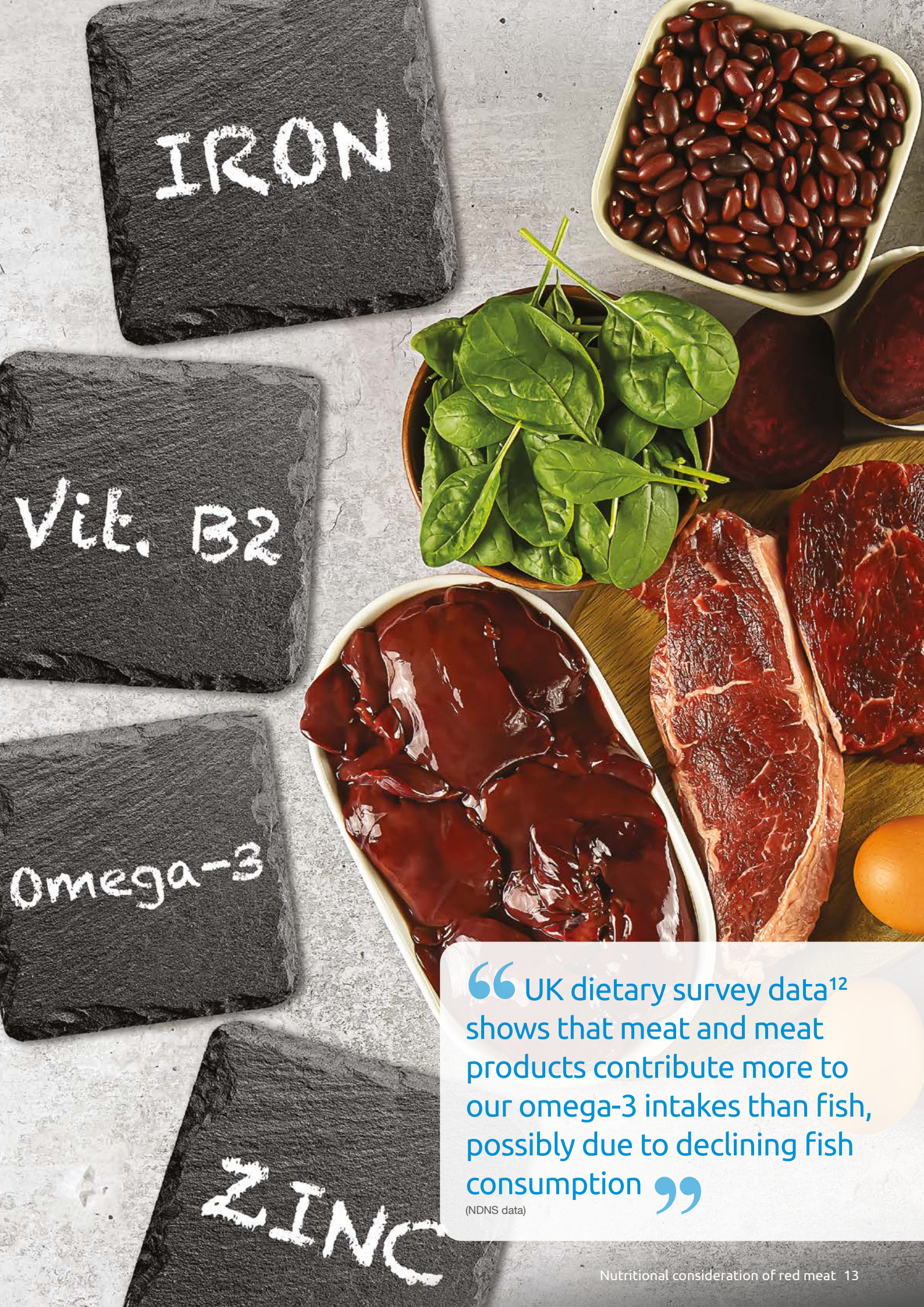
A mix of different types of fat

While animal foods are often associated with being high in saturated fat, lean cuts of meat, when trimmed of visible fat, can be low in total fat and saturated fat.

When looking at national dietary survey data, the contribution that red meat makes on its own to saturated fat intakes is between 3 and 6%. Whereas processed meats, such as bacon, ham, burgers, kebabs, meat pies and pastries, and sausages, contribute 6–11% to saturated fat intakes. Overall, red and processed meat contributes up to 11% of total fat and 13% of saturated fat intake in adults.[13]

Red meat contains a mix of fats, including significant amounts of unsaturated fats, particularly monounsaturated fats. Red meat typically consists of 40% saturated fats, 40% monounsaturated fats, 5% trans fats (with raw, lean lamb and beef at 0.01% and 3.25%, respectively) and 4% polyunsaturated fats.[28]

Although present in relatively small quantities, the unsaturated polyunsaturated fatty acids in red meat can help to enhance our omega-3 intakes.



> UK dietary survey data[12] shows that meat and meat products contribute more to our omega-3 intakes than fish, possibly due to declining fish consumption
>
> (NDNS data)

The nutritional implications of not eating meat

Eating a plant-rich diet undoubtedly has benefits to health and the environment. One of the most important benefits of eating more plant foods is the fibre, which supports a healthy gut microbiome.

With less than one in 10 people in the UK currently achieving the 30 g a day fibre recommendation, encouraging more whole plant foods in the diet will help improve the health and nutrition of the population.

It is important to note that although a diet with no meat can be nutritionally adequate, it needs careful planning. Low intakes of essential nutrients, such as iron, zinc, B-vitamins and vitamin D, are of concern in some groups of the population. For example, in the UK, almost 50% of teenage girls and 25% of women have low iron intakes.[12] While fortification can help, it often does not replicate the complete nutrient profile of whole foods.

The scientific evidence suggests that adopting sustainable diet strategies may compromise micronutrient intake and status.[29] Specifically, plant-based and flexitarian diets could result in lower intakes of vitamin B12, iodine, zinc and haem iron, as well as the contribution to vitamin D intake, compared to meat-inclusive diets, putting vulnerable population groups at risk of micronutrient deficiencies (see section: Valuable nutrition for vulnerable life stages, see page 15).

The UK faces the challenge of low intakes of essential nutrients combined with excessive consumption of unhealthy foods, hindering progress towards healthy, sustainable diets. Also, it is unclear what alternatives people will choose when reducing meat consumption such as fish, eggs or plant-based meat alternatives. Improving overall dietary habits is essential. Gradually adopting small changes, like mindful eating, meal planning and increasing plant variety in meals and snacks, can help shift eating habits towards healthier choices.

