University of Nottingham
Rights Lab

Towards a Just Transition in the UK food retail sector

The impact of climate change on the human rights of workers

Contents

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Acronyms

AWU	Annual Worker Units
BII	Biodiversity Intactness Index
CAT	Convention Against Torture and Other Forms of Cruel, Inhuman, or Degrading Treatment or Punishment
CERD	International Convention on the Elimination of All Forms of Racial Discrimination
CEDAW	Convention on the Elimination of All Forms of Discrimination Against Women
CO2e	Carbon Dioxide Equivalent
COP	Conference of the Parties
COPAD	Commercial Organisation and Public Authorities Duty Bill
CRC	Convention in the Rights of the Child
CRPD	Convention on the Rights of Persons with Disabilities
CSDDD	Corporate Sustainability and Due Diligence Directive
DRIP	Declaration of the Rights of Indigenous Peoples
ECHR	European Convention on Human Rights
GDP	Gross Domestic Product
GHGs	Greenhouse Gases
GMOs	Genetically Modified Organisms
GVI	Global Vulnerability Index
HDI	Human Development Index
HREDD	Human Rights and Environmental Due Diligence
ICCPR	International Covenant on Civil and Political Rights
ICESCR	International Convention on Economic, Social and Cultural Rights
ILO	International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
LDD	Land Degradation Debt
MSA	Modern Slavery Act
OECD	Organisation for Economic Cooperation and Development
SDGs	United Nations Sustainable Development Goals
SSE	Scottish and Southern Energy
SSPs	Shared Socioeconomic Pathways
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNGC	United Nations Global Compact
UNGPs	United Nations Guiding Principles on Business and Human Rights

Executive summary

This briefing paper considers the impact of climate change on agriculture and food systems, with a particular focus on an illustrative set of crops consumed in the UK, and the current and forecasted climate impacts on those working in food supply chains. It provides novel data analysis highlighting the human hours involved in the production of these commodities, as well as the climate hazards and patterns of nature loss associated with the geographies of production. It is intended to 'set the scene' and centre the 'Just Transition' paradigm as a unifying and meaningful way to capture the challenges of climate change mitigation, foster supply chain resilience, and ensure protection for the people involved in the production of food.

As food retailers take steps to identify, address, and mitigate their climate change impacts, and become more environmentally sustainable, it is imperative that due consideration is also given to the human rights of workers[1] and their communities in these climate-affected supply chains. As a starting point, retailers need to understand if and how their food supply chains are being affected by climate change hazards (e.g., heat stress, drought intensity), and nature loss (e.g., deforestation and loss of biodiversity), and the extent to which they will be affected as the climate crisis exacerbates.

Section 1 of this briefing paper provides a snapshot analysis of an illustrative set of crops consumed in the UK including maize, wheat and potatoes, among many others to understand the geographical regions where these products are grown for UK consumption, and the climate change hazards that are present in these regions.

Section 2 focuses on the human labour required for the production of these crops and considers the socio-economic vulnerability of these workers to understand the extent to which they may be negatively impacted by climate change.

Section 3 considers the two-way relationship between the exacerbation of climate change through environmentally degrading activities carried out by those engaged in modern slavery, and how this results in the increase of wider modern slavery vulnerabilities across populations. This circular relationship is illustrated by key case studies in food supply chains.

The briefing paper concludes by introducing high-level recommendations for UK food retailers on the steps to be taken to ensure that the human rights of workers in food supply chains are prioritised and centralised in the development and implementation of action to adapt and mitigate climate change. Simultaneously, this addresses the importance of climate change considerations in human rights due diligence actions.

[1] The food supply chain is complex and encompasses a vast number of employment types. The term 'worker' refers includes those employed in areas such as farming, harvesting and catching, transporting, processing, packaging, distributing, cooking, and waste disposal. This includes both large-scale and smallholding farms.

Key takeaways

- UK food production and consumption are part of a global food system with highly complex supply chains and networks across multiple tiers. Food production varies by country, commodity and production method, including levels of labour intensity.
- Global agrifood[2] systems make up around a third of all human-created annual Greenhouse Gas (GHG) emissions,[3] showing the food sector's burden on the planet, and the need for climate action from food retailers. The UK's food system carbon footprint is 129.5 MtCO2e, equivalent to around 30% of territorial emissions.[4]
- In addition to GHG emissions, food production also harms the natural environment in other ways e.g., by contributing to biodiversity loss, deforestation, and soil erosion.
- The global agrifood system is a significant contributor to climate change, and in turn experiences the many consequences of it.
- The UK food retail sector is projected to grow by 24.5% from £216.8 billion to £241.3 billion by 2027, and therefore the sector needs to take action now to sustain these supply chains environmentally and ethically, ensuring that workers' rights are protected.
- There has been a shift in the international governance of environmental transition activities to include companies, as actors with responsibility and accountability for human rights. Yet, the unifying concept of Just Transitions is currently underdeveloped for the food sector as compared to other sectors, e.g., energy.[5]

[2] 'Agrifood' refers to food produced as a result of agriculture. 'Agrifood system' encompasses all interconnected operations and actors within the food supply chain that get food from field to fork, from agricultural production and processing to distribution, consumption, and waste management.

[3] Food and Agriculture Organisation of the United Nations. (2022). *Greenhouse gas emissions from agrifood systems. Global, regional and country trends, 2000–2022*. https://www.fao.org/statistics/highlights-archive/highlights-detail/greenhouse-gas-emissions-from-agrifood-systems.-global--regional-and-country-trends--2000-2022/; Crippa, M., Solazzo, E., Guizzardi, D. *et al.* (2021). 'Food systems are responsible for a third of global anthropogenic GHG emissions'. *Nature Food* 2(3), 198–209 https://doi.org/10.1038/s43016-021-00225-9

[4] Institute of Grocery Distribution (IGD). (2024). *Summary Report: A Net Zero Transition Plan for the UK Food System*. https://www.bsas.org.uk/assets/files/IGD_A-Net-Zero-Transition-Plan-for-the-UK-Food-System-Summary_Nov-2024.pdf

[5] As is shown in this briefing paper, the genesis of the just transition paradigm is in the energy sector; however, there emerging awareness and discussion of using the paradigm in the food sector and in the construction sector.

- Workers in our food systems are vulnerable to climate change impacts to differing degrees (depending on geographical location and role, working hours, access to personal protective equipment (PPE), etc.).

- The greatest climate change hazard for workers in arable agriculture, across the illustrative set of crops analysed in this research (which represent 70-75% of all the crops consumed in the UK), is heat stress: 71% of workers are likely to be impacted by heat stress, rising to 88% if temperatures rise by 3.0°C above pre-industrial levels.

- Rice, sugarcane, and soybeans are the most common and top three commodity crops, of those analysed, associated with land degradation. These commodities are at further risk from nature loss, which will have its strongest impact on the livelihoods of farmers.

- Some crops such as rice and sugarcane require more human labour than others. The countries with the greatest labour intensity for UK food consumption, across the crops analysed, are India, Pakistan, Brazil, Thailand and Vietnam.

- These countries have medium levels of both development and climate change vulnerability, where automation and technological advances remain comparatively low, producing strong demand for labour in the agricultural sector.

