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REVIEW

It's bean too long: Interventions to reintroduce legumes to the UK palate and plate

Neil Bernard Boyle[1,2,3] | Beth Armstrong[1,2,4] | Nicola J. Buckland[1,2] | Laura Lane[5] | Samantha J. Caton[6] | Christian Reynolds[3,5] | Christina Vogel[3,5] | Louise Dye[1,2,3,4]

[1]School of Psychology, University of Sheffield, Sheffield, UK

[2]Institute for Sustainable Food, University of Sheffield, Sheffield, UK

[3]Co-Centre for Sustainable Food Systems, University of Sheffield, Sheffield, UK

[4]National Alternative Protein Innovation Centre, Sheffield, UK

[5]Centre for Food Policy, School of Health and Medical Sciences, City St George's, University of London, London, UK

[6]Sheffield Centre for Health and Related Research, Division of Population Health, School of Medicine and Population Health, University of Sheffield, Sheffield, UK

Correspondence
Neil Bernard Boyle, School of Psychology, University of Sheffield, S1 4DP, UK.
Email: n.boyle@sheffield.ac.uk

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Abstract

Legumes are a nutrient dense food group that can offer considerable health and sustainability benefits. Despite a long history in agricultural production and diverse dietary patterns, legume intake in the UK is chronically low. This narrative review proposes that the implementation of interventions to promote greater acceptability, access, and intake of legumes in the UK is a worthy endeavour to promote population and planetary health. The health and environmental impacts of legume intake are summarised, and existing barriers to consumption—taste, texture, cooking skills, time, convenience, familiarity, digestive concerns and allergenicity—are outlined. The Nuffield Council on Bioethics Intervention Ladder is adopted to frame and review intervention options that can be adopted to increase legume intake through proportionate population level action. Intervention strategies are identified in a narrative synthesis, mapped to intervention ladder levels, and appraised for feasibility, impact, and proportionality. We identify 'anchor institutions' and retail environments as high leverage settings. Progress requires coordinated policy and practice beyond the provision of information and the level of personal responsibility for food choice. Target interventions include: changes to choice architecture in public and retail food environments; increased availability of legumes (e.g., reformulation of familiar foods to incorporate legumes); harnessing public procurement (e.g., schools and the NHS) to increase exposure and normalise legume-based options; and deployment of incentive measures to promote access. The introduction of interventions across a number of 'levels' may offer an efficacious approach to support increased acceptance and consumption of legumes.

KEYWORDS
behaviour change, bioethics intervention ladder, dietary health, human interventions, legumes, pulses

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1 | INTRODUCTION

Legumes are plants from the Leguminosae (Fabaceae) family, one of the most prevalent and geographically distributed flowering plant families. Inconsistency in terminology often results in legumes, pulses, and beans being referred to synonymously; however, important distinctions exist. Legumes can be considered the umbrella term under which types and forms of pulses, beans, and peas reside (Lovegrove, 2024). Pulses are the dried edible seeds harvested from leguminous plants, including dry peas, lentils, chickpeas and dry beans (e.g., black beans)—sometimes referred to as grain legumes. All pulses are legumes, but not all legumes are pulses. Fresh peas, green beans, soybean and peanuts are legumes but are not classed as pulses, which include only the dry seeds of non-oilseed legumes (see Figure 1). Legume is used throughout this review to refer to the overall food group, whilst specific legumes forms are discussed in relation to specific topics (e.g., consumption data, evidence of interventions, allergens).

Legumes, and pulses in particular, are considered nutrient dense foods offering a rich source of low-fat plant-based protein, dietary fibre, complex carbohydrates, and an array of micronutrients including calcium, magnesium, potassium, folate, and iron (Azarpazhooh & Ahmed, 2022; Martín-Cabrejas, 2019; Singh, 2017). Legumes also contain a variety of non-nutrient compounds considered—at appropriate levels—to offer bioactive properties beneficial to health (e.g., phenolic acids, tannins, and flavonoids; Martín-Cabrejas, 2019). The favourable nutritional profile is reflected in the inclusion of legumes in many countries food-based dietary guidelines and diets associated with enhanced diet-related health, including the Mediterranean diet, the dietary approaches to stop hypertension (DASH) diet, and the UK Eatwell Guide (Appel et al., 1997; Hughes et al., 2022; Public Health England, 2016). The value of legumes has been further highlighted by the Food and Agriculture Organisation (FAO) of the United Nations, who consider pulses to offer significant capacity to contribute towards attainment of a number of Sustainable Development Goals (SDGs) including hunger (SDG13), health and well-being (SDG3), consumption (SDG12) and production and climate change (SDG13) (FAO, 2025a).

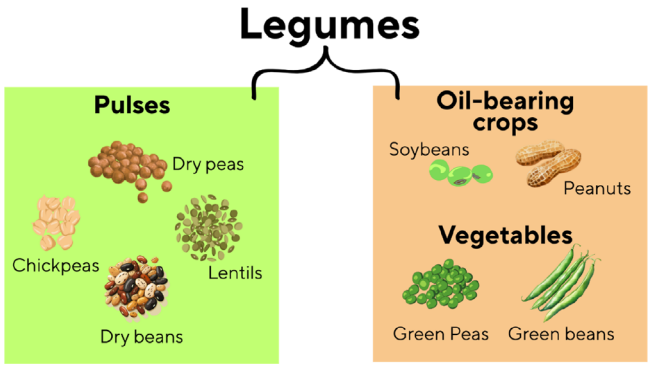

FIGURE 1 Overview of legume classes. Taken from FAO World Pulses Day infographic. Available at: https://www.fao.org/world-pulses-day/news-detail/what-is-the-difference-between-legumes-and-pulses/en.

This narrative review outlines current consumption levels of legumes in the UK, the potential health and sustainability benefits of increased legume intake, and the existing barriers that drive consumption patterns. Assuming increased consumption of legumes can offer benefit in the UK context, the Nuffield Council on Bioethics Intervention Ladder is employed to frame and outline candidate actions and approaches distinguished by increasing levels of intervention that can contribute towards the promotion of increased legume intake. This review does not aim to offer a systematic nor comprehensive review of these topic areas; rather, it draws on the authors' own research, expertise and knowledge of the published evidence to summarise the field and outline potential approaches to target increased legume consumption. A scoping search of existing approaches to promote legume intake in the UK was undertaken to retrieve examples of legume-focused interventions to populate the intervention ladder; this review of existing approaches is illustrative but not exhaustive. Where legume-focused interventions were not available, dietary and/or health interventions were adopted to illustrate intervention approaches. Drawing on the principles of the Bioethics Intervention Ladder and existing food system intervention examples, the identified intervention approaches to promote increased legume consumption are informally assessed for feasibility, potential impact, and proportionality of intervening using a discursive approach.

2 | DIETARY INTAKE OF LEGUMES IN THE UK

Legumes have a rich culinary history as a traditional staple, believed to be one of the earliest domesticated crops (Kislev & Bar-Yosef, 1988). Historically contributing a significant source of dietary protein to European peasant and serf populations (La Poutré, 2015), legumes were often considered a 'poor man's meat' reserved for those unable to afford animal source protein. In the UK, consumption of legumes as a primary protein source is believed to have decreased as (occasional) meat consumption became increasingly affordable for greater segments of the population during the Victorian era (Albala, 2007).

Advancements in agricultural production methods further eroded the availability and consumption of legumes in the UK. Legumes have been employed in crop rotation cycles for thousands of years due to the soil enrichment properties of many leguminous plants—three-course rotation systems utilising legumes were employed by the Romans in the UK from 1st Century AD (Cusworth et al., 2021). The advent of 'The Green Revolution' after the Second World War marked a significant shift in agricultural production practices as farmers moved away from crop rotations, grass-leys and fallowing, in favour of a high input high output model of agricultural production utilising artificial fertilisers and pesticides. Crop diversity was reduced in favour of high yield—predominantly cereal (e.g., wheat)—crop varieties, removing reliance on rotation methods that used legume crops

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and reducing the production and availability of legumes as a whole (Cusworth et al., 2021).

Recent dietary trends suggest contemporary legume consumption is endemically low in the UK, with legumes primarily consumed as an accompaniment to meals rather than a primary protein source. Recent analysis of UK National Diet and Nutrition Survey (NDNS) data (years 2008–2019) reported a mean (±SD) daily intake of legumes (defined as pulses, green beans and peas)[1] of 16.7 ± 32.5 g/day in children and adolescents (1.5–18 years), and 27.3 ± 26.0 g/day in adults (19–96 years; Kaimila et al., 2025). Consumption of pulses (defined as dried beans, lentils, peas and soy) was lower: 10.6 ± 27.0 g/day in children and adolescents, and 15.0 ± 21.0 g/day in adults (Kaimila et al., 2025). Only 1% of children and 2% of adults were reported to consume an average of one portion of pulses (stated as 80 g in the UK '5 A Day' recommendations) per day; 1.4% of children and 5.2% of adults consumed an 80 g daily portion of legumes. Baked beans (canned haricot beans served in tomato sauce that have tended to be high in sugar and salt—but reduced sugar and salt varieties are now available) are the most consumed pulse in both UK children and adults. Green beans, soybeans, peas, and chickpeas are the next most commonly consumed legumes (Kaimila et al., 2025).

It is clear there is significant work to be done to convince the UK population of the benefits of reembracing legumes and incorporating them to a greater extent into daily diets. However, growing evidence of the health and sustainability benefits of legume production and consumption suggests this challenging endeavour may be one worth pursuing.