Valuable nutrition for vulnerable life stages

It is well recognised that red meat is a valuable source of high-quality protein and essential micronutrients, particularly during key life stages.

Women of reproductive age

Red meat, especially beef and lamb, is nutrient dense, making it valuable for women of reproductive age and during the first 1,000 days of life. Women's higher iron needs due to menstrual blood loss and reduced red meat consumption raises concerns about inadequate iron and zinc intake. In the USA, iron deficiency among women of reproductive age rose from 13% to 20% between 2004 and 2016, partly due to a 15% decline in red meat consumption.[30] A similar trend is seen in the UK where 20% of women of reproductive age are iron deficient, which coincides with reduced red meat consumption.[12]

Pregnancy and breastfeeding

During pregnancy and breastfeeding, natural nutrient-dense foods, like red meat, can play a significant role in meeting the nutritional needs of both the mother and her baby. This includes providing iron-rich blood to the developing foetus, reducing infection risk and ensuring a healthy supply of breast milk which delivers essential nutrients to the growing baby. Although iron requirements for pregnant women in the UK are the same as for non-pregnant women (14.8 mg/day),[31] other countries, such as the USA and Canada, recommend 1.5 times higher iron intake during pregnancy.[32] There has been little research in the area of nutrition and plant-based eating during pregnancy. A recent study of 134 participants examined maternal B-vitamin status before, during and after pregnancy.[33] The findings revealed that many women in high-income countries had insufficient vitamin levels, with some experiencing vitamin B6 deficiency in late pregnancy.

Weaning, infants and young children

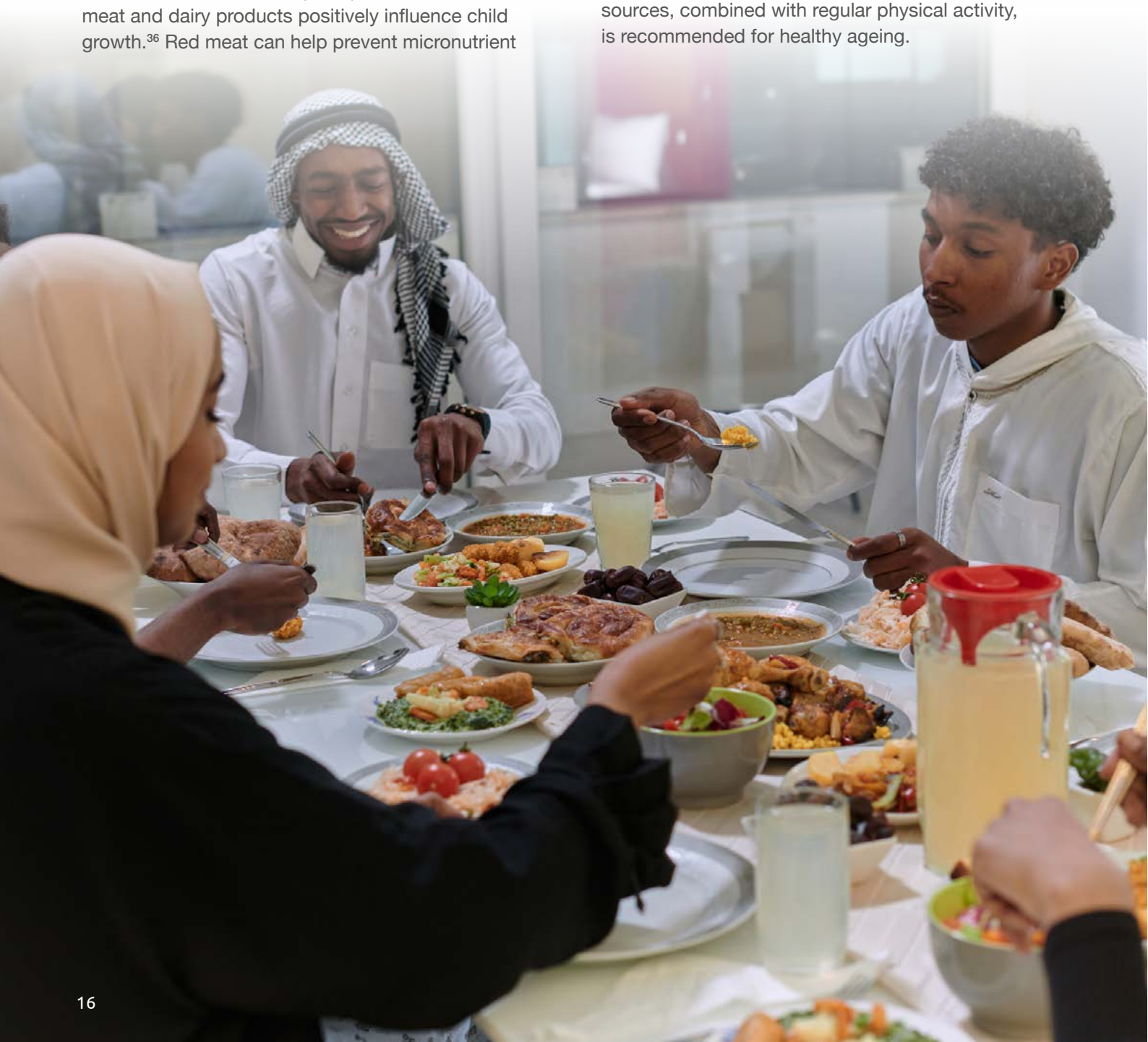
During weaning, infants and young children require diets rich in essential amino acids, iron, zinc and vitamin B12, typically from animal-based foods, to support rapid growth and cognitive function. For example, including red meat in the diet significantly increases children's body length for their age.[34] With their small stomachs, nutrient-dense foods are crucial for adequate nutrient intake. Too much fibre from plant foods can quickly fill a baby's or young child's small digestive tract. It is important to deliver a balanced variety of foods to ensure they get adequate nutrition. Offering smaller, more frequent meals can help meet their dietary needs. Introducing red meat into the weaning diets of breastfed babies can help prevent iron deficiency during the first year of life, particularly when there is a risk of inadequate iron intake.[35] Systematic reviews, meta-analyses and randomised control trials (RCTs) demonstrate that meat and dairy products positively influence child growth.[36] Red meat can help prevent micronutrient deficiencies that are common among preschool children, particularly iron and zinc, which affect growth, cognition and immune function.