- In order to develop a Just Transition in the food sector, it is important that the climate change impacts on the production of specific foods, and on the farmers, workers and communities involved in their production, is understood *in detail,* as each supply chain (dependent on factors like geography, methods of production, ability of workers to cope with the changing climate) will be vulnerable in different ways.

- There are strong links between different dimensions of climate change and modern slavery, including in food production, i.e., workers in food supply chains have been found to be working in modern slavery conditions, and, as a result of climate change impacts partially induced by working practices in the food sector, workers and their communities have been forced to migrate or look for alternative, often precarious, employment, which has increased their vulnerability to modern slavery.

Recommendations for UK food retailers

Whilst this briefing paper has not sought to review and critique UK food retailers' efforts to understand and address human rights impacts for workers and their communities as part of their climate transition work, our analysis has highlighted a number of steps that all retailers should be taking, as a minimum, as they develop strategies to adapt and mitigate climate change. Collective action is a necessary facilitator for sustainable impact, of which partnerships and collaborative initiatives between retailers and wider stakeholders are essential. As such, the following recommendations could be implemented by retailers individually or in collaboration with others.

1. Map and prioritise risk

Food retailers should map their supply chains to identify products, sourcing regions and workers and their communities most at risk to the impacts of climate change and nature loss, adhering to the principles of risk mapping set out in the United Nation's Guiding Principles on Business and Human Rights (UNGPs)[6] (including identifying risks to workers by sector, nature of work, type of worker, employment relationships and labour market dynamics; assessing workers' ability to access rights to freedom of association and collective bargaining; and ranking risks by severity, scale, and responsibility).

2. Encourage social dialogue

Retailers should cultivate opportunities to engage with workers and producers, and associated and representative organisations, across their supply chains to understand better the risks and opportunities associated with climate change and nature loss, ensuring that the voices of the most vulnerable workers, i.e., women, children, migrant and seasonal workers, contract and agency workers and other marginalised groups, are heard. Retailers should make an organisational level commitment to supporting freedom of association and collective bargaining in their supply chains, e.g., by developing and signing a Global Framework Agreement with a relevant international trade union federation, e.g., International Union of Farmworkers (IUF).[7]

3. Conduct human rights impact assessments for climate change mitigation and adaptation activities

Retailers should carry out impact assessments of any potential changes to working practices, procurement practices and sourcing approaches on workers and their rights, including the impact of a 'responsible exit' from suppliers and geographical regions. Where potential negative consequences or human rights impacts are identified, steps should be taken to mitigate these, including by retailers either individually or in collaboration with other actors e.g., through the provision of education or skills training, or the provision of financial support to workers to help them adapt to changing practices, and compensation to remediate harms.

4. Evaluate and report on the human rights impacts of their climate mitigation and adaptation activities

Retailers should not only evaluate and report on the activities undertaken to address climate change in their supply chains, but also on the impact these activities had on workers and their human rights, and the steps that have been taken by the business to address any negative impacts. Affected workers and local communities should be consulted as part of these evaluations. Retailers should encourage the practice of sharing any 'lessons learned,' providing examples of both successes and failures in their climate transition work from which other retailers and businesses can learn.

[6] United Nations. (2011). *Guiding Principles on Business and Human Rights*. https://www.ohchr.org/sites/default/files/documents/publications/guidingprinciplesbusinesshr_en.pdf
[7] International Union of Farmworkers. (2020). *Agreements* https://www.iuf.org/what-we-do/global-agreements/

Overview and approach

Methods

The briefing paper is based on (1) a review of academic, business, and policy literature on international human rights, climate change, Just Transitions, and the global food system, and (2) systematic data analysis of global food supply chains, including quantities of an illustrative set of commodity consumption in the UK and the human hours involved in the production of these commodities, as well as the climate hazards and patterns of nature loss associated with the geographies of production.

In drafting this briefing paper, the team collated and analysed a series of global data sets on climate change, climate hazards, nature loss, labour intensity, and other socio-economic indicators related to the production of commodities that are part of the global food system with a focus on the UK food retail sector. These data sets were broken down for a selected number of commodities in the UK food supply, the geographies and modes of their production, and the volume of their consumption in the UK. The data analysis shows the relationship between climate change, nature loss and affected workers, their livelihoods, and communities, modelled across different climate change pathways, which are scenarios describing how global society, demographics, and economies might change over the 21st century owing to climate change.[8]

Limitations

The briefing paper based its analysis on a selection of available climate change, nature loss, and labour data, combined with insights from existing literature. The analysis is based on an illustrative set of arable crops. Data availability, particularly in relation to measuring labour intensity of production, played a significant part in why these crops were included in the analysis; however, these thirteen crops also represent approximately 70% of total crops consumed in the UK (measured in tonnes), including 8 of the top 10, and 13 of the top 20 crops consumed. The analysis is therefore not exhaustive but provides robust evidence on the impact of climate change on the human rights of workers in a large section of the food supply chain. The food supply chain is complex and encompasses a vast number of employment types. The term 'worker' refers includes those employed in areas such as farming, harvesting and catching, transporting, processing, packaging, distributing, cooking, and waste disposal. This includes both large-scale and smallholding farms.

Further research is required on the explicit links and direct effects between different dimensions of climate change and nature loss and workers and their communities (for example, pollutant exposure, dependencies on land, or cultural significance of certain places for indigenous communities) grounded in human rights principles and obligations. Further research may also expand the range of crops to include the production and consumption of meat and other commodities, as well as consider in greater depth the impact of the changing diets of climate-conscious consumers on the realisation of a Just Transition in the UK food sector.

[8] Shared Socioeconomic Pathways (SSPs). See Riahi. K.(2017) 'The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview,' *Global Environmental Change*, Volume 42: 153-168, https://doi.org/10.1016/j.gloenvcha.2016.05.009.

Introduction

> **“ Efforts to limit the rise in global temperature to 1.5 degrees Celsius are slipping away. We need a massive global effort to steer our world onto a path to safety; a path to net zero by mid-century.... The future of humanity is at stake. Action cannot be optional. Disclosing credible transition plans, that align with 1.5 degrees must be mandatory for corporates and financial institutions.**
>
> **- UN Secretary-General's remarks at COP29 High-Level Event, 14 November 2024.** [9]

The latest estimates suggest that the world is now on a trajectory to exceed the 2015 Paris Agreement target of 1.5 °C average above pre-industrial temperatures. [10] Despite the increasing commitment from world leaders to address climate change, in the years since the 1992 United Nations Framework Convention on Climate Change (UNFCCC), annual greenhouse gas emissions (GHG) have increased by 44%. [11]

The impacts of the climate crisis are being increasingly felt around the globe, with rising air and water temperatures resulting in more extreme and frequent weather events, such as droughts, floods, and forest fires. Our changing climate is having an impact on the natural environment, with consequences for agriculture and food production, including changes in the availability, price and quality of some foods, changes in land use, increases in pollution, changes in access to water, and emerging patterns of urban development. As discussed in this briefing paper, agriculture and food production systems are significant emitters of greenhouse gases which exacerbate climate change and global warming. Furthermore, intensive farming practices, including monocultures and excessive use of chemical fertilisers and harmful crop protection products, are reducing biodiversity and having a negative impact on the functioning of vital ecosystems (e.g., on soil health). These combined issues are destabilising ecosystems and leading to food insecurity, disproportionately affecting already vulnerable populations and exacerbating existing inequalities. [12]

Globally around one billion people work in agriculture,[13] and these workers and their communities are witnessing and experiencing first-hand the impact of the changing climate and nature loss. As companies and nation states take action to address climate change and decarbonise the agricultural sector and food production systems, the challenge is to manage this transition in a way that does not adversely affect the livelihoods and well-being of workers and communities. This is the crux of a ‘Just Transition’ in food; ensuring that no one – no worker or community - is left behind as the food sector transitions towards becoming more environmentally sustainable and less carbon intensive.