3 | THE CASE FOR LEGUMES

3.1 | Health benefits of legumes

Dietary risk factors are one of the leading contributors to non-communicable disease burden, including cardiovascular disease, diabetes, and cancers (Afshin et al., 2019; Qiao et al., 2022). Suboptimal diets characterised by habitually low intake of whole grains, fruit, nuts, seeds, vegetables, omega 3 fatty acids, and fibre, and high intake of sodium are significant risk factors for global mortality and disability-adjusted life-years (DALYs; Afshin et al., 2019); contributing to reduced quality and quantity of life.

Enhancing diet quality can play a significant role in the mitigation of the impacts of dietary risk factors on health outcomes. Legumes have the potential to significantly enhance human diets due to their physiologically favourable matrix (Foyer et al., 2016; Torheim & Fadnes, 2024). Diets rich in legumes tend to be high in nutritional quality, characterised by lower saturated fats and sugar, high dietary fibre, and rich micronutrient availability (Kaimila et al., 2025; Olotu et al., 2023). There is growing evidence of the benefits of legume-rich diets on health parameters, with greater consumption associated with positive effects on cardiovascular risk factors (Hartley et al., 2022; Padhi & Ramdath, 2017; Viguiliouk et al., 2017), glycaemic control and diabetes (Becerra-Tomás et al., 2018; Ramdath et al., 2016; Sievenpiper et al., 2009), blood lipid profile (Ferreira et al., 2021; Padhi & Ramdath, 2017), improved satiety and weight management (Kim et al., 2016), gut microbiota composition (Clemente & Olias, 2017), and some types of cancer, notably colorectal cancer (Patel et al., 2024).

The evidence for health benefits of legumes is often correlational in nature, and reflective of the examination of diets rich in legumes, rather than analysing the impact of specific legumes on health parameters directly (e.g., by employing gold-standard randomised control trial (RCT), dietary intervention methodologies; Lichtenstein et al., 2020). Therefore, demonstration of specific mechanisms or causal relationships between legume intake and potential health impacts requires further elucidation via high quality prospective cohort studies and adequately powered, randomised controlled trials (Didinger & Thompson, 2022). However, existing evidence to date suggests increasing legume intake can support optimisation of diets, offering significant human health and nutritional benefits.

The optimal intakes of legumes to achieve these health benefits has not been clearly defined, and suggestions vary across national food based dietary guidelines (Hughes et al., 2022). The UK's Eatwell Guide recommends "Eat more beans and pulses" as a source of protein, and an 80 g portion is noted as counting towards one of the recommended five portions of fruit and vegetables per day in the associated '5 A Day' guidance (Public Health England, 2016; UK GOV, 2023). The FAO suggests that a substantial part of daily fibre requirements could be met with one cup of pulses per day (FAO, 2021b). A minimum serving of 100 g of cooked beans, lentils, chickpeas, or peas has been suggested as reasonable portion that can contribute to improving the nutrient density of healthy diets, providing a number of nutrients that qualify for nutrient content claims under regional regulatory frameworks (Marinangeli et al., 2017).

3.2 | Sustainability benefits of legumes

Legumes are central to dietary recommendations that prioritise healthy diets from sustainable food systems, such as the EAT-Lancet universal healthy reference diet (Willett et al., 2019). The FAO considers pulses to be an essential component in sustainable food systems: "Pulses play a key role in transforming agrifood systems by promoting sustainability, nutrition, and agricultural productivity while supporting people's livelihoods" (FAO, 2025a). In 2018 the FAO designated February 10th as 'World Pulses Day' to promote the role of pulses in healthy, sustainable diets (https://www.fao.org/world-pulses-day/en).

The environmental credentials of legumes are manifold. Legume production typically has much lower environmental impacts, and notably lower greenhouse gas (GHG) emissions, than animal-sourced

[1]In the Kaimila et al., 2025 analysis of NDNS data, pulses were categorised as all dried beans and their products (including soy beans and products containing soy). The legumes classification combined this pulse category with fresh peas, green beans, and fresh beans (e.g., faba beans). Both categories included intakes from composite dishes containing legumes and pulses

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protein (Clark et al., 2022; Poore & Nemecek, 2018). This is primarily because legumes form a symbiotic relationship with soil bacteria called rhizobia. Rhizobia allow legumes to 'fix' nitrogen from the atmosphere into the soil, reducing the need for fertiliser, and improving soil quality and productivity (Balázs et al., 2021; Duarte et al., 2024). This is the foundation for the historical use of legume plants in crop rotations. As fertilisers contribute significantly to agricultural GHG emissions, growing legumes can help to reduce agricultural contributions to climate change (Magrini et al., 2016). Supporting reductions in fertiliser can also improve water quality by reducing the impacts of run-off from farmland soils into rivers and streams (Einarsson, 2024). Additionally, there is evidence to suggest that legume cropping systems can reduce biodiversity loss (Iannetta et al., 2021; Kaljonen et al., 2020). The wider environmental benefits of growing legumes, known as 'ecosystem services', hold great promise to increase the environmental sustainability of European food systems (Ditzler et al., 2021; Horril et al., 2024). A systematic review of the wider benefits of integrating legumes into cropping systems provides evidence of range of ecosystem services, notably enhancing soil health, boosting resource efficiency, reducing pest and disease losses, and promoting biodiversity (Akchaya et al., 2025). Pulses are also highly shelf-stable—suitable for storing for long periods of time without spoiling or loss of nutritional value—which can contribute towards reductions in food waste (FAO, 2021b).

4 | BARRIERS TO CONSUMER ACCEPTANCE OF LEGUMES

Despite evidence for the growing and consumption of legumes to simultaneously offer positive impacts on human and environmental health, the UK population is not adopting legumes into their diets to any significant degree. This is perhaps not surprising considering adherence to dietary advice and guidelines is often startlingly low; analysis of NDNS data suggests <0.1% of the UK population meet all recommendations of The Eatwell Guide (Scheelbeek et al., 2020). The UK population is culturally and ethnically diverse, with a wide array of cuisines that reflect this diversity. We acknowledge that legumes form a key part of many cultural dishes and cuisines and are often consumed by segments of the UK population as part of this diverse national plate. Those following plant-based diets are also likely to more regularly consume legumes. However, consumption at the overall UK population level is low. Here, we outline reported barriers to consumption that are specific to legumes as a food, and reflective of populations that tend to consume little or no legumes.

4.1 | Sensory properties

The perceived sensory experience of legumes is a commonly reported barrier to acceptance (Henn et al., 2022; Onwezen et al., 2021). For instance, a pan-European survey of 2324 participants (including UK respondents) reported that a dislike for the taste and texture of legumes were major barriers to consumption (Henn et al., 2022). Other surveys have also reported taste concerns as a main barrier (e.g., Appleton, 2024; Onwezen et al., 2021; Winham et al., 2020). In qualitative studies, participants have described legumes as 'bland', 'tasteless' or 'not good' (Whittall et al., 2024). Such taste concerns are associated with reduced consumption (e.g., Appleton, 2024; Henn et al., 2022). Expected taste and enjoyment are key drivers to the consumption of legumes with participants reporting that taste concerns are more important than potential health benefits offered by legumes (Doma et al., 2019; Whittall et al., 2024).

4.2 | Lack of skill to prepare/cook legumes

Many UK consumers lack the knowledge and skills to prepare and cook legumes, particularly dried beans and pulses (Appleton, 2024; Michaels & Dickinson, 2025). Unsurprisingly baked beans, a familiar food requiring minimal preparation and cooking, are the most commonly consumed legumes in the UK (Kaimila et al., 2025). Dried legumes typically require multiple stages of preparation (e.g., washing, removing stones, soaking) and cooking (e.g., start in cold water, boil then simmer) before they can be incorporated into dishes (The Global Bean Project, N.D; https://www.globalbean.eu/publications/cooking-pulses-dry-seeds/#:~:text=Soaking%20pulses%20in%20water%20for,production%20of%20gas%20during%20digestion). A lack of knowledge and skills needed to prepare and cook legumes is a significant reported barrier to consumption across various western food cultures (Doma et al., 2019; Melendrez-Ruiz et al., 2019; Palmer et al., 2018; Whittall et al., 2024; Winham et al., 2020). Highlighting the crucial role of cooking skills and knowledge in relation to the consumption of legumes, a UK study demonstrated that perceived cooking abilities had a greater influence on consumption of legumes than the enjoyment, sensory properties and experience of legumes (Appleton, 2024).

Further, numerous studies have demonstrated that cooking interventions which develop consumers' skills and knowledge are associated with increased legume consumption (Didinger et al., 2023; Ingram et al., 2025; Whittall et al., 2024). A recent ethnographic and visual methods exploration of a bean-focused cooking intervention in a small sample of UK households found that respondents often lacked the skills and resources to add dried beans into their diets. Several participants did not regularly cook from scratch, and those who did were not necessarily familiar with preparing and cooking dried pulses. Many lacked the resources (e.g., worktop space) or equipment (e.g., pressure cooker) to enable the quick and convenient preparation of legumes. Following a cook and eat intervention, many participants successfully learned to integrate dried beans into their diets, resulting in greater consumption of legumes (Michaels & Dickinson, 2025).

4.3 | Convenience

Perceiving legumes as a convenient food to prepare, cook, buy and store at home is positively associated with a greater diversity of

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legumes in the diet (Henn et al., 2022). Therefore, understanding barriers related to the perceived convenience of legumes is important to inform effective strategies to promote consumption. Lengthy soaking and cooking times are commonly reported barriers, especially for dried legumes (Figueira et al., 2019; Havemeier et al., 2017; Henn et al., 2022; Onwezen et al., 2021; Whittall et al., 2024). Lengthy preparation times can be tedious and demanding, necessitating advanced meal planning and preparation which is at odds with modern consumption habits characterised by time constrained lifestyles and preference for convenience (Kuosmanen et al., 2023; Whittall et al., 2024). Perceptions of longer cooking times may also prevent consumers from lower income populations (or those with fewer resources) consuming legumes due to perceived greater energy costs required to cook these foods. There is also a perception that legumes require additional flavourings or ingredients to be palatable (Whittall et al., 2024).