Puberty

The growth spurt during puberty increases the demand for essential nutrients like amino acids fats, iron and zinc for physical and cognitive development. A diet rich in high-quality protein, B-vitamins and minerals (iron, zinc and selenium) is crucial for reproductive maturation and brain development.

Older adults

Maintaining muscle mass to prevent muscle wasting (sarcopenia) is vital for older adults. Red meat is recommended as a nutrient-dense food that supports muscle health, cognitive and immune function, and may help to reduce deficiencies in iron, zinc and B12. A balanced diet with both plant and animal protein sources, combined with regular physical activity, is recommended for healthy ageing.



Health impacts of red meat

The link between red meat and chronic diseases has been widely explored. However, the scientific community continues to debate the evidence, as an association does not imply cause. It is challenging to identify a single food as a cause of a disease because multiple dietary and lifestyle factors may be involved. The current evidence supports the recommendation of moderate amounts of lean red meat as a part of a healthy, balanced diet and lifestyle.

Understanding the evidence used in nutrition and health research

Understanding the levels of scientific evidence is important when looking at how red meat consumption might impact our health and risk of disease.

Observational studies, which look at associations, provide the lowest evidence level. Randomised controlled trials provide stronger insight on possible cause and effect between dietary factors and disease. Systematic reviews and meta-analyses, which combine results from many studies, offer even stronger evidence. At the very top are umbrella reviews which bring together multiple systematic reviews and meta-analyses, offering the highest levels of scientific evidence.

Systematic reviews and meta-analyses of observational studies suggest a link between red and processed meat consumption and increased risks of colorectal cancer, cardiovascular disease and type 2 diabetes. However, stronger evidence from randomised controlled trials often does not support a strong causal relationship.

A healthy, balanced diet is crucial in reducing the risk of chronic diseases. The following sections summarise the evidence on how red meat consumption affects the risk of colorectal cancer, cardiovascular disease and type 2 diabetes.

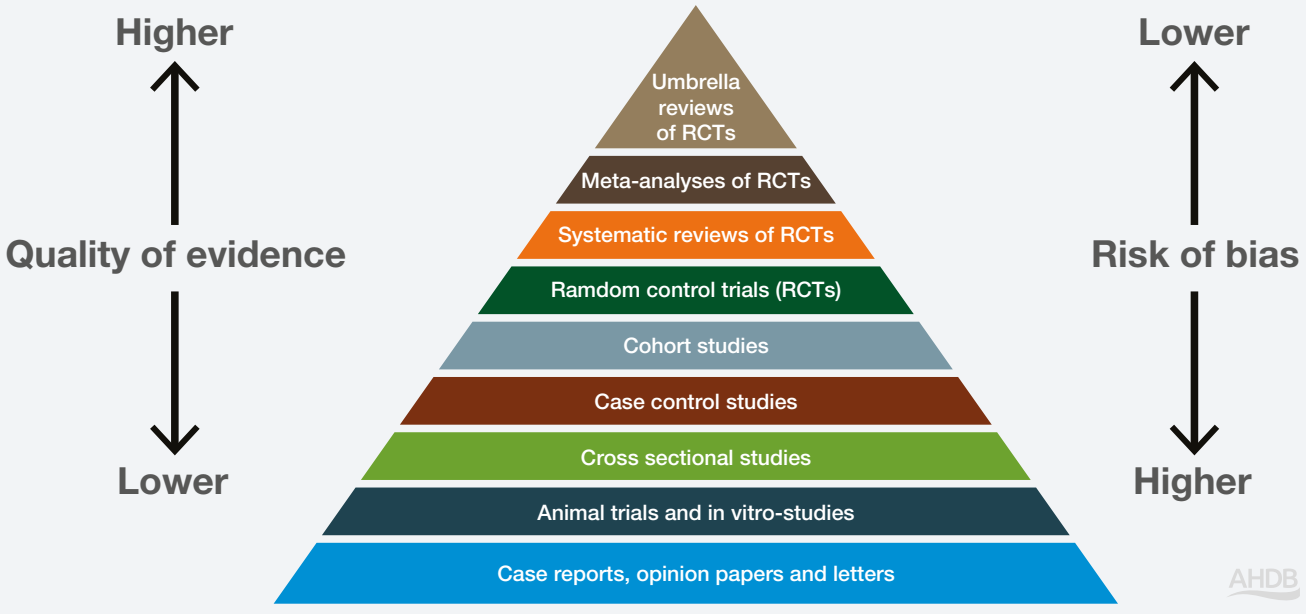


Figure 6. Hierarchy of scientific evidence pyramid

Colorectal cancer

Guidelines recommend limiting unprocessed and processed red meat consumption due to their association with colorectal cancer risk. Specifically, high consumers who eat more than 90 g a day are advised to reduce intake to no more than 70 g a day on average (or 500 g/week).[37,38,39]

Early research from 2007 suggested there was "convincing" evidence for a strong link between red meat and colorectal cancer risk.[37] This was based on observational studies linking red and processed meat consumption to increased colorectal cancer risk.

In 2017, the World Cancer Research Fund and American Institute for Cancer Research (WCRF/AICR) conducted a meta-analysis of observational studies and found that consuming 100 g of red meat per day increased colorectal cancer risk by 12%, while consuming 50 g of processed meat per day raised the risk to 16%.[16] Based on these findings, red meat was downgraded to a "probable" cause of colorectal cancer, while processed meat remains a "convincing" cause.

As a result, the recommendation to limit red and processed meat to no more than 70 g per day remain unchanged, from their (the WCRF/AICR's) last update in 2018. Eat no more than moderate amounts of red meat, such as beef, lamb and pork, and eat little, if any, processed meat.[16]

Encouraging heavy consumers of red and processed meat to reduce their intake could help reduce colorectal cancer rates in the population. The recent Food Standards Scotland report highlighted the need to target high meat consumers,[40] particularly young men, as most adults in Scotland (86%) consume some type of meat, with an average intake of 94 g a day. This comprises 37 g white meat, 32 g processed meat and 26 g of red meat. Men aged 25–34 years were the main group exceeding the 70 g a day threshold for red and processed meat, consuming an average of 117 g per day consisting of 55 g unprocessed red meat and 62 g of processed meat. Their typical meals included spaghetti bolognese, lasagne, chilli con carne and ham sandwiches.