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[9] United Nations. (2024, November 14). *Secretary-General's remarks at COP29 high-level event on the stocktake of "Integrity Matters".* https://www.un.org/sg/en/content/sg/statement/2024-11-14/secretary-generals-remarks-cop29-high-level-event-the-stocktake-of-integrity-matters-delivered

[10] Soener, M. (2024). ‘Decarbonisation and the Capitalist State,’ *Sociology Compass*, 18 (11), https://doi.org/10.1111/soc4.70011.

[11] POLITICO Mathesien, K. (2024). *Climate conferences are dying. How to save the world now?* https://www.politico.eu/article/climate-conference-die-how-save-world-cop29/.

[12] HLPE. (2023). *Executive summary of the report Reducing inequalities for food security and nutrition.* Rome, CFS HLPE-FSN. https://openknowledge.fao.org/server/api/core/bitstreams/58152ac2-0ef0-42a4-a840-72dbd7812a57/content

[13] Food and Agriculture Organization of the United Nations. (2023). *Statistics Working Paper Series - Estimating Global and Country-level employment in Agrifood*. https://openknowledge.fao.org/server/api/core/bitstreams/08f5f6df-2ef2-45a2-85aa-b29c2ce01422/content

The Genesis of Just Transition

The past 40 years have seen a convergence between the international environmental regime and the international human rights regime, manifested in the idea of Just Transition—a dual commitment to addressing climate change while also addressing the impact of climate action on the rights and dignity of people (See Box 1: International Action on Human Rights and Climate Change). The concept of a Just Transition stems from the trade union movement in the United States in the 1970s when decarbonisation in the energy industry and those working at fossil fuel sites were supported to transition to new industries. The concept has become increasingly globalised through the efforts of national trade union organisations in the United States, Spain, the United Kingdom,[14] Australia, and South Africa, whose advocacy has been embraced in part by the United Nations Environment Programme (UNEP) and the United Nations Framework Convention on Climate Change (UNFCCC). Interest has been further catalysed by the inclusion of Just Transition in the preamble of the 2015 Paris Agreement, adopted by 196 Parties at the UN Climate Change Conference (COP21) in Paris, France, on 12 December 2015.

Despite this growing interest, the definition of 'Just Transition' remains contested, with no single definition adopted globally. Perhaps the most commonly cited definition is that provided by the International Labour Organization (ILO), with which this briefing paper broadly aligns:

> **'A Just Transition means greening the economy in a way that is as fair and inclusive as possible to everyone concerned, creating decent work opportunities and leaving no one behind.'[15]**

In its 2023 'Resolution concerning a just transition towards environmentally sustainable economies and societies for all,'[16] the ILO further details that a Just Transition *'involves maximizing the social and economic opportunities of climate and environmental action, including an enabling environment for sustainable enterprises, while minimizing and carefully managing challenges. It should be based on effective social dialogue, respect for fundamental principles and rights at work, and be in accordance with international labour standards. Stakeholder engagement is also important.'*

Figure 1 provides a high-level overview of the relationships between climate change, business practice, and affected workers in the food system. This briefing paper recognises that many workers are currently experiencing the negative impacts of natural climate hazards, nature loss, and harmful business practices. These impacts can also stem from climate adaptation, mitigation and transition activities that are designed without due consideration of affected communities, as well as general purchasing practices and pressures on supply chains. The left-hand side of the figure shows where workers experience both environmental harms and potential harms from businesses as they implement climate transition plans without consideration of all risks.

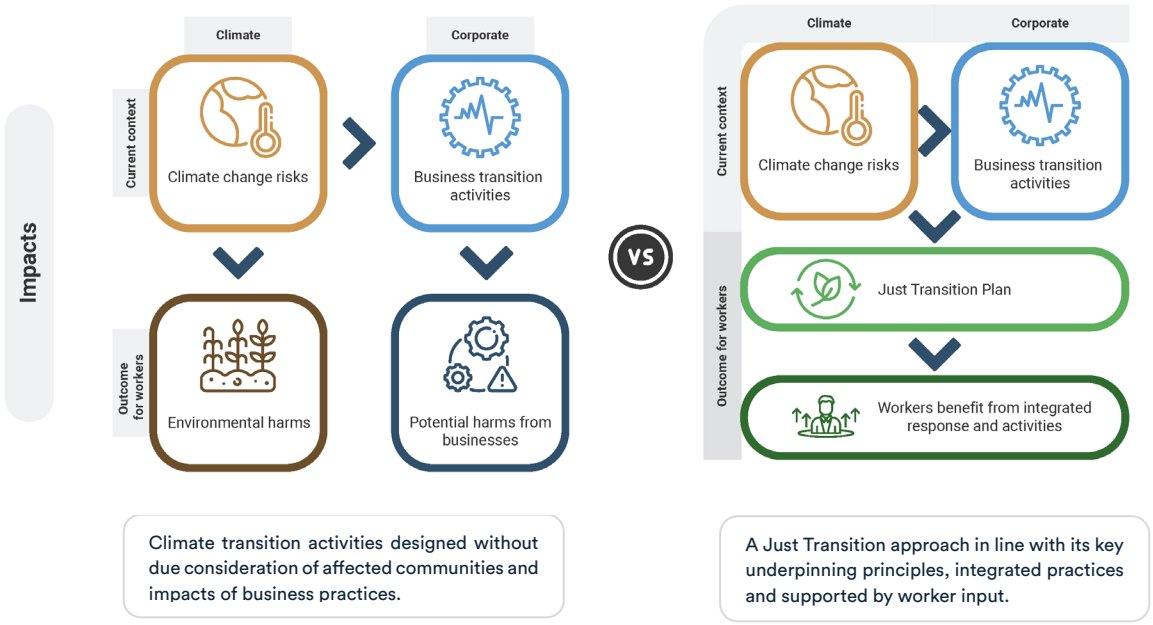
Workers benefit from an integrated business approach to climate and human rights, and through inclusive practices, can provide feedback to inform ongoing business activities (see the right-hand side of the figure). Businesses also benefit from stronger relationships and effective social dialogue with growers and workers in supporting the development and implementation of climate transition plans, resulting in reduced supply chain disruption.

