The Role of Plant-Based Diets in Creating a Fair, Healthy and Sustainable Food System

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This paper was prepared for the European Plant-Based Foods Association (ENSA) by Mark Driscoll - Sustainable Food Systems Consultant, Prof Dr Ian Rowland - Human Nutrition Expert, and Dr Harry Aiking - Environmental Expert.

Introduction

A global transformation towards sustainable food systems is crucial for delivering on climate change mitigation targets, reversing biodiversity loss, and addressing the triple burden of malnutrition (hunger, micronutrient deficiencies and overweight/obesity) [1] . Plant-based alternatives to animal sourced foods[2] are pivotal to the transition to healthy and sustainable diets and food systems which deliver better human and planetary health outcomes.

This paper defines plant-based diets as those dietary patterns that place a greater emphasis on a diversity of foods derived from plants. These include fruits and vegetables, wholegrains, pulses, legumes, nuts, seeds, seaweeds, microorganisms including microalgae and fungi (mycoprotein), and plant-based alternatives to substitute dairy and meat products (sometimes referred to as meat and dairy alternatives) [3].

The paper is aimed for use by policy makers and other stakeholders with an interest in food system policy across Europe, outlining why plant-based diets need to be at the heart of policies to create a fair, healthy and environmentally friendly food system within Europe. It is based on a scientifically rigorous peer review of the most up to date research and literature, assessing the evidence in line with six key sustainability criteria which were outlined within the JRC publication 'Concepts for a sustainable EU food system'*4*.

Globally, we are at a critical juncture with a 'decade of action'[5] needed to address key food systems challenges. Global commitments to deliver on the 17 Sustainable Development Goals (SDGs)[6], the Paris Agreement on Climate Change[7] and the need to eliminate malnutrition in all its forms[8], represent an unprecedented opportunity for universal and integrated change with nutritious and sustainable plant-based diets central to the shift towards a fair, healthy and sustainable food system. Furthermore, the war in Ukraine and the COVID-19 pandemic, are contributing to rising food prices and an immediate food crisis[9], demonstrating the vulnerability of our food system to these and other external shocks. Plant-based diets provide a unique opportunity to improve the resilience of European food systems, for example by alleviating pressure on global grain supplies which would otherwise be fed to animals and producing legumes, reducing over-reliance on fertilisers[10].

Section 2 below highlights the positive sustainability, health, and nutrition impacts of plant-based diets in all their forms and a growing consensus between the scientific, nutrition and sustainability communities on the urgent need for policy makers to act today for a better future tomorrow.

1 Human and Planetary Health: The Benefits of Plant-Based Diets

Food is at the heart of many of the critical environmental, health, social and economic challenges we confront in the 21st century. With a global population forecast to grow from 7.9 billion people to an estimated 9.7 billion by 2050[11], combined with significant growth in the consumption of meat and dairy products[1],these challenges are only likely to intensify. A number of international reports state with high confidence that balanced diets featuring plant-based diets present major opportunities to reduce climate impacts and biodiversity loss whilst generating significant co-benefits in terms of human health and nutrition[12] [13].

1.1 Reducing Climate, Water and Food Waste Impacts

Global food systems account for 31% of the total anthropogenic greenhouse gas emissions (GHGs),

[1] Beef, pork, poultry, and sheep meat is projected to grow 5.9%, 13.1%, 17.8% and 15.7% respectively by 2030. OECD/FAO. 2021. OECD-FAO Agricultural Outlook (Edition 2021). OECD Agriculture

including emissions arising from production, processing, packaging, transport, storage, consumption, and disposal of food[14]. Without adequate interventions, business-as-usual emissions from food systems alone would likely exceed the 1.5°C emissions budget between 2051 and 2063[15]. Reducing food waste and shifting diets towards diets that include more plant-based meat and dairy alternatives could mitigate 1.8 Gt CO2eq every year by 2050[16]. Meat and dairy alternatives have very low GHGs when compared to their animal-based counterparts[17]. For example, producing a kilogram of beef and dairy milk emits 60 and 3 kilograms of GHGs respectively whilst producing a kilogram of peas and soya-based drinks emit 0.9kg of GHGs. One study highlighted that replacing animal-source foods with plant-based ones was particularly effective in high-income countries, resulting in GHG reductions of 84%, whilst also improving nutrient levels[18]. On average, plant-based milks produce 19 times less GHG emissions than the same volume of animal-based milks[19]. Overall, alternative dietary pattern scenarios (for example, vegetarian, vegan or flexitarian diets)[20] [21] [22] or existing dietary patterns which include high levels of plant-based consumption (for example, Mediterranean or New Nordic diets)[23] highlight that significant reductions in GHG emissions and other environmental impacts can be achieved by shifting towards more plant-based diets.