In their 2018 report, WCRF/AICR concluded that being overweight or obese, alcohol consumption and processed meat consumption all had "convincing" evidence of increased colorectal cancer risk.[16] In contrast, the consumption of wholegrains, fibre and dairy products "probably" reduced the risk of colorectal cancer. Moderate to vigorous physical activity was also deemed "convincing" evidence of protection.

These findings reiterate the importance of a healthy, balanced diet, such as a plant-rich diet as illustrated in the UK Eatwell Guide.

Cardiovascular disease

Diet plays a significant role in cardiovascular disease (CVD) risk. For example, a high intake of saturated fat is linked with raised cholesterol and a high salt intake is linked with an increased risk of high blood pressure – both of which are major risk factors for CVD.

Taking into account the link between the consumption of red and processed meat and the risk of CVD, the evidence is mixed and depends on the type, quantity and frequency of meat consumed. Processed meat generally contains higher levels of saturated fat and salt compared to leaner cuts of red meat.

Observational studies suggest that processed meat is more strongly associated with increased CVD risk than red meat, with small increases in relative risk related to the consumption of 50 g of processed meat per day (e.g. two slices of ham, 1.5 rashes of bacon or one sausage).

> "While observational studies suggest a link between meat consumption and CVD, the limited evidence from RCTs makes it difficult to confirm causal relationships. This suggests that observational studies may overestimate the impact. Systematic reviews and meta-analyses of RCTs found little to no effect of meat consumption on CVD risk"[41,42,43]

Considering the whole diet in relation to heart health rather than one food is perhaps more useful. One meta-analysis of 36 RCTs compared the effects of diets containing red meat with those replacing meat, on CVD markers, including blood lipids, lipoproteins and blood pressure.[49] Findings revealed no significant differences between diets containing red meat and those without. Surprisingly, the red meat diet showed either neutral or more positive effects on serum blood lipids compared to a diet containing low-quality carbohydrates than against a diet containing plant-based proteins.

Many dietary factors contribute to CVD risk. Whole grains, fruits, vegetables, nuts and fish may protect against CVD, while sugar-sweetened beverages may increase the risk. Encouraging better adherence to current dietary recommendations, including increasing plant foods and reducing meat intakes, among high meat consumers is key.

Type 2 diabetes

Healthier lifestyles, such as eating better, exercising more and maintaining a healthy weight, play a crucial role in reducing the risk of type 2 diabetes and managing the disease.

Observational studies suggest a link between increased meat consumption, especially processed meats, and increased type 2 diabetes risk. However, these studies only show possible associations, not causation, and are prone to bias, such as relying on self-reported food intake data.

Randomised controlled trials (RCTs) provide stronger evidence for identifying cause-and-effect relationships. Meta-analyses of RCTs, however, find little evidence of causality. For instance, a meta-analyses of RCTs showed that higher red meat intake (more than 490 g/week) does not significantly affect blood sugar control or inflammation in adults at risk of type 2 diabetes,[44] and consuming more than 110 g of red meat daily had a neutral effect on risk.[45]

More robust research and standardised definitions are needed to clarify the relationship between meat intake and type 2 diabetes risk.

Diabetes UK provides specific guidance for the prevention and management of type 2 diabetes, which includes eating well, moving more and getting help if weight loss is needed. Key dietary recommendations from Diabetes UK to reduce the risk of type 2 diabetes in higher-risk groups include restricting energy intake, consuming less total fat and saturated fat, and more fibre. They also emphasise opting for whole grains, some fruit, green leafy vegetables, low-sugar yogurt and cheese, tea and coffee, while reducing unprocessed red and processed meat, potatoes (particularly French fried), sugar-sweetened beverages and refined carbohydrates.

The Diabetes UK guidelines for reducing intake of unprocessed lean red and processed meats, which have been associated with an increased risk of type 2 diabetes, are based on observation research findings from three studies.[46,47,48]

The wider evidence-base supports eating more in line with the recommendations of the Eatwell Guide, particularly reducing processed meat and encouraging high meat consumers to reduce their intake to below 70 g/day to reduce type 2 diabetes risk.

Key considerations of the evidence

Evaluating the health risks of red and processed meat consumption requires careful consideration of the strengths and limitations of different types of evidence.

More good-quality studies needed

While unprocessed red and processed meat consumption is linked to higher risks of colorectal cancer, CVD and T2D, especially for processed meats, systematic reviews and meta-analyses of observational studies often show positive associations. More robust RCTs and umbrella reviews tend to report minimal or no significant impact, suggesting that the health risks may not be as pronounced as observational studies indicate.

Research methodology concerns

Systematic reviews and meta-analyses of observational studies show mixed results, with some linking red meat to NCD risk while others do not. When associations are found, their strength varies widely, partly due to the limitations of observational studies, which can only show associations, not causation, yet they have been used to inform dietary guidelines to limit red and processed meat consumption.

While RCTs provide stronger evidence for causality, they also have limitations, such as issues with dietary compliance, large participant dropouts, shorter follow-up duration and unaltered disease risk markers,[49,50] limiting their ability to detect long-term health outcomes like coronary heart disease, type 2 diabetes and cancer. Additionally, the effects of reduced meat intake may vary depending on the alternative protein replacement (fish, chicken, whole grains or refined carbohydrates can have different health impacts).

Re-evaluation of data

Re-evaluating existing data using improved modelling, conducting comprehensive longitudinal studies and incorporating real-world dietary patterns would help to develop precise evidence-based nutritional guidelines.

Re-evaluation of data

Some scientists have identified significant weaknesses in studies linking red meat consumption to non-communicable diseases (NCDs),[51,52,53,54] suggesting that health risks may be overestimated and moderate consumption may pose lower risks than previously thought

Putting the evidence in context

Red meat consumption in the UK is declining, while poultry sales rise. At the same time, ready meals and convenience foods, often higher in calories, saturated fat, salt and sugar, are becoming increasingly popular.

While many consumers stay within the recommended daily limit of 70 g of red and processed meat, a smaller group, particularly men, exceed this, consuming over 90 g a day. Despite this, UK red meat intake remains lower than in many other EU countries.[56]

The UK faces a broad range of health challenges, including rising obesity rates, worsening mental health and increasing health inequalities. Focusing only on red meat consumption as a main risk factor for coronary heart disease, type 2 diabetes and cancer oversimplifies the issue. A more holistic approach is needed to address the many factors affecting the population's health.

> “Systematic reviews of red meat and health risks show mixed results, highlighting the need for better-quality studies”

Environmental sustainability of UK red meat

Farmers look after 70% of the UK's land.[57] As well as producing food, they have a crucial knowledge and a key role to help manage water quality, protecting and promoting soil health, enhancing biodiversity and mitigating against climate change, including the maintenance and sequestration of carbon stored within the natural landscape.

