The benefits and risks of a Western vegan diet for human and planetary health

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Abstract

Food production applies huge pressures on the environment and produces around a third of the global greenhouse gas emissions (GHGE). Its impact is increasing as growing populations, as well as changing food consumption habits, increase demand. The rearing of livestock through large-scale intensive farming practices demands a lot of land and contributes significantly to GHGE in addition to the carbon footprint of the various resources needed to support the meat industry. Much is made of the benefits of a vegan diet, not only for human health but also for environmental health. There are compelling reasons to avoid animal-based foods which have been linked to a number of non-communicable diseases (NCDs) and adopting a whole foods, plant-based diet may benefit many aspects of our health. However, foods derived from livestock production systems including grazing and pastoralist systems, and from the hunting of wild animals, provide high quality proteins, important fatty acids and various vitamins and minerals – contributing to healthy diets for improved nutrition and health. Traditional diets and lifestyles of non-Western populations have been associated with a significantly reduced risk of and rare incidence of NCDs. Whilst veganism has been touted in the West as a way forward in this challenge, it runs counter to planetary health with significant carbon footprints of mass-produced plants and heavy processing of some vegan products thus also compromising human health. A paradigm shift is urgently needed to really address both human health and planetary well-being that is fair and equitable to all nations.

Introduction

On the 15th November 2022, the world population reached 8 billion (Population Matters, 2024). This ever-growing global population presents a number of significant challenges; not least of which is agriculture, land use and food production. To grow and produce sufficient food to sustain a burgeoning human population in the long-term will be increasingly difficult as the amount of agricultural land currently available is nowhere near enough to supply everyone with sufficient food to satisfy every person's requirement (Ranganathan *et al*., 2018).

Food production applies huge pressures on the environment and produces around a third of the global greenhouse gas emissions (GHGE). The impact of food production is increasing as growing populations, as well as changing food consumption habits, increase demand. At the same time, we waste around a third of all the food we produce, and imbalances in food consumption mean that obesity is on the rise while millions of people suffer hunger and malnutrition (EAT Lancet Commission, 2019).

The UK has a long-established farming tradition and the farming industry works closely with the government to ensure food supplies not only satisfy demand but also meet the legal standards for safety including the welfare of livestock. The rearing of livestock through large-scale intensive farming practices demands a lot of land and contributes significantly to GHGE through methane production by livestock in addition to the carbon footprint of the various resources needed to support the practice such as animal feed, medicines, machinery and transportation. Additionally, the production of animal feed colonises large areas of land in the world. Quite often, wild habitats such as rainforests that invariably house endangered species are cleared through deforestation to make way for arable land to grow crops such as soy, maize and grain which are then used for animal feed; such is the demand for meat not only in the UK, but globally. The popularity of a vegan diet has grassroots in opposing the environmental impact of intensive farming of livestock but is also based in the manner in which animals are reared and farmed which vegans argue is cruel and unethical.

Much is made of the benefits of a vegan diet, not only for human health but also for environmental health so much so that a new term 'environmental nutrition' has been coined. However, to discuss this robustly, it is necessary to define the term 'vegan' as a starting point as there is much debate as to what this term means. It seems to represent different things to different people and also in different countries and cultures across the globe. Much of the public perception and narrative on veganism is dominated by a Western perspective which has been heavily criticised for its cultural appropriation. Although the premise of veganism is simple and seeks to create a more environmentally friendly world without animal cruelty, intersectionality, decolonisation and class consciousness tend to disappear in mainstream activist groups. Mainstream vegan activism, and the veganism adopted by corporations represents a faction of veganism called Western (or white) veganism (Frasunkiewicz, 2024).

Western veganism overlooks the colonial legacies of meat and dairy production and instead shifts the same systems onto the industrialisation of plants. Millions endeavour to lead a more ethically sound existence by cutting out animal products, whilst remaining in the dark about the colossal human rights breaches occurring in plant agriculture across the globe, the cultural sensitivities surrounding meat consumption from traditional hunting practices, and the capitalist systems which led to unethical farming practices in the first place (Walker, 2023 and Miller, 2024).

Traditional African dietary practices, plant-based diets have been the norm for generations but these have been suppressed by the influence of Western diets in recent decades in many African countries (Wachaya, 2024). Indigenous farmers around the world are being exploited for foods that are now being appropriated by white vegans, foods they once produced and personally consumed in moderation. The sudden mass production of foods such as chickpeas and avocados has had a devastating impact on the local price of the plants, the welfare of the farmers, and the land itself (Walker, 2023 and Miller, 2024).

There are approximately 79 million vegans in the world (Soylent, 2023). This is just under 1% of the global population. There are approximately 2.5 million vegans in the UK which is roughly 4.7% of the UK population (Finder, 2024). The term 'vegan' was first coined in 1944 by Donald Watson, an animal rights advocate and one of the founders of The Vegan Society as a statement against vegetarians who ate dairy products. But the roots of veganism go back much further than 1944 to ancient Indian and West Asian cultures being rooted in ancient dharmic tradition including followers of Buddhism, Hinduism, Sikhism and Jainism. Indian philosophers and emperors adhered to a diet based on non-violence or ahimsã; a sentiment that extends to humans as well as animals. The modern wave of veganism in the West started with The Vegan Society in 1951 as a dietary-based movement that soon shifted to an animal rights group (The Vegan Society, 2024). A lot has happened in the last 73 years not least of which are significant environmental issues and the impact of modern farming practices on climate change (Greenpeace, 2018).