[14] Recent parliamentary debates in the Great British Energy Bill yielded an amendment to Clause 3 addressing the risks of forced labour in the production of significant renewables, such as solar panels. See, e.g., https://www.gov.uk/government/news/great-british-energy-to-lead-the-field-in-ethical-supply-chains

[15] ILO. (2024). *Climate Change and Financing a Just Transition.* https://www.ilo.org/climate-change-and-financing-just-transition

[16] ILO. (2023). International Labour Conference, 111th Session. *Resolution concerning a just transition towards environmentally sustainable economies and societies for all.* https://www.ilo.org/sites/default/files/wcmsp5/groups/public/@ed_norm/@relconf/documents/meetingdocument/wcms_886647.pdf

Figure 1. Importance of worker engagement in Just Transition



Box 1 – International action on climate change and human rights

The regulatory landscape with respect to climate change, the environment, and human rights has evolved considerably with increased activity from governments and non-governmental organisations, and private corporations formulating climate action and climate transition plans.

The international environmental regime recognises the profound global challenge of climate change. Through the continued scientific research and guidance from the Intergovernmental Panel on Climate Change (IPCC) and the associated annual meetings of the UN Conference of the Parties (COP), governments and private corporations are engaged in climate action planning with a view to achieving net zero by 2050, and a significant reduction in carbon emissions by 2030 (see Annex A for further information on the evolution of the International Environmental Regime).

The international human rights regime recognises the inherent dignity of humans underpinned by the human rights principles of universality, inalienability, inter-dependence, and accountability. Through its laws and mechanisms, the international human rights regime codifies the promotion and protection of civil, political, economic, social, cultural, and minority rights (see Annex A for a summary of the evolution of the International Human Rights regime).

The past 40 years has seen a convergence between these two international regimes increasingly manifested in the idea of a Just Transition, a dual commitment to addressing climate change while also addressing the impact of climate action on the rights and dignity of people.

The 2015 Paris Agreement commits signatories to *'the imperatives of a Just Transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities.'* In particular, Article 9(c) requires:

'The assessment of climate change impacts and vulnerability, with a view to formulating nationally determined prioritized actions, taking into account vulnerable people, places and ecosystems.'

The 2015 Paris Agreement also recognises *'the fundamental priority of safeguarding food security and ending hunger, and the particular vulnerabilities of food production systems to the adverse impacts of climate change.'*

Developments in 2023

At COP27, the United Nations established the Just Transition Work Programme. The impact of climate change on agriculture and the need to tackle it have also been recognised in the 2023 Declaration on Sustainable Agriculture, Resilient Food Systems, and Climate Action adopted at COP28. The Declaration calls upon states to:

1. scale-up their adaptation and resilience activities to reduce vulnerabilities across food producers,
2. promote food security and nutrition among vulnerable groups through enhanced programmes of social protection and safety nets,
3. support workers through context-appropriate approaches,
4. strengthen the integrated management of water in agriculture and food systems,
5. maximise the climate and environment through more sustainable and production and consumption approaches.

Developments in 2024-2025

Continued attention to Just Transition through the COP process has been joined by the development and passage of new laws and regulations on corporate due diligence on the environment and human rights, including the European Union's 2024 Corporate Sustainability and Due Diligence Directive (CSDDD)[17] and at the national level.[18] There is thus an emerging commitment to consider the environment and human rights as inter-dependent concerns in need of public and private cooperation and coordination to achieve a Just Transition.

At the 2024 Conference of Parties meeting (COP29) in Baku, Azerbaijan, the UK Prime Minister Sir Keir Starmer pledged that the UK would seek to decrease carbon emissions by 81% on 1990 levels by 2035, which he described as 'urgent action' to 'protect our planet and its people'. Through the 2008 Climate Change Act, amended in 2019, the UK Government has committed to achieving 100% net zero emissions by 2050.[19] More recently, in June 2025, the UK launched an open consultation seeking views on options to take forward climate-related transition plan requirements for UK-regulated financial institutions (including banks, asset managers, pension funds and insurers) and FTSE 100 companies.[20]

[17] European Union. (2024). *Directive - EU - 2024/1760 - EN - EUR-Lex* https://eur-lex.europa.eu/eli/dir/2024/1760/oj. On 14th April 2025, the EU Council agreed to a 'stop-the-clock' proposals, which forms part of the 'Omnibus I' package adopted by the Commission at the end of February 2025. These stop-the-clock proposals delay the transposition deadline and the first phase of the application (covering the largest companies) of the CSDDD, and the entry into application of the Corporate Sustainability Reporting Directive (CSRD) requirements for large companies that have not yet started reporting, as well as listed SMEs.

[18] Due diligence laws and transparency frameworks have been established in France, Germany, Norway, Switzerland, Canada, the UK, Australia, and New Zealand.

[19] UK Parliament. (2019). *The Climate Change Act 2008 (2050 Target Amendment) Order 2019* https://www.legislation.gov.uk/ukdsi/2019/9780111187654

[20] UK Government. Department for Energy Security and Net Zero. (2025). *Open consultation: Climate-related transition plan requirements.* https://www.gov.uk/government/consultations/climate-related-transition-plan-requirements

Section 1: Climate change impacts in food production

Key takeaways:

- Globally, the agrifood sector makes up approximately a third of all human-created Greenhouse Gas (GHG) emissions, highlighting the food sector's burden on the planet, and the need for climate action from food businesses.
- In addition to GHG emissions, food production also harms the natural environment in other ways, e.g., by contributing to biodiversity loss and soil erosion.
- The global agrifood system is a significant contributor to climate change, and in turn experiences the many consequences of it.
- Workers in our food systems are vulnerable to climate change impacts to differing degrees (depending on geographical location and role, working hours, access to personal protective equipment (PPE) etc.).
- Heat stress is the climate change hazard with the highest risk for workers across the 13 crops analysed for this research: 71% of workers are likely to be impacted by heat stress, rising to 88% if temperatures rise by 3.0°C above pre-industrial levels.
- Rice and sugarcane require more human labour than other commodities. The countries contributing the greatest labour intensity for UK food consumption for these commodities are India, Pakistan, Brazil, Thailand and Vietnam.
- These commodities are at further risk from nature loss, which also have impact on the livelihoods of farmers and local communities.
- In order to develop a Just Transition in the food sector, it is important that the climate change impacts on the production of specific foods, and on the farmers, workers, and communities involved in their production, is understood in detail, as each supply chain (depending on factors like geography, methods of production, ability of workers to cope with the changing climate) will be vulnerable in different ways.