Food systems are complex and consumers are faced with a myriad of messages when trying to eat in an environmentally sustainable way.

The following section aims to clarify the current evidence while also highlighting data gaps and future opportunities to improve environmental sustainability.

Making informed sustainable food choices

- Are global or regional averaged data being used to reflect a local product's footprint?
- Are foods across different food categories that have no comparable nutritional value being compared?
- Is the focus only on one environmental metric such as carbon, while other metrics (e.g. biodiversity and water) are ignored?
- Is only one report cited, ignoring others that set out the counter argument?
- Are all greenhouse gases being represented as carbon dioxide equivalents (CO_2e) despite them acting very differently in the atmosphere? This particularly disadvantages industries that emit greenhouse gases other than CO_2 – such as agriculture, which predominately emits methane and nitrous oxide
- Is the focus on just gross emissions, thus ignoring the benefits of carbon sequestration and removals (i.e. net emissions)?

UK greenhouse gas emissions

UK agriculture is the fifth-largest contributor to greenhouse gas emissions, accounting for around 12% of direct emissions in 2022. Approximately 7% of this is from livestock.[58] The four sectors with higher emissions are domestic transport (28%), buildings and product uses (20%), industry (14%) and electricity supply (14%).

GHG emissions in the UK are reported through the GHG National Inventory, which is useful for tracking progress against targets. However, this system has limitations when applied to agriculture:

- Emissions are reported in separate categories or 'silos', but farming businesses do not fit neatly in just one silo as it involves diverse activities
- Unlike other sectors, farming primarily emits non-CO_2 GHGs, such as methane and nitrous oxide
- The agriculture silo only includes emissions from growing crops or rearing livestock. It does not account for actions that increase carbon sequestration, like planting trees. Such activity is captured in figures for land use and forestry
- Renewable energy generated on farms, such as through solar panels or wind farms, is captured within the energy silo rather than agriculture

As a result, agriculture's reported emissions reflect only its gross output (or emissions) and overlook its contribution to carbon sequestration and renewable energy generation.

Measuring the warming impact of greenhouse gases

GHGs all contribute to global warming, but they differ in terms of how powerful their warming effect is and how long they last in the atmosphere. Converting all these gases to one standardised measurement (CO_2e: carbon dioxide equivalent) makes it easier to count and compare emissions. This standardised figure is used to calculate the global warming potential (GWP) value. Reporting both GWP100 and GWP* will help provide better insight for informed decisions in the future.

GWP100	The most used GWP value is GWP100, meaning the average warming potential over 100 years. For gases that persist for over 100 years, like carbon dioxide (CO_2) and nitrous oxide (N_2O), GWP100 works well. Methane, however, breaks down over just 12 years, so GWP100 does not show the true impact of methane on global warming. Methane accounts for 58% of GHGs from agriculture.
GWP*	GWP* is a newer measure for calculating the impact of emissions of methane on the climate, taking account of the short-lived nature of methane. Methane emissions from agriculture (from enteric fermentation, or burping cows) is part of the natural carbon cycle – when methane breaks down over 7–12 years, the resulting carbon dioxide is returned to the natural carbon cycle. This is not the case for methane emissions from other sources such as mining and natural gas leaks that are not part of the natural carbon cycle.