Canned or pre-prepared legumes provide a more convenient option than dried legumes. In qualitative studies, canned legumes have been recognised as quick and easy to use and integrate into other dishes (Whittall et al., 2024). Canned legumes also have a long shelf-life and low perishability, contributing to reduced food waste (Henn et al., 2022; Whittall et al., 2024). However, this benefit is only realised when consumers feel confident preparing and cooking pulses. For those with limited familiarity or cooking skills, concerns about making mistakes and wasting food can act as a barrier. A study in older adults also reported concerns about food wastage due to the large portion size of canned legumes (Doma et al., 2019).

A final major factor related to convenience is price. The low cost of minimally processed legumes is frequently reported as a benefit of eating legumes (Figueira et al., 2019; Monge et al., 2019; Whittall et al., 2024). However, when legumes are defined more broadly to include both minimally processed forms (e.g., fresh, canned) *and* more processed legume-based meat analogue products (e.g., plant-based meat substitutes for mince or chicken) cost concerns emerge; plant-based meat analogues are predominantly less expensive than the meat products they emulate but more expensive than minimally processed legume forms. In one study, 44% of adults, particularly younger adults and those experiencing financial strain, identified cost as a barrier to consuming legumes (Kuosmanen et al., 2023). These findings highlight that promoting affordable legumes is particularly timely during a cost-of-living crisis. However, pricing-related communication should be carefully designed to position legumes to appeal widely, while avoiding messages that might inadvertently reinforce stigmatising associations with affordability, i.e., reinforcing the negative historical assocations of legumes as the 'poor man's meat'.

4.4 | Unfamiliarity of legumes

Low familiarity with legumes can act as a barrier to consumption. Individuals with low exposure to legumes, because they have not been raised eating legumes or do not view them as part of their traditional diet, are less likely to think of legumes as an option when planning meals (Doma et al., 2019; Figueira et al., 2019; Szczebyło et al., 2020). For example, not considering lentils as an option was rated as the fourth most common barrier to eating lentils in parents of young children (Phillips et al., 2015), whereas individuals who report growing up eating legumes are more likely to report regular and habitual consumption of legumes (Appleton, 2024). This demonstrates the importance of exposure to a variety of foods such as legumes—particularly in childhood—to increase acceptability (Caton et al., 2013).

4.5 | Digestive concerns

Concerns that eating legumes—particularly beans and pulses—will result in gastrointestinal discomfort, bloating and flatulence may increase avoidance behaviour in consumers (Didinger et al., 2023; Hall et al., 2017). High levels of fibre, non-digestible starches and anti-nutrients can contribute to gastrointestinal symptoms when consuming legumes (Ferreira et al., 2021; Lombardo et al., 2023). However, feeding studies have demonstrated that few people may actually experience symptoms when consuming legumes, such as beans (Winham & Hutchins, 2011). A systematic review that examined the benefits of pulse consumption highlighted that negative consequences were infrequently reported, with unwanted effects, primarily gastrointestinal symptoms, reported in 15% ($n = 3$) of studies (Ferreira et al., 2021). Though legumes can cause unwanted symptoms in those who do not regularly consume legumes, levels of bloating and flatulence experienced typically reduces with regular consumption (Winham & Hutchins, 2011). Further, the likelihood of symptoms can be reduced through preparation techniques such as extended soaking (FAO, 2021; Lombardo et al., 2023), and by the variety of bean consumed (Winham & Hutchins, 2011).

4.6 | Allergenicity and anti-nutritional concerns

Despite the nutritional benefits of legume consumption, a number of nutritional considerations need to be acknowledged. The degree to which legumes are introduced into the diet, and extent to which they replace animal protein is a key consideration. Animal protein is a key source of nutrients, including vitamin B_{12}, iron, zinc and selenium. Animal source proteins provide all nine essential amino acids whilst plant-based proteins—such as legumes—often lack or contain lower/less bioavailable amounts of essential amino acids (particularly tryptophan, lysine and threonine; Bessada et al., 2019). Consuming cereals (e.g., wheat and rice) as well as legumes can overcome some of the gaps in essential amino acid intake (Rawal & Navarro, 2019). However, this requires adequate nutritional knowledge to ensure the appropriate and complementary nutrient sources are consumed. The UK Climate Change Committee recommends that the UK should reduce meat and dairy consumption by 20% by 2030, and meat by 35% by 2050 (Vonderschmidt et al., 2024) meaning that significant reductions are not expected immediately. Given that 16% of UK adults consume over the recommended daily amount of red and processed meat (90 g

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per day; Office for Health Improvement & Disparities, 2025), there may be limited expected detrimental impacts on nutrition if levels were reduced.

The presence of antinutrients in legumes may present a challenge in the move towards increased legume consumption. At lower concentrations antinutrients can exhibit beneficial health effects such as reductions in blood glucose and triacylglycerols, and support liver function (Popova & Mihaylova, 2019). However, in higher concentrations antinutrients can disrupt digestion, reduce the absorption of nutrients and cause adverse gastrointestinal symptoms. The concentration of antinutrients can vary between types of legumes and can be managed through various preparation methods (e.g., soaking, sprouting, heating) and advances in biotechnology (e.g., genomic technology), meaning that the negative impacts of antinutrients can be reduced and the digestibility increased (Hertzler et al., 2020). However, consumption of specific legumes should be avoided in those with health conditions known to be affected by legume intake. Notably, the consumption of fava (broad) beans can result in Favism, characterised by haemolytic anaemia due to a congenital glucose-6-phosphate-dehydrogenase deficiency. Conditions such as 'Favism' need to be considered in any attempts to increase legume consumption at scale, particularly since suffers are often unaware of the condition (Amoah et al., 2023; Champ, 2002).

A further consideration is the prevalence of food hypersensitivities. UK food law requires that food businesses, caterers and manufacturers must provide information about the presence or potential cross-contamination of 14 key allergens (Food Standards Agency, 2025a). Legumes are well known allergens, with peanuts, soybeans and lupin featuring within the 14 foods which must be declared. Increased legume consumption, including the introduction of 'new' varieties, comes with increased risk of allergy, as demonstrated by the increased prevalence of lupin (Peeters et al., 2007), lentil, and chickpea allergies in recent years (Allergy UK, 2022). This may be further exacerbated by the concentration of proteins in processed legumes, with those who would not usually experience a reaction to a whole legume potentially being triggered by a concentrate or isolate of the same legume (Messina & Venter, 2020).

Following a UK-based local area survey of adult food allergies, legumes were highlighted as an important food group to consider given the prevalence of allergic reactions. Of the participants who reported a food reaction, around 1 in 10 had a reaction to chickpea (9.6%) or lentils (10.6%). Selected respondents were invited to take part in a follow-up survey, which demonstrated that many had a possible IgE-mediated allergy to peanuts (3.40%, CI 2.59–4.37), chickpeas (2.17%, CI 1.53–2.98), and soybeans (1.58%, CI 1.04–2.29) amongst other legumes. Of the foods to cause an allergic reaction, peanut (13.5%) was the second most common plant-derived food, following cereals containing gluten (31.71%); 1.5% of participants experienced a reaction to lupin (University of Manchester, 2024). Peanut allergy is one of the most common food allergies in children with 0.6% being affected (Emmett et al., 1999), and around 0.4% of the paediatric population have a soy allergy (Scientific Advisory Committee on Nutrition, 2020).

It is important to consider adverse reactions beyond allergies given the self-reported prevalence of food hypersensitivity (i.e., intolerance, coeliac disease or unpleasant reaction), which vary from 21% (Benson et al., 2019; Shillitoe et al., 2025) to 36.4% (35.0–37.7, 95%CI; University of Manchester, 2024) in the UK adult population. Recent data from the FSA shows that food intolerances (12%) are more commonly reported by adults than allergies (4%). Though data are limited when considering consumers who have a reaction to specific legumes, the proportion of allergy and intolerance varies, with allergy being more commonly reported for peanuts ($n = 57$; allergy 56%, intolerance 21%) and intolerance being more commonly reported for soya ($n = 26$; allergy 5%, intolerance 21%; Shillitoe et al., 2025). Whether considering allergies or other food hypersensitivities, it is possible that efforts to introduce new legumes or increase general consumption could result in an increase in adverse reactions presenting an additional barrier to increased legume consumption.

5 | INTERVENTIONS TO PROMOTE LEGUME INTAKE

The potential benefits of increased consumption of legumes are sufficient for their inclusion in dietary guidelines and recommendations of global intergovernmental organisations promoting healthy and sustainable diets (e.g., FAO). Accordingly, legume consumption is a pertinent target for interventions to influence dietary intake in populations. It is well established that health related habits are difficult to shift (Kelly & Barker, 2016). This is likely to be particularly difficult if the desired shift is away from highly palatable, calorie dense foods towards less palatable (perceived or otherwise), nutrient dense foods. This difficulty is compounded by the legume specific barriers to dietary uptake already stated. However, whilst acknowledging these barriers, the diverse prospective benefits of increased consumption affirm the value of attempting to promote greater dietary intake of legumes. Interventions designed to increase the acceptability, availability and consumption of legumes—that acknowledge and address the stated barriers—have the potential to deliver considerable health and sustainability benefits. We now examine an array of proposed intervention categories and examples—delineated by increasing degrees of action upon citizens' dietary choice and behaviour—that could contribute towards the aim of increased legume consumption.

