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Conference on 'Nutrition in a changing world'
Plenary Lecture

UK food policy: implications for nutritionists

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Implications of the 'changing world' for nutrition and nutritionists are considered, using the UK within a global context as an illustration. The first section summarises the slow recognition by policy makers of the significance of the changing world of food and nutrition. The second section 'Food system stress is now at a critical level' considers the present scale of global food system stress and the failure so far sufficiently to narrow the gap between evidence and policy change. The year 2021 was earmarked when three major UN conferences had the opportunity to chart food changes ahead. The third section 'Multi-criteria analysis helps frame 21st century nutrition science' proposes that multi-criteria analysis is an essential methodology for nutrition within this more complex policy world; nutrition studies can no long exclude social and environmental criteria. The penultimate section 'Nutrition science can reconnect its life science, social and environmental nutrition traditions to contribute to new paradigm formation' suggests that nutrition science can now recombine three traditions within its own history to address this complexity: social nutrition, environmental nutrition and life sciences. The final section 'Priorities ahead' concludes that this multi-criteria approach to nutrition offers new routes for science and policy influence. Five priorities are identified: (1) clarification of the features of a good food system; (2) new sustainable dietary guidelines which integrate different determinants of sustainability; (3) helping consumer engagement with change; (4) developing improved policy frameworks and (5) contributing to professional channels in these processes. In the UK, while the challenge of narrowing the gap between evidence, policy and change remains daunting, the risks of not attempting to improve the transition to an ecologically sound public health nutrition are even greater.

Food system: Brexit: Multi-criteria analysis: Food policy

The Nutrition Society Summer Conference 2021 had a deceptively simple title: 'Nutrition in a changing world'. When is the world not changing? When is nutrition science itself not developing? When have nutrition and all food-related sciences not had to be mindful of the realities and economic dynamics of the time? When is it not difficult to unravel the relationship between sciences and their historical or political context? How can nutrition and other food-related sciences have positive roles as the food system faces such unprecedented stresses? How can nutrition find a voice amidst other powerful social forces within and beyond the food system?

These questions are fertile for historians and science policy analysts, let alone us today. Rising incomes and greater availability of food have long been recognised

Abbreviations: COP, Convention of the Parties, COVID-19, coronavirus virus disease 2019, EU, European Union, MCA, multi-criteria analysis, UNFCC, UN Framework Convention on Climate Change, UNFSS, UN Food Systems Summit.

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as key social determinants of improved public health nutrition but the drivers of nutrition outcomes are now recognised to be complex and require ever more sophisticated understanding which makes the task of formulating policy recommendations more sensitive. Modern tools such as computerised modelling and forecasting have greatly improved policy-makers' capacity to analyse trends and risks but whether notice is taken of the data is another matter. Policy makers often are constrained by short-term political realities whereas nutrition science tends to seek longer-term understandings. Experience teaches us, too, that what seems unimportant in one era can become important in another; *vice versa*, what seems important at the time, can fade with time. The Summer Conference was a welcome opportunity to consider the challenges facing nutrition science today as well as ahead. Good science and good policy can surely only come from exploring and facing these realities. The present paper sets out to review those realities at the global level, with particular attention on the UK and to offer propositions about where they leave public health nutrition as science and contributor to the public good.

As the coronavirus virus disease 2019 (COVID-19) outbreak transitioned into a full pandemic in 2020, high level policy concerns were voiced about its potential further to disrupt a global food system already pressured over food employment, prices, purchasing patterns, environmental impacts everywhere and health transitions particularly in low-income countries[1–6]. Affluent countries such as the UK were not immune from COVID threats to their food systems, particularly for low-income consumers[7–10]. Despite the gravity of these concerns, at the turn of the millennium there had been surprisingly little high-level policy attention in high-income countries about risks from food systems. The problems were seen as affecting developing not developed countries. The 2007–08 food and oil commodity price rise crisis and the Great Recession of 2007–09 dented this complacency[11]. A flurry of interest and policy discussion about food's role in linking planetary and human health began, but was dissipated by a polarising wave of populism and anti-statism which in some quarters even denied issues such as climate change exist or, if they do, can be left to individual actions to resolve[12,13].

In the UK, for example, a governmental process of food policy engagement which had begun in 2008–10 was halted by a government change; 3 years of food system policy review culminating in a new consensus of what the UK's food system should become was abandoned just when needed[14,15]. Such ruptures happen in politics but a decade on, that lost momentum is significant. In its place a weaker voluntarist approach to behaviour change was encouraged[16]. Thus, when in 2016 the UK voted to leave the European Union (EU) whence it sourced about a third of its food supply[17], there was no governmental plan about food, nor public acknowledgement of its food supply implications[18]. Belatedly in 2019, an independent National Food Strategy review was initiated only to be delayed by crisis management in the parent department due to COVID. The final plan of the National Food Strategy was published in July 2021[10], only for the Prime Minister to dismiss one of its key proposals to tax salt and sugar to help break a 'junk food cycle'[19,20]. This initiated debate inside Government about what the formal response should be in a promised White Paper (due spring 2022) and, if Parliamentary timetabling allowed, a new Food Act. Thus in early 2022 the UK still lacked an official food policy and a clear position on the nutrition challenge, despite COVID exposing social faultlines and Brexit removing established intergovernmental frameworks.