Climate change and food production: A two-way relationship

> **"Agrifood systems account for about one-third of total anthropogenic greenhouse gas emissions. They are generated within the farm gate, from crop and livestock production activities; by land-use change, caused by deforestation, biomass fires and peatland degradation processes often linked to land clearance for agriculture; and in pre- and post-production processes, comprising the supply chain including food manufacturing, retail, household consumption and food disposal.**
>
> **– FA0, 2024[21]**

Food production and consumption in the UK contribute to climate change, across its full life cycle: farming, harvesting and catching, transporting,[14] processing, packaging, distributing, cooking, and disposing of waste. Globally, GHG emissions from the agrifood sector make up as much as one-third of human created emissions[22] and the *'sector is the largest contributor of non-carbon dioxide ... greenhouse gases, such as methane.'*[23]

In the UK, carbon dioxide equivalents (CO_2e)[24] for the food sector increased throughout the 1970s and 1980s, peaked in the 1990s, and started to increase again in 2012.[25] Since 2021, the UK has seen a 14% reduction in emissions associated with food and drink consumption, driven primarily by a decrease in the GHG intensity of energy since 2015 and process efficiency improvements, most notably in the household, retail, and manufacturing sectors.[26] The current per capita CO_2 equivalent for UK food is estimated to be approximately 2.2 tonnes CO_2 equivalent per person per year.[27]

In addition to generating GHG emissions, the agri-food sector globally is responsible for further negative impacts on the environment. For example, monocultures, the intensive cultivation of single crops without rotation, excessive tillage, and the mechanical preparation and break-up of the soil, can lead to a loss of soil nutrients and soil erosion. This can lead to reduced crop yields but also the release of carbon stores into the atmosphere. The use of synthetic fertilisers can be helpful for optimising plant development and crop yield but has also led to environmental degradation and lasting changes in soil ecology.[28] Excessive nutrient use can also impact biodiversity due to increased toxicity in the environment and nutrient enrichment, oxygen depletion in aquatic ecosystems, and soil or water acidification.[29] The use of pesticides in agri-food systems, such as insecticides, herbicides, fungicides and bactericides, can also result in biodiversity loss.[30]

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[21] Food and Agriculture Organization of the United Nations. (2024). *Greenhouse gas emissions from agrifood systems. Global, regional and country trends, 2000–2022*. https://www.fao.org/statistics/highlights-archive/highlights-detail/greenhouse-gas-emissions-from-agrifood-systems.-global--regional-and-country-trends--2000-2022/en

[22] Crippa, M., Solazzo, E., Guizzardi, D. *et al.* (2021). 'Food systems are responsible for a third of global anthropogenic GHG emissions'. *Nature Food* 2, 198–209. https://doi.org/10.1038/s43016-021-00225-9.

[23] Morrison, J. (2024). *The Just Transition: A Systems-Thinking Approach to Managing Climate Action*, London: Palgrave, p. 246.

[24] Carbon dioxide equivalents (CO_2e) are a measure of the effect of different greenhouse gases (GHGs) on the climate. By converting different emissions to the equivalent amount of carbon dioxide (CO_2), their impacts can be compared.

[25] Crippa, M., Solazzo, E., Guizzardi, D. *et al.* (2021). 'Food systems are responsible for a third of global anthropogenic GHG emissions'. *Nature Food.* (2021). doi:10.1038/s43016-021-00225-9; M. Crippa, E. Solazzo, D. Guizzardi, R. Van Dingenen, A. Leip (2022). 'Air pollutant emissions from global food systems are responsible for environmental impacts, crop losses and mortality' *Nature Food*. doi:10.1038/s43016-022-00615-7.

[26] WRAP. (2024). *Tracking UK Food System Greenhouse Gas Emissions: 2015-2021*, Prepared by Hamish Forbes and Ellie Trotman https://www.wrap.ngo/sites/default/files/2024-03/WRAP-GHG-Emissions-Update-Technical-Report-2024-v3.pdf.

[27] Carbon Independent (2025) *Emissions from Food* https://www.carbonindependent.org/18.html.

[28] Zuma, M., Arthur, G., Coopoosamy, R. and Naidoo, K. (2023). 'Incorporating cropping systems with eco-friendly strategies and solutions to mitigate the effects of climate change on crop production'. *Journal of Agriculture and Food Research*, 14, p.100722. doi:10.1016/j.jafr.2023.100722.

[29] OECD. (2018). Agri-environmental indicators http://www.oecd.org/tad/sustainableagriculture/agri-environmentalindicators.htm.

30 Geiger, F *et al.* (2010). 'Persistent negative effects of pesticides on biodiversity and biological control potential on European farmland'. *Basic and Applied Ecology*, *11*(2) pp. 97-105.

Different foods, and their differing methods of production, impact the climate and the natural environment to greater or lesser degrees. Animal-based products are thought to result in twice as many GHG emissions as those of plant-based foods.[31] This is due, in particular, to the release of methane (a potent greenhouse gas released by ruminants such as cows through digestion and manure), deforestation to clear land for animal grazing, and significant water use by animals and the production of animal feed. Research into fishing and fisheries has shown that unsustainable and intensified production practices have resulted in a global trend towards ecosystem decline in fisheries and reduction in fish stocks.[32] As a result of increasing demand for cheap seafood, combined with a reduction in natural fish stocks, aquaculture, or 'fish farming', has grown rapidly in recent years and currently produces more than half of all seafood globally.[33] Commercial fish farming has its own environmental impacts, including requiring large inputs of fish-feed which put pressure on wild fish stocks and can pollute the surrounding water around the fish farms.[34]

> **'More than 570 million farms produce in almost all the world's climates and soils, each using vastly different agronomic methods; average farm sizes vary from 0.5 hectares [ha] in Bangladesh to 3000 ha in Australia; average mineral fertilizer use ranges from 1 kg of nitrogen per ha in Uganda to 300 kg in China; and although four crops provide half of the world's food calories, more than 2 million distinct varieties are recorded in seed vaults. Further, products range from minimally to heavily processed and packaged, with 17 of every 100 kg of food produced transported internationally, increasing to 50 kg for nuts and 56 kg for oils.'[35]**

In this way, what we as consumers eat will have differing impacts on the environment and climate. What we choose to eat is, however, often dependent on numerous, and varying, factors, including price, affordability, availability, and appeal (e.g., awareness of a product and the success of its marketing).[36] Consumer priorities when purchasing food are likely to be complex and fluid; issues of price, value, convenience, health, ethics and environment, etc., may be difficult for the consumer to juggle.[37] For many on lower incomes, the cost of living crisis and rising food prices have meant that price is the predominant driver of food choices.[38]

[31] Xu, X., Sharma, P., Shu, S. *et al.* (2021). 'Global greenhouse gas emissions from animal-based foods are twice those of plant-based foods'. *Nature Food* 2, 724–732. https://doi.org/10.1038/s43016-021-00358-x.
[32] Rights Lab, Royal Holloway, IASC. (2018). *Modern Slavery, Environmental Destruction and Climate Change: Fisheries, Field, Forests and Factories.* https://www.nottingham.ac.uk/research/beacons-of-excellence/rights-lab/resources/reports-and-briefings/2018/november/modern-slavery-and-the-environment.pdf.
[33] Food and Agriculture Organization of the United Nations. (2024). *Global fisheries and aquaculture production reaches a new record high.* https://www.fao.org/newsroom/detail/fao-report-global-fisheries-and-aquaculture-production-reaches-a-new-record-high/en.
[34] *See supra note* 32.
[35] Poore. J., Nemecek. T. (2018). 'Reducing food's environmental impacts through producers and consumers'. *Science* 360,987-992. DOI:10.1126/science.aaq0216.
[36] The Food Foundation. (2023). *The Broken Plate 2023: The State of the Nation's Food System.* https://foodfoundation.org.uk/sites/default/files/2023-10/TFF_The%20Broken%20Plate%202023_Digital_FINAL..pdf.
[37] Food Standards Agency (2022) *Research project: UK Public's Interests, Needs and Concerns Around Food.* https://www.food.gov.uk/research/consumer-interests-aka-wider-consumer-interests/uk-publics-interests-needs-and-concerns-around-food.
[38] *Ibid*