A key consideration in the design of interventions to affect a behaviour is: what *level* of intervention is feasible, justified, and likely to have impact? The Nuffield Council on Bioethics Intervention Ladder (Nuffield Council on Bioethics, 2007) is a conceptual framework designed to support the ethical scrutiny of public health policies. The Intervention Ladder defines increasing levels of intervention differentiated by escalating gradients of intervening, and therefore intruding upon, citizens' choices and lives (see Figure 2). Interventions range from doing nothing and simply measuring a behaviour of interest in a population (e.g., measurement of legume consumption via the NDNS), to the outright removal of a choice (e.g., mandatory reformulation of a food to include a minimum level of legume-derived protein). The

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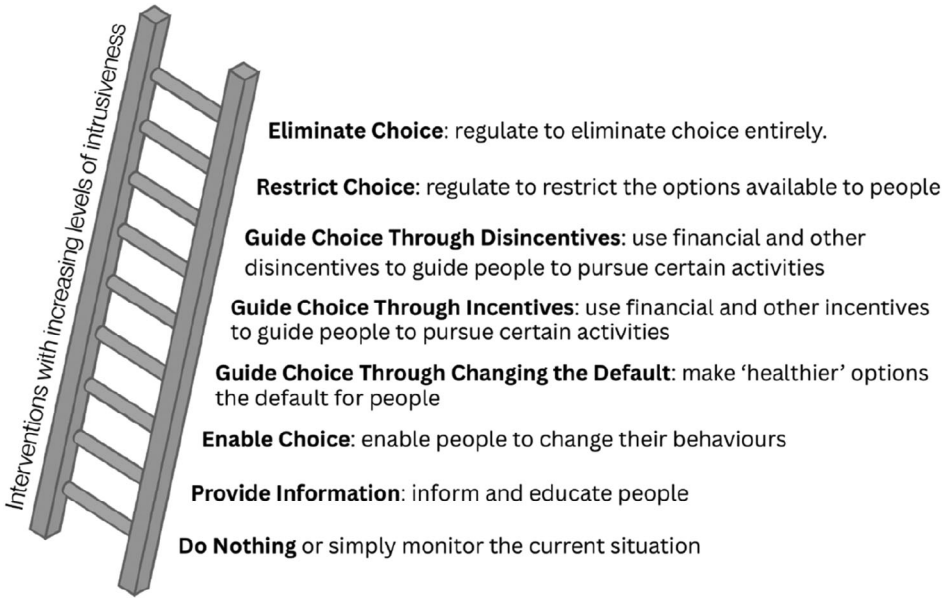

FIGURE 2 The Nuffield Council on Bioethics Intervention Ladder adapted from: Nuffield Council on Bioethics. (2007). Public health: Ethical issues. Retrieved November 2024 from https://www.nuffieldbioethics.org/publications/public-health.

Intervention Ladder was primarily designed as a tool to support evaluation and inform decisions on proportionate justification for escalating levels of intervention to influence population behaviour (Nuffield Council on Bioethics, 2007). The Intervention Ladder offers a useful framework against which an array of behaviour change interventions with increasing degrees of control on behaviour can be arranged. Here we apply the model to outline potential and existing approaches to support increased acceptability, availability, and consumption of legumes in the UK. Further, we discuss the feasibility, potential impact, and proportionality of the increasing level of interventions in the context of the UK food system. A summary of these increasing levels of intervention to promote legume intake is shown in Table 1.

5.1 | Do nothing or simply monitor the current situation

Considering the potential benefits of increased legume intake on dietary and planetary health appear largely underexploited in the UK context, doing nothing is not considered a viable position. Indeed, an increase in production and consumption of legumes has been identified as a key action area for transforming the UK food system (Bridle et al., 2025; Ingram et al., 2025; Jones & Cottee, 2024; Lovegrove et al., 2023).

Dietary trends indicate that habits will not change without intervention at some level. It is clear that a large proportion of the UK population does not consume a diet consistent with that recommended in The Eatwell Guide (Scheelbeek et al., 2020). It seems unlikely that increased legume intake, nor any diversification of dietary protein incorporating more plant-based proteins such as those offered by legumes, will occur naturally or at scale. Monitoring of the current situation via the collection of high-quality legume intake data would support evaluation of the efficacy of interventions; this data is largely lacking in the UK context to date (Lane et al., 2024). Greater granularity of data specific to legumes collected by population surveys such as the NDNS and Family Food Survey would support monitoring of future intakes.

5.2 | Provide information: Inform and educate people

The provision of information is often the primary level of intervention employed to influence dietary behaviour. Policy attempts to improve suboptimal diets commonly adopt 'soft' policy strategies aimed at promoting greater adherence to dietary guidance, for example, via the provision of dietary advice and guidelines, and informative labelling on food packaging and menus. Current UK public health approaches to increase intake of legumes are limited to the provision of dietary recommendations. Legumes are promoted in the '5 A Day' recommendations: 80 g of beans and pulses count towards part of your '5 A Day' (but only once, no matter how much is consumed; UK GOV, 2023). Chickpeas, beans, and lentils are given prominent positions in the protein source segment of The Eatwell Guide infographic with accompanying text advising "Eat more beans, pulses, fish, eggs, meat and other protein foods". Further, advice in additional resources linked to The Eatwell Guide webpage state: "Pulses, such as beans, peas and lentils, are good alternatives to meat because they're low in fat and they're a good source of fibre and protein, too" (Public Health England, 2016).

Designation of 2016 as the International Year of the Pulses and creation of an annual World Pulses Day can further contribute to increased awareness of the role legumes can play in healthy and sustainable diets (FAO, 2025b). UK campaigns to promote awareness of the benefits of legumes have also recently emerged, such as the "Bang in Some Beans" initiative led by The Food Foundation and Veg Power to highlight the health benefits, affordability, and positive environmental impact of legumes (https://foodfoundation.org.uk/initiatives/bang-some-beans).

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TABLE 1 Applying the Nuffield Council on Bioethics Intervention Ladder to increase the consumption of Legumes in the UK.

Intervention level	Potential interventions	Legume intervention examples
1. Do nothing	Do nothing or monitor situation	Improved monitoring and reporting of legume consumption using NDNS or Family Food datasets.
2. Provide information	Food Based Dietary Guidelines (FBDGs)	Updating UK Eatwell Guide to provide greater clarity and promotion of legumes (including recommended daily intake amount).
	Food education	Incorporation of health and sustainability benefits of legumes (and cooking skills) in school curricula.
	Labelling	Promoting legumes via food labelling to communicate environmental/nutritional/health benefits.
	Multi-actor information campaigns	Information campaigns to promote benefits of legume intake in populations (e.g., 'Bang in some beans;' 'World Pulses Day').
3. Enable choice	Behavioural 'nudges' to make it easier to undertake target behaviours	Environmental changes to promote availability, acceptance, and access to legumes: • Wholesale increase in availability of legumes and legume-based foods in food environments via reformulation of familiar, popular, staple products. • Food environment adaptations to increase prominence of legumes (e.g., end of aisle promotions, menu placement). • Increased availability of legumes via public institution contexts (e.g., school meals). Recipe and cooking skill development
4. Guide choice by changing the default	Making target option the default choice	Making legumes and legume-based foods the default choice on menus and food choices in out-of-home (e.g., restaurants) and public institutions (e.g., schools and hospital menus).
5. Guide choice through incentives	Population incentive policies	Subsidised purchase of legumes (e.g., Healthy Start vouchers can be used to purchase fresh, dried, or tinned pulses). Expansion of such schemes can ensure greater impact on legume intake.
	Promote domestic production	Increase the availability of legumes and bolster sustainability/food security via incentivisation of domestic growing of legume crops.
	Use of incentives in retail environments	Employing price discounts, food vouchers, and rewards schemes (e.g., store card points) for targeted legume products to incentivise increased consumption.
6. Guide choice through disincentives	Taxes or charges on adjacent foods	Meat taxes to encourage dietary shifts/product reformulation incorporating legumes.
7. Restrict choice	Restrict options to target choices	Restrict choices to target options (e.g., though stricter public procurement approaches restricting choice to legume-based meals in hospitals and schools on a minimum number of days).
8. Eliminate choice	Mandatory product reformulation	Difficult to mandate increased consumption of a food, but options include mandatory minimum nutrition standard regulations for target foods to promote reformulation/inclusion of legumes.

Note: Authors; after Nuffield Council on Bioethics (2007) cited in Willett et al. (2019).

Providing information and raising awareness of legumes and the benefits offered by consuming them is important. Understanding the benefit of consuming a food or making a dietary change is a critical component in the formation of food behaviour. However, insights from behaviour change research suggest whilst providing information and increasing knowledge are important precursors of changing behaviour, they are rarely sufficient in isolation to promote sustained behaviour change (Kelly & Barker, 2016).

Public campaigns promoting dietary advice can raise awareness, but there are doubts regarding their efficacy to drive substantive dietary change (Culliford et al., 2023; Leme et al., 2021). Overall, <0.1% of the UK population meet all recommendations of the Eatwell Guide (Scheelbeek et al., 2020). Less than 9% of children (11–18 years) and <17% of adults in the UK meet the '5 A Day' recommendation for fruit and vegetable intake; intakes are even lower in those living in the most deprived areas (UK GOV, 2025). In April 2022, mandatory calorie labelling of menus for out-of-home food businesses was introduced in England to increase awareness of the energy content of menu choices as part of obesity prevention measures. Analysis by Polden et al. (2025), reported that the policy of providing this information reduced consumer underestimation of the energy content in meals and increased awareness of calorie content (reported noticing and utilisation of calorie labelling), yet had no significant effect on calories purchased or consumed (data taken from exit surveys from 330 outlets pre- and post-introduction of calorie labelling; $N = 6578$).