Meat and dairy use a significant amount of water with agriculture accounting for 70% of freshwater withdrawals globally[24]. Compared to omnivore diets, vegan diets reduce water use by 22–70%, and vegetarian diets reduce water use by 15–69%, with significant variations reflecting whether plant-based foods are irrigated or rainfed[25]. For example, on average, 628 litres of water are required for every litre of dairy milk, compared to 371 litres for almond, 270 litres for rice, 48 litres for oat and 28 litres for soya drinks[26]. Water pollution due to animal waste and the use of fertilizers (nitrogen) is a common problem across Europe leading to biodiversity loss (see section 2.2) and nitrate concentrations that are considered dangerous for human health[27]. The high content of nitrogen, phosphorous and other nutrients in manure runoff can also lead to dead zones in downstream waterways and seas, where an overgrowth of algae, results in bacteria blooms which consumes all the oxygen[28]. Shifts in diets to those that decrease meat and dairy consumption, replacing them with plant-based alternatives, significantly reduce eutrophication potential, according to research conducted by WWF[29]. For example, soya drinks emit only 6% of the eutrophication substances that occur during milk production[30]. According to research by the EU Joint Research Centre[31], greater compliance with national dietary guidelines would result in water reductions of 11% to 35% for diets with meat, 33% to 55% for pescatarian diets and 35% to 55% for vegetarian diets – recognising that many national dietary guidelines are still not compatible with global health and environmental targets and need reform[32].

One third of the food produced in the world for human consumption every year, approximately 1.3 billion tonnes, gets lost or wasted,[33] with the highest rates of losses associated with livestock production[34]. Food waste drives a range of other impacts including 6% of total global greenhouse gas emissions[35], uses up to 1.4 billion hectares of land, or 28% of the world's agricultural area[36]. Livestock are inefficient and wasteful feed converters. It takes much more grain, land, and water to grow an animal to produce meat than it does to produce the same number of calories in the form of any grain or plant that is eaten directly. Poultry, for example, has an efficiency of about 20% (5 kg of protein in feed grain yields about 1 kg of meat protein) and beef has an efficiency of about 3.8%[37] [38]. 75% of the world's agricultural land is used to raise animals, through growing crops for animal feed and using pastures as grazing land (71% of agricultural land is used for grazing livestock and 4% of agricultural land (23% of total cropland) is used for feed)[39] [40]. This includes high-quality soy protein, used for animals, which could otherwise be used to feed humans directly much more efficiently.

1.2 Protection of the Natural Environment, Biodiversity and Land-use change

Biodiversity generates critical ecosystem services that support food production including pollination, healthy soils, pest control, water regulation, carbon storage, and a habitat for wildlife[41]. Despite this, global wildlife populations have decreased by 60% globally between 1970 and 2014[42]. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) reported that nature is declining globally at rates unprecedented in human history, with over one million species threatened with extinction[43]. According to one estimate, 30% of global biodiversity loss is linked to livestock production[44], driven by livestock's role in deforestation and land conversion, overgrazing and degradation of grasslands, and desertification. 77% of soya produced globally is used in animal feed for factory farmed animals (two thirds of which goes to poultry and pigs)[45], driving deforestation and biodiversity loss in the Amazon for example.

Increasing consumption of plant-based alternatives to animal-source foods is essential for reducing biodiversity loss, with a significant driver being reduced pressure on natural ecosystems at risk of conversion[46]. According to WWF, a shift toward more plant-based foods could reduce

global biodiversity loss by between 5% (flexitarian diet) up to 46% (vegan diet)[47]. An area 1.5 times the size of the European Union would be saved from agricultural production if more balanced and nutritionally rich plant-based diets were adopted[48]. A switch from beef to beans in the diets of the entire US population could free up 692,918 km2 – equivalent to 42% of US cropland – for other uses such as ecosystem restoration or more nature-friendly farming[49].