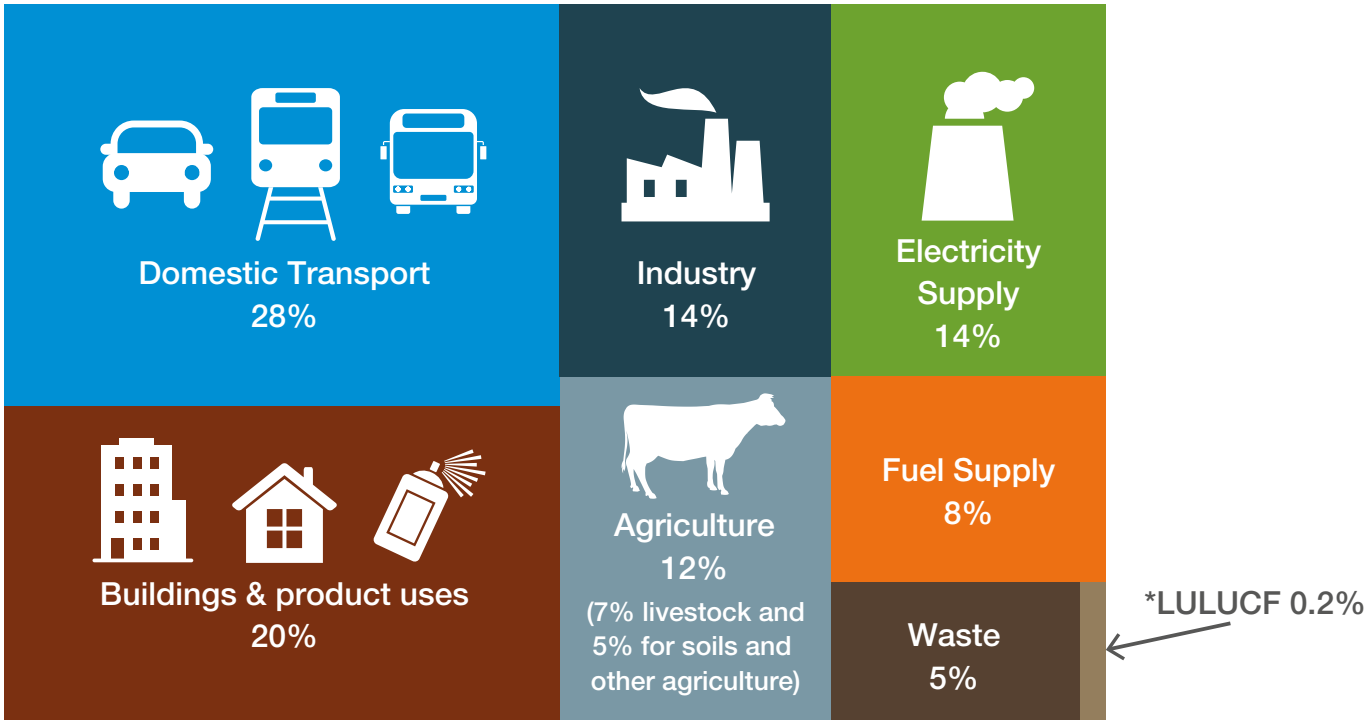


Figure 7. UK greenhouse gas emissions by sector

Source. DESNZ, 2024.[58] *LULUCF = Land use, land-use change and forestry

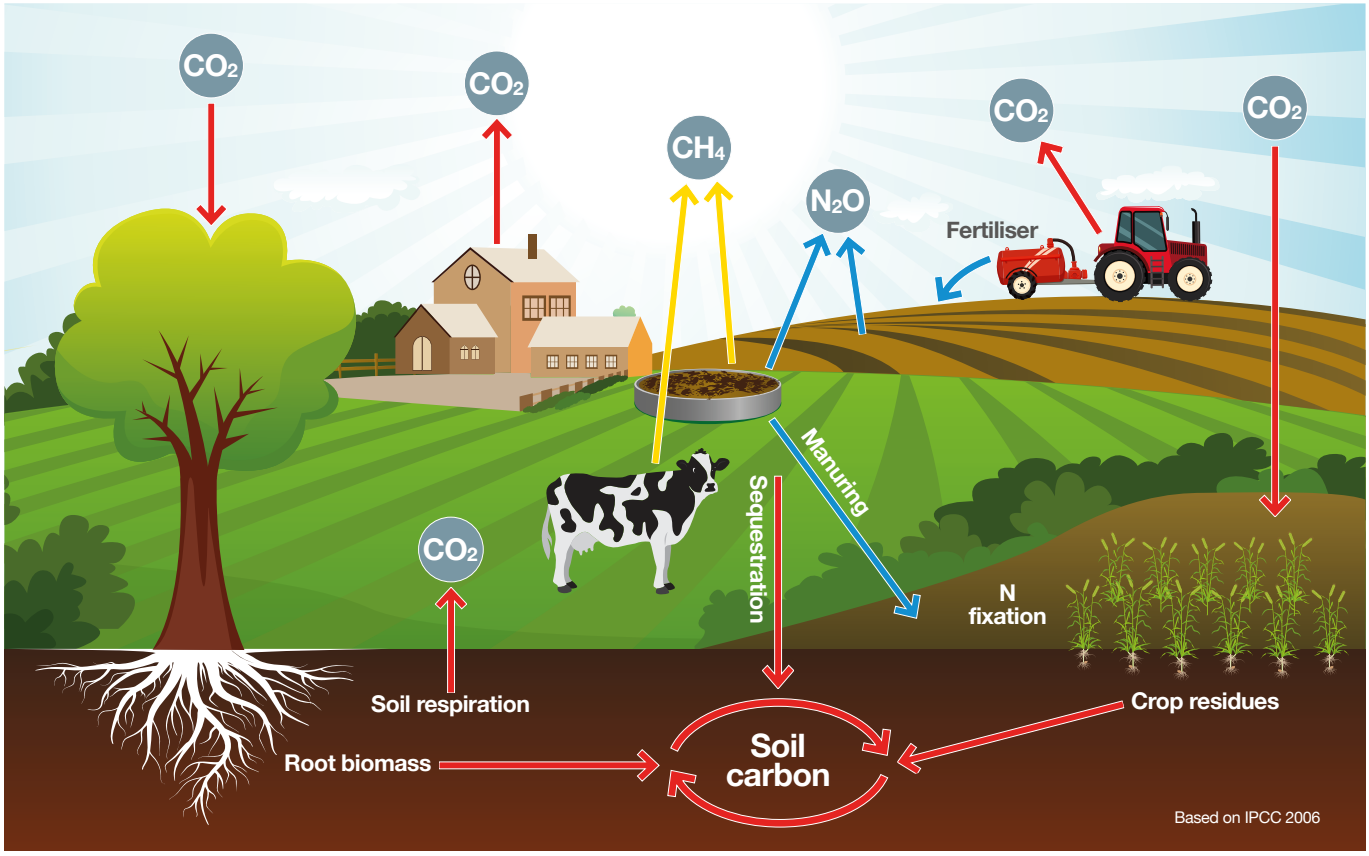


Figure 8. Demonstrating the carbon balance on farm through the carbon cycle.
Source: AHDB

Achieving net zero

The journey to net zero began in Paris in 2015, where 196 parties of the UN Climate Change Convention agreed to limit global warming to ideally 1.5°C.[59] To do this, emissions will need to reach net zero by 2050. However, the meaning of net zero is often misunderstood to mean zero emissions.

Net zero is defined as where any GHG emissions are reduced as much as possible, with any remaining emissions balanced by activities that remove the same amount from the atmosphere.[60] In other words, net zero is where the sum of emissions is equal to the sum of sequestration.

Considering both sides of the net zero equation

Agricultural emissions are reported as gross emissions. However, there are two sides to the net zero equation: emissions released and carbon removed and sequestered from the atmosphere. The diagram below shows the impact of agriculture on the whole environment, including GHG emissions and removing carbon from the atmosphere.

Net-carbon position – Getting the right measurements/or measuring what matters

To manage something effectively, you need to be able to measure it. For UK agriculture to help deliver net zero by 2050, farmers need to track both emissions and carbon removals to understand their overall carbon balance or net carbon position.

Measuring and reporting on the balance of both GHG emissions and carbon removals as a singular net carbon position is critical. This insight and knowledge will empower farmers to make the right decisions for their landscapes and farming systems, as well as receive due recognition and reward. However, this all starts with a baseline.

To track progress accurately, the first step is establishing a nationwide carbon baseline. This will show the current state (and starting point) of carbon emissions and sequestration. Repeating measurements every five years will track changes (positive or negative) as carbon stored in the landscape can rise or fall depending on farming practices and land management. The Agriculture and Horticulture Development Board (AHDB) is currently piloting this approach on 170 farms across Great Britain.

The story of seven farmers across Northern Ireland: Net zero and beyond

In 2020, a group of seven farmers across Northern Ireland came together to explore what the journey to net zero looked like for UK agriculture. This pilot project was known as ARC Zero (ARC being an acronym for Accelerating Ruminant Carbon).[61] The seven farms included in the project were a mix of arable and livestock (e.g. dairy farms, sheep and beef, arable and beef farms).

The farmers wanted to know where their emissions were coming from and how to reduce them, and where their carbon stocks were in their landscape and how to increase them.

The results of the project were a revelation, for the first time having data showing the net carbon position of each of the seven farms. It demonstrated that not only are **some farms almost at net zero but some were beyond it** – taking more GHGs out of the atmosphere than they put in.