There are a number of key organisations, campaign groups, charities and governments that are all engaged with finding more effective solutions to the problems created by a growing human population which shows little sign of abating. Meanwhile, there are clear correlations with human habitation and consumption of natural resources, changes to our landscapes and climate change. If there is a concern about food poverty now to the extent that it occupies two of the UN's Sustainable Development Goals (SDG): zero hunger (SDG 2)and no poverty (SDG 1), which is already affecting some of the world's poorest communities, surely this can only get worse given the current population trajectory?

The food system is also under pressure from non-climate stressors (such as population growth, income growth and demand for animal-sourced products) as well as from climate change which are impacting on the four pillars of food security:

availability, access, utilisation and stability. An estimated 821 million people are currently undernourished, 151 million children under five are stunted, 613 million women and girls aged 15 to 49 suffer from iron deficiency and 2 billion adults are overweight or obese (IPPC Special Report, 2019).

A plant-based diet is widely regarded to be better for the planet than those that include animal products. Its global adoption as a healthier, more sustainable diet will help reduce the risk of obesity-related and malnutrition-related non-communicable diseases (NCDs) while protecting the future health of our planet (Moreno *et al.*, 2022). Most scientists now agree that a shift towards a plant-based diet combined with sustainable food systems is crucial for delivering on climate change mitigation targets worldwide (Alae-Carew *et al.*, 2022). There are however, many variations of a plant-based diet as well as other types of diet which require clarification for the purposes of this article:

Table 1: Definitions of various human diets

(adapted from Moreno *et al.*, 2022)

Type of Diet		Definition/Comments
Western-style diet	Omnivorous	Typically includes high intakes of animal-sourced foods, highly processed foods and lower-than-recommended intakes of plant-sourced foods. Not ideal for anyone and whilst affordable to HICs*, it may not be affordable nor accessible to LMICs*. Higher than recommended intakes of energy, SFAs++, salt, sugar, and refined grains and increased risk of NCDs**. Adverse environmental impact and high waste with increased risk to food security in LMICs* due to unequal distribution of foods across the world.
Flexitation	-	Omnivorous diet that includes high amounts of plant-sourced foods (e.g., fruits, vegetables, unrefined grain, legumes, nuts and seeds), moderate amounts of poultry, dairy and fish, and low amounts (1 serving/week) of red meat, highly processed foods, and added sugar. Suitable for those wishing to transition from a Western diet to a sustainable healthy diet, who might struggle to maintain vegan/vegetarian/pescatarian diets. Reduced risk of NCDs** and nutritional deficiencies compared with unsupervised vegetarian/pescatarian/vegan diets Reduced environmental impact compared with Western diets but might not be appropriate for certain populations due to religious, cultural, or ethical beliefs or for people with food (e.g., milk) allergies/lactose intolerance.
Traditional plant-based diets	Vegan	Excludes all animal products including meat, fish/shellfish, insects, gelatin, eggs, dairy, and honey. Affordable and accessible for most people in HICs* but not for LMIcs*. Reduced risk of NCDs** compared with omnivorous diets but unsupervised vegan diets are associated with an increased risk of energy/nutritional deficiencies compared with vegetarian/pescatarian/flexitarian diets.
	Vegetarian	Excludes meat, fish/shellfish, insects, and gelatin but includes plant-sourced foods and (usually) dairy and eggs. Suitable for those wishing to transition from a Western diet to a sustainable healthy diet, who might struggle to maintain a vegan diet or have religious, cultural, or ethical beliefs that exclude flexitarian diets. Reduced risk of NCDs** and environmental impact compared with Western diets and flexitarian diets. Affordable and accessible for most people in HICs*. Unsupervised vegetarian diets are associated with an increased risk of energy/nutritional deficiencies compared with pescatarian/flexitarian diets
	Pescatarian	Vegetarian diet that includes fish/shellfish. Suitable for those wishing to transition from a Western diet to a sustainable healthy diet, who might struggle to maintain a vegan diet or have religious, cultural, or ethical beliefs that exclude flexitarian diets. Reduced risk of NCDs** and environmental impact compared with Western and flexitarian diets. Affordable and accessible for most people in HICs* but less so for some LMICs* than vegetarian/flexitarian diets. Unsupervised pescatarian diets are