When the UK public were questioned in 2022[39] around the need for fair, ethical, and sustainable food systems and futures, the following views were reported:

- **60% of people were worried about the environmental impact of our food systems.**
- **58% cited the impact of climate change on food production as a major concern for the next 3 years.**
- **46% said that they saw treatment of workers in the food chain as a major concern.**
- **32% cited fair treatment of these workers as a priority over the next 3 years.**
- **48% chose 'ensure fair treatment for workers, farmers and small producers in the food chain' as a priority area for action from the food regulator.**

Whilst an individual's diet will fluctuate for the reasons noted above – finances, location, health etc. – there are reports of certain macro-trends in food consumption. For instance, consumption of meat in the UK is falling, and the number of 'flexitarians'[40] actively reducing their meat consumption, as well as the number of people who follow vegetarian and vegan diets, is increasing.[41]

As well as being a **significant contributor to climate change, the food production sector also experiences the many consequences of it.** The overall increase in global temperatures and extreme weather events result in environmental degradation, nature loss, decreased biodiversity, increased heat and water stress, and increased levels of air pollution, amongst other things. These in turn are resulting in lower crop yields (or even crop failure), reduced nutritional quality of crops and livestock stress (e.g., from high temperatures). Increasing attention is being paid to the powerful, positive feedback loop between climate change and the negative environmental impacts of agriculture.[42]

[39] *Ibid*
[40] Flexitarians are primarily vegetarians but occasionally eat meat and fish.
[41] J Sainsbury's PLC. (2019). *Future of food report*. https://www.about.sainsburys.co.uk/~/media/Files/S/Sainsburys/pdf-downloads/futureoffood-10c.pdf.
[42] See, for instance, Yi Yang et al. (2024). 'Climate change exacerbates the environmental impacts of agriculture'. *Science385*, eadn3747. DOI: 10.1126/science.adn3747.

Climate change impacts on workers in food supply chains

In general, we know that climate change is impacting workers and their communities involved in food production, including through displacement, migration, and economic precarity,[43] which further exacerbates risks of exploitation of workers (see Section 3 on Modern Slavery).[44] These changes are having a disproportionate impact on less developed countries in the Global South, where there is a *'closing window of opportunity to ensure a sustainable future for all',*[45] even though the most vulnerable populations in the world actually have the lowest per capita emissions.[46]

In order to develop a Just Transition in the food sector, it is important that the climate change impacts on the production of specific foods, and on the farmers, workers and communities involved in their production, is understood *in detail,* as each supply chain (depending on factors like geography, methods of production, ability of workers to cope with the changing climate) will be vulnerable in different ways. The following section details the different types of impact that climate change can have on the natural environment and on workers.

Climate change impacts can be broken down into measurable climate change hazards[47] and nature loss indicators.

Climate change hazards include:

Heat stress, or 'heat event exposure' measured as the sum of days from heat events lasting 3 or more consecutive days.

Water stress, a measure of the net annual human-economic water demands (irrigation, industry, households) relative to available renewable surface water supply.

Peak river flows risk, derived as locations where there is significant (50%+) risk of a flood event.

Drought intensity, calculated by considering the difference between the actual river discharge and a threshold level of discharge, together with drought event duration.

Crop yield change, a measure in the variation in the amount of a specific crop produced per unit of harvested area over a given period.

Nitrogen leeching, a measure of the amount of nitrogen lost from soil. The nitrogen can run into waterways causing contamination, leading to eutrophication[48] and reduced water quality.

Habitat degradation, a measure of % change from the share of land area being converted from natural land to agricultural land.

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[43] University of Nottingham Institute for Policy and Engagement. (2024). *Delivering a Just Energy Transition, Report of the University of Nottingham's Policy Commission on the Just Transition to Net Zero, University of Nottingham.* https://www.nottingham.ac.uk/policy-and-engagement/documents/policy-commission-nz.pdf.

[44] Jackson, B., Decker Sparks, J.L., Brown, C., and Boyd, D. S. (2020). 'Understanding the co-occurrence of tree loss and modern slavery to improve efficacy of conservation actions and policies,' *Conservation Science and Practice*, 2 (5): e183; https://doi.org/10.1111/csp2.183; Brown, D., Boyd, D. S., Brickell, K., Ives, C. D., Natarajan, N., and Parsons, L. (2021). 'Modern slavery, environmental degradation and climate change: Fisheries, field, forests and factories,' *Environment and Planning E: Nature and Space*, 4(2), 191-207. https://doi.org/10.1177/2514848619887156; Decker Sparks, J.L., Boyd, D.S., Jackson, B., Ives, C.D., and Bales, K. (2021). 'Growing evidence of the interconnections between modern slavery, environmental degradation, and climate change,' *One Earth*, (4) 2: 181-191; https://doi.org/10.1016/j.oneear.2021.01.015; Jackson, B., and Decker Sparks, J. L. (2020). 'Ending slavery by decarbonisation? Exploring the nexus of modern slavery, deforestation, and climate change action via REDD+,' *Energy Research and Social Science*, 69: 101610. https://doi.org/10.1016/j.erss.2020.101610.

[45] Eriksen, S.H., Simpson, N.P., Glavovic, B. et al. (2024). 'Pathways for urgent action towards climate resilient development,' *Nature Climate Change*. https://doi.org/10.1038/s41558-024-02190-0.

[46] Intergovernmental Panel on Climate Change. (2023). *Climate change 2023: Synthesis report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H. Lee & J. Romero, Eds.). https://doi.org/10.59327/IPCC/AR6-9789291691647.

[47] Byers, E., Gidden, M., Leclère, D., Balkovic, J., Burek, P., Ebi, K., Greve, P., Grey, D., Havlik, P., Hillers, A., Johnson, N., Kahil, T., Krey, V., Langan, S., Nakicenovic, N., Novak, R., Obersteiner, M., Pachauri, S., Palazzo, A., Riahi, K. (2018). 'Global exposure and vulnerability to multi-sector development and climate change hotspots,' *Environmental Research Letters*, 13(5): 055012. https://doi.org/10.1088/1748-9326/aabf45.

[48] Over-enriched water (e.g., nitrogen and phosphorous) which can lead to excessive growth of algae and other water-based plants.

Nature loss indicators include:

1. The **Biodiversity Intactness Index (BII)** represents the average abundance of originally present species relative to their abundance in an ecosystem that has been impacted by climate change and human pressures. The BII ranges from 0% (total biodiversity loss) to 100% (no biodiversity loss), where levels greater than 90% have enough biodiversity to be a resilient and functioning ecosystem. Levels below 30% signal significant depletion of biodiversity, placing the ecosystem at risk of collapse. The global average for the BII is 77%.

2. **Land Degradation Debt (LDD)** for tree cover, soil erosion, above-ground carbon, and below-ground carbon. A measure of the difference between the natural potential condition and the current condition.