Relying on the provision of information to change dietary behaviour intrinsically places responsibility solely upon individuals to change (Theis & White, 2021). Consumers are further expected to make these changes in food environments that constrain choices away from recommended dietary advice (e.g., food environments in which

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healthier foods are often more expensive per calorie; reduced availability of nutritious food options in areas of high deprivation; greater promotion of energy dense, nutrient poor foods; Dimbleby, 2021). Forthcoming sections will outline potential approaches with increasing levels of intervention beyond the level of personal responsibility that can support and build upon the provision of information to more effectively promote increased legume intake. First, we propose a number of approaches that can enhance the provision of information on the benefits of legumes.

Greater clarity in the promotion of legumes in The Eatwell Guide would help deliver more consistent and unambiguous messaging regarding how legumes should be incorporated into diets. Simply advising "eat more beans and pulses" lacks specificity in terms of portion size and frequency of intake. Whilst more research is required to ascertain and reach consensus on optimal consumption levels needed to maximise health benefit, a recommended daily/weekly intake recommendation and greater promotion of the health benefits of legumes may increase appeal (Didinger & Thompson, 2022; Marinangeli et al., 2017). Clearer, consistent dietary guidelines can be further supported by accessible information targeted at addressing barriers preventing incorporation of legumes into diets (e.g., concerns regarding cooking and preparation, gastrointestinal effects, anti-nutrient content; Didinger & Thompson, 2022).

Targeting information at specific demographic groups can also support more efficacious awareness raising. For example, the FAO produced a comic to inform children of the role of pulses in sustainable food systems (FAO, 2021a). Promoting awareness of the sustainability credentials of legumes may be particularly relevant since knowledge of the sustainability benefits of plant-based proteins in the UK may be low (Culliford & Bradbury, 2020; Hutchings et al., 2024; Sánchez-Bravo et al., 2021). Further, increasing food education in UK school curricula to promote greater understanding of the nutritional and environmental benefits of specific foods and diets can be harnessed to inform the basis of future dietary habit formation, a key recommendation of the National Food Strategy Independent Review (Dimbleby, 2021). Educational approaches could also include provision of cooking skills relevant to preparing meals with legumes.

There are no authorised health claims that can be made for any specific legumes/legume product in the UK. Rejected submissions to the Great Britain Nutrition and Health Claims (NHC) Register include health claims related to reduction of body weight (white kidney bean), reduction of post-prandial glycaemic responses (fenugreek seed extract), and cholesterol-lowering effects (soya protein; Department of Health and Social Care, 2020). However, legumes could be promoted based on their nutritional composition. For example, many legumes will meet the standards for nutritional claims of source of fibre (3 g/100 g), high in fibre (6 g/100 g), source of protein (12% of energy value from protein), high in protein (20% of energy value from protein), and as a source of specific vitamins and minerals (containing at least 15% of nutrient reference value per 100 g; Department of Health and Social Care, 2020). Legumes and legume products may be well placed to benefit from the recent surge in consumer interest in protein ("High protein claims dominate Europe": https://www.foodnavigator.com/Article/2025/03/27/high-protein-claims-dominate-europe/). Identifying the most compelling nutrition claims in the consumer market can inform labelling of legume products to increase commercial appeal. This is critical since adoption of healthier food behaviour may be impeded by low health and nutrition literacy (Magrini et al., 2018).

5.3 | Enable choice: Enable people to change their behaviours

Whilst providing information and raising awareness of the benefits of a behaviour has value, creating environments in which target behaviours are easier to perform may increase the likelihood of a target behaviour being enacted. Enabling choice to change behaviour is central to Nudge Theory which has increasingly been employed to inform the design of public health interventions since the theory was proposed by Thaler and Sunstein in 2008. Nudging aims to influence behaviour by altering the decision-making environment to 'nudge' individuals towards making certain 'desired' choices. Nudges are employed to influence individuals' actions without limiting their options or enforcing rules and regulations (Thaler & Sunstein, 2008). Decisions are instead influenced by 'choice architecture', that is, making subtle adjustments to environments in ways that alter behaviour in predictable ways—without restricting choice—making the 'desired' choices easier, more salient and attractive.

Approaches that aim to enable individuals to make target choices, such as consume more legumes, still rely on a level of personal responsibility to undertake the behaviour, but the choice architecture is adapted in a way to influence behaviour towards the '*preferred*' choice, therefore enabling that choice. 'Preferred' in this case refers to the preference of the agent trying to change a behaviour, not necessarily the individual(s) making the choice. Nudging interventions are rooted in the concepts of *liberalism* (choice is influenced but it is not curtailed) and *paternalism* that assumes that the behaviour being influenced and shaped is in the best interest of the individual or society as a whole (Thaler & Sunstein, 2008).

Nudges may be particularly relevant to dietary behaviour since food environments play a key role in determining food choices. Food environments (e.g., supermarkets, restaurants, work cafeterias) are often not conducive to making healthful dietary choices such as choosing to consume legumes. Consumers are expected to make nutritious dietary choices in environments awash with highly palatable, calorie-dense options that are often less expensive than more nutritious foods (Dimbleby, 2021). To better enable individuals to increase their intake of legumes it is critical to ensure food environments are structured to promote easier access to affordable, accessible and appealing legume products.

A potentially potent approach to enable access, acceptability and prominence of legumes and legume products is promoting a wholesale increase in the availability of legumes in food environments. Considering the stated barriers of palatability, ease of use (e.g., preparation/cooking requirements), and familiarity, it is essential to identify

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appealing legume products, or vehicles in which legumes can be incorporated, to nudge consumers towards choosing legumes more often. Taste concerns are less likely to act as barriers in individuals with greater exposure to legumes, and increased enjoyment of flavour and texture are reported with greater exposure (Figueira et al., 2019; Whittall et al., 2024). As people tend to choose foods they are familiar with, incorporating legumes within familiar dishes may be an effective strategy to increase awareness and exposure, which over time may support habitual consumption. Targeting familiar staple foods as vehicles for reformulation to incorporate legumes is one promising approach. For example, the UK Research and Innovation (UKRI) Transforming the UK Food System (TUKFS) programme funded 'Raising the pulse of our daily bread' project is increasing the nutritional profile of white bread by substituting a proportion of wheat flour with UK grown faba bean flour (RaisingThePulse https://ukfoodsystems.ukri.org/research-projects-training-reports/raising-the-pulse-rtp/; Lovegrove, 2024). Similarly, the TUKFS funded Healthy Soil, Healthy Food, Healthy People (H3; https://h3.ac.uk) project is conducting a trial with the University of Leeds catering teams to replace 30% of beef mince content with lentils in the most popular dish served across campus (https://gfal.leeds.ac.uk/whats-new/serving-up-sustainability-and-a-new-twist-on-a-campus-favourite/).

Reformulation of popular products to replace a proportion of processed animal protein with legumes has the double potential benefit of increasing the dietary quality of food products and sustainability of diets (Grasso et al., 2022; Spiro et al., 2024). Legumes have great versatility to be easily integrated within well-known and familiar dishes and can enhance nutrient profile (Whittall et al., 2024). By targeting familiar products (e.g., ready meals, pies, burgers, pasta dishes), healthier and more sustainable hybrid versions of these dishes can be developed to promote and enable greater acceptability, availability, access, and intake of legumes. To date, the popularity and market success of emerging blended meat/plant-based products has been somewhat mixed, suggesting more work on these product types is required (Grasso, 2024; Grasso et al., 2022; Melios & Grasso, 2024). However, reported willingness of UK consumers to consume hybrid products suggests continued development of these products is warranted (Melios & Grasso, 2024).

Retail environmental factors such as product positioning, presentation, and ease of access can all be adapted to influence the choices people make and support increased purchasing of target foods. Product placement in supermarkets to influence consumer purchasing behaviour has a long history with specific locations associated with increased prominence and sales (e.g., end of aisle, eye level placement; Drèze et al., 1994; Garrido-Morgado & González-Benito, 2015; Wilkinson et al., 1982). Harnessing supermarket placement to promote nutritious and sustainable products has the potential to enable consumers to purchase more legumes and legume-based products. This may be particularly relevant since several studies report consumer challenges in locating legumes in retail and food environments (Kuosmanen et al., 2023; Whittall et al., 2024).

Displaying legumes in locations known to increase in-store prominence (e.g., a beans and pulses promotion on the end of an aisle) can be employed to promote greater access and increased consumer exposure to legumes in retail environments. Promoting healthier and more sustainable food in this manner can contribute to increased likelihood of purchase, however, such increases may not be sustained outside of the promotional period (Luick et al., 2024). Evidence on the most efficacious positioning of hybrid or 100% plant-based products developed as an alternative to meat (e.g., bean burgers) requires further elucidation. Recent findings suggest that integrated-segregated placement of plant-based and meat products may be most efficacious in promotion of plant-based alternatives (van der Meer et al., 2025). However, interventions that report increased plant-based food purchases often find no change in meat sales (Trewern et al., 2022; van der Meer et al., 2025).

The emergence of artisanal and premium legume product lines brought to market by emergent small and medium-sized enterprises (e.g., the Bold Bean Co.) could also support greater appeal and prominence of legume products. The promotion of legumes as luxurious, high-quality products with high health and sustainability credentials is a potential pathway to increased appeal, consumption and availability (Jones & Cottee, 2024). This pathway is likely to be restricted to higher income consumers considering the likely high price point of these product lines. However, establishing legume products as luxurious may increase the overall appeal of legume products in more affordable product ranges.

Nudges to promote greater legume intake are also relevant to out-of-home food purchases. For example, presenting target food choices at the top or end of a food menu can increase the probability of the choice being selected (Dayan & Bar-Hillel, 2011; Gynell et al., 2022; Kurz, 2018). Manipulation of meal descriptions to increase the salience or appeal has also been shown to increase the reported likelihood of choosing plant-based meals (e.g., using "Chef Recommends" or "dish of the day", or using indulgent descriptors [*slow-roasted, caramelised, rich buttery roasted*]; Bacon & Krpan, 2018; Turnwald et al., 2017; Vennard et al., 2019; Zhou et al., 2019). Changing the position and prominence of legume products on display in cafeterias or restaurants could also be employed to enable greater appeal. For example, placing plant-based meal options first in a university cafeteria display has been shown to increase the probability of plant-based options being selected (n.b., if choices were placed more than 1.5 meters apart from meat options; Garnett et al., 2019).