		associated with an increased risk of energy/nutritional deficiencies compared with flexitarian diets.
	Whole Foods	The term 'whole foods' generally describes foods that are left close to their natural state so foods that are minimally processed. The diet includes fresh fruits and vegetables, nuts, seeds, oils, and whole grains, resonating perhaps with that of our hunter-gatherer past. Suitable for those wishing to transition from a Western diet to a sustainable healthy diet, who might struggle to maintain vegan/vegetarian/pescatarian diets. Reduced risk of NCDs** and environmental impact compared with Western and flexitarian diets. Affordable and accessible for most people in HICs* but less so for some LMICs* than vegetarian/flexitarian diets.
Territorial Diversified Diets (TDD)	Mediterranean	Flexitarian-style diet that includes high intakes of seasonal, locally produced foods. Suitable for those wishing to transition from a Western diet to a sustainable healthy diet, who might struggle to maintain vegan/vegetarian/pescatarian diets. Environmental impact may be reduced compared with some flexitarian diets due to the inclusion of large quantities of seasonal, locally sourced foods. Reduced risk of NCDs** and nutritional deficiencies compared with unsupervised vegetarian/pescatarian/vegan diets
	New Nordic	Flexitarian-style diet that includes high intakes of seasonal, locally produced foods. Suitable for those wishing to transition from a Western diet to a sustainable healthy diet, who might struggle to maintain vegan/vegetarian/pescatarian diets. Environmental impact may be reduced compared with some flexitarian diets due to the inclusion of large quantities of seasonal, locally sourced foods. Reduced risk of NCDs** and nutritional deficiencies compared with unsupervised vegetarian/pescatarian/vegan diets

*HICs = high income countries LMICs = low-middle income countries, **NCDs = non-communicable diseases including obesity, ++SFA = saturated fatty acids

The case against animal-based diets

There are compelling reasons to avoid animal-based foods especially red meat and in particular processed meats. The strongest association found so far, between red meat-based diet and cancer risk is for bowel cancer (colorectal cancer) which kills over 16,000 people in the UK every year. Even those who ate moderate amounts of red meat (76g a day in line with UK Government recommendations) still had a 20% higher chance of developing bowel cancer than those who only ate on average 21g a day (Oxford Population Health, 2024). There is little evidence that meat consumption increases the risk of other common cancers including prostate, breast, stomach and lung cancer.

With regards to coronary heart disease (CHD), heart attacks and stroke, a study on the Pan-European EPIC Cohort (Key *et al.*,2019) concluded that CHD risk is positively associated with an individual's consumption of red and processed meat which showed also that there was a positive association with LDL cholesterol concentration and systolic blood pressure (BP). Analysis of the Oxford EPIC Cohort Study showed that the evidence on stroke, however, remains inconclusive (Oxford Population Health, 2024). The risk of stroke in pescatarian participants appeared to be no higher than for meat-eaters (Clem & Barthel, 2021).

Meat consumption has also been linked to an increased risk of developing type 2 diabetes (T2D). However, results of meta-analysis of randomised controlled trials did not show any effect of eating red meat on glycaemic index or insulinaemia biomarkers that are associated with developing T2D (Sanders *et al.*, 2023). Scientists

say that more research is needed on other markers of glucose homeostasis to better understand whether a causal relationship exists between red meat and the risk of T2D (Sanders *et al*., 2023).

The case for plant-based diets

Adopting a whole foods, plant-based diet may benefit many aspects of our health offering protection against a number of chronic diseases routinely seen in the Western world. However, there is insufficient incontrovertible evidence to say that a vegetarian or vegan diet reduces the risk of cancer. Observational studies demonstrate decreased overall risk with plant-based diets (DeClerq *et al*., 2022) but further research is needed from intervention studies, great detail on underrepresented groups as well as addressing the inconsistencies in dietary assessment methods (DeClercq *et al*., 2022) to state this for certain.

A vegan diet may reduce the risk of cardiovascular disease (CVD) and improve cardiac function (Clem & Barthel, 2021). There are a number of studies that show the benefits of plant-based diets on cardiovascular outcomes. A meta-analysis featuring seven prospective cohort studies reviewed heart health in vegetarians versus omnivores. The analysis concluded that those who do not consume meat have significantly lower rates of both ischaemic heart disease (IHD) and all-cause mortality (Huang *et al*., 2012).

Moreover, multiple studies have shown that a vegan diet has beneficial effects on T2D with evidence suggesting that a plant-based diet can help patients achieve weight loss and improve glycaemic control (Clem & Barthel, 2021). Diabetes incidence is inextricably linked to obesity rates, and a high BMI is a key indicator. Various studies have confirmed that vegetarians and vegans generally have a lower BMI compared to those who do not follow these diets and less likely to be overweight (Bakaloudi *et al*, 2020).

Additionally, a meta-analysis and systematic of review of the effect of dietary changes on BP in T2D patients showed that a vegan diet was found to significantly lower both systolic and diastolic pressures (Abbasnezhad *et al*., 2020). A similar systematic review also showed that a vegan diet is associated with a significant reduction in BP in those with hypertension (Lee *et al*., 2020).

A study published in May 2020 analysed the correlation between meat consumption and low-density lipoprotein (LDL) levels in patients diagnosed with coronary artery disease (Vinay *et al*., 2020). The mean LDL level in the omnivorous group was found to be 34.75 points higher than the mean of the vegetarian group. Similarly, a large review of vegetarian diets and health outcomes, published in 2020, found there to be a clinically significant decrease in both total and LDL cholesterol levels in those who do not consume meat or fish products (Oussalah *et al*., 2020). High levels of LDL are known to increase both the risk and severity of coronary artery disease including heart disease, angina, and myocardial infarction (MI).