At the global level, policy development is not necessarily more successful. UN food agencies such as the WHO, FAO, UN Environment Programme and World Food Programme have mostly advisory status and are as strong as member state support allows. Policy frameworks can be loose and the gap between science and policy can be wide. From the 1980s to the 2000s, for example, growing evidence questioned the complacency that the world's food problems lay wholly in developing not developed economies. The rise in diet-related non-communicable diseases[21], the experience of the nutrition transition[22,23] and the growth of overweight and obesity[24], all questioned the default view that affluent nations offered good role models for food system development. While such deliberation was occurring over public health, environmental scientists were also building evidence about the environmental costs of the 'westernisation' of diet with regards to land and water use, and methods of production[25]. Together, human and ecosystems health analysts began to doubt the policy assumption that the future of food entailed the expansion of choice, cheap foods, ready-made processed food and longer supply chains[26,27]. A rethink of agri-food systems within the 'changing world' was emerging, with some seeking further intensification of food production[28], others 'sustainable intensification' particularly on the farm[29,30], and others a more radical low impact, ecological public health and 'greener' future[31].

Within this context, the UK has provided and continues to provide an interesting case study. It had experienced great shock to its imperial era food supply in World Wars I and II[32,33], and post-1945 initiated a new direction of providing more food from its own resources for strategic purposes. Joining the Common Market in 1973 and then voting to leave the EU in 2016, its people and certainly its government had perhaps underplayed the possible effects when Brexit finally happened in January 2021. *Not* to think about its own food security when deciding its future suggests some deep-seated political confidence in its own capacities[34,35]. In fact, import reliance on the EU continues but whether this will remain the case is again uncertain, already affected by loss of access to European migrant labour to work on farms, in factories and hospitality.

Food system stress is now at a critical level

Without doubt, climate change currently dominates policy discourse about food system threats, and evidence

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on the importance of climate stability for agri-food systems has grown in the three decades since the Intergovernmental Panel on Climate Change was created to distil data and make recommendations to governments[36]. However, climate is not a single factor; it sits within a number of planetary cycles including nitrogen, phosphate and water that provide the infrastructure for the biological 'web of life' (to use Darwin's phrase) on which human life and food depend[37]. This natural ecological web should not be ignored by any science or profession which studies how people live their daily lives, how they eat and where their food comes from yet in the early 21st century, policy makers and consumers were slow and reluctant to recognise the role of food in changing these dynamics[38]. With the sustainable development goals targets less than a decade away, the scale of scientific concern is considerable[39].

At a mass population level, humanity has seemingly lost touch with how the model of food production and consumption developed from the late 19th into the 20th centuries contributed to the 'mining' of ecosystems and thus the destabilisation of natural biogeochemical cycles such as nitrogen, carbon, hydrogen, oxygen and phosphorus on which life depends[40]. It is as though what Western societies have today is the benchmark for desirability. How the understandable imperative to drive food progress – better and more plentiful food and diets for all – has changed what and how food is produced and consumed and with what impacts is increasingly discussed as a paradigm crisis[38,41–44]. The 21st century now faces a challenge of how to address the co-existence of ecosystem stresses and societal dynamics such as inequality and other socio-cultural determinants of nutrient intake which appear to be locked-in for maintaining rather than preventing the damage. We should not be surprised therefore that policy makers now face a multiplicity of calls for urgent attention ranging from polluted waterways and seas to inappropriate food waste[45,46]. The challenge is how to address these simultaneously, not to retain them in policy silos. Table 1 provides a short list of salient concerns about the current 'changing world'. Some of these might be obvious to nutrition scientists but not to others. This table is the type of list which ought to be presented to policy makers routinely with the proviso that these need to be addressed at the same time, not 'cherry-picked'.

For some nutritionists, such considerations though sobering merely reinforce the view that, first, clear divisions should be maintained between science and political arguments about what to do and that, second, the job of scientists is to produce evidence and to leave how it is used to policy makers. Many difficulties are known to arise from that assessment – and emerged in the COVID pandemic as politicians grappled with how to translate the evidence. The position raises what is known as the use–abuse debate about science – that science is neutral yet the 'messiness' of policy makers can misuse what should be to the public good. Others argue that since this litany of concerns is the unintended consequence of the entire post-World War II 'productionist' approach to food, in which nutrition data and nutrition scientists were so visible a force, nutrition science has a moral obligation to learn the lessons and to contribute to more appropriate food goals ahead. If nutritionists do not engage with today's challenges, others might misuse their data; better to engage, therefore, and help frame the discourse.