These different measures of climate change and nature loss can be mapped across food commodities and then cross-tabulated against a measure of labour intensity, in this instance, annual worker units, or 'AWUs', which is a unit of measurement for the amount of human labour, including the labour of workers and farmers, required for the agricultural production of a commodity, equivalent to the work of one person working full-time for one year. The insight this achieved is outlined below.

Climate change hazards

This briefing paper analysed the above listed climate change indices and cross-tabulated them with AWUs to understand better the relationship between the different dimensions of climate change and their impact on workers. The analysis modelled this relationship for projected climate change scenarios of 2.0°C and 3.0°C (Figure 2).

Figure 2. Climate hazards and labour intensity in food production for climate change scenarios of 2.0°C and 3.0°C.

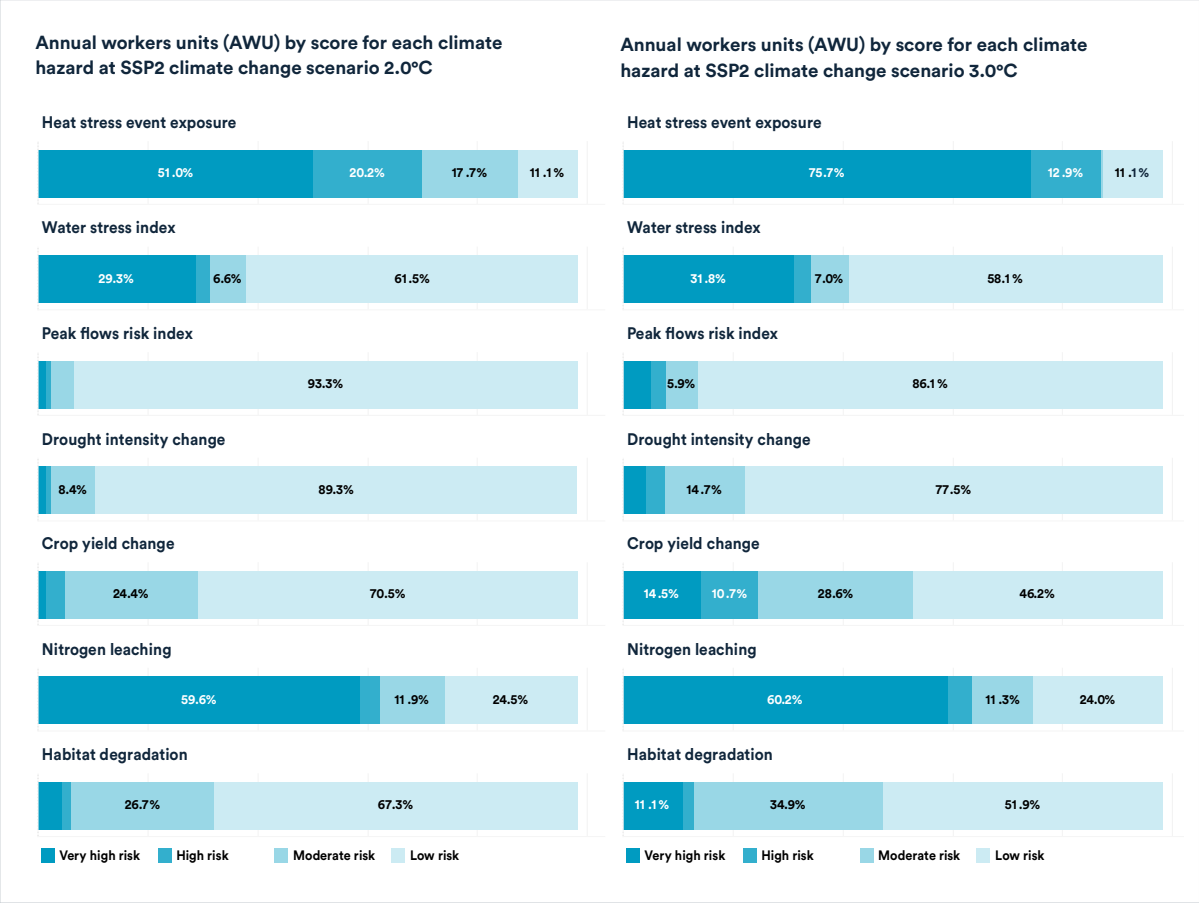
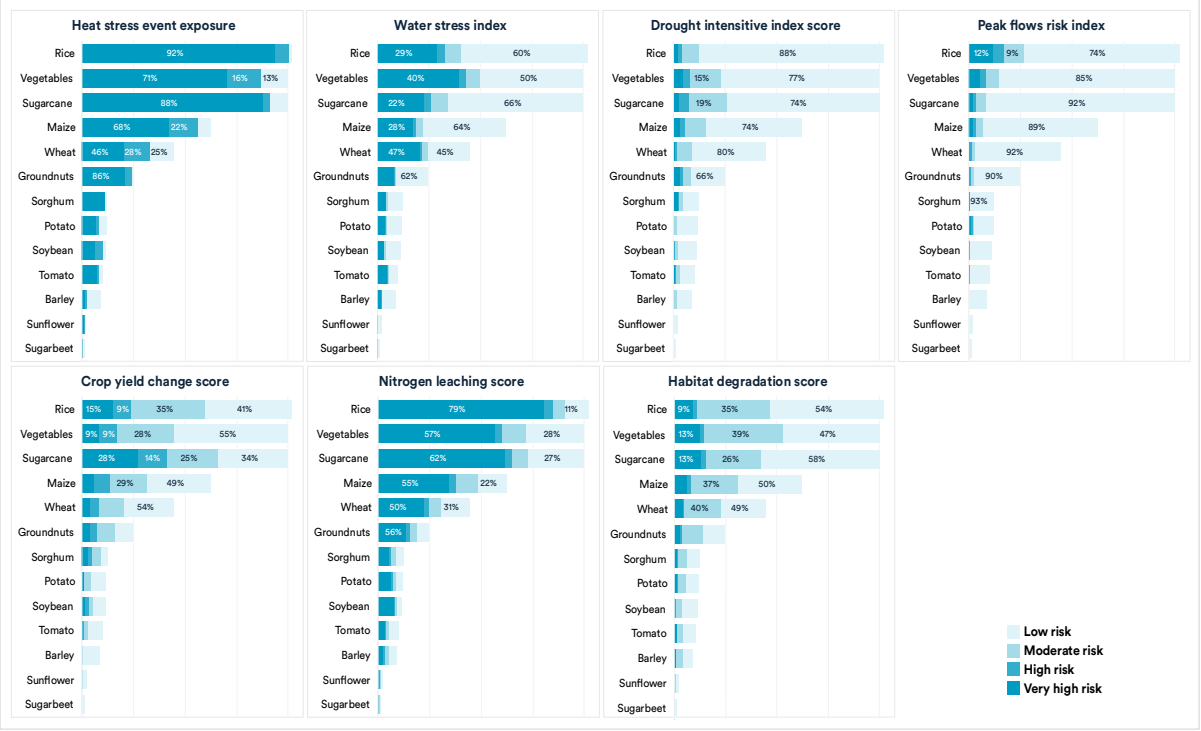


Figure 2 shows that of the seven climate hazards, heat stress has the highest impact on total AWUs (and therefore workers) across all of the key 13 crops analysed as part of this research (which represent 70-75% of all of the crops consumed in the UK[49]): 71% of workers are at high or very high risk of heat stress in the scenario of average global temperatures warming by 2.0°C; reaching up to 88% of workers if the average global temperatures rise to 3.0°C above pre-industrial levels.[50] Heat stress affects the ability of workers to endure working hours in fields, and leads to long-term and short-term negative health outcomes, such as exhaustion, heat induced strokes, chronic kidney disease, and even death. The second highest climate change hazard is nitrogen leaching with 63% and 65% of AWUs (and therefore workers) in food supply chains at high or very high risk for 2.0°C and 3.0°C, respectively. Nitrogen leaching occurs from runoff of nitrates from fertilisers and manure into the fresh water supply, which contaminates the water and is related to negative health outcomes, such as harm to children and increased risks of cancer in adults.