Contrary to modern scientific papers and models, the **two farms beyond net zero raised cattle or sheep. Soil data showed the farm landscapes with multiple species and, most crucially, grazing livestock, had the highest soil quality and biodiversity scores.**

Among the seven farms, over 500,000 tonnes of carbon is locked up in the landscape in stocks, with the bulk of this carbon (on average 97%) held in the soil, rather than above-ground vegetation like trees. This raises questions on the best course of action to increase nationwide sequestration.

Ways to lower livestock emissions

The UN's Food and Agriculture Organization (FAO) suggested that global consumption of livestock products could increase by 21% between 2020 and 2050 and still stay within the 1.5˚C global temperature limit.[62] This would require small changes to diets, focusing on reducing overconsumption, particularly in developed countries.

The FAO highlights that the key to lowering livestock emissions lies in improving productivity, animal genetics and enhanced animal health. Choosing sustainably produced livestock products from the most environmentally better-suited regions of the world, like the UK, can also help achieve this goal.

Better breeding practices

Improving breeding practices in cattle and sheep can help lower livestock emissions by making herds and flocks more productive and efficient. Each year, a reduced level of GHGs is achieved due to better breeding practices. The industry is accelerating progress in this area, driving more rapid genetic improvements. These improvements are both permanent and accumulate over generations, so the impact over a 20-year period is substantial.

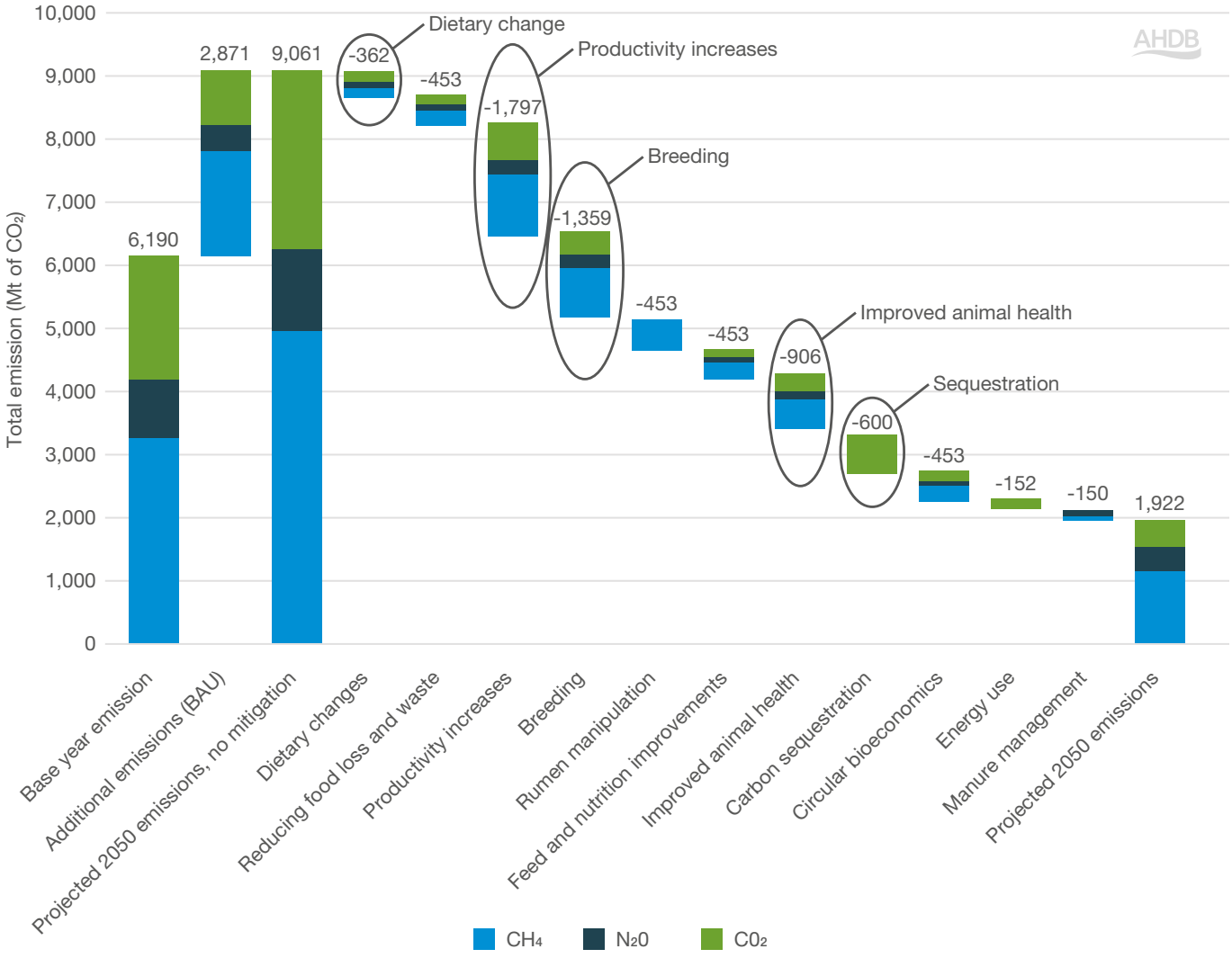


Figure 9. Pathway to lower livestock emissions

Source: FAO 2023[70]

High animal welfare and improved health

Britain's laws ensure some of the highest animal welfare standards in the world. These are further supported by independent quality checks from various assurance schemes so consumers can be confident in British meat products.

Healthy, well-cared-for animals lead to reduced need for antibiotics, increased efficiency and lower environmental impacts.

Ideal conditions for beef production

Cattle in the UK are primarily fed on grass. Grass-derived feed amounts to 91% of the diet of UK beef cattle. This comprises of fresh grass (74%) and conserved grass (17%), such as from hay and silage. The remainder of the diet is made up of crop residues/ co-products, grains, brassicas and fodder beet.

Imported soya

In 2019, net UK imports of both soya beans and cake represented less than 1% of the world's soya. Of this, 62% was considered to be soya sources at low risk of deforestation/conversion or covered by a deforestation- and conversion-free certified soya standard. The UK Soy Manifesto[63] is a collective industry commitment for 100% of soya from deforestation-free and conversion-free sources by 2025.

Over 90% of the imported soya is estimated to be for animal feed, with the majority (53%) being used in broiler chicken production.