Such positions deserve more discussion within nutrition science. The mid-20th century food paradigm's rationale was certainly liberal and humane: to prevent mass hunger, to make food more plentiful and affordable[43,70]. In key respects, the development of the food policy challenges today can be traced back to the 1943 Hot Springs Conference called by US President Roosevelt. Forty-four countries met for 3 weeks and agreed a post-war world food strategy; its goal was to prevent hunger and provide food stability for the world after decades of conflict and food systems crisis[43,71–74]. The means was to be investment to increase output. The focus was on production and raising output; nutrition's task was to educate and help the farmer[74,75].

This productionist paradigm has been in place for 70 years[43]. Some argue the paradigm now merely needs partial and pragmatic rather than fundamental adjustment to adapt to and address the tensions listed in Table 1. With nearly 1 billion people still experiencing hunger worldwide and projected huge population increases ahead[76], the case for producing more food remains important. One much-repeated estimate by the FAO is that 70 % more food is needed by 2050 compared to 2005[77]. Others counter that the need for that scale of increase ignores the case for changing what is eaten, how it is produced, dietary culture and levels of waste; and, further, that the productionist model has actually encouraged dietary patterns now recognised to be undesirable for public health, by overproducing cheap commodities and ultra-processed foods[59,60]. Inefficient agricultural resource use is another concern; mining phosphates, for example, only for much ultimately to leach into the sea leading to poor management[78,79]. A conservative estimate is that 37 % of land use is for feed for animals – down from 50 % in the 1970s[80]. Others counter that this feed could not be used for human population directly[81]. The pursuit of efficiency could, they argue, continue if resources are better managed; and the disruptions and impacts, though significant, could be brought under control by change at the primary production level with changed farm practices, application of new technology and better management such as for livestock, in particular[82,83].

As such arguments continue, the call for consumers to be more centrally involved as change agents grow, as does recognition that market forces cannot move fast enough unless demand is reframed[43,84,85]. The range of choice can be 'edited' and the assumption that choice is best left unfettered by other public policy considerations has been criticised for normalising an 'eat whatever we like whenever we want' culture[86,87]. The scale of change now widely agreed to be necessary almost certainly requires governmental support and leadership, if there is to be clarity about the process of transition and its management. Even large food corporations find

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Table 1. Joining-up challenge: a summary of for high level policy makers

Problem	Why it matters for food and nutrition
Anthropogenic greenhouse gases	Food accounts for c. 26% with animal production accounting for about half of that, yet meat output and consumption continue to rise[47–49]
Water	Agri-food accounts for 70% of potable water use globally, yet trade in foodstuffs barely recognises nor audits the value of embedded or 'virtual' water in food[50–54]
Biodiversity loss	Food is a major driver of biodiversity loss by deforestation, agrichemical use and poor land use yet leverage to stop this loss is weak[55,56]
Health	Diet is a major cross-cutting factor in disability-adjusted life years and population-scale ill-health which most countries cannot afford to treat[57]
Growth of processed food markets	Sales of ultra-processed foods continue to rise even in developing countries despite association with ill-health and warnings that this is likely to create immense, externalised costs, unaffordable in high-income countries, and certainly in low- and middle-income ones[58–60]
Land-use competition	50% of habitable land on the planet is currently used for food production, but this now competes with other uses such as 'rewilding' and nature conservation[61,62]; the advisability and ecological efficiency of growing cereals for animal feed is now being questioned[44]
Production capacity	Food production capacity is likely to be affected by rising sea levels, which rose 11–16 cm in the 20th century and are estimated to rise by 0·5–1·0 m in the 21st century[63]
Food labour	Food is the world's greatest source of work, employing an estimated 1·1 billion in agriculture alone[64], yet the drift of populations from rural to urban in search of work continues with 55% of world population urbanised in 2018[65]
Money flows	Primary producers receive a small share of what consumers pay for food, c. 9% of gross value added in the UK[17], and c. 11% in the USA[66]
Wasted food	The UN estimates 14–17 % of food is wasted between production and retail, and one-third is wasted overall, with business calculating this as worth $1·2 trillion and accounts for 8% of all greenhouse gas emissions[67]. The UN Environment Programme's Food Waste Index 2021 estimates 61% of food waste is by consumers[68]. Low-income consumers spend a high percentage of incomes on food, and waste relatively little. Low-income economies have relatively little food waste (and what there is occurs mostly on or near farms) compared to high-income economies. Consumers in rich societies waste more but spend proportionately less on food[69]

what is required daunting and seek more urgency from governments[88].

These concerns featured in the run-up to three significant global meetings in the last quarter of 2021 (see Table 2). In September 2021, a one-off meeting of the UN Food Systems Summit (UNFSS) was held[89]; some hoped this might generate a reset but critics from civil society and academia argued this goal was unlikely to be met, as its direction was being set by 'Big Food' interests[90]. It met for a single day, barely time for the politicians' set speeches, let alone serious decision making. In October 2021, the latest Convention of the Parties (COP) meeting of UN Convention on Biodiversity met at Kunming, China[91]. In November 2021, the UN Framework Convention on Climate Change (UNFCC) COP26 met at Glasgow, UK[92,93]. Both latter meetings, too, were troubled by arguments about whether the urgency of need for change was being recognised by governments.