The case for animal-based diets

The reporting of red meat and its links to a higher incidence of CVD, MI, strokes and T2D and certain cancers is not the whole story as not all studies have reported these links (Stanton, 2020). Careful examination of the studies show that those who ate moderate portions of red meat (120g or 4oz) two to five times a week were less likely to die than those who ate large quantities of red meat regularly, or those that ate meat very rarely if ever (Stanton, 2020).

Red meat provides an excellent balance of proteins, key micronutrients such as vitamin A, vitamin B_{12}, Vitamin D, vitamin K_2 as well as various important minerals such as iron, zinc and selenium. Red meat also provides long-chain omega-3 essential fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Consuming dairy products also provides health benefits since the top 15 dietary risk factors for ill-health including diets that are low in calcium and milk, both of which are provided by dairy products (Stanton, 2020). Animal-based diets also contain higher amounts of leucine and other essential amino acids which are associated with increased anabolic potential and muscle protein synthesis. The Food & Agriculture Organisation (FAO) (2023) of the UN examined the nutrient composition and value of terrestrial animal source food and concluded the following:

- Terrestrial animal source food (TASF) within appropriate dietary patterns can make important contributions to reducing stunting and wasting in children under five years of age, low birth weight, anaemia in women of reproductive age (15–49 years), overweight in children under five years of age, and obesity and diet-related non-communicable diseases (NCDs) in adults.
- Evidence from the evolutionary past of *Homo sapiens* shows that higher levels of TASF intake were associated with increased stature, brain size and longevity, probably establishing metabolic needs in the human body that have remained into the present.
- TASF provide higher quality proteins than other foods, with some nuanced differences in digestibility. Some specific amino acids and bioactive compounds with roles in human health (carnitine, creatine, taurine, hydroxyproline and anserine) are found primarily in TASF. The long-chain fatty acids and the ratios of essential fatty acids found in TASF are important for cognition across the human life course.
- Iron and zinc in red meat are bound in compounds that are more bioavailable and may be more easily digested than those in which these nutrients are bound in plant-based foods.
- Milk is recognised for its high concentration and bioavailability of calcium, among other nutrients.
- Eggs have high concentrations of choline and some long chain fatty acids.
- TASFs are also generally a rich source of selenium, vitamin B_{12} and choline. Consumption of TASF has been shown to counteract the effects of antinutritional compounds found in plant-based foods.
- The nutritional quality of TASFs (especially the fat composition) can be influenced by (in order of priority) animal species and feeding system, breed and production environment.
- Husbandry practices barely affect the protein composition and amino acid profile of TASFs.

- Feed and feeding systems mostly affect the nutritional quality of TASFs, especially fat and fatty acid content and especially in monogastric livestock (such as poultry and pigs).
- High dietary intake of polyunsaturated fatty acid dense plants, in both ruminants and monogastrics, results in higher quantities of beneficial fatty acids (omega-3) in eggs, meat and milk.
- Feed and feeding systems affect, in particular, the technological and organoleptic quality and the commercial value of TASFs.
- Genetic selection programmes predominantly focus on increasing production and productivity, improving economic performance and meeting the demands of the food-processing industry. A few initiatives aim to improve nutritional quality.
- Causing stress to animals before slaughter affects the quality of TASF

They also concluded that foods derived from livestock production systems including grazing and pastoralist (nomadic or part-nomadic) systems, and from the hunting of wild animals, provide high quality proteins, important fatty acids and various vitamins and minerals – contributing to healthy diets for improved nutrition and health (FAO, 2023).

If protein and other requirements are easily met by plant-based products, why do people crave meat? Is it because meat is a food our bodies crave? The common desire of people to eat meat in excess, and for vegetarians and vegans to want protein similar to meat, stems from a false sense of need. Cravings for animal products are deeply rooted (Pitchford, 2002). The protein requirements are routinely exceeded in wealthy countries is demonstrated by the fact that nearly everyone has symptoms of excess protein consumption: acidic blood, calcium deficiency and a tendency to carcinogenic and other diseases (Pitchford, 2002). However, this is not a profile matched by people in the less economically developed nations in rural communities, which then begs the question of the quality and quantity of proteins consumed.

The protein debate

Protein is a macronutrient that is responsible for multiple functions in the human body. Essential amino acids which are needed to synthesise other amino acids to make proteins for the body can only be obtained from the diet. These essential amino acids are obtained easily from animal sources. Moreover, all twenty amino acids are easier to find in meat and other animal products and thus referred to as 'complete proteins'. Complete plant-based proteins do exist and include foods such as quinoa, tofu, edamame, amaranth, spirulina, buckwheat and natural yeast (BANT, 2022). However, these complete sources are limited in number and variety, and so vegans require a wide diversity of foods in order to consume sufficient amounts of all amino acids (Mariotti & Gardner, 2019 and Haas & Levin, 2006). But despite the availability of amino acids in plant foods, several factors indicate that vegans may still be at risk of protein insufficiency (BANT, 2022).