Furthermore, significant freshwater and marine biodiversity loss is attributed to the production of fertilisers and manures by the livestock sector. The abundance of populations monitored in freshwater and marine systems has fallen by 83% and 36% respectively between 1970 and 2014[50]. Industrial and intensive livestock systems are often associated with higher incidences of water pollution because of animal wastes contaminating local water courses[51]. In addition, the use of nitrogen in fertilisers, has had a significant impact on habitats across Europe with concentrations and depositions continuing to exceed safe limits and thresholds[52] (see section 2.1).

Plant-based foods that are produced using regenerative or agroecological agricultural practices [53], using fewer pesticides and fertilisers, can help build soil health and fertility, increasing water percolation and retention, increasing biodiversity and ecosystem health, and reducing carbon emissions[54] [55]. In addition, many leguminous crops, such as beans, soybeans, peas, chickpeas, peanuts, and lentils, add nitrogen to the soil, contribute towards improvements in soil health. Used in rotation with other crops, leguminous crops can significantly reduce the need to use fossil fuel-based fertilizers [56]. Legumes also contribute to reduce the emission of greenhouse gases, as they release 5–7 times less GHG per unit area compared with other crops[57].

1.3 Provision of healthy, nutritious foods

Several recent studies have demonstrated the significant impact that increasing consumption of plant-based foods relative to animal-source foods can have on human health[58]. The EAT-Lancet Commission on Food, Planet, Health found that premature mortality could be reduced for up to 11 million people by a shift toward a nutritious flexitarian diet[59]. Furthermore, adopting the EAT-Lancet diet, which emphasises plant-based foods, was associated with 40% greater reductions (21% overall) in premature mortality. While Non-Communicable Diseases (NCDs) are responsible for 71% of all premature deaths (41 million deaths a year) globally [60], overall evidence from epidemiological and intervention studies, suggests that plant-based diets have a protective effect against coronary heart disease [61] [62] and a lower risk of cancers when compared to omnivore diets[63] [64]. There are some concerns about the nutritional adequacy of plant-based diets, particularly vegan diets which exclude all forms of animal foods in their entirety. Plant-based alternatives to dairy and meat often have lower protein content than their animal-based counterparts[65] [66]. However, protein intake in the EU substantially exceeds recommended daily amounts [67]. While the absorption and availability of specific micronutrients (such as iron, vitamin A and zinc) may be lower in plant than animal foods, obtaining recommended levels of these micronutrients can still be achieved with an appropriately planned diet that includes a variety of different plant-based foods[68] [69].

Recently, a new approach to food classification has been proposed that is based, not on nutrient composition or dietary patterns, but on the degree of processing. NOVA is the most common of these systems and divides foods into four categories: minimally/unprocessed; processed culinary ingredients; processed foods (e.g., bread, canned vegetables, and fruits, cured meats); 'ultra-processed' foods (UPFs) which are defined as "ready-to-eat, industrially formulated foods" [70]. In some epidemiology studies UPFs have been linked to obesity and metabolic syndrome[71], but there are challenges to the use of the system in nutritional epidemiology studies and there are contradictory findings[72]. The definitions of UPFs in the various systems are inconsistent[73] and the terms have not been incorporated into legislation. In particular the systems have been criticised for the difficulty of distinguishing between processed products with different nutritional qualities [74]. This has relevance for the plant-based alternatives to dairy and meat products, which usually fall into the UPF category. Despite this, recent studies demonstrate that plant-based alternatives to dairy and meat products can score better in nutritional terms than their animal counterparts. For example, soy-based drinks have a lower energy density than cow's milk (whole and low fat), are lower in saturated fat and sugar, similar in protein content and are considered a low glycaemic index (GI) food [75] [76]. Fortification ensures that plant-based milk alternatives match the calcium and vitamin contents of cow's milk[77]. A 2021 comparison of 226 meat products with 207 plant-based meat (PBM) alternatives available in the UK showed PBMs to have a better nutritional profile, with significantly lower energy density, total and saturated fats, protein, and significantly higher fibre, although the majority had a higher salt content[78]. Using the UK Nutrient Profiling Model, 86.3% of PBM fell into the 'healthier' category

compared with only 60% of the meat products. Similar results were reported from a comparison of the nutritional composition of 41 conventional beef burgers with 117 non-meat alternatives available in the USA (containing a wide variety of plant protein sources including soy, pea, wheat, rice, and mushroom) [79].