Of the three conferences (UNFSS, UN Convention on Biodiversity and UNFCC), the UNFSS was the least directive, and was designed at best to conclude with only voluntary national commitments rather than international binding agreements. It simply listed national commitments, leaving what they were to member states rather than any formal set of goals or benchmarks. Although the UN Convention on Biodiversity COP15 and UNFCC COP26 meetings brought thousands of outside interests *into* the arguments, the UNFSS was disappointedly riven by splits *away* from the process. Hundreds of food academics and analysts, including three UN rapporteurs[94], were critical of the UNFSS for ignoring inequalities of power in the world's food systems[95–98]. Hundreds also remained engaged, seeing it as *realpolitik*. That the COP15 and COP26 meetings were to review existing binding conventions helped engagement, and although they nominally are single issues – biodiversity, climate – both bodies of knowledge see the food system as a common cross-cutting determinant. The issues raised at and around these conferences will not be resolved unless the food system changes. The implications for nutrition science are stark. Like all sciences, it must accept it now operates within a world where public policy has to address complexity rather than simplicity. If the nutrition agenda is now located amidst multiple challenges, how can this complexity be addressed?

Multi-criteria analysis helps frame 21st century nutrition science

One immediate methodological implication is that food-related sciences now have to engage with multi-criteria analysis (MCA) in one form or another. In this more complex changing world, nutritionists, such as policy makers, need methods which integrate nutritional needs alongside other goals. Wider awareness of what MCA is overdue. The idea of MCA is that complex problems should not be simplified to single metrics unless these are located within a web of contextual or parallel factors. The literature on MCA locates it within public policy as an approach that helps state institutions

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Table 2. 2021 UN conferences

Event	Date	Duration (d)	Place in UN	Comment
UN Food Systems Summit (UNFSS)[89]	23 September 2021	1	A 'one-off' meeting	The first such meeting; drew together years of debate inside and outside the UN; criticised for being too high level and industry dominated; others saw it as building long-needed new consensus; no formal resolutions or follow-up Convention of the Parties (COP) system; outcome uncertain
Convention on Biological Diversity (CBD)[91]	Two parts: (a) 11–15 October 2021 (b) 25 April–8 May 2022	14	Began in 1992; 15th COP	Increasingly recognised as raising fundamental issues which policy makers and nutritionists have found hard to address
UN Framework Convention on Climate Change (UNFCC)[92]	31 October–12 November 2021	13	Began in 1994; 26th COP	Now a well-established policy advice system to 'bound member states to act in the interests of human safety even in the face of scientific uncertainty'

prioritise competing demands[99]. It has been adapted particularly within science policy as a way to address complexity[100]. MCA is a modern reassertion of 'systems' thinking that spread across the sciences from 1960s computer sciences, organisation studies and cybernetics. These shared a common focus on trying to find order (pathways) within complex and sometimes apparently chaotic systems[101–103].

In the food-related sciences, recognition of interdisciplinary and multi-criteria complexity has a natural fit. Food can be viewed through many scientific and policy lenses, and in relation to multiple metrics and dynamics. Nutrient flows can be analysed in relation to genetics, bio-chemical processes, social and cultural norms, economic factors such as cost or labour processes, as well as supply chain determinants from farm to factory, shop and kitchen. Such MCA requires *inter*-disciplinary collaboration yet professional interests and university and research demands tend to encourage *intra*-speciality collaboration. The challenge is how to place them together in a meaningful way which helps mitigate not add to problems.

Nutrition improvement already emerged as a cross-cutting priority in the seventeen UN sustainable development goals agreed in 2015 by governments after considerable scientific input. This was surely not a signal for nutrition science to continue doing what it was already doing but to reassess priorities, one being the redefinition of a 'good diet'[104]. From an MCA perspective, the long-term UN support for national nutrient or food-based dietary guidelines as shapers of food systems is now too restricted[105]. These instead could integrate environmental and social criteria, yet when advisory bodies have recommended this, there has been strong resistance from some commercial quarters[106–109].

The diversity of factors known to shape food systems has been a key driver of the success of modern modelling studies. Developing models which help estimate food system interactions has enabled sophisticated assessments of the post-Malthusian question about planetary capacity to feed populations healthily without contributing to ecosystems' destruction[44,108,110]. Although modellers are able to conduct such analyses and to show the possibilities of an MCA-informed food system, the realities can become more sensitive when turned into official advice. When two Swedish agencies co-operated in the late-2000s to produce the world's first official governmental advice on how to eat in an environmentally conscious way[111], the document became mired in EU political complications and met resistance from powerful meat industry lobbies, and was withdrawn. Six years later, the Swedish Government produced not dissimilar but looser 'cultural' advice[112]. Governmental desire to help the consumer with clear eating advice may have been given by Sweden, but that it was made to restrict the basis for doing so and that Sweden's policy leadership in producing fully fledged evidence-based MCA-informed dietary guidelines had been pushed back. Similar commercial difficulties emerged in Australia and the USA[113]. This situation is surely unacceptable today.