The vitamin B_{12} debate

Vitamin B_{12} is an essential nutrient for the production of energy, synthesis of haemoglobin, red blood cells, the amino acid methionine, and folate. It is also necessary for the nervous system to function, for homocysteine metabolism and DNA synthesis. Recent estimates suggest high rates of vitamin B_{12} deficiency among vegetarian and vegan populations (Nicklewicz *et al.*, 2022). Plant-based vitamin B_{12} is difficult to find since is not synthesised by plants and consequently not a reliable source for vegans or vegetarians. To ensure adequate intake of this essential vitamin, the British Association for Nutrition and Lifestyle Medicine (BANT) recommend consuming seaweed (classed as algae), cereals fortified with vitamin B_{12} or taking a supplement (BANT, 2022). Addressing micronutrient status is vital for vegans and relying on unfortified plant foods or not taking supplementation can result in acute deficiencies in individuals who do not plan their meals adequately (BANT, 2022).

Nutritional deficiencies in vegans

Vegans rely entirely on plant-based foods and can be at risk of nutritional deficiencies which could, in the long-term lead to chronic illness and disease (BANT, 2022). Iron (Fe), vitamin B_{12}, zinc (Zn), vitamin D and calcium (Ca) are all either low in level or have poor bioavailability in a typical vegan diet (BANT, 2022). Recently published research has identified other potential risks of plant-based diets such as reduced bone mineral density, higher risk of fractures (increased BMI/obesity is a protective factor in fracture risk) and an increased risk of haemorrhagic stroke in vegetarians and vegans (Tong *et al.*, 2020, Malmir *et al.*, 2020, Tong *et al.*, 2019).

Soy is arguably one of the most controversial nutrition topics. Soy products are often a staple in a vegan diet in the Western world to provide the protein content that would ordinarily be provided in animal-based diets. However, the variety of processed soy products that dominate the Western food market is a far cry from the traditional fermented soy foods of miso, tempeh, tamari and natto that are much healthier than their Western counterparts (Boutas *et al.*, 2022). The term soy and soya are generally used interchangeably but they are the same (soybean). Soy has many health benefits but particularly so for perimenopausal and menopausal symptoms owing to the high levels of phyto-oestrogens in them (isoflavones) which are only beneficial in the traditional fermented product or as isolated standardised extracts taken as a supplement. A recent meta-analysis showed that the consumption of soy isoflavones can reduce the risk of breast cancer in pre-menopausal and post-menopausal women (Boutas *et al.*, 2022). However, there are concerns about soy-rich diets. For instance, some fear that eating too much soy may increase the risk of breast cancer, hinder thyroid function, or have feminising effects in men, to name a few (Panoff & Goodson, 2022).

Many vegan foods are highly processed and further add to potential deficiencies. Vegan junk food such as instant noodles, vegan nuggets, crisps and desserts for example offer very little nutritional value. They also have high levels of sugar, salt, fat and additives although this is also the case for all junk foods. The current concerns

around ultra-processed foods (UPFs) and their links to poor health outcomes (Lane *et al.*, 2024) are however applicable to all diets and not just to a vegan one. This may perhaps provide the strongest case yet for a whole foods diet which promotes minimal processing and consumption of foods (animal or plant) in their natural state.

The EAT-Lancet recommendations

The EAT-Lancet Commission report which was published in 2019 aimed to highlight the need for a radical transformation of the global food system that delivers both environmental sustainability and improved human health (EAT-Lancet Commission, 2019). The recommendations towards a plant-based diet is widely regarded as the 'planetary health diet' which projects a baseline for food consumption to 2050 based on expected population growth and current trends in food consumption. It also proposes evidence-based targets for what a healthy, sustainable diet which could feed a global population of 10 billion people by 2050 within planetary boundaries would look like (EAT-Lancet Commission, 2019).

There is much to praise the recommendations; the planetary health diet is high in fruits, vegetables, nuts and legumes, and low in food from animal sources (meat and dairy) as well as low in ultra-processed foods. It also requires food waste to be reduced by half. However, the World Health Organisation (WHO) has withdrawn its support for these recommendations due to its lack of scientific rigour and the diet's negative impact on human health and livelihood (Haigh, 2019). Similarly, a report from the UN's FAO states that meat, eggs and dairy provide essential nutrients that are harder to obtain from plants explaining that animal parts offer the required quality and quantity of nutrients needed for human health and that they can be harder to locate in plants. However, it also states that governments should take into account the challenges linked to livestock including environmental issues (FAO, 2023).

BANT supports some of the recommendations of the EAT-Lancet Report such as the no/low intake of processed foods, added sugar and the reduction of food waste. However, it does sound a note of caution on some of the more draconian advice stating that humans are physiologically and metabolically omnivores, and for some people, reducing the amount of animal protein to the levels recommended in the report may be problematic without supplementation or intake of fortified foods (BANT, 2019). The nutritional body state that there are other earth-sustainable solutions which also respect livestock such as prioritising fresh, locally farmed ingredients including grass-fed meat, over meat sources from unsustainable farming practices and industrialised, ultra-processed, packaged foods (BANT, 2019).

Corporate-pushed plant-based food has also had an adverse effect on the environment from bee slavery in the production of almond milk, particularly in the US (McGivney, 2020) to insect apocalypse in Germany and Puerto Rico even in neighbouring non-arable land (Goulson, 2019); these apply to innumerable invertebrates and particularly insects which are integral to every terrestrial food web

and freshwater ecosystems which would all collapse without insects (Goulson, 2019).

