London's Global University

IRDR0012 MSc Independent Research Project

Towards an Explanatory Model for UK Food Security: Testing Veganism as a Variable

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DECLARATION

I declare that the following work is my own and, where the work of others has been used, it has been clearly identified.

Signed, 22214894/XRBH1

Abstract

This research project investigated the influence of veganism upon UK food security within the *Global Food Security Index* (by *The Economist/ Corteva Agriscience).* To test the target variable of veganism, the Index's underlying indicators were filtered for quantitative indicators with outlined methodologies that were applicable to the research question regarding veganism. After which, a search was conducted for appropriate datasets to analyse the indicators in relation to the research question – filtering out indicators without appropriate data available. Analysis was conducted whereby alternative indices were produced, namely an Adjusted Baseline, a Vegan Index and an Animal Agriculture Inclusive index. The scores for these indices were compared against each other and the original output scores from the model. The results were relatively inconclusive, highlighting a slight detrimental effect of veganism and the overall inappropriateness of the chosen methodology in testing veganism's influence upon UK food security.

Glossary of Acronyms

CO2e – CO2 equivalent

CPI / CPIH – Consumer Price Index / Consumer Price Index Harmonised

DEFRA – Department for Environment, Farming and Rural Affairs (UK Government)

FAO – Food and Agriculture Organisation, the United Nations

ONS – Office for National Statistics (UK)

UK – United Kingdom

UN - United Nations

UNDP – United Nations Development Programme

USDA – United States Department for Agriculture

WRI – World Resources Institute

WTO – World Trade Organization

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Introduction

Widespread veganism and adoption of plant-based diets has been suggested as an ecological imperative in securing an environmentally secure future. In the United Kingdom (UK), veganism is one of the most rapidly growing lifestyle choices, with an estimated 1.5% of the UK population reported as vegan - in addition to considerably more vegetarians and those following a plant-based diet (The Vegan Society, 2019). A trifecta of reasons bolsters this trend, with individuals acting for moral, health and environmental concerns. Despite these benefits a key question remains: how might this radically different lifestyle influence UK food security?

In light of these changing diets, non-academic actors have been quick to highlight the UK's animal-centred agriculture system – questioning the viability of widespread plant consumption (Blythman, 2019; British Meat, n.d.; The Guardian, 2018; Kilcooley, 2017). In response to this media posturing, this research project sought to test how veganism may be influencing UK food security, by questioning the influence of *animalisation*[1] (to what extent animals are involved) within UK food security metrics.

Definitions and Research Question

Although the definition of veganism extends to lifestyle choices, for practical purposes, this research focussed on the dietary practice element of that philosophy – considered as a diet featuring no animal products (The Vegan Society, 2020). In considering veganism as a target metric, this research also created inferences for 'plant-based' diets (*vegetarianism, flexitarianism, freeganism*, etc.) that have varying levels of animal products, with veganism being considered indicative (as the most committed version) of such diets.

As such, the central research question behind this research was:

1) To what extent does veganism influence UK food security?

To answer this, food security requires a working definition and scope. Food security has a plethora of definitions, but principally relates to universal access to nutritious food (FAO, WFP, and UNICEF, 2019; FAO *et al.*, 2022). The Food and Agricultural

[1] This research will take slight liberty with the definition of *animalisation*, and will use the term literally: to what extent does variable X include or not include the influence of animals.

Organization of the United Nation's (FAO) widely disseminated definition, as of 2022, is as follows:

A situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Based on this definition, four food security dimensions can be identified: food availability, economic and physical access to food, food utilization and stability over time.
-FAO et al., 2022

This definition has been taken further by practitioners in the field. Based on these definitional foundations, *The Economist* (a key practitioner in food security) created their influential *Global Food Security Index* to track food security across different nation-states (The Economist, 2022). It is this index that was specifically utilised in this research project as its foundations are similar to the widely accepted FAO definition - however the individual parameters are better outlined in *The Economist's* Index and the analysis is at a nation-state scale (explored further in *Methodology*).

Study Area

The area under study in this research project was the United Kingdom. The UK is a relatively food secure nation, despite ongoing issues regarding equitable access to food and unhealthy dietary patterns (Hasnain, Ingram and Zurek, 2020; The Economist, 2022). As such, there has been little academic interest to date in interrogating UK food security metrics with a holistic approach, likely due to assumed safety and resilience of the UK food system. With this stated, global environmental changes in the 21st century may cause a weakening of UK food security at a national scale by increasing the frequency of extreme weather events such as extended drought (i.e. crop stress and/or failure) (Richardson *et al.*, 2018). Conversely, climate change may lead to more productive growing conditions in Europe (Knox, Morris and Hess, 2010). At the same time, heat and drought events of extreme nature will increase in prevalence at an unpredictable rate (Knox, Morris and Hess, 2010). In parallel to changing hazards, the UK food system has become increasingly *fragile* as 'Just in Time' business practices have entered the food sector (Benton *et al.*, 2019). Supermarkets have become dominant players, shaping the structure of the global and national food industry to meet demands for efficiency (Weis and Weis, 2007). Consequently, the UK may now have increased vulnerability to these changing hazards. All such influences justify research into understanding the factors influencing UK food security – this research sought to test one such factor: the influence of veganism.

As aforementioned, plant-based diets have become increasingly popular in the UK due to a variety of reasons including health, environmental concerns, moral concerns and the rise of 'Big Veganism' (The Vegan Society, 2019; Sexton, Garnett and Lorimer, 2022). Considering the growth in veganism *and* the changing nature of food-production hazards in the UK, veganism should be considered as a factor influencing UK food security deserving research interest as it is an area that is both pertinent and prescient. In addition to the aforementioned media posturing, studying veganism is pertinent where plant-based diets are suggested to influence food security directly (Sun *et al.*, 2022). In further, it is prescient when considering the influence that plant-based diets may have in a changing geopolitical situation (Clark *et al.*, 2020; Sun *et al.*, 2022). Furthermore, should veganism positively influence UK food security, and considering its ongoing popularity, it may serve as a fundamental cultural tool for the UK to address present and future food security issues. In other words, veganism may represent an opportunity for 'transformative adaptation' where the change to plant-based diets in the UK isn't incremental, but rapid and radical (Lonsdale, Pringle and Turner, 2015; Carter *et al.*, 2021).

Objectives and Proposition

Foremost the influence of veganism must be discerned. Resultantly, the specific objectives of this research were to:

A) Analyse the importance of veganism to UK food security by:
   1. Desegregating food security indicators within a given methodology between vegan/ non-vegan **or** animal/non-animal origins.
   2. Evaluate said methodology for its capacity to fulfil sub-objective 1.

Given these objectives, and after the literature review, the research developed into a more specific proposition that within a given methodology, veganism would have a positive influence on UK food security (explored further in *Methodology*). Using a quantitative approach, this proposition was tested.

Considering these objectives and the proposition, the scope of the research was purposefully limited. Foremost the geographic scale chosen was the UK. The UK was chosen due to its high-meat consumption (Lang, 2020), public availability of data and the cultural influence of meat consumption in the country (Bryant, 2019). Likewise, the research was also temporally delimited, only considering how veganism influenced UK food security during a recent 10-year period (2012-2022).

Background and Literature Review

The History of Food Security

To understand how veganism influences food security, the concept, history, and utilisation of ‘food security’ must be outlined. Although food security can be broadly understood as the universal access to nutritious food as defined in the *Introduction* (FAO, WFP, and UNICEF, 2019; FAO *et al.*, 2022), it is important to note the contested history of food security (and its contested definition). Jarosz (2011) has reviewed the evolution of food security within literature produced by the *World Bank* and the *Food and Agriculture Organization of the United Nations* (FAO). Although multiple principles remain constant, at the national scale there has been a notable shift in focus from ‘national self-sufficiency’ (1950-1970s) to a definition of food security rooted in global interaction and dependence upon international food markets (1980s-) (Jarosz, 2011). In response, food security, defined as integration with international markets, has been contested by Via Campesina (*the international peasants voice*) with their concept of ‘Food Sovereignty’ (Jarosz, 2014). This alternative emphasizes the participatory right of producers to be involved in sufficiency of supply – a concept somewhat addressed by the FAO’s recent addition of *Agency* to food security (Clapp, 2014; FAO *et al.*, 2022). Such definitions utilised by these international organisations are of importance because the concepts and definitions they use become widely disseminated throughout global political and economic spheres (Barnett and Finnemore, 1999). For example, *The Economist’s* highly influential *Global Food Security Index* adopts a framework of *Affordability, Availability, Quality & Safety and Sustainability & Adaptation* which is clearly delineated from the dominant FAO framework of *Availability, Access, Utilisation* and *Stability* (Pérez-Escamilla *et al.*, 2017; FAO, WFP, and UNICEF, 2019). It would appear however, that the recent addition of *Agency* has not yet filtered through to practitioner tools such as the *Global Food Security Index* (FAO *et al.*, 2022; The Economist, 2022).

Additionally to the normative influence of its definition, the concept of food security itself has been politicised. Tomlinson (2013) note the use of ‘food security’ challenges as a device by agents with ‘prior ideological commitments’ - e.g. the contested requirement to *increase* food production. Tomlinson's (2013) argument is that in the name of food security, key analyses such as that provided by the FAO

(2009) have been mis-represented by various organisations including the UK Government, the agriculture industry and the biotech industry. For this example, there is not an environmental-economic imperative to produce *more* food, but this framing has been adopted because it suits an ideological commitment to: a) economic growth, b) commitment to a liberal and global trade system and c) belief in technocratic-scientific solutions (Tomlinson, 2013; De Schutter, 2014). These framings of food security support supply-side solutions, diminishing the contribution of demand-side solutions such as veganism that may question technocratic and globalist agendas (Clapp, 2014; Jarosz, 2014). Such diminishment may partly explain the relative lack of UK government research, supported research, and policy on veganism as a potential solution to UK food security issues.

In sum, food security is a highly influential concept. Its definition, controlled by influential international organisations, has changed through time - often running co-current with the ideological commitments of organisations that utilise the concept. The concept has been challenged within and out-with academia, however its fundamental analytical focus on the provision of universal, safe and nutritious food remains a useful tool. This stated, it may be blind to the contribution of demand-side solutions regarding dietary type.

Veganism and Food Security

A prevailing issue within the academic literature is a lack of research questioning specifically how veganism, and plant-based diets does, and will, influence UK food security. There is wide-ranging literature on elements of food security, explored below, but holistic studies are lacking. Within the grey literature there is basic assessments that plant-based foods (fruits, vegetables) may be more environmentally sustainable at a global scale, somewhat refuted by assessments the UK is a particularly suitable environment for the rearing of animals (MacMillan and Dowler, 2012; Lang, 2020). Sun *et al.*, (2022) have highlighted at a European scale that plant-based diets are a desirable response to conflict in order to bolster resilience within the *Availability* and *Affordability* aspects of food security. Land-use change in the UK in relation to climate pressures has been studied, however, Smith *et al.* (2023) note that limited scale of such papers and the limited scope of policy changes included in their models – including considering dietary change as a potential demand-side solution. Smith *et al.*, (2023) also note that should the UK's diet remain unchanged, future afforestation and habitat restoration targets cannot be achieved, with key biodiversity habitats lost. However, there is not a comprehensive study to date attempting to combine each element of food security into a holistic approach within the UK in relation to veganism. With this stated, there is a plethora of research papers questioning each individual aspect of food security and how this relates to veganism, plant-based diets and plant-based food at a global scale - with inferences for the UK. Such literature predominantly falls under the following themes: agriculture and its impact; the economic organisation of food provision; and the social impacts and pathways of demand-side solutions. Each in turn, are considered:

Agriculture and its Impact

Moving into the 21st century, human agricultural systems has placed, and will place, an ever-increasing burden on the natural productive capacity of Planet Earth (Steffen *et al.*, 2015). Through extensive agricultural systems, enough food for approximately 10 billion or more people is produced, yet approximately 1-2 billion people are hungry or undernourished today (De Schutter, 2014; Holt-Giménez, 2019; Latham, 2021). Despite economic disparities and lack of physical entitlement being the principal driver of inequal food access, the political focus to date has been to produce more food (Tomlinson, 2013; De Schutter, 2014). Resultantly, the situation is one of over-abundance in certain places, and undernourishment in others ('the dual burden' – which can be between countries, communities and also between those within living units i.e. families) (Doak *et al.*, 2005; Thow *et al.*, 2016; Chappell, 2018). Considered in greater detail, the agro-ecological landscape has been optimised to support the demands of diets heavy in animal products, and global meat consumption is rising annually (Godfray *et al.*, 2018). Meat and dairy heavy diets are popular in wealthier Western countries, including the United Kingdom (Weis, 2013; Garnett *et al.*, 2017). Said diets have also become 'aspirational', where diets heavy in animal products have become associated with wealth within developing countries - fuelling the increasing demand for such products (Shono, Suzuki and Kaiser, 2000; Pingali, 2007).