The British Dietetic Association's Blue Dot programme and Reference Guide for dieticians is perhaps the closest to an overt translation of MCA into UK public dietary advice[114], but this has not been taken up or supported at the governmental level in the UK as yet. The UK national Eatwell dietary guidelines remain nutrient- and food-based, with a small acknowledgement of meat's carbon impact[115–117]. Eatwell surely ought to be based on multiple criteria and become MCA-based sustainable diet guidelines. Carbon should not be taken as the only or most important environmental criterion shaping consumer food choice. In 2021 the FAO gave a welcome signal that this is required when it recognised that nutrition education should convey food's multi-dimensional role[118]. International progress would surely be helped if the UN bodies agreed to recommend member state should revise food-based dietary guidelines to include environment and social criteria. 'Pointers' in that direction have been made since 2010[119], but rarely with conviction or with unity across the UN system which is what the evidence warrants.

Possibly the most recognised illustration of MCA is the One Health movement, initiated by veterinarian scientists over a decade ago, arguing that the professional and disciplinary divisions between human, animal and ecosystems health are no longer justified[120–124]. The

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spread of antimicrobial resistance contributed to that rethink, with antimicrobial resistance being accepted as misuse in animal and human disease control[125,126]. One Health proposed a new integrated paradigm for health. For the UNFSS, too, the Health and Climate Network, for instance, a coalition of twelve public health bodies based in India, Europe, Scandinavia, Africa and Latin America, produced a strong MCA statement calling for dietary change to be the post-UNFSS policy redirection[127]. And one of the five UNFSS Action Tracks discussed how to create a new 'omni-framework' setting common criteria for food system evaluation, thus juxtaposing nutrition with pressures such as labour rights and equitable access[128].

Table 3 provides examples of where MCA is applied to nutrition-related matters by scientists, governments, civil society and businesses (see Table 3). Possibly, the most important policy illustration of MCA entering public policy is the EU's *farm to fork strategy*. Ratified by the European Commission in 2020, this broke with the long-term European focus on prioritising farm output as the prime driver of a good food system[129]. Instead the farm to fork strategy set out new multi-criteria goals for the EU food system. Concerned at the lack of firm, clear criteria for food system reform ahead of the UNFSS, Fanzo and a large number of scientists proposed a five-criteria audit of food systems change[130]. They distilled possible metrics for auditing food down to: (1) diet, nutrition and health; (2) environment and climate; (3) livelihoods, poverty and equity; (4) governance and (5) resilience and sustainability. These metrics approximate the six headings approach proposed a decade earlier by the UK Sustainable Development Commission in its final report on food. That classified factors under (a) food quality, (b) socio-cultural, (c) economic, (d) health, (e) environment and (f) governance[131]. As for Fanzo *et al.*, each of these was itself an umbrella term. Health covered issues such as nutrition, safety and well-being. Environment covered climate, water, biodiversity, air quality and soil. Each of those can be given more detailed underpinning by a third order of metric. Climate, for example, could include not just commonly cited carbon but also methane[132], and other atmospherics. The EAT-Lancet Commission, however, took nutrition as a fixed criterion, assessed in relation to diverse environmental metrics such as biodiversity, land use and threats to water systems.

These examples suggest diverse ways in which MCA is emerging in the food-related scientific and grey literature (civil society and government). More specific metrics are being developed and applied within these examples, providing detail to multi-criteria 'templates' for diet and the wider food system. Business is both influenced by this growing sophistication and is contributing to it. It is aware that public and scientific concerns are building a case for new commercial models more appropriate to known 21st century challenges. Some businesses are also conscious of the need to defend corporate reputations and brand integrity, if their products are exposed by this new MCA sophistication. They have all noted the policy 'heat' around the meat industry and have noted the product innovation for plant-based substitutes. A familiar dynamic emerges in which growing scientific and civil society concerns lead to product development, reformulation and market 'disruption'. It is surely essential that nutrition considerations help shape this dynamic and are not side-lined by it.

In the UK, a Consortium for the Labelling of the Environment, Animal welfare and Regenerative Agriculture was launched by forty UK civil society organisations in 2021, proposing food business adopt better labelling[138]. In March 2021, it petitioned the UK Government to deliver such labelling, and to create a trustworthy mechanism of independent audit[137]. Coincidentally, Foundation Earth, a new 'not-for-profit' social enterprise, was created with support of big food processors such as Danone, Nestlé, PepsiCo and Tyson, and retailers such as Tesco, Morrisons, Marks & Spencer, Sainsbury, Aldi, Lidl, Coop and Waitrose. It developed a methodology to generate an agreed environmental score for food products[136,139]. In effect, commercial interests are thereby creating a system of information standards at arms-length from themselves. This 'third party' standards-setting approach was pioneered by Unilever in the 1980s when it, then a huge fish processor, saw the need for independent monitoring of fisheries' sustainability. Its policy solution was to create the Marine Stewardship Council as 'independent' auditor. It remains to be seen how Foundation Earth metrics and any others of this type are operationalised and actually applied and whether the organisations behind third-party audits gain consumer credibility. The metrics emerging so far focused on food's environmental impacts but was weaker on the social aspects of food sustainability. It has been argued elsewhere that without the social dimension and metrics, the term sustainability is only partial[140].