To assess the nutritional implications of replacing meat with meat alternatives in the context of the whole diet, Farsi et al [80] used data from the latest UK Diet and Nutritional Survey to develop models based on replacing 25, 50, 75 or 100% of current meat intake with plant- based alternatives. Overall, the intake of carbohydrates, fibre, sugar, and sodium increased while reductions were seen in total and saturated fats, protein, iron, and vitamin B12. The long-term impact of plant-based alternatives reducing intake of excess calories and nutrients associated with cardiovascular disease and obesity has yet to be established, but a recent study is indicative of benefits. There were reductions in some cardiovascular disease risk factors in an intervention study where 2.5 servings/d of meat products were replaced with plant alternatives for 8 weeks [81]. Although it is clear that many plant-based alternatives to dairy products have a very good nutritional profile, it would be helpful to conduct studies similar to those above to assess the nutritional consequences of substitution in the context of the whole diet in various populations.

Antimicrobial Resistance (AMR) is declared as one of the top ten global public health threats facing humanity[82] with the death toll from drug-resistant diseases at 1.27 million each year[83]. Plant-based foods do not require the use of antibiotic and therefore have the potential to significantly reduce the AMR burden, which by 2050, will be the leading cause of death globally, with a total economic cost of USD 100 trillion[84]. In Europe it is estimated that AMR costs 1.5 billion Euros per year in healthcare costs and productivity losses[85].

The industrial production of animals is also associated with increasing pandemics of zoonotic diseases (such as influenza, COVID-19, BSE, SARS, MERS, EHEC, Q fever)[86] and as such, plant-based diets are a vital tool in our response to global health threats such as pandemics and other zoonotic diseases[87].

1.4 Driving Innovation and Economic Growth

In Europe, the plant-based food market, including alternatives to meat and dairy, is booming with 2020 sales growing 46% over two years, hitting 3.6 billion Euros[88]. Europe has a unique opportunity to play a world leading role in supporting innovation and research in plant-based foods and the transition to a more sustainable food system whilst meeting the EU's net zero climate[89] and biodiversity targets which put nature on the road to recovery and restoring degraded ecosystems by 2030 [90]. Alternative proteins and dietary shifts are a key priority under 'Food 2030' [91], the EU's research and innovation policy to transform food systems and ensure everyone has enough affordable, nutritious food to lead a healthy life.

The plant-based market, including alternatives to meat and dairy, is projected to become a 7.5 billion Euro market by 2025[92] and the need to promote innovation and investment in this sector to boost economic growth and green jobs has never been more urgent and would contribute to the objective of the EU Recovery Plan, Next Generation EU[93], aiming to support economic recovery, modernise the farming sector, and accelerate the green transition.

There is an opportunity to support a 'Just Transition[94] for farmers and livestock producers no longer wishing to engage in industrial livestock systems – for example those who wish to move to growing crops as alternatives to meat and dairy. The Paris Agreement acknowledges *'the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities'* and highlights the importance of workers and farmers in responding to climate change[95]. A recent report looking at dietary change in Latin America highlighted that reducing meat and dairy consumption while increasing plant-based foods, would create 19 million full-time equivalent jobs despite 4.3 million fewer jobs in livestock, poultry, and dairy sectors[96].

In addition to being of economic benefit for farmers, the development of plant protein production in the EU also carries a range of environmental benefits. In particular, leguminous crops contribute to fixing the atmosphere's nitrogen in the soil and therefore play an important role in a more sustainable nutrient cycle[97] and the EU's target of reducing fertilizer use by at least 20%.

1.5 Ensuring Food Security and Resilience

Food security is defined as ''*a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life''*[98]. Many countries are facing the double burden of hunger and undernutrition alongside overweight and obesity, with 811 million people suffering from hunger[99] and one in three people across the globe currently suffering

from some form of malnutrition.[100] There are now 677.6 million obese adults and one in three people are now overweight[101]. Obesity is one of the leading causes of NCDs (such as diabetes, heart disease, stroke, and cancer) which are responsible for 41 million of the world's 57 million total deaths (71%) – diets containing excessive livestock derived foods and too few plants are one of the four leading risk factors of these NCDs[102] [103].