Considering the fourth element of food security, *Sustainability*, sustaining intensive agriculture has had a heavy impact on the environment. Regarding emissions, Clark *et al.*, (2020) find that the agriculture sector alone will breach 1.5°C and 2°C targets set at the Paris Agreement (UNFCCC, 2015) if dietary changes are not implemented.

Soil, the essential element in most farming systems is being degraded at rates beyond natural replenishment rates (Amundson *et al.*, 2015). Likewise, biogeochemical loading of ecosystems is far beyond the carrying capacity of the earth and agricultural expansion continues to pressure ecosystems and biodiversity (Steffen *et al.*, 2015). The relationship to diet type, including veganism, is that these impacts are disproportionately caused by *animal agriculture* – often to support meat and dairy heavy Western diets (Herrero *et al.*, 2011; Lymbery and Oakeshott, 2014; Hallström, Carlsson-Kanyama and Börjesson, 2015; Campbell *et al.*, 2017). Due to the demands of feed production, enteric methane production by cattle, and manure decomposition, animal agriculture has been estimated to be responsible for 14.5 – 35% of global greenhouse gas emissions (Herrero *et al.*, 2011; Gerber *et al.*, 2013; Stoll-Kleemann and O'Riordan, 2015; Twine, 2021). Likewise, animal agriculture also has placed a heavy burden on planetary biodiversity, with livestock being a principal agent behind large biodiversity losses (Westhoek *et al.*, 2011; Stoll-Kleemann and O'Riordan, 2015; Filazzola *et al.*, 2020). Land-use change has increased to created grazing lands and increase cropping area for feed crops (Stoll-Kleemann and O'Riordan, 2015). The large land demand of animal products means substitution of animal products for their nutritionally equivalent plant-based products would reduce the land area required for food production (Chai *et al.*, 2019). Finally, animal agriculture has further impacts in relation to water usage, scarcity and pollution. Animal-based food has a higher water footprint than its plant-based counterparts, due to the volumes of feed required and its production (Mekonnen and Hoekstra, 2012). In addition, nitrogen and phosphorus contained within animal manure contributes to 'run-off' issues causing eutrophication and other risks in aquatic environments (Stoll-Kleemann and O'Riordan, 2015; Godfray *et al.*, 2018). In sum, the *Sustainability* impact of agriculture has been reviewed in depth within the literature, leading to the measured conclusion that animal-based foods are having a disproportionate environmental impact compared to their plant-based counterparts (consumed by plant-based diets such as veganism). Thus, any food security Index should consider dietary type as an important element of measuring the *Sustainability* aspect of food security.

The Economic Organisation of Food Provision

Relevant to *Availability, Affordability, Quality & Safety*, there is significant literature on the global organisation of food supply chains. Critiques in this area are focussed on the increasing length of fragile global supply chains that procure goods 'just-in-time', contamination risks, contingency planning, diversification strategies and global interdependence (Puma *et al.*, 2015; Septiani *et al.*, 2016; Behzadi *et al.*, 2018; Lyu *et al.*, 2020). Such risks directly impact the continued *Availability* and *Affordability* of food. Likewise, fewer countries are now self-sufficient in food production as global food trading has become the norm (Puma *et al.*, 2015). In addition, the COVID-19 pandemic brought UK supply chain issues to the fore, exposing entrenched dietary issues such as malnourishment and its connection to international trade policy (MacMillan and Dowler, 2012; Benton *et al.*, 2019; Clapp and Moseley, 2020; Lang, 2020; Power *et al.*, 2020; Do *et al.*, 2021). In such a context, critiques regarding dietary type become relevant. A wider example, Stoll-Kleemann and O'Riordan (2015) illustrate that displacement of small-hold farmers in South America and Africa has occurred to support an international production-apparatus of cheap meat supplying developed countries such as the UK. In addition, where crops grown for livestock feed compete with crops grown for food, the *Availability* and *Affordability* of food is impacted (van Hal *et al.*, 2019). West *et al.* (2014) illustrate that without this competition, if plants were consumed directly, enough food for an additional 4 billion people could be produced.

Furthermore, a broad category of research has investigated deregulation within the food industry. Globally, the production, trading and sale of food has become increasingly centralised in a small number of large multi-national corporations (henceforth: *mega-corporations*) (Moodie *et al.*, 2013). These mega-corporations have been criticised for the reduction in the quality of the average diet, damaging healthy lifestyles in the pursuit of profit, thus influencing the *Quality & Safety* element of food security in the UK (Wiist, 2011; Scrinis, 2016). Likewise, the political context of neoliberal deregulation has been criticised as enabling the damaging activities of these mega-corporations, including the UK Food Sector (Bartle and Vass, 2007; Brownell, 2012; Scrinis, 2016). Although some merits have been highlighted in the capacity for mega-corporations to self-regulate (Bartle and Vass, 2007; Baldwin and Black, 2008; Lodge, 2015), the overriding academic judgement is that these mega-corporations are not acting in the public interest (Hawkes and Buse, 2011; Bryden *et al.*, 2013; Scrinis, 2016), thus questions remain regarding their influence upon food security (Weis and Weis, 2007; Wiebe, 2012; Chappell, 2018; Holt-Giménez, 2019). With this stated, mega-corporations have moved towards partaking in the growth of plant-based foods – which conversely may benefit food security through increased *Sustainability* (Sexton, Garnett and Lorimer, 2022). 'Big Veganism' has introduced a broad range of analogues for animal-based food items to consumers, predominantly in the West – including the UK (Sexton, Garnett and Lorimer, 2022). However, such food items are often highly processed and are inherently embedded in the corporate dominated food system (Sexton, Garnett and Lorimer, 2022). As such they may not necessarily challenge all food security issues created by this system, particularly issues regarding nutrition as part of *Quality & Safety*. In either case, to measure food security it is imperative to consider dietary type considering its impact on *Availability, Affordability, Quality & Safety*.

Veganism as a Demand-Side Solution in the UK

Due to the environmental and economic impact of animal agriculture, plant-based diets (including veganism) have been recommended as societal tool for humanity to remain within ecological 'Planetary Boundaries' (Hallström, Carlsson-Kanyama and Börjesson, 2015; Steffen *et al.*, 2015; Campbell *et al.*, 2017; Smith *et al.*, 2023). Inversely to the aforementioned effects of animal agriculture, following a vegan, or plant-based diet in the UK likely reduces the CO2e intensity of an individual's diet, alongside the land and potentially the water footprint (Garnett, 2011; Hallström, Carlsson-Kanyama and Börjesson, 2015; Ridoutt, Hendrie and Noakes, 2017; Reynolds *et al.*, 2019; Harris *et al.*, 2020). However, reservations have been made regarding the potentially increased area of mono-cropped land, displacement of water scarcity to third countries and the reliability of popular metrics (Garnett *et al.*, 2017; Ridoutt, Hendrie and Noakes, 2017; Dorgbetor *et al.*, 2022).

At the UK level, the key components comprising food security have been studied individually as they relate to implementing social change through veganism. Specifically, diets higher in plant-products are generally affordable in Western countries, however due to the high cost of analogues and context specifics these diets on the whole can sometimes be more expensive in the UK (Schenk, Rössel and Scholz, 2018; Bryant, 2019; Steenson and Buttriss, 2020; Mullen, 2021; Ghaffari *et al.*, 2022). Plant-based food, including modern animal-food analogues, is widely available in the UK although this is location specific and nutrient consumption may be lower than nutritional recommendations in certain areas (Kumar *et al.*, 2017; Widener, 2018; Lang, 2020; Gallagher, Hanley and Lane, 2022). However, despite this *Availability,* there exists key barriers to switching to plant-based food. These have been well-studied, with culture, financial costs, pleasure, social pressure, and habits identified as the main barriers in the UK (Bryant, 2019; Fehér *et al.*, 2020; Williams *et al.*, 2023). This is congruent with the (Piazza *et al.*, 2015) 4N's typology: meat as *natural, normal, necessary, and nice*. Furthermore, plant-based food in the UK benefits from the UK's strong food safety regulations (Mensah and Julien, 2011; Skuland *et al.*, 2020), whilst uniquely benefitting from being lower-risk of food-borne disease than animal-based foods (Da Silva Felício *et al.*, 2015). As such, the UK shows societal promise for a shift towards vegan diets, which are highlighted as a key adaptation strategy in creating sustainable food futures in the UK (Lymbery and Oakeshott, 2014; Simonsen, 2015; Smith *et al.*, 2023). However, a holistic approach combining all of these elements in a critique or model centred around food security is missing within the academic literature.

Considering the importance, influence, and multifaceted nature of food security as a concept, the impact of agriculture, the influence of an increasingly globalised agricultural system and the recommendations for plant-based diets as an adaptation strategy, there is an imperative to study the intersection of these areas. As such the research question of this study, asking to what extent veganism influences UK food security, is well-grounded at this intersection.

Methodology and Methods

Methodology

The central research question that was utilised for this project was: to what extent does veganism influence UK food security? Considering the results of the literature review, indicating the broadness of 'food security' and the analysis of veganism, the following research proposition was made:

1) Veganism will have a positive influence on UK food security

In this case 'veganism' may be understood as an independent variable, with UK food security as the dependent variable. The parameters defining food security are well defined in available methodologies, however the parameters composing 'veganism' as proposed are not well defined. Questions remain regarding the parameters that comprise veganism as a concept – is veganism measured by number of self-reported vegans; number of vegan products sold; or the number of people eating vegan food? As such a hypothesis can not be formed at this stage. Despite such difficulties, a quantitative analysis was attempted in this research project to examine the proposed relationship between the two variables, veganism and food security, whilst making assumptions regarding veganism. This analysis assumed a deductive approach, testing if increased veganism led to higher food security scores within a chosen index of food security.

Veganism was used as an overall indicator for adoption of plant-based diets in the UK. To test veganism, the research assumed that a) the self-declared adoption of this diet and b) the consumption of plant material were the underlying indicators of 'veganism'. Due to the mixed nature of omnivore diets, any benefit for food security indicated in desegregating plant and animal foods can likewise be applied to the majority omnivore population (who also eat plants) rather than solely to the minority plant-based population. However, the key caveat is that any proven benefits (for food security) of plant-foods against animal-foods in this study can logically be expected to increase should veganism continue to grow in the UK.

Aforementioned, the methodology of *The Economist's* (with *Corteva Agriscience*) *Global Food Security Index 2022* (henceforth: the Index) (The Economist, 2022) was chosen. This Index was chosen because of its widespread dissemination, comparative utility, clearly outlined methodology and the availability of its underlying data (Pérez-Escamilla *et al.*, 2017; Thomas *et al.,* 2017; Izraelov and Silber, 2019; Allee, Lynd and Vaze, 2021). The methodology of this Index follows the concepts of food security outlined by the FAO *et al.* (2022). However, the Index's publicly available methodology is testable and adaptable to different research questions such as the one posed here. In testing if veganism positively influences food security scores within the Index, this research also developed a secondary research outcome: assessing the suitability of the Index's methodology (specifically it's underlying indicators) for appraising veganism's influence on UK food security.

Within the Index, food security is assessed using a weighted calculation of four key sections: *1) Affordability*, *2) Availability*, *3) Quality & Safety*, and *4) Sustainability & Adaptation*. Within each section, the Index is comprised of underlying metrics which are weighted in their contribution to their 'parent' section. Each metric is given a 0-100 score, feeding into a 0-100 section score and finally an overall 0-100 score for food security. As veganism was tested as a target variable within Index, this would lead to an increased overall 'score' for UK food security using the Index's scoring system should the proposed link prove true.

Accepting that diets have differential impacts upon food security regardless of personal interpretation, this research took a positivist philosophy. Certain elements of food security (e.g. interpretations over definitions of *safety*), and indeed the definition of food security itself, are/is open to interpretation. Despite this potential limitation, given the selected definition and methodology used, this research worked under the assumption that food security and most variables constituting it are objective structures that can be better understood with more study. The same assumption is made for veganism, whereby the underlying indicators of veganism (number of vegans, the number eating vegan food, availability of vegan products) are objective variables that can be better understood with more study. A normative assumption was made: increased food security is a *good outcome*. As the methods utilised for the analysis stage of this research were quantitative, combined with the outlined methodology, they are repeatable by an independent researcher.