Some of the criticisms of the EAT-Lancet recommendations state that millions of small farmers especially in remote, rural regions of the world will be hurt first by an anti-meat agenda. Already, suicides and economic hardship are rife in farmers (Borts-Kuperman, 2024). These regions are not arable so crops cannot be grown on them, grazing livestock are better suited to these regions and provide meat, manure and are physiologically geared to be the best converters of vegetation to animal protein. Crucially, grazing animals also restore vital nutrients back into the soil. Another criticism is that the recommended diet is unaffordable to low-income communities and poorer nations particularly in Africa and South Asia (Green, 2019).

Non-Western Diets

Traditional diets and lifestyles of non-Western populations have been associated with a significantly reduced risk of and rare incidence of NCDs, especially those that are chronic in nature such as obesity, T2D, heart disease and cancer (Pressler *et al.*, 2022). Traditional diets including those of the Maasai and Inuit cultures have had a high protein, high fat and low carbohydrate content for years. In the Maasai community, meat and milk are the main components of their diet (as almost everything they consume comes from their animals). The protein intake of the Maasai comes from their herd animals (consumed either as meat or from their milk). Their pastoral lifestyle may be the biggest contributor to the prevention of disease (Campbell, 2019 and Schiller, 2010). This active lifestyle involves plenty of walking outside while tending to their livestock, although intense exercise is rare and they hardly ever run (Peterson, 2012).

Similarly, the Inuit consume seafood, seals and whales with the traditional diet being very low or non-existent in refined carbohydrates and sugar with rarely any fruits or vegetables (DiNicolantonio & O'Keefe, 2017). There are more than 125,000 Inuit belonging to about 40 different ethnic groups living in an enormous area that includes parts of Alaska (United States), Canada, Greenland (Denmark) and Russia. Even though groups of them may be separated by huge distances, the Inuit have remained remarkably homogeneous including their diet. Malignant diseases including cancerous tumours were believed to be non-existent during the early 1900s (Friborg & Melbye, 2008). Like the Maasai, they have a moderately active lifestyle and hunting whether on land or in water on a daily basis promotes cardiovascular health and muscle strength (Peterson, 2012).

For centuries, the Inuit were a nomadic people who spent their time hunting and fishing, but today they have become sedentary. In recent years, elements of the Western diet have been introduced to the traditional hunting, herding and pastoralist lifestyles of both the Maasai and Inuit cultures. Consuming more carbohydrate-rich foods and refined sugars maybe having a detrimental impact on the health of these communities owing to an increased incidence of diseases such as cancer, T2D and

heart disease as well as an increased obesity levels previously unseen (Pressler *et al*., 2022 and DiNicolantonio & O'Keefe, 2017).

The Japanese traditional diet and cuisine (washoku), which is characterised by high consumption of fish and soybean products and low consumption of animal fat and meat, relies on the effective use of umami taste to enhance palatability. There may be a link between washoku and the longevity of the people in Japan. In 2013, washoku was registered in UNESCO's Intangible Cultural Heritage list as a unique culinary culture that has been handed down from generation to generation. However, as incomes steadily increase globally, traditional diets have been displaced (Gabriel *et al*., 2018). The Ainu are the original inhabitants of Hokkaido, living on and with the land for many years. Unlike the Japanese, who practiced rice farming, the Ainu traditionally hunted, foraged and fished. Much of the Japanese tastes originate from the Ainu cuisine. With much of the Ainu culture eradicated after the Japanese government formally colonised Hokkaido in the late 1800s and banned their traditional hunting and fishing, there is now a movement to showcase Ainu cuisine and culture to outsiders, as well as a resurgence of interest in their traditions and ingredients. And while Japan is known for its love of sushi and sashimi, the Ainu rarely eat raw fish or flesh – it is usually boiled into soup or roasted, with the fish skin and animal hides traditionally used for clothes. Traditional seasoning would be plain – usually salt, kombu or animal fat – with no use of soy sauce or other soy products (Cobb, 2020). There is a strong drive to restore some of these traditional diets in light of the adverse effects seen in modern Western diets.

The environmental argument

Many people are turning to vegan diets or a predominantly plant-based diet for environmental reasons. Global food systems are complex and there are huge disparities in wealth between nations coupled with inequalities in access and availability of food leading to problems of excess and waste at one end and poverty and hunger/starvation at the other. Governments are looking at sustainable food systems but veganism (or at least the 'Western; version of it) is not the solution (Smith, 2016 and Tree, 2018).

Given the intrinsic relationships between nutrition and the environment, it seems logical to integrate environmental sciences with nutritional sciences to address the sustainability of food systems. There is broad consensus among scientists and major organisations such as WHO and the Intergovernmental Panel on Climate Change (IPCC) that a diet rich in plant-based whole foods is better for human and environmental health (Takacs, 2024).

Land and water are closely connected; critical for human health and ecological survival. However, access to these resources are unevenly distributed and those who reap the benefits are not always those who bear the costs, and society's most vulnerable groups are often the most affected.