A different avenue for change has been championed for a decade by World Wildlife Fund, the world's largest conservation non-governmental organisation, in its definition and promotion of sustainable diets. Its motive was that conservation is undermined by agri-food pressures, and that if consumer-eating trends could be reframed, biodiversity could be improved. Beginning in the UK, then across the EU and now globally, it actively promotes sustainable diets as the meeting point for health, environment, culture and economy. It has created a Livewell Plate to rival Eatwell, the UK national guidelines[134,141]. The Ethical Consumer Research Association, a small but long-established UK non-governmental organisation, has also developed metrics centred on social criteria such as labour conditions, fair pay, whether the company is subject to boycotts on social justice grounds; these, combined with environmental reporting, are used to audit food company performance[135].

What is emerging in all these developments and variants is a recognition that food and nutrition assessments are strengthened if subject to multi-sector, multi-level and multi-criteria evaluation. This makes the task of nutrition apparently more complex but might well become the 'new normal' for nutrition-related science.

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Table 3. Examples of academic, government, civil society and business application of multi-criteria analysis (MCA) to nutrition in food systems issues

Sector	Authors	Date	Purpose	Metrics
Academic	Fanzo *et al*.[130]	2021	Food system audit	(1) Diets, nutrition and health; (2) environment and climate; (3) livelihoods, poverty and equity; (4) governance; (5) resilience and sustainability
	Hanley-Cook *et al*.[133]	2021	Biodiversity–nutrition links	Dietary species richness
	EAT-Lancet[44]	2019	Dietary public health in relation to planetary boundaries	Nutrition taken as core criterion, within the environmental context of carbon, biodiversity and land use
Government	European Union (EU) farm to fork strategy[129]	2020	Provide new EU food policy direction within European Green Deal framework (in effect a revision of Common Agricultural Policy)	(1) Neutral or positive environmental impact; (2) mitigate climate change; (3) reverse biodiversity loss; (4) ensure food security, nutrition and public health ('access to sufficient, safe, nutritious, sustainable food'); (5) economics ('preserve affordability of food while generating fairer economic returns, fostering competitiveness of the EU supply sector and promoting fair trade')
Civil society	World Wildlife Fund-UK[134]	2017	Conservation-motivated advice on sustainable diets	Food-based guidelines linking diet groups to carbon, land use and water footprint
	Ethical Consumer Research Association[135]	2020	Application of complex food metrics to operationalise a modern food ethics	Animal welfare, environment, society (people and work), corporate ethos and finance
Business	Foundation Earth[136]	2021	Develop metrics for a food rating system for retailers (A+ = good; G = not good)	Four measures to reflect Environment, Social and Governance concerns: carbon, water usage, water pollution and biodiversity
	Consortium for the Labelling of the Environment, Animal welfare and Regenerative Agriculture[137]	2020	Transparent and verifiable labelling of method of production	Three measures: animal welfare, environment and regenerative farming

Source: Author.

Research by Parsons, for example, into where decision-making on food lies within the UK government, for example, has underlined how weak policy is made if it lacks co-ordination. Conflicts over food policy emerge because not enough attention is given to ordering and combining different interests and 'demands' for change. Across the many Whitehall ministries is a policy web in which one department can unintentionally affect others and block the transition to what is ostensibly the agreed goal of more sustainable food governance[142].

MCA is not a methodological recipe for merging factors or metrics to the point of indistinguishability, the policy equivalent of a multi-ingredient soup, high-speed blended to the point where it is hard to tell what it is made from. On the contrary, the 'changing world' that the Nutrition Society Summer Conference 2021 considered requires food policy-makers to be clear about the different strands of change. Being clear about what those strands are is a prerequisite for rational food policy making, a process which must aspire to be evidence-informed even if the goal of being fully evidence based can be hard to achieve. A degree of judgement, not least in relation to the future, is inevitable.

Nutrition science can reconnect its life science, social and environmental nutrition traditions to contribute to new paradigm formation

Nutrition science has the advantage of being able to draw on at least three traditions that can contribute to a multi-criteria approach to 21st century food policy: (1) nutrition as what now is termed life science environmental science, (2) nutrition as social science and (3) nutrition as environmental science. Modern nutrition's roots lie in the late 18th and 19th century scientific exploration when all three traditions emerged, then sharing a focus on energy[143,144], only for the traditions to fragment in the second half of the 20th century. Today, climate change and other planetary challenges are again requiring a more integrated nutrition that has closer working links to other disciplines and a shared commitment to world and national food problem resolution[34]. The case for better integration can be made from each of the three traditions.