The time horizon chosen for this research is a recent ten-year period of which the Economist's 2022 Index covers: 2012-2022. The time-period chosen notably includes the worldwide 2020-2021 COVID-19 Pandemic. The inclusion of the pandemic in the time-series yielded interesting results regarding how the different agricultural systems under study responded to an external stressor. In addition, the time series includes the United Kingdom's exit from the European Union (colloquially known as *Brexit)* which had potentially attributable effects within the time series (more in *Discussion*). This also influenced the time series on 'Agricultural Import Tariffs', which prior to 2020 was aligned/ decided upon with the European Union. Data was available across the time horizon for *Availability* and *Affordability* indicators, however indicators within *Quality & Safety* and *Sustainability & Adaptation* are limited to specific years.

The research project uncovered key methodological issues with the availability of open-access data useful for testing the role of veganism and UK food security. To collect additional data, 13 Freedom of Information Requests were sent to the Department for Farming, Environment and Rural Affairs (*DEFRA* – 11 requests), the Department of Health and Social Care (1 request), the Environment Agency (the same 11 requests sent to DEFRA) and the Office for National Statistics (1 request). These were sent in late June 2023, with clarifications negotiated and responses received by mid-July 2023. Of the 13 requests, only 3 were responded to with actionable data (of which was already in the public domain), hampering the scope of the project. Notably missing from the analysis is a breakdown of the UK's Basic Payment Scheme (a land-use dependent government grant in the UK). DEFRA were unable to provide a breakdown of this scheme by agricultural type, despite land-use codes being a pre-requisite for end-user application. Land-use subsidies by agriculture type was a key target variable for the project and would be a fruitful area of future research as it relates to food security in the UK. Further enquiries were made with the University of Oxford, who administer EPIC-Oxford (a longitudinal study of British vegetarians and vegans) however due to time constraints access to the data was denied. In sum, the UK data landscape created *considerable* issues during the data collection phase of the project. This finding has key policy and academic implications for the field.

The research was given due respect regarding the academic ethical process. In utilising anonymous records within the public domain, there was minimal ethical concern as it relates to participants. All secondary data collected was sourced ethically and legally - free of personal information. The author declares themselves interested in advancing Vegan causes under the auspices of moral and environmental concerns, which did create a concern for personal bias. This was countered by utilising an externally conceived methodology and the use of a deductive, quantitative, approach which is repeatable and testable.

Methods

The underlying indicators within the Index are a mixture of qualitative assessments and quantitative metrics. The quantitative indicators were isolated, as their underlying data is publicly available and the methodology outlined. The qualitative indicators in the Index were removed from analysis as the methodology isn't outlined, is reliant on unknown key experts, and there is a risk of personal bias.

The principal method employed in this research was to create alternative indicators based upon the role of animalisation[2] of any given indicator. Alternative indicators were created by desegregating the quantitative indicators based on related veganism or animalisation of that indicator. For example, changes in farm-gate prices for farmers, or consumer prices, were split by changes for animal and non-animal foods. The intention was to create alternative indicators for a 'Vegan Index' score, 'Animal Agriculture Inclusive' scores, and an 'Adjusted Baseline' so that the scores could be compared. This process was completed as follows:

Filtering and Weighting

In the 2022 Index there are 68 indicators of food security. After removal of the qualitative indicators there remained 39 indicators. These indicators were each analysed in turn for their viability in answering the research question, with logically incongruent indicators (e.g. Mobile subscribers per 100 inhabitants) removed. With the qualitative and incongruent indicators removed, the research continued by interrogating the remaining 23 indicators for their suitability to be desegregated based upon the influence of veganism, or plant/animal food provision, on the indicator. Indicators that did not have suitable data available were filtered out. After such filtering, 12 indicators remained. Of the 12 indicators, some required methodological adjustments to be utilised for the research question. The remaining

[2] *Animalisation* for the indicators will be defined as how involved animals are in any given process/indicator.

indicators, any adjustments, and their relative weight(s) in the Index are outlined in Figure 1. Sub-weights are represented in Figure 1 to indicate the contribution of any indicator to its parent group/ section. The sub-weights do not sum to 100% as there are missing indicators that have been filtered out.

Figure 1: Weights of Sections and Indicators

Category:	**Indicator:**	**Weight:**	**Adjustments:**
1. Affordability		30% *Represented here:* 15.56%	
1.1) Change in average food costs	Annual change in Consumer Prices, Food Indices (2015 = 100)	23.85% (subweight)	
1.2) Proportion of population under global poverty line	% of population living under $3.20/day 2011 PPP	19.23% (subweight)	USD/ Day by diet type in the UK.
1.4.1) Agricultural import tariffs	Agricultural import tariffs, %	8.79% (subweight)	
2. Availability		25% *Represented:* 5.25%	
2.1.3) Agriculture producer prices	Average annual change over time in the selling prices received by farmers (2014-2016 = 100)	1.93% (subweight)	
2.2.1) Public expenditure on agricultural research and development	Ratio: Agriculture share of government expenditure (%) / Agriculture value added share of GDP (%)	3.45% (subweight)	
2.2.2) Access to agricultural technology, education and resources	Annual growth in agricultural output (%) minus annual growth in agricultural inputs (%)	4.35% (subweight)	
2.4) Volatility of agricultural production	Standard deviation of production growth rates.	11.26% (subweight)	
3. Quality & Safety		22.5% *Represented:* 4.39%	
3.3.1) Dietary availability of vitamin A	A measure of the availability of Vitamin A, expressed in micrograms of retinol activity	6.92% (subweight)	Utilised same quantitative recommended

	equivalent (RAE)/capita/day on a 0-2 scale.		daily allowance approach as with Iron/Zinc.
3.3.2) Dietary availability of iron	mg/person/day	6.61% (subweight)	
3.3.3) Dietary availability of zinc	mg/person/day	5.98% (subweight)	
4. Sustainability & Adaptation		22.5% *Represented:* 2.00%	
4.1.1) Temperature rise	Index score, 0=least vulnerable	4.35% (subweight)	Emissions kg / co2e / 2000kcals / annum by diet type
4.1.2) Drought	Risk rating 0-4, where 4=highest risk.	4.55% (subweight)	Blue/Green Water Footprint: l/capita/day by diet type

Combined, these 12 indicators represent 27.20% of the weight in the original Index. As such, the inferential scope of the research was limited by this filtering process. The weights of the indicators were pre-determined by *The Economist* and the expert panel they utilised in the creation of the Index.

Desegregation and Data Sources

To analyse these indicators based on their animalisation, where possible, the original data source was downloaded and investigated for its potential to be split. Ten of the indicators required further data in order to desegregate the target variable, as the original source data did not have enough categories or high enough resolution. As such, data which could be split at a higher resolution was downloaded from a variety of sources outlined in Figure 2. At this stage the data was manually split by the Author between vegan/ non-vegan and plant agriculture/ animal agriculture. Some data sources required a high degree of manual separation, for example, *1.4.1) Agricultural Import Tariffs* required each tariff to be downloaded from WTO Tarriff Analysis Online (WTO, 2023) then manually split between what was an animal product and what wasn't – to the best knowledge of the Author.

Figure 2 – Desegregation and Data Sources

Category:	Indicator:	Desegregation:	Original Data Sources:	Additional Data Sources:
1. Affordability				
1.1) Change in average food costs	Annual change in Consumer Prices, Food Indices (2015 = 100)	Plant vs. Animal Foods	FAO	ONS CPI Inflation Indices (all beverage items excluded) (Year 2020 is missing)
1.2) Proportion of population under global poverty line	% of population living under $3.20/day 2011 PPP	Cost of vegan vs. baseline diet	World Bank; World Development Indicators	Springmann *et al.*, 2021
1.4.1) Agricultural import tariffs	Agricultural import tariffs, %	Plant vs. Animal Foods	World Trade Organisation	
2. Availability				
2.1.3) Agriculture producer prices	Average annual change over time in the selling prices received by farmers (2014-2016 = 100)	Plant vs. Animal Foods	FAO (2022 values missing)	
2.2.1) Public expenditure on agricultural research and development	Ratio: Agriculture share of government expenditure (%) / Agriculture value added share of GDP (%)	Subsidy for plant farming vs animal farming (considering coupled payments and animal disease compensation)	UN	Agriculture in the UK - Chapter 10; UK General Government Expenditure
2.2.2) Access to agricultural technology, education and resources	Annual growth in agricultural output (%) minus annual growth in agricultural inputs (%)	Cereal + General cropping vs. Dairy, LFA and Lowland Grazing (Total Factor Productivity)	USDA	Total Factor Productivity - Production (England - DEFRA)
2.4) Volatility of agricultural production	Standard deviation of production growth rates.	Output of cereals vs output of livestock	FAO	Agriculture in the UK – Chapter 5
3. Quality & Safety				

3.3.1) Dietary availability of vitamin A	A measure of the availability of Vitamin A, expressed in micrograms of retinol activity equivalent (RAE)/capita/day on a 0-2 scale.	Vegans vs. baseline	Global Nutrient Database	EPIC-Oxford (Davey *et al.*, 2003; Sobiecki *et al.*, 2016)
3.3.2) Dietary availability of iron	mg/person/day	Vegans vs. baseline	Global Nutrient Database	EPIC-Oxford (Davey *et al.*, 2003; Sobiecki *et al.*, 2016)
3.3.3) Dietary availability of zinc	mg/person/day	Vegans vs. baseline	FAO, WHO	EPIC-Oxford (Davey *et al.*, 2003; Sobiecki *et al.*, 2016)
4. Sustainability & Adaptation				
4.1.1) Temperature rise	Index score, 0=least vulnerable	Vegan diet vs. baseline (CO2e)	Notre Dame Global Adaptation Initiative	Scarborough *et al.* (2014)
4.1.2) Drought	Risk rating 0-4, where 4=highest risk.	Vegan diet vs. baseline (blue-green water footprint)	World Resources Institute (WRI) Aqueduct	Kim *et al.* (2020)

Indexing and Analysis

In order to analyse the role of veganism within the testable portion of the Index (27.20%), absolute values required conversion to relative values to work within the Index. The original Index approaches this by converting the absolute values to a 0-100 score using a threshold adjusted linear transformation, with varying thresholds for each indicator. The equations for the linear transformations are not given in the methodology outlined by *The Economist* but can be computed from the score ranges given (see Figure 3). For most indicators, the same transformations were applied to the new generated values - in line with the original thresholds. However, some new transformations were required where the ancillary data values didn’t align with original data values. These were chosen logically and are outlined below. For example, for a new transformation for *3.3.1) Vitamin A Intake*, a value of 700mcg (the recommended daily intake - NHS, 2017) was chosen as the upper requirement for a perfect score– in line with the logic for the given values for Zinc and Iron. A further example would be *1.2) % of population living under $3.20/day,* where the % reduction/increase of the Vegan diet was projected onto the baseline values. Importantly, if the new chosen thresholds (below – Figure 3) are sub-optimal, any inefficiency is mitigated by the new threshold being applied both to vegan/non-vegan or plant food/non-plant food.