Food security is under huge pressure from climate change and from non-climate stressors, such as population growth and demand for resource intensive animal-sourced products[104]. Transitioning to more plant-based diets is key to ensuring long term food security. If everyone shifted to a plant-based diet, we would reduce global land use for agriculture by 75%. This large reduction of agricultural land use would be possible thanks to a reduction in land used for grazing and a smaller need for land to grow crops[105]. The use of crops and arable land for livestock production indirectly places rich meat and dairy consumers in competition for calories with those who need them most. Moreover, 6 kg of plant protein is required to yield 1 kg of meat protein, on average. Consequently, only 15% of protein and energy provided by feed crops will be consumed by humans indirectly[106], contributing to the food security crisis.

Furthermore, the issue of food resilience, the ability of our food system to prepare for, withstand, and recover from a crisis or disruption[107], has come to the fore in recent months because of the COVID-19 pandemic and war in Ukraine. This reinforces the need to ensure that EU focusses on opportunities to promote shorter value chains with greater emphasis on increasing the production of a diversity of plant-based crops, such as fruits, vegetables, nuts, legumes etc, ensuring great self-sufficiency in the production of these crops [108]. The latest report from Chatham House highlights those interventions to encourage healthier and more sustainable diets through reduced consumption of meat, the production of which often depends on high volumes of grain for feed, can free up land and negate the impacts of the ongoing war in Ukraine[109].

1.6 Creating a Fair, Ethical, and Inclusive Food System

The transition to plant-based diets and food systems can create opportunities for regenerative and agroecological plant-based agricultural practices which are fair, ethical, equitable and inclusive, improving the livelihoods of farmers whilst improving citizen access to healthy, nutritious, affordable, and culturally appropriate foods, particularly for the poorest in society. There is a need to ensure that food systems support local food value chains and citizen engagement, reconnecting citizens with their food[110]. Schemes which encourage the growing, cooking and preparation of nutritious and sustainable plant-based foods, whilst ensuring citizens are engaged in food systems decision making, are a powerful driver of citizen behaviour change and have potential in driving healthy, nutritious, and sustainable diets.

Further opportunities exist to improve economic opportunities for farmers by diversifying to more crops for human consumption, often referred to as 'orphan crops'[111] including a variety of ancient cereals, grains, legumes, seeds, nuts, fruits, vegetables, and roots. Today 75% of the global food supply comes from only 12 plants and five animal species - Rice, maize, and wheat make up nearly 60% of calories from plants in the entire human diet[112] – and yet there are over 20,000 species of edible plants in the world[113], many of which are sustainable, nutrient rich and may be more suited to changing climatic conditions, whilst improving the income and livelihoods of smallholder farmers[114].

Globally we spend an estimated USD 9 trillion on food and yet the real costs are triple this (USD 19.8 trillion) because of the USD 7 trillion in environmental costs (climate change, biodiversity loss, soil degradation, water contamination), the USD 11 trillion in human health costs and the USD 1 trillion in economic costs[115], much of which is associated with unsustainable and unhealthy industrial livestock systems.[116] There is a need to develop ways of internalising these negative impacts so that the costs and losses they engender are properly reflected in the price of food[117]. If this was done, industrially produced meat and dairy would be far more expensive than plant-based foods produced using high environmental standards[118]. A wider implementation of plant-based eating would lead to large net economic gains for society and improved health outcomes for the population as a whole[119].

Creating healthy food environments is also critical to support a dietary shift – so planning policy and urban design, for example, plays a vital role in shaping these environments and ultimately access to plant-based diets, particularly for the most vulnerable and disadvantaged in society[120].Public procurement also offers an opportunity to make plant-based foods accessible and affordable to all Europeans, within schools, hospitals, and other public sector settings, resulting in reductions in GHG emissions, significant cost savings [121], and an improvement in educational outcomes[122].

Conclusion

We are living through turbulent times; the war in Ukraine, combined with COVID-19, biodiversity loss and the impacts of climate change are already being felt through rising input costs and food prices across Europe[123]. The resulting cost-of-living crisis is already impacting the poorest in society. These events shine a light on the vulnerabilities of a food system that is heavily reliant on livestock production and feed systems that are inefficient, use vast quantities of resources, and damage planetary and human health in multiple ways. The ambitions, as set under the EU Farm to Fork Strategy are more important today than they have ever been. The transition towards more plant-based diets, including alternatives to meat and dairy, offers a unique opportunity to move towards creating a fair, healthy and sustainable food system.

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