Since the 1920s, symbolised by the discovery of vitamins, nutrition science has been dominated by the life sciences[145]. This tradition has explored the chemical,

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molecular, biophysiological and latterly genetic strata of life, identifying the role of nutrients in determining life chances, health and ill-health[143,146]. From the 18th–19th century flowering of food chemistry to the 1985–2003 mapping of the human genome, the life science tradition has transformed understanding of the interaction of dietary, genetic and social determinants of health and life[147,148]. One intellectual strand has interpreted life sciences as enabling a 'personalisation' of health, but this may be simply the emergence of nutrigenomics rather than the totality of life science nutrition. The application of this tradition to a world of climate change and societal disruption requires engagement with culture and food choice. Not everything in life science nutrition can be 'reduced' to the bio-chemical or genetic determination of health.

The reductionism implicit in an individualised approach to dietary requirements has encouraged a rebirth of interest in the social nutrition tradition. Since the 19th century, the latter has explored the human and societal determinants of food flows, much driven by concerns and calculations about the limits of poor diets[70]. It explored the interaction of diet and health with social circumstance. Diet's role in life chances is conceived as socially determined by income, birthplace, social class, culture and sex. This social perspective on nutrition was proposed by British analysts of the food–health–society connections such as Mayhew in the mid-1800s, Rowntree and Pember Reeves in the first half of the 20th century, Boyd Orr at the mid and Marmot today[149–153]. Commercially, social nutrition is mostly reduced to food choice – the micro-determinants and 'triggers' of diet rather than the macro-determinants of social class and economic circumstance, sketched by the social researchers. Marketing using social media is adept at mining consumers' socio-economic status, for example. At the global policy level, social nutrition plays a strong role in commitments and institutions concerned about hunger and under-nutrition.

The environmental nutrition tradition is arguably the earliest perspective of the three outlined here. To ancient Greek and Roman writers, food's direct environmental roots were obvious; they realised that food quality and crop performance are a function of land characteristics and management[154,155]. Centuries later, building on emerging chemistry, environmental nutrition could be more detailed about the significance of minerals, carbon, the source of nutrients and how they are internalised physiologically. In a post-Malthusian industrial economy with growing populations, there was a political imperative to see how food production can be increased[156,157], but also to understand how food can be mishandled. Famously, in 1820 Accum, an employee of the Royal Society of Chemistry in London, applied new chemical analysis to expose what he said was routine adulteration and pollution of food, arguing that these human acts defrauded as well as endangered consumers[158]. Three decades later, the exposes of food adulteration by Hassall and Wakely led to UK law changes, and were to some extent forerunners of contaminant and pollutant studies today[159,160]. In the 1960s Rachel Carson questioned whether agrichemical use, as part of 'modern' farming, was as beneficial to the web of life as its proponents claimed[161]. Her epidemiological successors still question the efficacy of modern methods of production if they create persistent contaminants in foods from land and sea[162]. Nanotechnology and packaging technology, for example, might be functionally remarkable but their residues are increasingly questioned[163–165].

Priorities ahead

How can nutrition address this more complex changing world? The 2019 Lancet Syndemic Commission gave a lead by showing that the public health challenges require both policy makers and scientists to address the coincidence of mass impacts such as climate change, obesity and hunger[27]. Equally pressing cases can be made for biodiversity loss[166], water stress[167] and social inequalities[168]. These all illustrate how it is no longer reasonable to view nutrition from any single tradition; all are needed. Now is the time for nutrition and food scientists, despite often being locked into project after project, to review the big picture. History rarely repeats itself but lessons can be learned. As Hassall, Wakely and Accum showed in the mid-19th century, the effectiveness of evidence in improving nutrition can occur not only from data publication but from contributing to public discourse. They used 'life science' of the day to explore how social conditions allowed commercial profiteering to occur, and they demanded a change in the food environment on which urban consumption depended. They used but did not fixate on the laboratory; they looked at what people were actually eating, and consulted through democratic processes – it helped that Wakely not only published The Lancet but was a member of the UK Parliament! They argued for population scale change, however, daunting the task initially seemed, but based their case on the evidence. Today, a number of priorities should shape nutrition science.

Two linked priorities are to *clarify, first, what is a good food system, and, second, what is a good 21st century diet*. These might seem naïve questions to which the joint answer is obvious: to feed everyone and to feed them well. But how? And why does this not happen? And measured against which criteria: sufficiency alone or in relation to environmental and social criteria too? This is why the terms 'sustainable diet' and 'sustainable food systems' have crept into policy use. Agreement on what they mean was the hope for the coincidence of the UNFSS, UNFCC and UN Convention on Biodiversity, but their focus, if anything, was still mostly on agriculture rather than post-farmgate and consumption determinants. This is regrettable when at the national level the urgent need for dietary culture change has been recognised by bodies such as the UK's Committee on Climate Change, a statutory body[169–171]; from the Parliamentary Environmental Audit Committee in relation to biodiversity loss[172] and from government advisory inquiries on food poverty[10,173,174]. Nutrition scientists can help provide the detailed advice now being sought.