Soya products currently offer good sources of protein for pigs due to the amino acids contained and their digestibility, which is greater than most alternative plant proteins available at present. The replacement of soya bean meal with protein not associated with land-use change has the greatest impact for reducing the overall carbon footprint of pig production.

Replacing animal protein with legumes

It has been argued that animal protein could be partly replaced by that of legumes (beans and peas). Faba bean and peas are currently the UK's major legume crops. But further developments in genetics and agronomy would be needed both for home-grown established and alternative legume crops to meet the protein requirements needed. The benefits and challenges of growing more legumes in the UK for us to eat are outlined below.

Benefits of growing legumes

Natural nitrogen boost – Increasing legumes in arable rotations can be beneficial and can help reduce the demand for nitrogen from synthetic fertilisers, as legumes form symbiotic relationships with nitrogen-fixing bacteria in the soil.

Break crops in rotation – They are also valuable as break crops in arable rotations, which helps control pests and diseases as well as benefiting biodiversity.

Challenges of growing more legumes

Limited planting area – The area available for planting grain legumes in the UK is limited by frequency of legumes in the rotation and in turn by the type of legume and the other crops in the rotation.

Soil suitability – Soil type is also an influencing factor – for instance, peas are unsuited to heavy soils and beans to light soils.

Climate constraints – Popular and alternative legumes for human consumption are not necessarily suited to UK climatic conditions.

Why not use grassland to grow more crops?

In the UK, 72% of agricultural land is permanent grassland, rough grazing or temporary grassland.[64] Simply replacing established grasslands with arable land to grow crops for human consumption has many challenges that need to be considered, for example:

- Changing the land use from grazing to growing crops would release carbon from the soil
- The land conditions and location may be unsuitable for growing crops – e.g. inaccessible for machinery or in a high-flood-risk area
- The quality of the land is likely to be too poor for growing crops that are of acceptable quality and profitability

Grazing livestock benefits the soil

Well-managed grazing lands provide habitats for shelter, feeding and breeding and help to enhance ecosystems and biodiversity. Indeed, the removal of livestock in certain UK landscapes could have detrimental impacts on land quality and flora and fauna diversity.

Grazed grassland removes and sequesters more carbon than mown grassland due to the greater return of manure and nutrients. Grazing also alters the soil microbial community, which enhances the availability of substrate favouring carbon sequestration into the soil at depth.[65]

Circular farming: The benefits of farming animal and crops

Livestock systems play a key part in circular farming. For example, livestock converts surplus arable and grass products into valuable food, fibre, pharma, energy and fertiliser.

Livestock helps recycle crop material

It is estimated that 1 kg of plant-based food production generates at least 3–5 kg of crop material that is not suitable for human consumption but is suitable as feed for animal production. Thus, there is a need for strategies to manage and recycle plant nutrients.

Livestock can help reduce food waste

Waste and Resources Action Programme (WRAP) estimated that 660,000 tonnes of UK food waste (2016), both from retail and manufacture, were being used for animal feed – equivalent to 93% of the total food surplus.[66]

Regenerative agriculture

Regenerative agriculture encompasses several farming practices, including no-till, cover cropping (i.e. growing crops without ploughing or turning the soil), diversified crop rotations (i.e. planting a variety of different crops over several seasons) and the integration of livestock into farming systems, and in the process minimising waste. These practices can improve soil quality, help mitigate climate change and enhance biodiversity.

How livestock can enhance biodiversity

Grazing by animals like cattle and sheep can help create and maintain habitats for wildlife such as ground-nesting birds.

A recent study showed that stopping grazing can lead to biodiversity loss, in terms of soil microbes and fauna.[67] Some of the healthiest soils are found in areas where livestock graze, showing how grazing animals help maintain diverse soil communities, which is essential for healthy ecosystems.[67]

“Grazing by animals like cattle and sheep can help create and maintain habitats for wildlife such as ground-nesting birds”

What's next?

Many farms are already taking steps to be more environmentally friendly. By improving the breeding and rearing of livestock, farms are successfully lowering their emissions, as demonstrated in the Defra Farm Practices Survey 2023.[68]

There are a number of emerging technologies and innovations in livestock, where research has shown considerable reductions in GHG emissions, helping progress toward net zero goals.[69] For example:

- Exploring ways to reduce methane emissions from livestock, especially from their digestion. Collecting data on how much methane animals produce and using this to make breeding decisions
- Exploring the use of methane-reducing products like inhibitors or vaccines, some of which are already on the market
- Using rapid tests to detect diseases in animals can help farmers work more efficiently and reduce water pollution and ammonia emissions
- Preventing animal diseases with vaccines and other health products can improve productivity, leading to fewer resources used and lower emissions
- Replacing soya bean feed with alternative protein sources that are better for the environment could significantly reduce emissions. However, more research is needed to ensure these alternatives are safe, nutritious and effective on a large scale
- Innovations like treating slurry with plasma could greatly reduce ammonia and methane emissions, but these would require a low-carbon energy source to minimise the carbon footprint. Using manure additives and better tracking systems on farms can also help farmers manage nutrients more efficiently

Achieving net zero and zero hunger

In late 2023, the FAO outlined its plan to tackle global hunger while keeping global temperature rise below 1.5°C.[70]

The plan focused on balancing environmental actions with the adequate food provision worldwide. Their modelling research showed that global dietary change has one of the smallest impacts on reducing GHG emissions. Instead, improving the productivity and efficiency of livestock farming would have the biggest impact on reducing emissions, followed by focused breeding strategies and proactive animal health management, especially in regions like Africa and Asia.

With the world needing 70% more food by 2050, the FAO determined that global livestock productivity must grow by 1.7% each year to meet zero hunger goals.

Most of this growth will likely come from countries like the UK, where extreme weather will be least impactful and where livestock production is among the most sustainable in the world. It is important to consider the UK's role in a global context. If the UK produces less red meat and ends up importing more from less environmentally conscious countries, the global impact is negative.

UK livestock production not only ensures local food security but also supports global nutritional goals by enabling the exporting of meat to countries that cannot produce it as sustainably. A sustainable food system, therefore, does not necessarily require less meat and dairy but a focus on improving the sustainability of its production. The key is not to overproduce or underproduce but to optimise production for both environmental health and global food security. The UK has a unique opportunity to contribute to global food security and delivering zero hunger while protecting and enhancing the environment.

> "Global dietary change has one of the smallest impacts on reducing GHG emissions. Instead improving the productivity and efficiency of livestock farming would have the biggest impact on reducing emissions"

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