Figure 3 – Threshold Adjusted Linear Transformations

Indicator:	**Original Transformation** All score ranges given by *The Economist* All transformations computed by Author based on ranges given	**Adjustments**
1. Affordability		
Annual change in Consumer Prices %, Food Indices (2015 = 100) (1.1)	0 or below = 100 20 or greater = 0 **Transformation:** y = -5x + 100 (computed)	Unadjusted
% of population living under $3.20/day 2011 PPP (1.2)	<0 = 100 =>98.5 = 0 **Transformation:** y = -1.105x + 100 (computed)	Cast % reduction/increase **(percent change)** of Vegan diet onto baseline values prior to linear transformation
Agricultural import tariffs, % (1.4.1)	0.1 or below = 100 40 or greater = 0 **Transformation:** y = -2.506x + 100.2506 (computed)	Unadjusted
2. Availability		
Average annual change over time in the selling prices received by farmers (2014-2016 = 100) (2.1.3)	2 or below = 0 5 = 100 8 or above = 0 **Transformation:** Values 2-5 scaled 0-100 y = 33.33x – 66.66 (computed) **Transformation:** Values 5-8 scaled 100-0	Unadjusted

	y = -33.33x + 266.64 (computed)	
Ratio: Agriculture share of government expenditure (%) / Agriculture value added share of GDP (%) (2.2.1)	0 or below = 0 1.35 or above = 100 **Transformation:** y=74.07x (computed)	Unadjusted
Annual growth in agricultural output (%) minus annual growth in agricultural inputs (%) (2.2.2)	-0.2 or below = 0 0.2 or above = 100 **Transformation:** y=250x+50 (computed)	Unadjusted
Standard deviation of production growth rates. (2.4)	0.006 or below = 100 0.3 or above = 0 **Transformation:** y=-340.136x + 102.04 (computed)	Unadjusted
3. Quality and Safety		
A measure of the availability of Vitamin A, expressed in micrograms of retinol activity equivalent (RAE)/capita/day on a 0-2 scale. (3.3.1)	Value of 0 = 0 Value of 1 = 50 Value of 2 = 100 (index) **Transformation:** Non-required. All values >700.	0 or below = 0 700 or above = 100 (recommended daily intake) (prior to linear transformation)
Iron: mg/person/day (3.3.2)	0 or below = 0 25 or above = 100 **Transformation:** y=4x (computed)	Unadjusted
Zinc: mg/person/day (3.3.3)	0 or below = 0 13 or above = 100 **Transformation:** y=7.69x (computed)	Unadjusted
4. Sustainability and Adapatation		
Temperature Rise: Index score, 0=least vulnerable (4.1.1)	30 or below = 100 170.9 or above = 0 **Transformation:** y=-0.71x + 121.29 (computed)	% difference **(percent change)** between diets cast onto original values (prior to linear transformation)
Drought: Risk rating 0-4, where 4=highest risk. (4.1.2)	0 or below = 100 4 or above = 0 **Transformation:** y=-25x + 100 (computed)	% difference **(percent change)** between diets cast onto original values (prior to linear transformation)

At this stage it was also discovered that indicator 3*.3.1) Dietary availability of Vitamin A* had likely been incorrectly analysed within the original Index based on its source data – the UK consistently scoring 0 in the Index despite solid evidence of the widespread availability of Vitamin A (and/or its Retinol Equivalent) in the UK diet (Sobiecki *et al.*, 2016). As such the baseline figures were updated for use in the Adjusted Baseline score.

After transformation, the scores given were used to create two parallel indices (Vegan Index & Animal Agriculture Inclusive) and an adjusted baseline indice (Adjusted Baseline). To do so, each indicator score (both tested and untested indicators) was multiplied by its 'sub-weight' and summed to give a section score – the tested indicators varying by segregation (see *Figure 2, Desegregation*). Then each section score was multiplied by its weight and summed to give an overall score for each: Adjusted Baseline, Vegan Index, Animal Agriculture Inclusive. With two parallel indices and a new baseline created, the suggested influence of veganism upon the original Index was reported *(Results)* for analysis (*Discussion)*.

Limitations

This research was limited to a quantitative interpretation of UK food security defined by *The Economist*. This creates key methodological limitations where important topics prevalent in the literature, such as import dependency, have not been considered. Likewise, the methodology chosen focusses on long-term indicators of food security and has no consideration for emergency planning/ acute shortages which should also be considered as part of food security: to what extent can a nation 'absorb' the shock of a short-term food crises and what measures do they have in place? It is suggested in the literature that livestock act as an emergency calorie buffer for food security (Erb *et al.*, 2012). In addition, the weightings within the methodology itself were not criticised, representing an additional limitation. An additional restriction is that for one indicator (2.2.2), data for England was used as representative of the UK. Finally, as previously mentioned, the methodology chosen limits the deductions that can be made as any observed benefits of 'vegan' food (plants) also benefits omnivorous diets in the UK. Further complicating such deductions is the mixed role of cereal cropping, included in 'plant-agriculture' metrics, where certain cereals (such as Triticale) are grown predominantly for animal feed.

Results

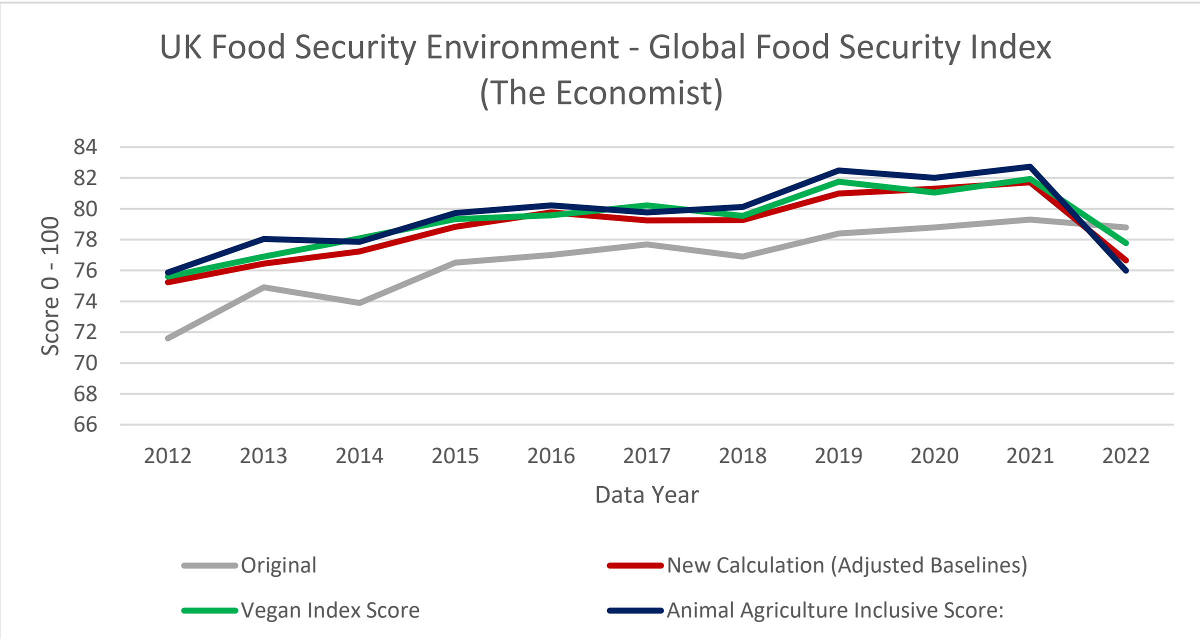
Overall Food Security Environment

As planned, all source data was successfully transformed to a 0-100 scaled 'score' in line with the outlined transformations in the methodology. Thus, a 0-100 score was produced for each indicator under analysis in three ways (Vegan Index, Animal Agriculture Inclusive, Adjusted Baseline), feeding a group score and ultimately an overall score. The overall Vegan Index scored consistently lower (average score across the time series: 79.51) than the Animal Agriculture Inclusive score (Average score: 79.88) – see Figure 4 and Figure 5. Both indices scored higher than the Adjusted Baseline score (Average 79.00), which was higher than the original score given by the Economist for the UK (Average 76.51).

Figure 4 – Overall Results. UK Food Security Index Scores.

Series	Category:	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Weight:	10 Year AVG
Overall Score:														
	Original (The Economist)	71.60	74.90	73.90	76.50	77.00	77.70	76.90	78.40	78.80	79.30	78.80		76.50
	Adjusted Baseline Score	75.24	76.45	77.23	78.83	79.77	79.25	79.27	81.00	81.30	81.72	76.66		79.01
	Vegan Index Score	75.71	77.01	78.20	79.44	79.69	80.33	79.65	81.88	81.17	82.05	77.89		79.51
	Animal Agriculture Inclusive Score	75.87	78.04	77.86	79.72	80.22	79.77	80.13	82.48	82.01	82.73	75.99		79.88
Pillars:														
1. Affordability	Original	84.30	87.60	87.30	91.70	92.20	92.30	89.30	89.00	90.40	91.00	91.50	30%	89.51
	Adjusted Baseline Score	87.77	86.16	91.72	91.67	92.19	88.29	89.41	90.09	90.39	91.75	78.69		89.94
	Vegan Index Score	88.88	84.90	92.57	92.34	92.49	89.73	89.94	89.96	90.62	91.40	81.15		90.28
	Animal Agriculture Inclusive Score	87.74	88.27	90.24	91.45	91.65	86.74	88.63	90.52	89.84	91.60	76.45		89.67
2. Availability	EIU calculation	65.60	71.30	71.60	71.40	70.60	71.30	71.20	70.60	70.70	71.80	71.60	25%	70.61
	Adjusted Baseline Score	66.66	69.83	70.22	71.33	72.23	72.82	71.22	70.53	71.32	71.37	69.05		70.75
	Vegan Index Score	65.27	71.61	71.13	70.99	69.61	73.42	70.11	72.23	68.58	71.14	69.05		70.41
	Animal Agriculture Inclusive Score	69.24	73.64	74.50	75.16	74.70	76.75	75.59	75.92	74.85	75.60	69.05		74.59
3. Quality & Safety	EIU calculation	76.90	77.20	71.50	77.40	79.90	79.40	79.80	80.00	80.00	80.00	77.60	23%	78.21
	Adjusted Baseline Score	87.19	87.53	81.85	87.78	90.26	89.74	90.11	90.36	90.40	90.40	87.91		88.56
	Vegan Index Score	86.91	87.26	81.57	87.50	89.98	89.46	89.83	90.09	90.12	90.12	87.64		88.29
	Animal Agriculture Inclusive Score	87.19	87.53	81.85	87.78	90.26	89.74	90.11	90.36	90.40	90.40	87.91		88.56
4. Sustainability & Adaptation	EIU calculation	56.10	59.80	61.10	61.10	61.10	63.90	63.90	71.20	71.20	71.10	71.10	23%	64.05
	Adjusted Baseline Score	56.10	59.80	61.08	61.08	61.09	63.87	63.86	71.15	71.15	71.15	71.15		64.03
	Vegan Index Score	58.57	62.26	63.54	63.55	63.56	66.33	66.33	73.62	73.62	73.62	73.61		66.50
	Animal Agriculture Inclusive Score	56.10	59.80	61.08	61.08	61.09	63.87	63.86	71.15	71.15	71.15	71.15		64.03

Figure 5 – UK Food Security Environment Results



1) Affordability

The 10-year average score (0-100) after indexing for the 'Affordability' section was an Adjusted Baseline score of 89.94, a Vegan Index score of 90.28 and an Animal Agriculture Inclusive score of 89.67. This overall score is inclusive of all the tested indicators and all of the unincluded/untested indicators (where the values remain constant across each new Index Score). The scores for each tested indicator are available in Figure 5 below. Perfect scores (100) are highlighted in yellow.