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Some of what is needed has been sketched globally, even if the official imprimatur is still lacking. The EAT-Lancet Commission and others have calculated that 9–10 billion people could be fed healthily without further eroding ecosystems, but not if the population eats or is fed as is the affluent world at present. The challenge is *how* is this change to be initiated and how can it be translated in different localities, tastes and cultures. Does it matter, for example, how fruit and vegetables are grown or just that more should be consumed, however grown? Surely it does, if they are grown on or imported from land where ecosystems are in stress, or where worker health and safety standards are less than desirable, or from land which is water-stressed. Should food labels now give more environmental information to help consumers change? Surely, yes. The embedded water in food can be considerable[51,175], yet no dietary guidelines consider embedded water. Since 2016, UK's Eatwell guidelines have recommended consumers eat fish which is sustainably sourced, a welcome and rare example of MCA. But how is this advice applied nationally? Given fluctuations in fish stocks, how variable is that advice? Nutritionists should note that marine biologists are beginning to recommend reduction in wild-catch and radical change of global management[176,177]. In this respect, the social and environmental criteria for 'good diet' now suggest the need for a reformulation of food-based guidelines; advice to eat 'sustainably sourced' fish may even be inadequate. If the UNFSS, UNFCC and UN Convention on Biodiversity failed to be specific about that task, surely in a country such as the UK, now no longer bound by EU processes, the Food Standards Agency together with the new Office of Health Improvement and Disparities created from the closure of Public Health England, together with bodies such as the Environment Agency could revise the Eatwell Guidelines, much as Sweden's relevant bodies began to in 2008.

A third priority is *to help consumers engage with what the EAT-Lancet called the Great Food Transformation*. Although food labelling is a relatively weak form of behaviour intervention, it sends a signal for product reformulation. In 2008, the present author proposed the development of 'omni-labelling' schemes that combine health, environmental and social information in one format[178]. At the time, this was considered too complex, lacking technological infrastructure and met resistance from industry. Today, those blockages have evaporated. Mobile phones, quick response codes, electronic shelf data and computerised databases mean the technical capacity to deliver and combine complex information of food products and diets could be made available to consumers. Food industry resistance is also evaporating, as was noted with Foundation Earth earlier. A rapid process of democratic experimentation is underway[139], to which nutritionists can contribute. This requires the kind of data sharing recommended by the English National Food Strategy final report[174], and also a rewriting of labelling regulations.

The fourth challenge to nutrition science is to *help promote better policy frameworks*. Nutrition science was given a lead in the 2005 Giessen Declaration supported by the International Union of Nutrition Sciences and three of its Presidents[179]. There is no shortage of evidence or arguments for this role for nutrition science[180,181]. The Paris Climate Agreement and the UN's sustainable development goals in 2015 recognised the importance of nutrition. A third of the sustainable development goals imply food change. But follow-up can be weak. A report prepared for the 26th meeting of the UNFCC in Glasgow in November 2021 showed that countries were collectively not on track to meet the Paris agreement; and the 2021 evidence from Nationally Determined Contributions (which give country data) suggested considerable cuts in greenhouse gas emissions are required to keep the planet within a rise of 1·5 or 2·0°C[182,183]. The UK Committee on Climate Change has recommended a 20% reduction in UK meat production and consumption[169–171,184]. In 2019–20, six House of Commons select committees combined to create a Climate Assembly, a 6 month citizens jury of over a hundred consumers representative of UK society, to take evidence from diverse experts about how to meet the legal goal of zero carbon by 2050. This concluded that land use and agri-food should change significantly[185].

This leads to a fifth priority for nutritionists to *contribute professional insights to these processes*, and help translate scientific complexity for everyday food culture. Although there have been failures to recalibrate formal nutrition advice into sustainable dietary advice[113,186], the evidence inexorably points to its need. We can take comfort from the history of public health advance being not to give up at the first fence![187] Change can be frustratingly slow. The many studies of food waste, for example, too easily became vehicles for moralism, with consumers blamed for buying excess or incompetence, as though price incentives and marketing did not encourage over-buying or waste[188]. This has not halted food scientists from producing data on food waste and contributing evidence to food's role in a modern circular economy[189]. A paradigm shift entails more than positive directions and experimentation but recognition grows that one is needed, and that food and nutrition scientists continue to open discussion about the future direction of the food system. So far, however, no politician has yet taken the kind of lead that President Roosevelt showed with the 1943 Hot Springs Conference. The UNFSS was an opportunity but lacked the mix of external pressure and institutional leadership that achieved the Paris Climate agreement after years of failure. After the COP26 Glasgow conference, pressure is already strong for COP27 to address food and consumption more openly. Nutrition science can contribute to that process, and at the national, regional and local levels. As the EAT-Lancet Commission recommended, countries must develop solutions appropriate to their circumstance.

To conclude, nutrition science was born from and contributed to changes in the collective human understanding of food and life. Today, nutrition scientists can again play a full part in helping redefine food progress.

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The evidence of the 'changing world' of food discussed at the Nutrition Society Summer Conference 2021 is that food and nutrition science now operate in a 'multi' world: multi-criteria, multi-disciplinary, multi-level, multi-sector and multi-national.

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