It is not only retail environments that are relevant contexts for interventions to enable the UK population to consume more legumes. A significant proportion of food is consumed in public institutions—so called 'anchor institutions' (e.g., schools, hospitals, prisons)—for which the government is directly responsible. Public procurement—the purchasing of goods and services by public authorities (e.g., local councils, government departments) for public services (e.g., schools, hospitals)—is one of the government's most direct tools to shape the food system (Dimbleby, 2021). Harnessing public procurement to increase the availability of target foods across public institutions has great potential to influence dietary habits at scale in equitable ways. For example, increasing the availability of legume-based choices in school meals can enable children to choose legumes more often, potentially increasing awareness, accessibility, and acceptance (Ingram et al., 2025), as trialled in the UKRI funded BeanMeals project (https://www.eci.ox.ac.uk/beanmeals). Another example is the ProVeg UK's School Plates programme (https://

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proveg.org/uk/school-plates) that works with local authorities, contract caterers and schools to provide recipe and menu advice, consultation, and training to support and enable schools to make school food healthier and more sustainable via plant-based foods. These approaches can contribute to promoting healthy and sustainable food preferences (that can track into adulthood; Anzman-Frasca et al., 2018; Venter & Harris, 2009) in a significant proportion of the population in equitable ways; almost 9.1 million children attend school in England alone, 24.6% of these children can access free school meals (ONS, 2024). Nudging techniques may be particularly impactful in public institutions as a greater degree of environmental control and influence can be implemented without counteracting influences—such as marketing—vying for customer attention.

Finally, there is growing interest in the impact of recipe and cooking skill promotion on legume intake (Amoah et al., 2023; Caballero et al., 2020; Polak et al., 2015). Positive correlations exist between cooking and food skills (knowledge, confidence, skills, and attitude required to perform culinary tasks) and diet quality (Hartmann et al., 2013; Larson et al., 2006; Lavelle et al., 2020); although more granular elucidation of this association may be required (Mills et al., 2017). Supplementing the provision of nutritional guidelines with easy, accessible legume recipes and practical cooking skill training can enable individuals to consume more legumes by increasing confidence, motivation and skills. Such activities can address barriers to legume consumption, including: unfamiliarity with legumes and legume-based recipes, promoting appropriate preparation and cooking skills to maximise nutrient content and reduce antinutrients effects, and ensuring legumes are cooked appropriately in palatable recipes to increase acceptance. Campaigns such as 'Beans is How' and 'Bang in some Beans' promote the inclusion of beans into everyday meals via recipes and community outreach skill programmes (Beans is How, 2024; https://www.globalbean.eu/partners/beans-is-how/). Similarly, the UKRI TUKFS H3 project has developed an accessible (in terms of affordability, ingredient access, and simplicity) lentil cookbook to promote easy legume based recipes (https://h3.ac.uk/lentils-for-life-cookbook-3/). The TUKFS BeanMeals project has also developed recipe resources focussed on promoting beans (https://www.foodforlife.org.uk/learning-and-skills/cooking-and-nutrition/beanmeals-project/). This has provided the foundation for community outreach work, offering practical cooking classes and demonstrations to community groups and schools to promote acceptability and consumption of legumes. Research is ongoing to measure the impact of such interventions on diet quality.

5.4 | Guide choice through changing the default: Make 'healthier' options the default for people

Guiding choice via the use of default options falls within the realm of Nudge Theory but can be considered a subtle increase in intervention level to shape behaviour. Setting a target behaviour or choice as a default does not remove the number of choices offered to the decision-maker, rather, the target choice is presented as the default option to create a path of least resistance for this choice, thus increasing the likelihood of this choice being selected over alternative choices. Changing the default option has been applied in a number of contexts in the UK to influence behaviour. For example, all nations of the UK effectively operate a 'soft' opt out system for organ donation that presumes an individual consents to be an organ donor upon death (the default position) unless they have specifically indicated they do not wish to do so (British Medical Association, 2025). The success of the legislation to date is debated, potentially as a result of interventions by families who can override the presumed consent (McLaughlin et al., 2025; O'Neill et al., 2024). The use of default auto enrolment into a pension scheme introduced in the UK in 2012 has been a notable success, considerably increasing pension savings (Department of Work and Pensions, 2022).

In a food context, choosing between food options is often guided by fast, habitual, automatic and/or low cognitive effort responses to environmental stimuli (e.g., habitual choice in a food context, menu layout, presentation/placement of food, food descriptions, sensory qualities of food; Cohen & Babey, 2012; Ensaff, 2021; Riet et al., 2011). The use of default options has potential application in the promotion of increased legume intake. For example, making a plant-based burger the default burger on a menu requires the customer to override this choice to request the beef version. This extra cognitive effort to override the default choice to select an alternative may, for some, be sufficient to retain the default plant-based option. Indeed, there is some evidence to suggest this approach can influence food choice behaviour: introducing default vegetarian menu options has been shown to increase willingness to choose vegetarian dishes (Dagevos et al., 2024; de Visser Amundson et al., 2025; Hielkema et al., 2022).

Public institutions could be efficacious contexts in which to apply default menu interventions to reach impact at scale. For example, Sodexo has expanded a US initiative offering appealing plant-based default meals on hospital menus after initial success in 22 New York hospitals (https://us.sodexo.com/newsroom/2025/greener-by-default-sodexo-expansion). The introduction of plant-based or hybrid default options incorporating legumes on NHS menus could make a significant contribution to increasing legume intake and diet quality, support the NHS to make cost savings, and contribute to meeting Net Zero commitments. Recent evidence suggests that there is significant room for improvement in the provision of plant-based choices and use of choice architecture in UK hospital contexts (Sadler et al., 2025). Further, other public procurement contexts can utilise the default approach to increase the regularity of target foods being selected. For example, the use of default legume-based meals or default inclusion of legumes as side dishes on school menus. Setting automatic enrolment as the default for those children eligible to receive free school meals could further support access and accessibility to any school meal-based interventions introduced to promote legumes.

5.5 | Guide choice through incentives: Use financial and other incentives to guide people to pursue certain activities

The use of incentives to promote a target behaviour is an increased intervention level that falls outside of Nudge Theory since it relies

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upon attaching a reward to a desired action. Incentives to increase the likelihood or appeal of a target behaviour can be fiscal or offer some form of positive outcome for the decision maker. For example, the UK Cycle to Work Scheme aims to increase physical activity in the population and reduce use of cars to travel to workplaces by offering cheaper access to bikes via employers. Employees can opt to give up part of their pre-tax salary to purchase a bike for active travel to work. This reduces taxable income, resulting in a tax saving for the individual and incentivising behaviour adoption (UK GOV, 2011).

Incentives have been employed to promote dietary behaviour in the UK population, although these tend to be limited to specific population subgroups. A prime example of this is Healthy Start Vouchers to promote nutrition in pregnancy and early childhood (Scotland employs a separate Best Start Foods scheme; NHS, 2025). Healthy Start vouchers are available to women more than 10 weeks pregnant and children under 4. The use of the vouchers is restricted to the purchase of specific foods known to provide nutrients to support healthy pregnancy and early infancy. This includes cow's milk, infant formula based on cow's milk, vitamins, fruit and vegetables, and fresh, dried, and tinned pulses. The scheme is also restricted to those in receipt of certain benefits (pregnant women under 18 years old are eligible regardless of benefit status). This approach is designed to target those at the lower end of the socio-economic gradient that are at increased risk of poor diet and dietary related health outcomes (Carrillo-Alvarez et al., 2025; James et al., 1997). Whilst the approach has utility in targeting those most at risk of diet-related health inequality during a critical developmental life-stage, a significant majority of the population are not eligible and are therefore not incentivised to consume more of the target foods.

The use of incentives to promote healthy and sustainable food choices in the population as a whole is an area of growing interest as governments in high-income nations struggle to support populations to adopt healthier and more sustainable diets (Quach et al., 2025). Retail environments are one context in which the application of incentives to promote certain foods could have an impact at scale by employing incentives such as price discounts, food vouchers and rewards (Quach et al., 2025). Targeting food retailer environments to promote greater legume access is a key element of the 'Bang in Some Beans' campaign, asking food retailers to make sales-based pledges to significantly increase legume-based sales (https://foodfoundation.org.uk/keen-bean-pledgers). Suggested incentives include increasing the availability of beans and bean products in promotions and meal deals, introduction of bundle deal promotions, and ensuring bean-based products have at least price parity with equivalent meat products (The Food Foundation, 2025). Several large retailers have already signed up to the campaign (e.g., Lidl, Waitrose, Marks and Spencer). It is too early to assess if incentives, and what form of incentive, will be used to promote increased legumes sales. Such approaches have great potential to increase the acceptability and access to legumes but more evidence of the efficacy of incentives to increase the sale of healthy foods is required (Quach et al., 2025).