Today's food supply chain creates approximately 13.7 billion metric tonnes of CO_2 equivalent ($CO_{2\text{-eq}}$) (Poore & Nemecek, 2019). Further, the global food system accounts for a third of anthropogenic GHGEs, approximately 32% of global terrestrial acidification and approximately 70% of eutrophication. Agriculture uses 70% of all fresh water and 50% of the world's habitable land (Takacs, 2024). Beef farming in particular, devours more land and water causing more environmental damage than any other single food product (Gray, 2020). It has the largest carbon footprint compared to other livestock and on balance, even compared to some exotic fruit and vegetable imports. But anyone looking to adopt a vegan or vegetarian diet for environmental reasons may want to consider that not all plant-based foods have a small environmental footprint.

Table 2: Typical carbon footprints and water usage of selected fruits, nuts and vegetables
(adapted from Gray, 2020 and Marie, 2022)

	Average carbon footprint ($KgCO_{2\text{-eq}}$ per kg)	Water usage to cultivate the crop (L/kg)
Vegetables		
Avocado	2.2 (imported)	1,981
Asparagus	5.3	2,150
Mushrooms	2.13-2.95	322
Fruits		
Watermelon	0.06	235
Strawberries	0.13	347
Blueberries	2.62	845
Plums	0.14	2,188
Mangoes	4.4 (imported)	1,800
Nuts		
Cashews	4.99	4.13
Almonds	2.3 (nuts) 2.89-3.07 (paste)	8,040 (with shell) 16,095 (shelled/peeled)
Miscellaneous		
Cocoa*	11.2 (for 1Kg of chocolate) 33.6 (for 1Kg of cocoa powder)	15,636
Mycoprotein	5.55-6.15	not applicable

*2-3 hectares of tropical forest was lost to cocoa plantation between 1988-2008.

The land, water and transportation of certain fruits and vegetables as well as other perishable foods have significant environmental costs. To mitigate such costs, there are calls to consume locally grown varieties that are seasonal.

Plant-based meats and plant-based milk

At present, novel plant-based meat alternatives should arguably be treated as meat in terms of sensory experience but not as per se as nutritional replacement for meat

(Van Vliet *et al.*, 2020). The lower carbon footprint of plant-based meat alternatives is touted as a main reason for choosing plant alternatives over beef. While meat alternatives may have a lower environmental impact when compared to feedlot-finished beef, well-managed pasture-based livestock systems fix at a minimum all the GHG they emit (and sometimes more) even when taking into account all aspects of the production process. Pastured beef systems that use land management practices such as rotational grazing—where lands are allowed to properly recover after a grazing period—and/or cover crop grazing suggest that the amounts of carbon sequestered in the soil more than offsets the ruminants' GHGE, resulting in a net negative carbon footprint. (Allard *et al.*, 2007; Teague *et al.*, 2016; Stanley *et al.*, 2018). By having livestock participate in carbon cycling by spending their lives on well-managed pastures, grooming and fertilising vegetation and soil (Reeder and Schuman, 2002), such production systems have the potential to help mitigate climate change (or in the very least not exacerbate it further) while ensuring a degree of food security (van Vliet *et al.*, 2020).

The ecological impacts of human diets are not as simple as plant vs. meat discussions might suggest. The global food system is far too diverse and contingent on unique environmental and socio-economic circumstances to allow for one-size-fits-all policy recommendations. As the latest IPCC Report (2019) points out, mixed plant farming-livestock grazing systems can heal damage done by years of continuous arable cropping reliant on mechanical and chemical inputs. In the process, we may increase the number of animals grazing phytochemically rich landscapes that nurture animals, soil, plants and people, and provide food that is biochemically richer and arguably more nourishing for *Homo sapiens* and the planet (van Vliet *et al.*, 2020).

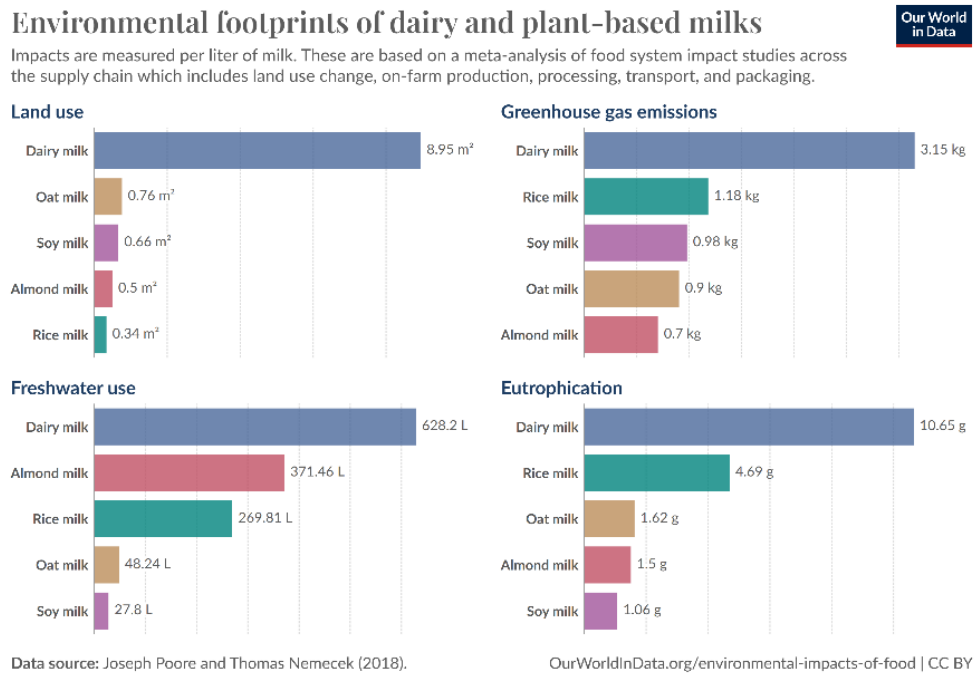

Fig 1: Comparison of the environmental footprints of dairy and plant-based milks (taken from Richie, 2023)