Figure 6 – Affordability Index Scores

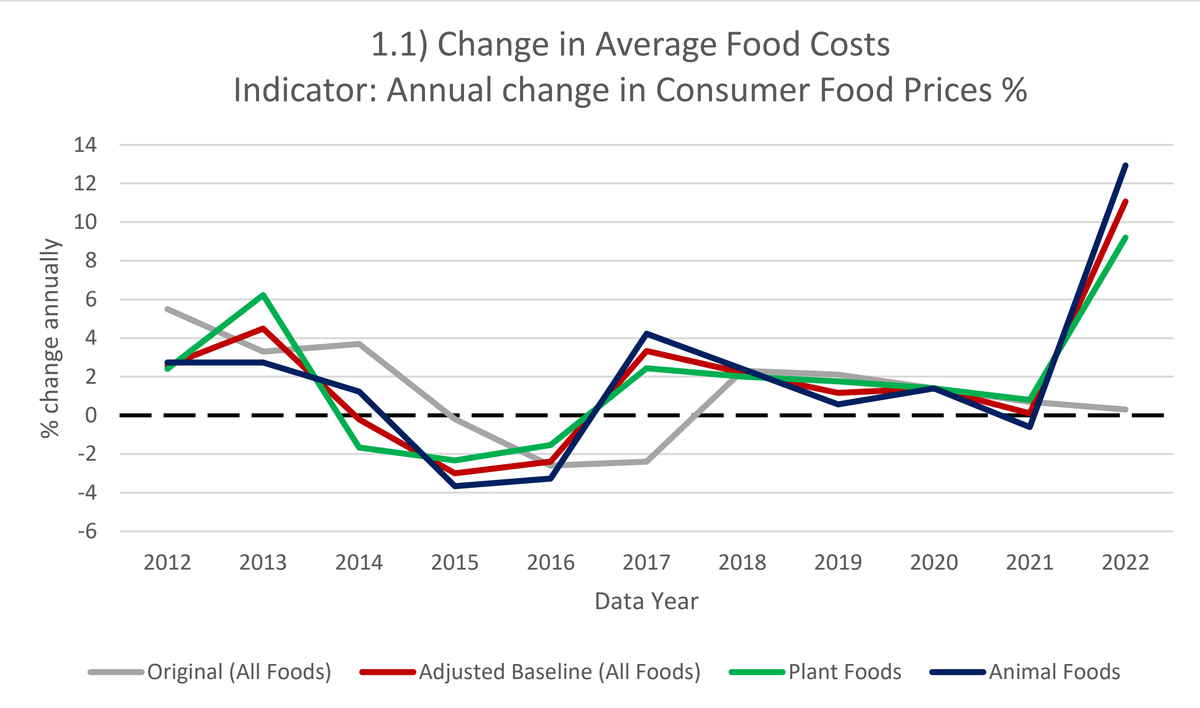
Affordability:	Year:	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10 Year Average
Overall Score:	Adjusted Baseline	87.77	86.16	91.72	91.67	92.19	88.29	89.41	90.09	90.39	91.75	78.69	89.94
	Vegan Index Score	88.88	84.90	92.57	92.34	92.49	89.73	89.94	89.96	90.62	91.40	81.15	90.28
	Animal Agriculture Inclusive Score	87.74	88.27	90.24	91.45	91.65	86.74	88.63	90.52	89.84	91.60	76.45	89.67
Adjusted Indicators:													
1.1) Change in Average Food Costs	Adjusted Baseline:	87.17	77.58	100.00	100.00	100.00	83.33	89.00	94.17	93.00	99.50	44.67	88.04
	Plant Foods:	88.00	68.83	100.00	100.00	100.00	87.83	90.00	91.17	93.00	96.00	54.00	88.08
	Animal Foods:	86.33	86.33	93.83	100.00	100.00	78.83	88.00	97.17	93.00	100.00	35.33	87.17
1.2) Proportion of population under global poverty line	Baseline:	99.67	99.45	99.78	99.78	99.67	99.67	99.67	99.45	99.45	99.45	99.45	99.59
	Vegan Score	99.68	99.46	99.79	99.79	99.68	99.68	99.68	99.46	99.46	99.46	99.46	99.60
1.4.1) Agricultural Import Tarriffs													
	All Foods Baseline:	65.42	67.17	67.17	69.68	73.44	72.43	73.19	70.18	71.68	72.18	72.18	70.43
	Plant Foods	75.82	76.59	76.88	77.23	76.87	76.64	76.51	76.83	74.33	77.67	74.71	76.37
	Animal Foods	67.38	67.47	67.12	67.11	67.29	67.01	67.07	67.00	65.44	69.15	71.91	67.63

1.1) Change in Average Food Costs – Annual Change in Consumer Prices

The source data influencing Index scores for Average Food Costs is displayed in Figure 7. The average change in food prices per year over the 10-year period, as per the UK's Consumer Price Inflation Index (ONS, 2023a), was +1.88% (Figure 7). Likewise, in an interesting anomaly, the price change for plant-only foods and animal foods was also an average (mean) of +1.88% (annum) during this time period (Figure 7).

However, after being indexed, food items derived from plants (Vegan Index) scored consistently higher within the Index for changes in consumer food prices (Average Score: 88.08) vs animal products (Animal Agriculture Inclusive) (Average Score: 87.17) (Figure 6). The Adjusted Baseline (Using UK government data) (Average: 88.04) was slightly lower than the original value (90.5) (Figure 6).

Figure 7 – Change in Average Food Costs (Author's, 2023). Data: ONS CPI Inflation Indices (ONS, 2023a)



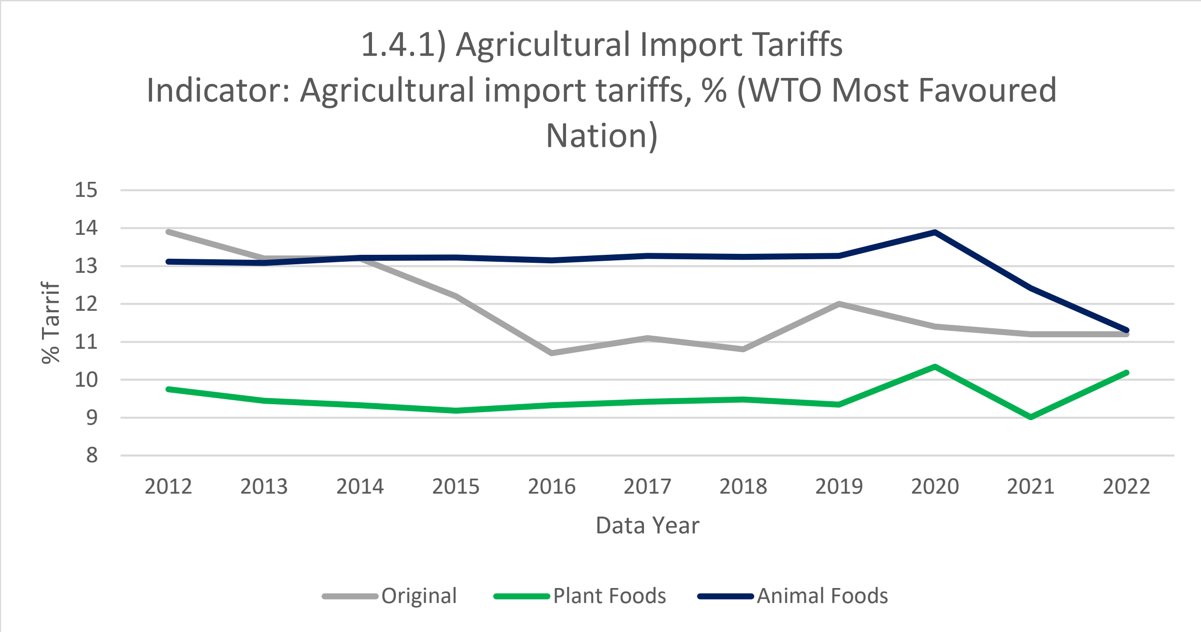
1.2) Proportion of population under global poverty line

The estimated cost-saving (%) of a Vegan diet in the UK was cast onto the original figures provided for this indicator and is reflected in a marginally higher score (Figure 6). The average score with the adjusted baseline is 99.59 (near perfect) and the average Vegan Index score is 99.60.

1.4.1) Agricultural Import Tariffs

Agricultural import tariffs varied by animalisation of the category. The average % tariff of agricultural products between the UK and a third-party, 'Most Favoured Nation' (WTO Model) was 11.9% over the 10-year time period (Figure 8). For plant foods the average was 9.53%; animal foods 13.02% (Figure 8). When transformed into the Index this led to an average score for plant foods of 76.37 (Vegan Index), animal foods at 67.63 (Animal Agriculture Inclusive) and an Adjusted Baseline average of 70.43 (Figure 6).

Figure 8 – Agricultural Import Tariffs (UK – WTO – MFN) 2012-2022 (Author's, 2023). Data: World Trade Organisation Tarriff Analysis (WTO, 2023)



2) Availability

The 10-year average score (0-100) after indexing for the 'Availability' section was an Adjusted Baseline of 70.8, a Vegan Index Score of 70.4 and an Animal Agriculture Inclusive Score of 74.6. This is inclusive of all the tested indicators (and all of the unincluded/untested indicators). The scores for each indicator are available in Figure 9 below:

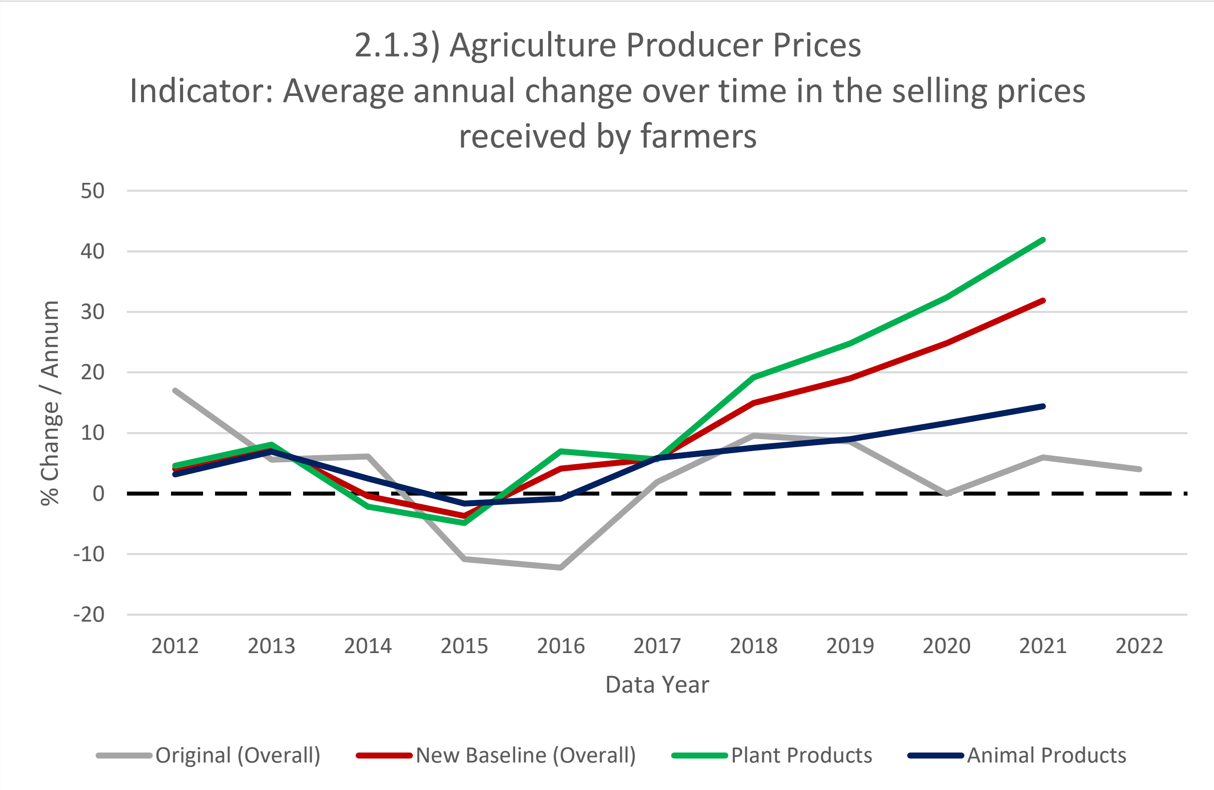
Figure 9 – Availability Index Scores

Indicator:	Year:	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10 Year Average
Overall Score:	Adjusted Baseline	66.66	69.83	70.22	71.33	72.23	72.82	71.22	70.53	71.32	71.37	69.05	70.75
	Vegan Index Score	65.27	71.61	71.13	70.99	69.61	73.42	70.11	72.23	68.58	71.14	69.05	70.41
	Animal Agriculture	69.24	73.64	74.50	75.16	74.70	76.75	75.59	75.92	74.85	75.60	69.05	74.59
Adjusted Indicators:													
2.1.3) Agriculture Producer	New baseline:	69.59	11.15	0.00	0.00	70.61	75.29	0.00	0.00	0.00	0.00	0.00	20.60
Prices	Vegan Score	87.20	0.00	0.00	0.00	34.39	77.43	0.00	0.00	0.00	0.00	0.00	18.09
	Animal Agriculture in	39.72	36.03	16.39	0.00	0.00	71.56	15.07	0.00	0.00	0.00	0.00	16.25
2.2.1) Public expenditure on													
agricultural research and development	Adjusted Basline:	37.75	36.75	30.22	33.99	36.81	35.23	36.02	34.55	54.41	60.73	0.00	36.04
	Vegan Score	49.24	49.77	36.18	40.61	48.23	46.77	47.56	43.35	34.06	32.19	0.00	38.91
	Animal Agriculture in	49.89	50.39	36.69	41.45	49.27	47.84	48.67	44.33	34.81	32.93	0.00	39.66
2.2.2) Access to agricultural technology,													
education and resources	Original	42.40	55.20	55.10	30.00	52.70	63.50	55.10	37.50	55.30	44.90	60.50	50.20
	Plant Agri Score	3.61	66.37	80.31	50.38	22.34	74.58	45.95	68.00	24.34	81.27	60.50	52.51
	Animal Agri Score	36.32	51.09	59.67	57.02	45.79	50.18	42.64	56.77	48.73	60.76	60.50	51.77
2.4) Volatility of Agricultural Production													
	Overall SD	64.60	64.60	61.20	71.40	61.20	61.20	61.20	61.20	57.80	57.80	51.00	61.20
	Plant Growth SD	60.69	74.01	57.61	58.54	52.34	58.33	51.31	61.75	51.66	50.41	51.00	57.06
	Animal Growth SD	91.20	91.53	92.57	92.71	94.04	98.01	98.32	98.55	97.71	97.71	51.00	91.22

2.1.3) Agriculture Producer Prices

Agriculture producer prices varied by animalisation. The average annual % change of farm-gate prices received by farmers was calculated to be 10.8% (Figure 10). For plant-foods this was higher at 13.66% and much lower for animal-foods at 5.85%. When indexed this led to low average scores (high variations scoring 0), with the overall average score being 20.60 (Adjusted Baseline), plant-foods scoring 18.09 (Vegan Index) and animal-foods scoring a 16.25 (Animal Agriculture Inclusive - Figure 9). No data values were given for 2022 and a 0 score was given for each category.