The utility of using incentives to support greater intake of legumes in the UK may not be restricted to the consumer segment. Achieving a significant increase in legume intake will likely require changes across the supply chain (Jones & Cottee, 2024; Magrini et al., 2018). Depending on the scale of change envisaged and the legume form(s) selected, it will likely be necessary to incentivise increased legume supply, particularly if supply from domestic food producers is to be prioritised (as suggested by the tone of the most recent government Food Strategy; DEFRA, 2025). Taking beans for an example, the majority of beans consumed in the UK are imported from Brazil, Canada, the Netherlands and Kenya (Kaimila et al., 2025). Without appropriate incentives, domestic UK farmers may be reluctant to upscale or transition to bean production to meet any increased demand due to the lower profitability of legume crops compared to wheat, greater yield fluctuations, and susceptibility to biotic stress (Semba et al., 2021). It is also important to consider unintended consequences of any intervention to avoid net negative impacts on the food system. For example, promoting domestic legume intake but not domestic production may result in increased reliance and demand on legume supply from climate vulnerable regions—depending upon the legume crop being considered for promotion. Further, if domestic production is increased to meet demand, a lack of legume processing facilities in the UK may result in increased transportation impacts due to a need to offshore processing. Whilst transportation contributes significantly to the environmental impacts of food, the relative impact of transport compared to production stage costs is often overstated (Le Page, 2022; Weber & Matthews, 2008) and is crucially determined by the form of transportation (e.g., ocean freight vs. air freight; Coley et al., 2011). The net sustainability benefit of legume production has the potential to outweigh the impacts of transportation, as evidenced by Life Cycle Assessments (LCAs; Poore & Nemecek, 2018). However, the impact of transportation is nuanced, has been proposed to be underestimated, and often fails to account for entire upstream food supply chain costs (Li et al., 2022). Therefore, depending upon the scale of change and the legume form, any increase in domestic production or importation of legume produce needs to be carefully considered to mitigate unintended environmental implications.

5.6 | Guide choice through disincentives: Use financial and other disincentives to guide people to pursue certain activities

The use of disincentives to influence behaviour can be considered a further increase in intervention level since pursuit of a target behaviour is not encouraged by delivery of some form of reward when a behaviour is pursued; rather, a punitive outcome is introduced to discourage or devalue a behaviour option. This can be considered a greater impingement on individual autonomy (Nuffield Council on Bioethics, 2007). Examples of the use of disincentives include: increased taxation on behaviours known to be detrimental to health (e.g., disincentivising smoking by increasing tax—and therefore cost—on cigarettes); and the designation of clean air zones in many UK towns and cities in which charges are applied to vehicles above an emission threshold entering specified areas (DEFRA, 2020).

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The application of disincentives in the food system is rare. Governments are often reluctant to intervene in the free market activities of the food industry or risk accusations of 'nanny stateism' by impinging upon the highly personal dietary choices of citizens (Frieden, 2010). Indeed, the Dimbleby (2021) National Food Strategy Independent Review of the UK food system reported keen opposition to any notion of a meat tax to disincentivise meat consumption to meet the review's recommended 30% reduction in red meat intake. A recent exception is the soft drinks industry levy (SDIL) that promoted reformulation of sugary drinks in the UK by imposing a tax levy disincentive on the sugar content of drinks. This has resulted in a gradual reduction in sugar content due to manufacturers reformulating products to avoid the tax levy (Scarborough et al., 2020).

It is difficult to envisage a disincentive that could have a positive impact upon legume intake. Successful disincentive approaches such as the SDIL and other public health interventions target the *reduction* of a behaviour (i.e., not adding high levels of sugar to a product, not smoking). The proposed target of increasing legume intake intrinsically requires the promotion of an increase, not reduction, in behaviour. The notion of a meat tax to disincentivise reliance on meat consumption may indirectly result in individuals consuming more legumes as an alternative to meat, yet this is likely to be so unpopular that it risks being counterproductive (Dimbleby, 2021). Similarly, a meat tax levy to promote reformulation and inclusion of plant-based proteins in hybrid meat products risks public resistance and is unlikely to increase the acceptance and appeal of legumes. Indeed, attempts to disincentivise behaviours such as meat consumption often result in defensive reactance responses in which the lack of willingness to adopt a behaviour is intensified (Graça et al., 2026).

5.7 | Restrict choice: Regulate to restrict the options available to people

The restriction of choice is the first intervention level at which some degree of personal freedom of the individual is removed independent of behavioural intentions. Rather than enabling target choices by manipulating the choice environment to increase ease or appeal of a choice or making certain choices more or less appealing by attaching rewards or punishments, restricting choice directly impedes the selection of specific choice(s). Despite representing an increase in intervention level, restriction of choice is commonly used and accepted in many dietary contexts. For example, the food served to children in UK schools must adhere to specific standards and regulations to ensure safe and nutritious food is served (e.g., the School Food Standards for schools in England; Department for Education, 2019). This includes minimum and maximum amounts of nutrients/foods that should be served across the school week (e.g., salt, sugar, and fried foods). The current standards in England include the recommendation to: "encourage all children to have a meat-free day each week, using alternatives such as pulses, soya mince, tofu and mycoprotein-based meat substitute" (Department for Education, 2019). Legumes are also promoted as a good way to increase iron in meals. However, guidelines relating to legumes are recommendations, not mandated requirements nor restrictions.

Introducing more stringent dietary guidelines for anchor institutions such as schools to restrict choices to target foods has the potential to make a significant impact at scale. The setting of standards restricting choice to legume-based foods in school meals on specific day(s) could significantly increase exposure and consumption. Repeated exposure has been shown to increase acceptability of foods (Caton et al., 2013) and can influence dietary patterns that are more likely to be maintained into adulthood (Lake et al., 2006). Restrictions that promote greater inclusion of plant-based options such as legumes could be expanded to include all food procured for public institutions by mandating food buying standards. Indeed, one of the recommendations of the National Food Strategy Independent Review was the redesigning of the Government Buying Standards for Food (GBSF) to strengthen public procurement rules to prioritise health and sustainability when purchasing food for public institutions (Dimbleby, 2021); greater inclusion of legumes can contribute to meeting both these goals. Mandating a minimum amount or frequency of legumes or legume-based meals served in public institutions will directly increase consumption levels and support increased sustainability standards.

The UKRI TUKFS funded H3 project trialled a choice restriction approach in a school context to increase fibre intake in primary children attending breakfast club provision (Wilkinson et al., 2025). This approach demonstrated the feasibility of removing the availability of white bread and restricting choice of breads to only high fibre options to increase exposure and acceptance of foods with greater nutritional value. The higher fibre breads—that all provided between 4.4 g and 7 g of fibre per 100 g—varied in colour (i.e., hues of brown) and level of particulate inclusion (e.g., seeds, degree of grain flakiness). By restricting choice to only high fibre options, but still offering a choice of these options, most children found a bread(s) they *liked enough* to eat even if they may have preferred and chosen white bread more frequently should it have been offered. We contend that restricting choice to the kinds of foods we want individuals to eat—ensuring these options are appealing—has great potential utility in driving change in dietary behaviour (Wilkinson et al., 2025).

5.8 | Eliminate choice: Regulate to eliminate choice entirely

At the summit of the intervention ladder is the removal of choice altogether. This can be considered the ultimate infringement upon personal choice and liberty and is typically employed in limited public health spheres. For example, mandatory restrictions on movement and social contact were introduced in response to the COVID-19 pandemic (The National Archives, 2020). Interventions that effectively eliminate choice have not been widely employed in the spheres of food system and dietary choice and tend to operate at the food industry/regulatory level, for example, bans on foods that do not meet specific food standards in the UK, including the production or import of hormone-treated meat (Council Directive 96/22/EC) and chlorine-washed poultry (EC No 853/2004; Article 3(2)). Fortification

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of non-wholemeal wheat flour with calcium, iron, niacin and thiamine is mandatory in the UK; folic acid fortification will commence from December 2026 (Food Standards Agency, 2025b). Since 2018, Transport for London (TfL) has banned promotion of foods categorised as high in fat, salt, and sugar (HFSS) across their entire network (underground tubes, bus stops, and railway stations) to support obesity prevention measures (Mayor of London, 2018). There is some evidence to suggest this removal of choice—the choice of the food industry to advertise freely—has had an impact on localised dietary behaviour in London (Yau et al., 2022).

Food system interventions that eliminate choice altogether as implemented by TfL are rare. Often measures that appear to be an elimination of choice are in fact restrictions; the long delayed 'ban' on advertising of HFSS food and drinks to children online and on TV that came into force January 5th 2026 (House of Commons Library, 2025) is effectively a restriction—on when products can be advertised—rather than an elimination of this practice. Similarly, the mandatory banning of promotions and preferential placement of specified foods categorised as HFSS in retail environments is another example of a restriction rather than elimination of choice; retailers are still permitted to sell HFSS foods but restricted in promotion methods and where they can place these products in store. Further, many other existing regulatory interventions to improve the nutritional quality of foods in the UK have often tended to be non-mandatory measures, for example, attempts to encourage industry reformulation (e.g., the sugar and salt reduction campaigns).

Since governments have been reluctant to introduce mandatory regulations to reduce the amounts of fat, salt and sugar in food products, the application of mandatory regulation to increase legume intake seems preposterous. However, it could be argued that chronically low fibre intakes in the UK—which legume intake could make significant contributions to addressing—warrant the same level of public health action as fat, salt, and sugar consumption (Boyle et al., 2024). One potential area of intervention is targeting enhanced nutritional content of ready-made meals with mandatory minimum nutritional standards. For example, mandating that all processed meat-based ready meals must meet minimum nutritional standards for saturated fat, sugar, salt and fibre content. This could promote the increased use of foods such as legumes in blended formats to bolster the nutritional quality of ready meals to meet these minimum nutritional standards. Despite evidence that mandatory reformulation approaches may be more effective than voluntary measures (Gressier et al., 2025), consumers may be resistant to enforced reformulation, particularly if product qualities such as taste and texture are significantly impacted (Gillison et al., 2022). Removing choice from consumers altogether is also likely to be unpopular and risk defensive reactive responses (Graça et al., 2026).