As an increasing number of people in the UK are switching to plant-based milks as an alternative to dairy, many questions remain about how plant-based milk products compare to dairy milk from a nutrition, public health, and planetary health perspective. How much better are they for the climate, what about nutrition, and which is the best plant milk for the environment? Does

dairy or plant milk have a higher carbon impact? For each litre of dairy milk produced, it has almost three times the carbon footprint of the next highest emitter, rice milk. For the plant-based milks examined, the greenhouse gas emissions were diminished by 59–71% per 250 mL, and the land use and eutrophication impact was markedly less than the levels displayed by dairy milk. The water usage for the oat and soya drinks, but not rice drinks, was substantially lower compared to dairy milk (Craig *et al.*, 2023).

From a nutritional perspective, the replacement of dairy with plant-based milks is unlikely to be a concern for those with a diverse diet, and for those who do not rely on milk as an important source of protein. Many lower-income countries get most of their calories from cheap, energy-dense crops like cereals and tubers (like cassava). This can be more than three-quarters of an individual's calorie intake. These diets do not provide the diversity of nutrients needed for good health – they are likely to be deficient in a number of micronutrients, and protein. In such cases, removing dairy from a person's diet without sufficient replacements could have a negative impact on health and nutrition (Richie, 2023).

Conclusions

It is evident that in light of climate change, environmental sustainability and concerns over global food security, we need to examine our current food systems more thoroughly than we have ever done before if we are to meet the nutritional needs of a growing human population in addition to addressing planetary health.

Whilst veganism has been touted in the West as a way forward in this challenge, it runs counter to planetary health with significant carbon footprints of mass produced plants and heavy processing of some vegan products thus also compromising human health. Western veganism is also not reflective nor respectful of the long traditions of plant-based diets practised for many centuries in other parts of the world which has deep connections to ancient religions and cultures. Some traditional diets are already showing signs of loss such as native American, traditional Japanese including those of the Ainu and aboriginal diets which have always been informed by their culture.

There are also significant disparities in food distribution systems, availability, access and affordability. The market forces that dictate the price of foods especially staples such as wheat, maize (corn), rice, cassava, meat, fish and dairy are based on the price of what the markets can bear and not influenced by the costs to produce them, quite often leading to food waste. The political will to regulate this is currently sadly lacking and has been for many years.

Inside of these issues, there is a conscious bias emanating from socio-economic and cultural factors which need to be understood. The majority of capitalist economies that dictate growth dynamic (whether good or bad) strongly influence availability and price of food; growth for its own sake is a problem. A capitalist economy is

disconnected from fair distribution and production of food often resulting in huge waste; one of the biggest tragedies of modern food systems.

The complexities that surround the challenges of tackling food systems also means that countries and key organisations need to work together to understand problems at a local, regional, national and international level. For instance, promoting an anti-meat agenda where a local beef farmer's livelihood is at stake is invariably going to be met with resistance unless suitable alternatives can be supported. Equally, there needs to be a greater understanding of the quality of meat eg. the differences in meat from small-scale, natural/organic pasture-fed/grazing animals compared to those derived from large-scale feedlots kept in close proximity and given growth hormones, antibiotics and commercial feed. Many of the medicines used end up the food chain and in our systems. We already have a global crisis with antibiotic resistance such is its abundance in our environment and food chain.

Poor soil health and environmental pollution through intensive farming practices, pesticides, herbicides and artificial fertiliser use (usually in excess) among a raft of chemicals is another factor that compromises food quality leading to systems that require processing and fortification. Important vitamins and minerals are added post-harvesting in order that nutritional requirements can be met. Paradoxically, some of the poorest nations in the world have some of the best quality crops having avoided any processing simply due to its prohibitive costs and affordability.

Most scientists including nutritionists now agree that a flexitarian diet which resembles the TDD diets of the Mediterranean and New Nordic is the way forward to preserve both human and planetary health. Whilst there continues to be limitations in scientific studies/trials when it comes to diet, it is clear that we should embrace whole foods that are locally produced and promote the consumption of seasonal produce. With an estimated human population of 10 billion by the end of the century (2100), many scientists are already examining alternative methods of farming that includes permaculture, biodynamic farming, regenerative farming, hydroponics, aquaponics, vertical farming, urban agriculture, agroforestry and food forests, polycultures and crop rotation, heirloom and older varieties, natural animal raising, natural pest management, mulching and manual weed control. This is potentially an exciting time for the farming industry. Lab-grown meat however, currently under consideration, remains far too controversial at present.

A fundamental shift is urgently needed to really address both human health and planetary well-being that is fair and equitable to all nations. Since we cannot survive as a species without ensuring the existence and health of all living things, a deeper understanding is required of food systems that operate in the biggest ecosystem of all, planet earth.

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