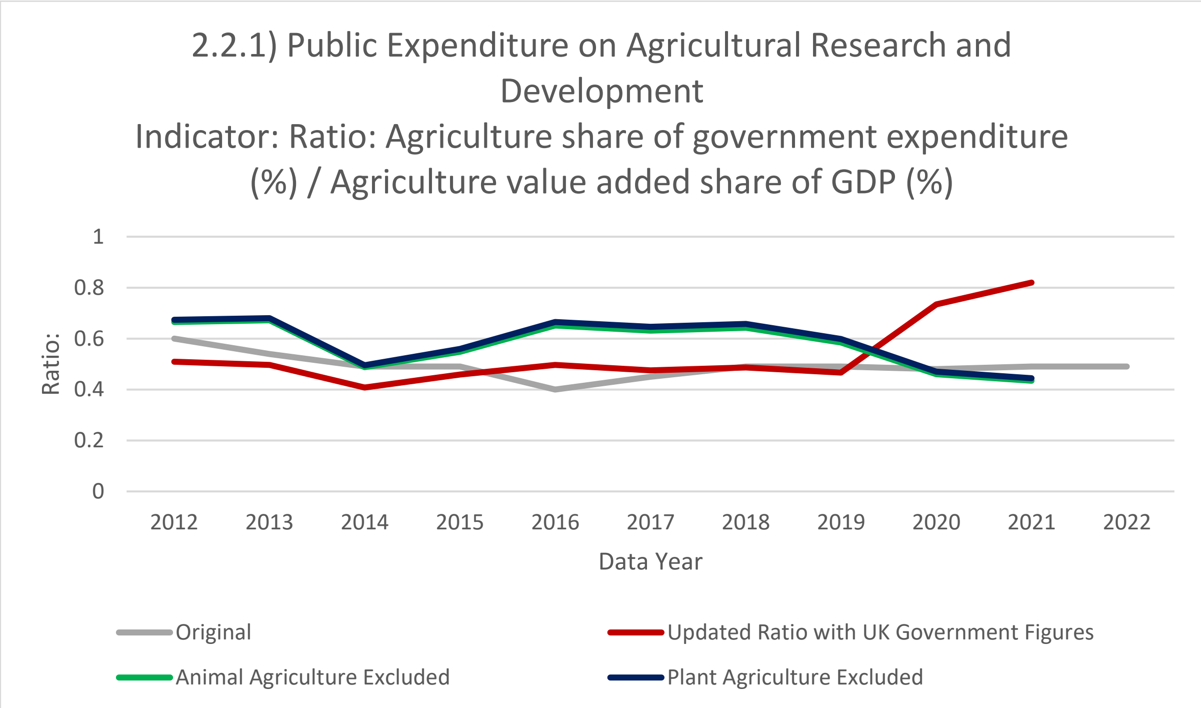
Figure 10 – Agriculture Producer Prices % Change (Annum) 2012-2022 (Author's, 2023). Data: FAOSTAT (FAO, 2023)



2.2.1) Public expenditure on agricultural research and development

Measured by the ratio between agriculture's share of government expenditure against its value-added share of the economy, agricultural development showed little difference between plant-foods and animal foods. An adjusted baseline ratio, averaged over the time series, indicated a baseline of 0.54 expenditure to value-add, vs 0.58 for plant-foods and 0.59 for animal-agriculture (Figure 11). After indexing, the new 10-year average baseline score was 36.04 (Adjusted Baseline), with a plant-agriculture score of 38.91 (Vegan Index) and an animal agriculture score of 39.66 (Animal Agriculture Inclusive - Figure 9). No values were given for 2022 and a 0 score was given for each category.

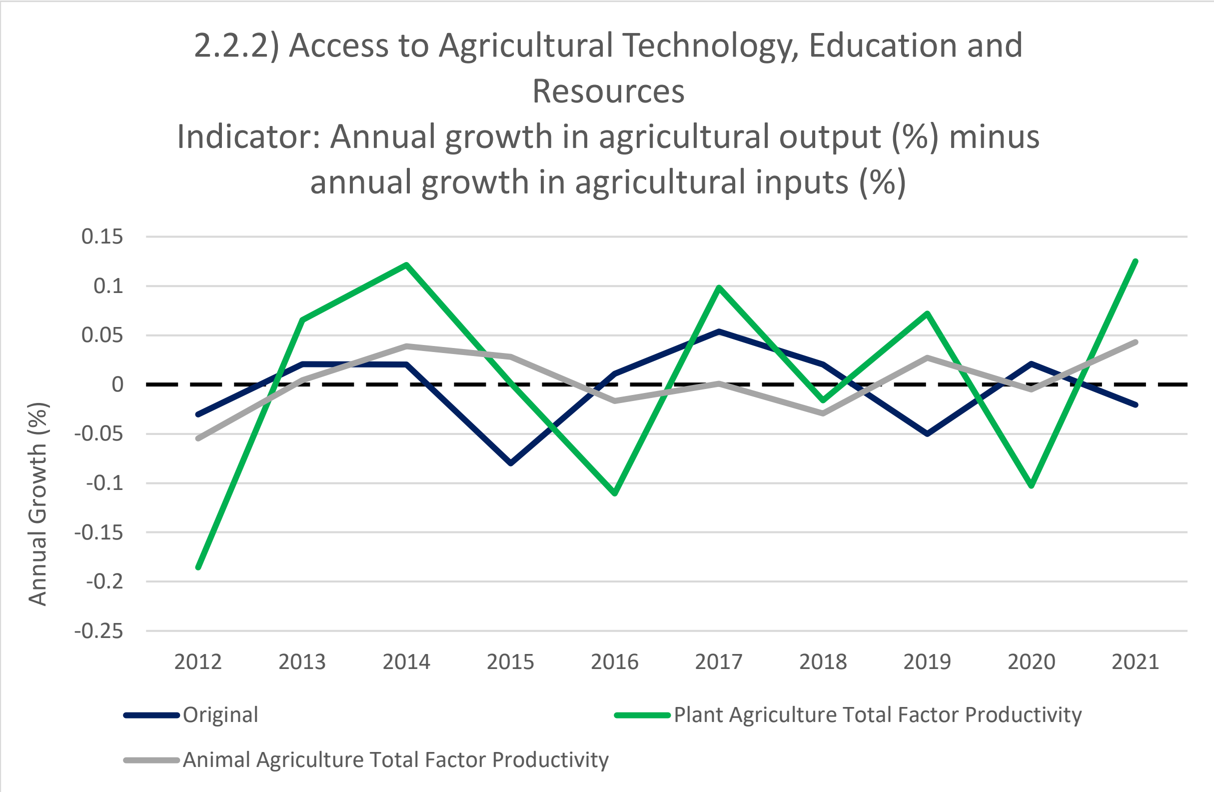
Figure 11 – Public Expenditure on Agriculture vs. Agriculture Value Add to GDP (UK) 2012-2022. (Author's, 2023). Data: UK Government Agricultural Expenditure and UK Government General Expenditure (DEFRA, 2023a; ONS, 2023b)



2.2.2) Access to agricultural technology, education and resources

Measured by Total Factor Productivity (given by measuring growth in inputs vs outputs), this indicator showed considerable differentiation between plant agriculture and animal agriculture at various points in the timeline, ultimately averaging to a similar score over time. The annual average overall change was -0.34%, plant-based agriculture 0.69% and animal agriculture 0.36% (Figure 12). After indexing the average overall score was 49.2 (Adjusted Baseline), against plant-agriculture's score of 51.7 (Vegan Index) and animal-agriculture's score of 50.9 (Animal Agriculture Inclusive - Figure 9).

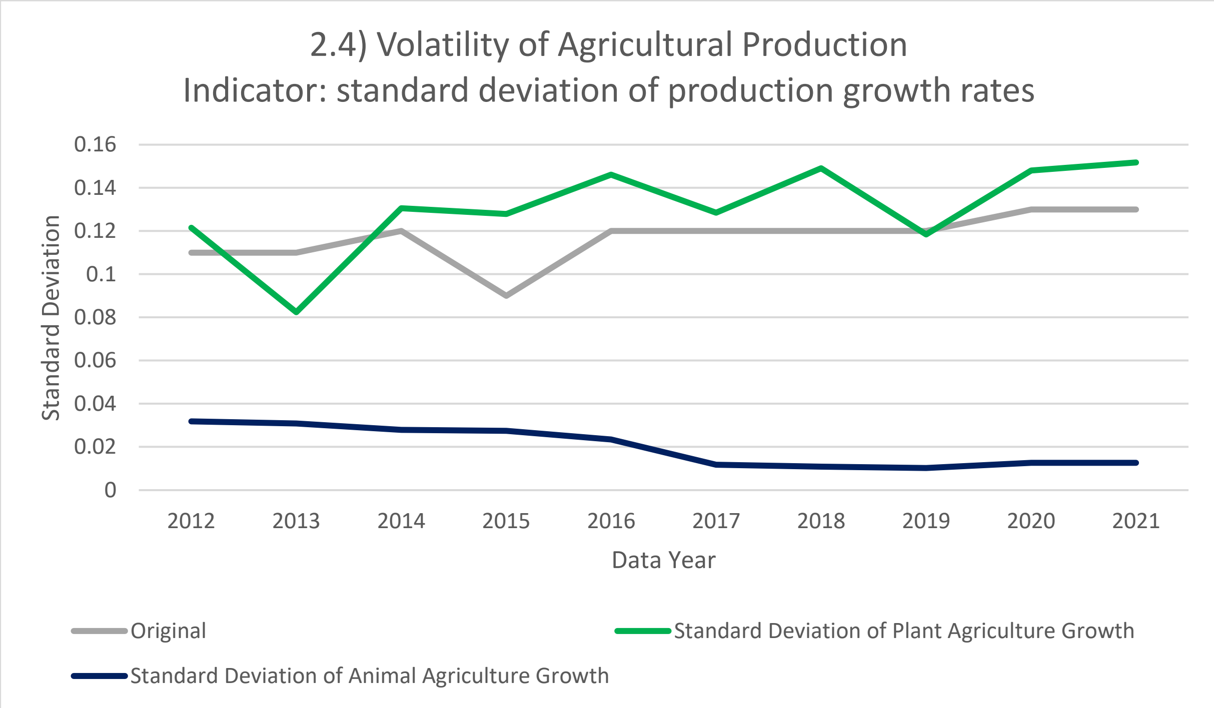
Figure 12 – Growth in Agricultural Output less Growth in Agricultural Inputs (England, 2012-2022). (Author's, 2023). Data: England Total Factor Productivity (DEFRA, 2023b)



2.4) Volatility of Agricultural Production

This indicator captures the volatility of agricultural production by measuring the standard deviation of growth rates. This indicator varied considerably between plant agriculture and animal agriculture (Figure 13). The *unadjusted* baseline for this indicator showed an average of 0.12 as the year-on-year standard deviation of growth rates in the UK. Analysing by agricultural type, plant-agriculture over the time period indicated a standard deviation of growth rates of 0.13 against animal-agriculture's standard deviation of growth rates of 0.02. After indexing, the original values indicate a score of 62.2 (Baseline), with a score of 57.7 for plant-agriculture (Vegan Index) and a score of 95.2 for animal agriculture (Animal Agriculture Inclusive - Figure 9). No values were available for 2022 so the original overall value was carried across plant/animal agriculture.