6 | DISCUSSION

The nutritional and sustainability benefits of greater incorporation of legumes into UK diets are clear. Despite the potential benefits offered by increased intake, the UK population overall is not consuming legumes regularly. Diet-related health in the UK is low. Population data shows consumption of many essential nutrients needed to live healthy lives falls below recommended levels; this includes many nutrients in which legumes are rich (e.g., fibre, iron, zinc; Public Health England, 2020). Therefore, specifically promoting legume intake in approaches aimed at improving dietary health appears appropriate and justified. This is further supported by the potential sustainability benefits in terms of reduced environmental footprint offered by specific legume production.

Even though legumes are consumed as part of many diverse cultural dishes in the UK, they are not a significant component of diets for the majority. Low habitual intake is compounded by additional barriers specific to legumes (e.g., palatability, convenience) that combine to limit the appeal of legumes. Therefore, any meaningful change in dietary intake of legumes seems likely to necessitate intervention(s) of some description to promote greater intake. The Nuffield Council on Bioethics Intervention Ladder offers a framework against which such interventions can be ordered and considered based on feasibility and proportionate justification.

We naturally reject doing nothing as an option for promoting legume intake since our contention is that intervention is needed to promote greater legume consumption. The provision of information to promote increased knowledge of the benefits offered by legumes is considered integral to supporting additional interventions, but not sufficient as an intervention in isolation. Awareness and understanding of the need or benefit of consuming legumes can set the foundation for further interventional approaches. Of importance here is understanding and adopting the most compelling framing of the benefits of legumes when providing information to citizens. Potential motivations for consuming legumes will vary across population segments. For example, those following plant-based diets, and more likely to be already consuming legumes, may be motivated by factors such as ethical beliefs and/or sustainability concerns. These motivators may not be as compelling for those not following plant-based dietary patterns or regularly consuming legumes, who may find factors such as protein content, cost, or convenience more persuasive motivators to change dietary habits. Whilst there is ample evidence elucidating the barriers that may prevent consumers from eating legumes more readily, more insight across population segments into motivators that could be adopted as enablers of legume intake is needed to better inform citizens and interventions.

Succeeding intervention levels above *doing nothing* and the *provision of information* are characterised by increasing levels of intrusion and action upon individual behavioural capacity. Interventions from this level upwards do not place sole responsibility for enacting a behaviour on the individual. Considering low habitual intakes and stated barriers, we propose adoption of interventions that operate above the level of personal responsibility are necessary to increase legume consumption. Making subtle changes to food environments to make it easier for populations to access and choose legumes and legume foods (e.g., increasing number of legume products, selective reformulation, use of defaults in retail and out-of-home environments)

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is unlikely to be viewed as a significant infringement on individual choice. Such approaches offer relatively cheap and easy intervention approaches to influence population behaviour. It should be noted that nudging approaches are not without controversy (Tummers, 2023), and there is some debate on the effectiveness or effect sizes of nudge interventions (Mertens et al., 2022). Any interventions should be carefully designed and monitored for efficacy and unintended consequences, for example, avoiding negative impacts on individuals with legume allergies. However, interventions targeting choice architecture in food environments to promote greater access and acceptance of legumes is considered a viable intervention option.

The use of incentives to promote legume intake offers potential benefits. These can be offered by government (e.g., specific vouchers for target foods, including legumes) or retailers (e.g., promotions on legume foods). Incentives to promote domestic production of legumes is also likely necessary considering the risks for producers inherent in switching production. Approaches that adopt disincentives to increase legume intake are considered inappropriate and likely to be ineffective in the context of attempting to increase the frequency of a behaviour (e.g., taxing meat production is likely to be very unpopular and nothing suggests this will naturally result in increased legume intake as an alternative protein source). Similarly, removal or elimination of choice is considered unlikely to be effective in increasing legume intake and risks resistance from populations.

Despite restriction of choice being categorised as the second highest level on the intervention ladder, there are specific scenarios in which choice restriction appears reasonable. Food served in schools is already restricted to ensure a minimum level of nutritional quality. Extending this restriction to mandate that legumes or legumes-based dishes are to be served a minimum number of days in the week can have a significant impact on children's diets in the UK. This is highly pertinent since the UK government is currently consulting on dietary changes to the School Food Standards for England (UK GOV, 2026). Indeed, public procurement is considered a key food system lever that can be harnessed to promote legume consumption in equitable ways. Promotion of legumes via public procurement and anchor institutions ensures greater control over pricing, capacity to constrain availability of competing food choices, and allows for the provision of balanced dietary information to promote healthier, more sustainable choices that may not be possible in retail food environments.

It is important to note that implementation capacity of interventions is not uniform across the UK due to devolution. As an example: although public procurement offers a promising lever for increasing legume intake, more centralised school meal systems and stronger local authority control in Scotland and Wales may make procurement-led legume interventions easier to implement and monitor than in England, where provision is more fragmented across local authorities, academies, and catering arrangements. Recent examples nonetheless illustrate what is possible: Sustain's Give Peas a Chance pilot (https://www.sustainweb.org/bridging-the-gap/aberdeen-gives-peas-a-chance/) has introduced Aberdeenshire split peas into school meals across Aberdeen, Moray, and Highland, while BeanMeals-related work in England demonstrates that innovation is feasible but often depends on local champions and navigating heterogeneous implementation contexts. These governance differences should therefore be considered when assessing the feasibility and scalability of procurement-based interventions (Michaels & Barling, 2025).

Likewise, the feasibility and likely impact of different intervention levels vary in the UK context. Lower- to mid-ladder interventions (particularly those that enable choice or shift defaults in retail, food service, and public procurement) are likely to be the most immediately feasible and scalable, as they build on existing institutional levers while remaining relatively acceptable to the public. Higher-level measures, such as stronger production incentives or more restrictive procurement standards, may deliver greater long-term impact but are likely to require stronger political commitment, cross-sector coordination, and greater system readiness. This points to a sequenced approach: prioritising interventions that increase exposure to, familiarity with, and acceptability of legumes, while progressively creating the conditions for more structural action over time (Agora Agriculture & IDDRI, 2025; Balázs et al., 2021; Dagevos et al., 2024; Montfort et al., 2023).

Whilst the intervention ladder offers a useful structuring device against which to discuss intervention options, it is primarily a behavioural and ethical framework, not a model for food system transformation. It is employed here as a structuring device to order potential policy and behavioural intervention strategies by increasing levels of intervention; it is not intended to model an integrated, whole food system transformation approach to promote legume intake. The intervention ladder outlines escalating levels of intervening; it does not capture nor reflect system path inter-dependencies built into the existing food system that drive—and constrain—food system dynamics. Further, the approach does not allow for consideration of food system mechanisms such as increasing returns, infrastructure lock-in, feedback effects, or political economy constraints (see the following publications for a whole food system overview of transforming legume intake in the UK context; Horril et al., 2024; Jones & Cottee, 2024).

This review focuses primarily on palate- and plate-level interventions, but scaling legume consumption meaningfully also depends on upstream changes across the food system. Increased demand must be matched by supportive production incentives, coordinated supply chains, adequate storage and processing infrastructure, and careful management of trade dependencies. In the UK, this is particularly salient given the lower profitability and higher agronomic risks of legume crops relative to dominant cereals, continued reliance on imports, and limited processing capacity for some domestically grown legumes (Farming UK, 2026; Guerrero, 2026; Nicholson, 2023; PGRO, 2018). Palate- and plate-level interventions should therefore be understood not as stand-alone solutions, but as demand-side levers within a broader transition in which production, processing, trade, retail and consumption are mutually shaping and require system-wide alignment.

The optimistic tone in which the proposed intervention approaches are presented is not intended to suggest the task of increasing the consumption of legumes will be an easy one. Diets and

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dietary choice are inherently complex and influenced by individual, social and environmental factors. Further, the impact of behaviour change and choice architecture interventions are often modest (Afshin et al., 2019; Broers et al., 2017; Lara et al., 2014; Timlin et al., 2020). However, modest change is not inconsequential at scale. Sizeable dietary change in the sustainable food sphere is also possible—perhaps few would have predicted the growth in acceptance and consumption of plant-based 'milk' products in the UK prior to 2010, yet today they approach mainstream status (GFI Europe, 2025). There will be no one size fits all approach, nor will factors moderating the success—or otherwise—of attempts to increase legumes uptake be the same for different segments of the population. When designing interventions, it is essential to consider moderating factors such as cultural norms, social identity, economic structures, food environments, and drivers of food choice within population segments, to maximise the efficacy of strategies. Ensuring interventions are designed to promote equitable impact is also critical to avoid 'intervention-generated inequalities' for lower-income populations that can disproportionally benefit less from certain intervention forms (Bull et al., 2014).

7 | CONCLUSIONS

It is proposed that adopting intervention strategies that span across a number of levels of the intervention ladder offers an efficacious approach to affect legume acceptability, access and intake in the UK. Supplementing information provision with environmental changes in food environments to make it easier to access and choose legumes, using incentives to increase the appeal of legumes, and harnessing public procurement to ensure populations are exposed to legumes can support the reintroduction of legumes to the UK palate and plate.

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CONFLICT OF INTEREST STATEMENT

Laura Lane is on the Advisory Board of The Food Foundation's 'Bang in some beans' campaign. CR serves in advisory roles with the Nutrition Society, Institute of Food Science & Technology, Faculty of Public Health, and ISO/TC 34/SC 20. He has received consulting payments via City St Georges, University of London, from WRAP, Zero Waste Scotland, DEFRA, Wellcome trust, and the FSA. He has undertaken pro bono advisory, speaking, and review work with various organisations. In 2020, he received €49,858 in research funding from the Alpro Foundation. No other conflicts of interest are reported.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ORCID

Neil Bernard Boyle https://orcid.org/0000-0002-0604-4712

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