Figure 13 – Volatility of UK Agricultural Production (UK. 2012-2022). (Author's, 2023). Data: AUK Chapter 5 (DEFRA, 2023a)



3) Quality & Safety

The 10-year average score (0-100) after indexing for the 'Quality & Safety' section was an Adjusted Baseline of 88.56, a Vegan Index score of 88.29 and an Animal Agriculture Inclusive score of 88.60 (for the Quality & Safety section the Adjusted Baseline is the Animal Inclusive Score). This is inclusive of all the tested indicators (and all of the unincluded/untested indicators). The scores for each indicator are available in Figure 14 below. There is no 10-year average as the same values are utilised across the entire time period.

Figure 14 – Quality & Safety Index Scores

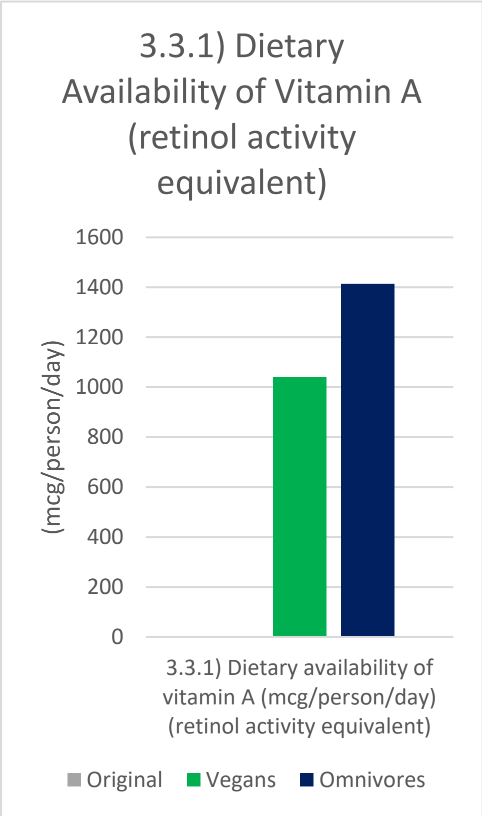
Year		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10 Year AVG
Overall Score:	Adjusted Baseline	87.19	87.53	81.85	87.78	90.26	89.74	90.11	90.36	90.40	90.40	87.91	88.56
	Vegan Index Score	86.91	87.26	81.57	87.50	89.98	89.46	89.83	90.09	90.12	90.12	87.64	88.29
	Animal Agriculture Inclusive Score	87.19	87.53	81.85	87.78	90.26	89.74	90.11	90.36	90.40	90.40	87.91	88.56
Adjusted Indicators:													
3.3.1) Vitamin A	New baseline	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Vegan Score	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Omnivore Score	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
3.3.2) Iron													
	New baseline	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00
	Vegan Score	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00	75.00
	Omnivore Score	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00	67.00
3.3.3) Zinc													
	New baseline	81.90	81.90	81.90	81.90	81.90	81.90	81.90	81.90	81.90	81.90	81.90	81.90
	Vegan Score	68.44	68.44	68.44	68.44	68.44	68.44	68.44	68.44	68.44	68.44	68.44	68.44
	Omnivore Score	81.90	81.90	81.90	81.90	81.90	81.90	81.90	81.90	81.90	81.90	81.90	81.90

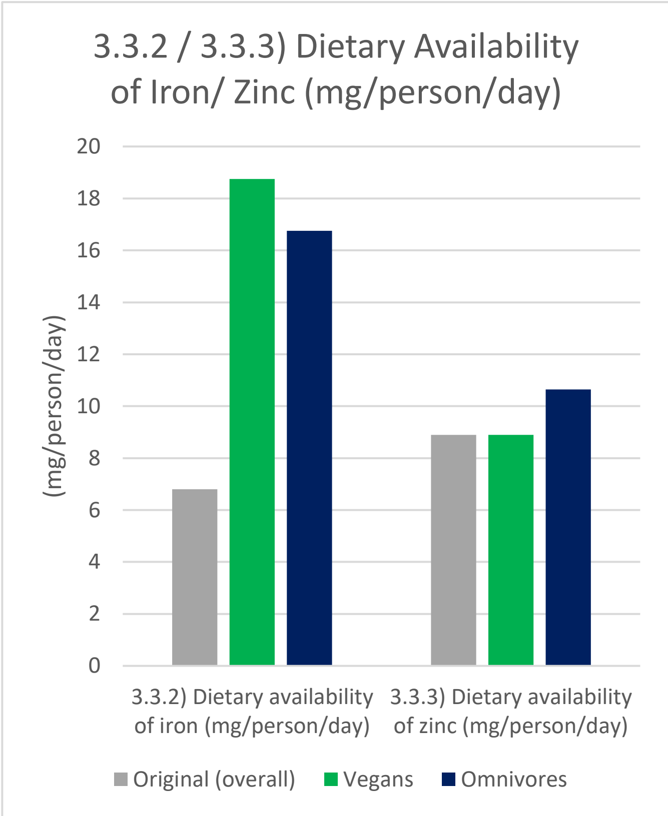
3.3.1 to 3.3.3) Dietary availability of Vitamin A, Iron and Zinc

Dietary availability of Vitamin A is measured with the estimated 'Retinol Activity Equivalent' (mcg per person per day). The original score given is an index score of 0, with no underlying values given. The study used in this analysis Sobiecki *et al.* (2016) gave values for both omnivores and vegans based on the longitudinal EPIC-Oxford study (1992-). The results indicated that omnivores had a Vitamin A intake of 1414 mcg/ person / day and vegans had a Vitamin A intake of 1089 mcg/ person/ day (Figure 15). These values were used across the time series. After indexing this gave both omnivores (Animal Agriculture Inclusive) and vegans (Vegan Index) a perfect score of 100, as such the baseline score was adjusted to 100 (Figure 14).

Dietary availability of Iron and Zinc was measured using mg per person per day. The original input values (and hence scores) given by the Economist vary slightly, but are mostly consistent across the time period. Values from Sobiecki *et al.* (2016) indicate for Iron intake: 18.75 mg/person/day for vegans and 16.75mg/person/day for omnivores (Figure 16). Values from Sobiecki *et al.* (2016) indicate for Zinc intake: 8.9 mg/person/day for vegans and 10.65 mg/person/day for omnivores (Figure 16). Transformed into scores for the index, Iron intake was 75/100 for vegans (Vegan Index) and 67/100 for omnivores (Animal Agriculture Inclusive - Figure 14). For Zinc the scores were 68.4/100 for vegans (Vegan Index) and 81.9/100 for omnivores (Animal Agriculture Inclusive - Figure 14). For Iron and Zinc the omnivore values became the Adjusted Baseline score.

Figures 15 and 16 – Dietary Micronutrient Uptake (UK 2016). (Author's, 2023). Data: Sobiecki *et al.* (2016)





4) Sustainability & Adaptation

The 10-year average score (0-100) after indexing for the 'Sustainability & Adaptation' section was an Adjusted Baseline of 64.03, a Vegan Index score of 66.50 and an Animal Agriculture Inclusive score of 64.03 (again, the Adjusted Baseline is the Animal Agriculture Inclusive score) (Figure 17). This is inclusive of untested indicators and the indicators tested below. The scores for each indicator are available in Figure 17 below. There is no 10-year average as the same value is utilised across the entire time period.

Figure 17 – Sustainability & Adaptation Index Scores

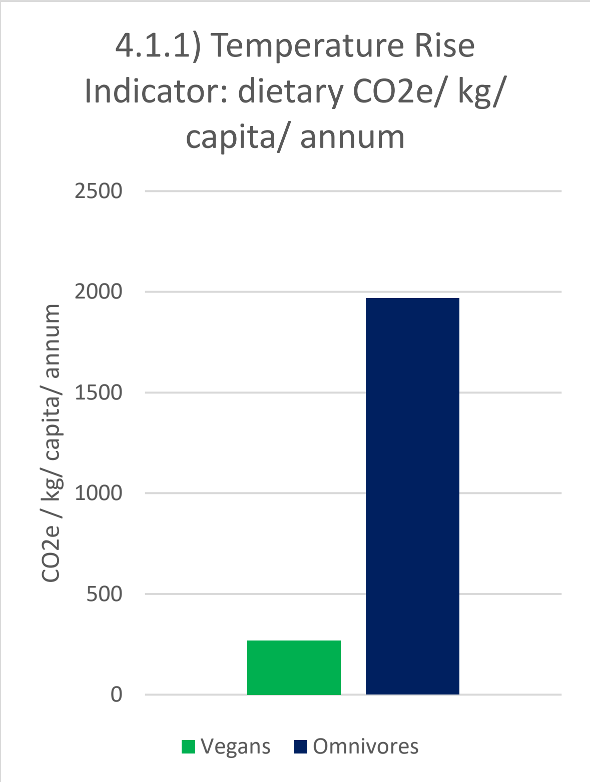
Indicator	Year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	10 Year AVG
Overall Score:	Adjusted Baseline	87.19	87.53	81.85	87.78	90.26	89.74	90.11	90.36	90.40	90.40	87.91	64.03
	Vegan Index Score	86.91	87.26	81.57	87.50	89.98	89.46	89.83	90.09	90.12	90.12	87.64	66.50
	Animal Agriculture Inclusive Score	87.19	87.53	81.85	87.78	90.26	89.74	90.11	90.36	90.40	90.40	87.91	64.03
Adjusted Indicators:													
4.1.1) Temperature rise *(as Emissions)*													
	New baseline	83.50	83.50	83.50	83.50	83.50	83.50	83.50	83.50	83.50	83.50	83.50	83.50
	Vegan Score	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	Animal Agriculture Inclusive Score:	83.50	83.50	83.50	83.50	83.50	83.50	83.50	83.50	83.50	83.50	83.50	83.50
4.1.2) Drought *(as Water Footprint)*													
	New baseline	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
	Vegan Score	63.46	63.46	63.46	63.46	63.46	63.46	63.46	63.46	63.46	63.46	63.46	63.46
	Animal Agriculture Inclusive Score:	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00

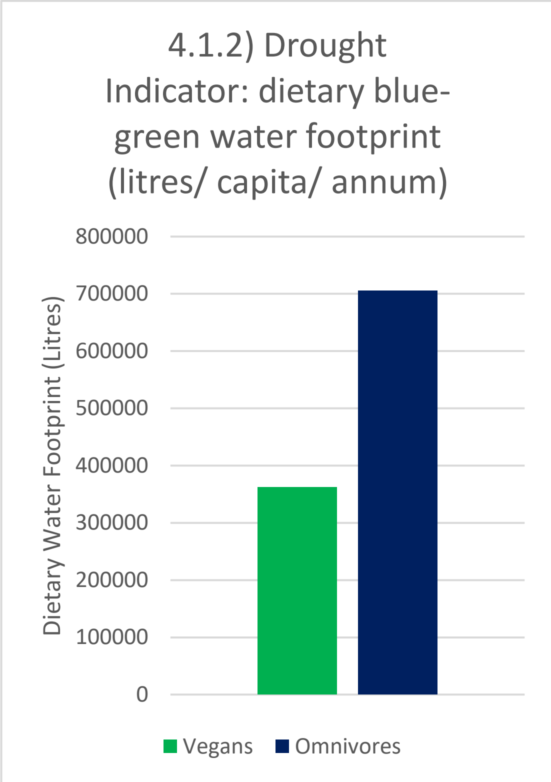
4.1.1) to 4.1.2) Temperature Rise and Drought

For these two indicators, proxy data was utilised. Impact on temperature rise was measured by CO2e impact of vegan diets vs omnivorous diets in the UK. Values by Kim *et al.* (2020) indicate an average UK vegan diet to emit an estimated 267.53 kg of CO2e per capita per annum, whereas a UK omnivorous diet is estimated to emit 1968.10 kg of CO2e per capita per annum (Figure 18). To index these values, the percentage change (86% reduction for vegan diets), was applied to the original indicator value (53.2) to give a 'vegan' indicator value of 7.45. The original value was assigned as the omnivore value. After transforming these adapted values, the new Adjusted Baseline score (and the omnivore value) was 83.5 and the vegan score was 100 (Figure 17).

For drought, a similar process was followed regarding the water footprint of the different diets. This was measured in the estimated 'blue-green' water footprint of each diet in litres per capita per annum, with the values likewise given by (Kim *et al.*, 2020). The UK vegan diet utilises an estimated 361,657 litres of water/ capita/ annum against the UK omnivore diet of 705,195 litres of water/ capita/ annum (Figure 19). As with emissions, the percentage change (48% reduction) of the vegan diet was applied to the original indicator value (value = 3.00) to give a 'vegan' value of 1.46. The original value was assigned as the omnivore value. After transforming these values, the new baseline score (and the omnivore value) was 25 and the vegan score was 63.46 (Figure 17).

Figures 18 and 19 – Dietary emissions and water footprint (UK - 2016) (Author's, 2023). Data: Kim *et al.* (2020)





Discussion

The results contradict the original research proposition that veganism would have a positive influence on UK food security when analysed through the lens of the Index. With this stated, the individual results are consistent with the analysis of the underlying indicators and the scores they produced and will be further explored below. Foremost, the research project's success in achieving its objectives is evaluated – they are considered in inverse, with the capacity of the Index to assess veganism's influence on UK food security first, and the implications of testing veganism's influence on food security within the model second.

Towards an Explanatory Model

Overall, the work of the research project proved to be a useful, if frustrated, process towards developing an explanatory model capable of capturing the role and influence of veganism in the United Kingdom towards national food security. The UK is a relatively food secure nation, as such there is less of a focus on the relevant food security issues within the academic literature. That stated, studying the UK food system through a food security lens has allowed this research project to capture a broader scope of considerations when questioning growing veganism in the UK – questions beyond carbon emissions, or water usage, but also affordability, availability, and quality.

The research utilised an established and disseminated methodology, the *Global Food Security Index* by *The Economist/ Corteva Agriscience*. In theory this should have made the research more simple than working with the more broad definitions of food security utilised by the FAO (FAO, WFP, and UNICEF, 2019; FAO *et al.*, 2022). However, significant methodological difficulties were encountered during the project's data collection, filtering and selection process – in part due to unforeseen difficulties in the UK's data landscape for the subject of veganism and UK food security. An additional key roadblock was the reticence of various government departments to be forthcoming with governmentally held data, even in consideration of the Freedom of Information Act (*Freedom of Information Act*, 2000). Of particular difficulty for this project was the role of DEFRA, who received 11 of the 13 FOI requests in June, providing satisfactory answers to 3 of them, none of which with data not already in the public record. Defensibly, DEFRA may not have data on all areas, however there is a significant and troublesome concern for certain requests.

For example, one such request related to providing a land-use breakdown for applicants to farm subsidies (via the UK's 'Basic Payment Scheme' - administered by DEFRA). DEFRA stated they did not have this data (email thread with Author - 26/06/2023), however considering applicants must provide land-use codes when applying for such subsidies, the author considers it highly unlikely that DEFRA did not have access to such data, or similar data capable of answering this request satisfactorily.

A range of methods were utilised to mitigate the impact of such unforeseen impacts: ancillary data was requested in adjacent areas to target variables; different government departments were contacted (namely the *Environment Agency*) and the literature review was extended to find secondary datasets which could be utilised. After such mitigation, there remained 12 of the original 68 indicators of food security. As such, the original intention of 'hypothesis testing' was abandoned due to the low weight of the remaining indicators in the overall model (~27%) and the difficulty of narrowing the independent variable (veganism) sufficiently within the remaining indicators. The project continued as a quantitative analysis of a) veganism's role within the Index and b) the appropriateness of the model for testing veganism's influence upon food security. The broadening of the project's aims created both strengths and limitations of the project. Shifting from strict hypothesis testing created flexibility within the project to use ancillary data and proxy indicators (such as using *Emissions* to test *Temperature Rise* and *Water Footprint* to test *Drought*). Likewise, attributing differences for plants vs animals, as differences between vegans and omnivores, was better justified under this methodology due to its less strict nature.

In changing approach, limitations were also created. The project cannot definitively provide conclusions regarding the role of veganism on UK food security, although it is able to comment on the appropriateness of the *Global Food Security Index* in testing veganism's influence. On this note, the project can conclude that the Index is not well suited to testing this variable due to the above three factors: 1) the UK data land-scape is not suited to testing the Index's underlying indicator's based upon *animalisation* - with data only available for 12/68 indicators; 2) even so ancillary data had to be used and proxy indicators generated due to the nature of the indicators used in the Index; 3) finally, attributable gains to 'plants' and 'plant agriculture' can only loosely be connected with veganism. This is somewhat in contrast to the existing literature affirming and validating the utility of the *Global Food Security Index* (Thomas *et al.,* 2017; Izraelov and Silber, 2019; Allee, Lynd and Vaze, 2021).

Results of the Quantitative Analysis

With such methodological conclusions discussed, the results themselves of testing veganism within the model provided interesting results which could provide fruitful launching points for future research. Of foremost pertinence is the unexpected outcome that the constructed Vegan Index scored **less** than the Animal Agriculture Inclusive Score. This contradicted the original research proposition that veganism would have a positive influence on UK food security. As such the proposition needs further scrutiny as veganism within the indicators tested, utilising the Index's methodology, provided a negative effect on the overall model testing UK food security. Reflection is required however, due to the underlying results - considered in order:

Veganism scored higher under the *Affordability* section of food security, with higher scores relating to changing average food costs at the consumer level, influence on poverty (cost of diet) and most prominently, lower agricultural import tariffs. These findings are consistent with Springmann *et al.*'s (2021) global study focussed on the costs of different diets at a national scale. To some degree this finding contradicts perceptions of vegan diets as more costly (Bryant, 2019), supporting literature indicative of their low-cost (both at a national level and consumer perception) (Schenk, Rössel and Scholz, 2018; Ghaffari *et al.*, 2022). Of particular note is that the different influences on poverty were marginal within this study – reflecting the methodological difficulties of capturing this effect accurately (namely: lack of available data and the use of a generic indicator within the Index). A mixed impact can potentially be assigned to the United Kingdom's departure from the EU single market (2020-), with scores under *1.4.1 Agricultural Import Tariffs* slightly improving overall, reducing for plant foods and notably improving for animal foods. However, this doesn't capture the agricultural effects of trade well, as this indicator measures tariffs with third-party 'most-favourable nations' (as opposed to the impact of trade deals including agriculture). Finally, there is a notable spike across consumer food prices in 2021 (*1.1 Change in Average Food Costs)*, validating literature illustrating the impact of the 2020/2021 COVID-19 pandemic and its impact on supply chains (Clapp and Moseley, 2020; Garnett *et al.*, 2020).

However, veganism scored notably lower under the *Availability* section. Scores were higher for producer prices, and Total Factor Productivity, but lower for agricultural development and considerably lower for volatility of production. All indices scored relatively high in the index – cautiously explained by the UK enjoying relatively high production rates in agriculture due to political stability, established production processes (including a large percentage of available land being committed to agriculture) and relative wealth when trading in international commodities markets. Each indicator in this section provides interesting discussion in isolation:

2.1.3) Agriculture producer prices showed higher growth in each year for plant-agriculture vs animal agriculture. Interestingly, when desegregated the outlined transformation rewards plant-agriculture higher scores for this effect. However, it can be contested whether price variance is a more important metric than desired growth ranges as the Index rewards (Timmer, 2000). In the absence of a breakdown of the UK's subsidy scheme (Basic Payment Scheme), *2.2.1) Public expenditure on agricultural research and development*, could not be properly tested. This is unfortunate as this would effectively highlight how much the UK subsidises plant vs animal agriculture, and its relative contribution to GDP and/ or food security. This specific indicator would prove a pertinent research question on its own. The scores for Total Factor Productivity *(2.2.2 Access to agricultural technology, education and resources)* provided interesting results, despite annual growth in output (*less inputs)* for plant-agriculture being nearly double that of animal agriculture, the linear transformation chosen by *The Economist* smoothed out this effect. This finding, of growth in plant-agriculture outpacing animal-agriculture in the UK is consistent with more dated literature, however there remains a lack of up-to-date analyses of this metric divided between animal and non-animal agriculture (Thirtle and Bottomley, 1992; Thirtle *et al.*, 2004). The last indicator, *2.4) Volatility of agricultural production*, strongly influenced the constructed indices, with Animal Agriculture Inclusive receiving a near-perfect score. Upon reflection, the scoring for volatility is unsurprising in the UK context: arable farmers in the UK are not immune to crop failure events related to climate change, weather-related yields and shifting demands (Austin, 1999; Slater *et al.*, 2022). However, due to the UK's relative global wealth, UK animal farmers are able to purchase grain on international markets in times of low domestic production to provide for a growing demand (Erb *et al.*, 2012; Godfray *et al.*, 2018). Such volatility is also represented in the previous Total Factor Productivity analysis, where the deviation of plant agriculture Total Factor Productivity is larger year-to-year than animal agriculture Total Factor Productivity. These volatility observations raise two key factors not discussed in this paper: the role of short term, acute emergencies for UK food security – to what extent does UK livestock act as a biological ‘calorie’ emergency reserve for the UK, delaying the impact of acute shortages. In addition, ‘import dependency’ is a measure of food security poorly addressed by the original Index (and as such this project) and is a contested discussion point in the literature surrounding veganism in the UK (Hubbard and Hubbard, 2013; Benton *et al.*, 2019; Sajeev *et al.*, 2020). Both areas could be a fruitful area of future research.

Veganism scored slightly lower in the *Quality & Safety* element of the Index, however the difference was marginal. This section was more static than the others, with values from 2016 being projected across the Index. Again, this method was chosen due to a lack of available data tracking the dietary micronutrient intake across the population – split by dietary type. Although no original analysis was done in this section, the higher intake of Iron, and adequate intake of Vitamin A and Zinc among UK vegans is notable due to the contested cultural perceptions of the healthiness of vegan diets (Bryant, 2019; Williams *et al.*, 2023). Of interesting note from the *Methodology*, was the apparent error within the original Index – whereby the UK consistently scored 0 for Vitamin A uptake, which is not consistent with either omnivore or vegan diets in Sobiecki *et al.*'s (2019) analysis.

Finally, veganism scored higher in the *Sustainability & Adaptation* section of the Index. This influence was somewhat expected considering the weight of scientific evidence indicating that plant-based diets have a lower environmental footprint and are a key element of adaptation pathways in responding to the climate crisis (Hallström, Carlsson-Kanyama and Börjesson, 2015; Campbell *et al.*, 2017). With this stated, the original Index is poorly suited in capturing this effect due to the nature of the indicators. The original Index*’s* choice to use index scoring and risk ratings to measure the role of temperature rise and drought was questioned by this research project, instead utilising Emissions and Water Footprint – indicators better able to capture differences in diet type. Some factors of the original Index’s *Sustainability & Adaptation* section were of keen interest in answering the research question. For example: 4.3.1) land degradation, 4.3.2) grassland emissions, 4.3.3) change in forest area and 4.3.4) soil organic content were all of interest to the project, as separating these based on *animalisation* would have provided interesting results. Unfortunately, the aforementioned UK data landscape prevented analysis of these areas. Questioning each with primary research would provide invaluable data for building a model that could effectively capture the influence of veganism/ the influence of *animalisation* within diets on UK food security.

Conclusions

This research originally sought to test veganism's influence upon the UK's food security through the lens of *The Economist/Corteva Agriscience*'s *Global Food Security Index*. Despite encountering significant issues with the UK data landscape, 12 indicators of food security were analysed in turn to construct altered indices: Adjusted Baseline, Vegan Index and Animal Agriculture Inclusive. Comparing the results of these indices to each other, and the original values, indicates that veganism has a negative influence on the overall Index in comparison to the Animal Agriculture Inclusive score. At a finer resolution veganism was found to have a positive effect on the underlying *Affordability* and *Sustainability & Adaptation* sections, whilst having a negative effect on *Availability* and *Quality & Safety*. At this resolution, the project teased out important observations in the underlying datasets. Key original findings were observed regarding the differences in Total Factor Productivity and annual variability of production between plant and animal-agriculture. However even with such observations, due to the small weighting of studied variables within the original Index, it is difficult to state definitively that veganism negatively influences UK food security solely because it does so within the studied variables of this Index.

With this stated, the project discovered two further main findings. Foremost, the *Global Food Security Index* in its original form is poorly suited to studying the role of veganism upon UK food security. This is in part due to the choice of indicators within the Index and their relationship to veganism and is not a reflection of the academic validity of the model. More importantly is the influence of the data landscape for relevant data within the UK. The lack of available data for studying the indicators within the Index was a more important limiting factor – making the Index not well suited for this task. This does however leave some promise: future research could continue to build upon utilising the Index to test veganism by creating primary datasets, or utilising secondary datasets not currently available to expand the number of indicators involved. As such, independent research could repeat the process outlined here and expand the number of indicators included to provide new observations.

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