The third highest climate change hazard is water stress, with 33% of AWUs with high and very high in the 2.0°C scenario and 35% in 3.0°C scenario. Water stress and water scarcity can lead to higher operational costs and lower productivity, ill-health (diarrheal diseases or malnutrition), communities spending time and energy searching for clean water, and the migration of workers and their communities to areas with greater water availability, which can in turn increase the risks of workers being subject to labour exploitation and modern slavery (see Section 3).[51]

Figure 3 shows that the patterns in heat stress are highest for the production of rice, sugarcane, vegetables, maize, and wheat. Water stress hazards are highest for vegetables, rice, sugarcane, and maize. Nitrogen leaching risks are highest for rice, sugarcane, vegetables, maize, and wheat (See footnote 49 for listed vegetables).

Figure 3. Labour intensity associated with UK food consumption by climate risk for 3.0°C scenario.



[49] These crops, selected largely due to data availability, are rice, vegetables (including cauliflowers, broccoli pumpkin, squash and gourds, cucumbers, gherkins, aubergine, chillies, peppers, green, leeks, other alliaceous vegetables, carrots, turnips and okra), sugarcane, maize, wheat, groundnuts (i.e. peanuts), sorghum, potato, soybean, tomato, barley, sunflower, sugar beet.

[50] Heat stress on workers is disproportionately higher in agriculture and construction across the world. For a 3°C warming scenario, projected labour losses (involuntary or conscious reduction in working time) are -33% in Asia, -25% in Africa, and -18% in Oceania. These heat-induced losses in the labour supply affect labour productivity and as a consequence, Gross Domestic Product (GDP). See Dasgupta et al. (2024) 'Heat Stress and the Labour Force', *Nature Reviews: Earth and the Environment*, 5: 859-872; https://www.nature.com/articles/s43017-024-00606-1.

[51] See, e.g., Water Aid. (2016). *Water at What Cost: The State of the World's Water in 2016* https://washmatters.wateraid.org/sites/g/files/jkxoof256/files/Water%20%20At%20What%20Cost%20%20The%20State%20of%20the%20Worlds%20Water%202016.pdf.; ISS Insights (2023) *The Social Impact of Water Scarcity: The Risk of Modern Slavery in Corporate Supply Chains*. https://insights.issgovernance.com/posts/the-social-impact-of-water-scarcity-the-risk-of-modern-slavery-in-corporate-supply-chains/.

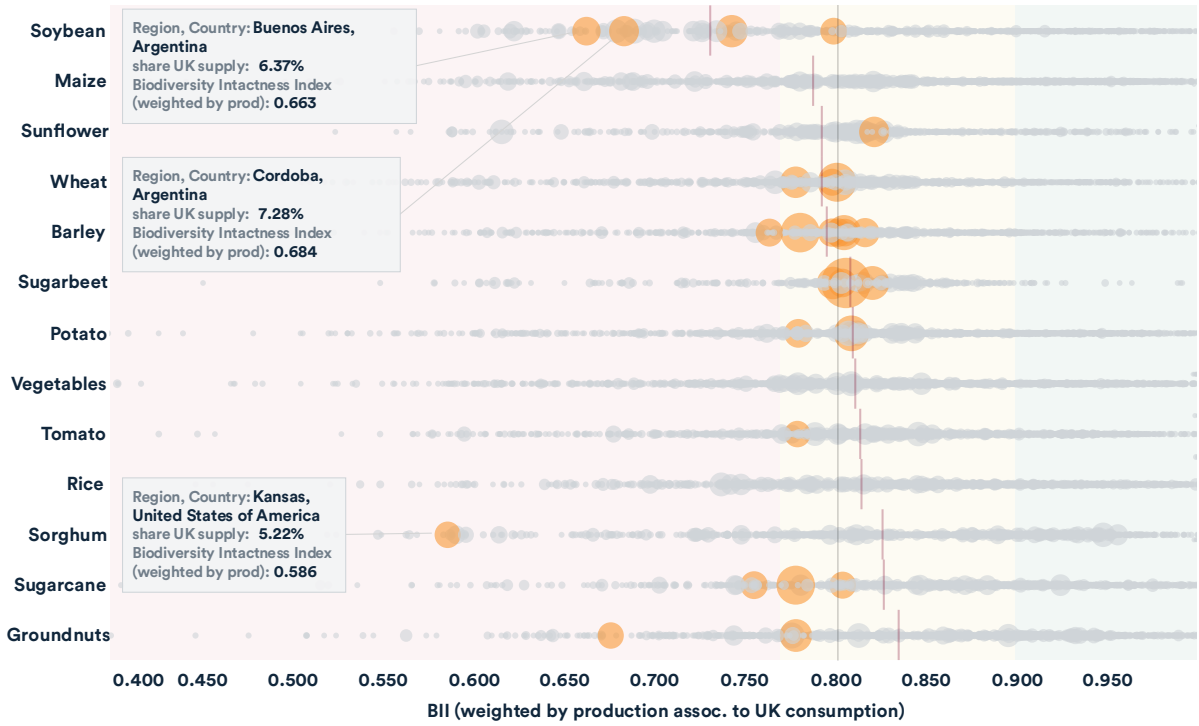
Nature loss indicators

Biodiversity

The first measure of nature loss, the Biodiversity Intactness Index (BII) concerns the degree to which biodiversity around the world remains intact. A lower BII reflects a higher loss in biodiversity.

Figure 4. plots the BII for food production that forms part of the UK food consumption, broken down by product. The figure shows that the labour-intensive products, of the 13 analysed for this research, associated with the most profound reduction in biodiversity (a biodiversity intactness index of between 30% and 70%) are: soybeans, maize, sunflowers, and wheat. However, specific regions linked to other crops also have high BII reductions. For example, the production of sorghum in Kansas, a midwestern state in the US, which makes up 5.22% of UK food consumption, is associated with the lowest biodiversity intactness index, i.e. there has been a significant reduction of biodiversity in this region from which sorghum is being sourced.

Figure 4: Biodiversity Intactness Index (BII) weighted by production associated with UK consumption broken down by subnational administration and crop.



Note: The bubbles represent the producer data available for each region the crop is produced in; size is the share that makes up the UK supply (%); states with >5% of total production share are highlighted in orange; the red line is the BII weighted average by crop.

Land degradation

Land Degradation Debt (LDD) can be broken down into the following sub-categories: tree cover debt, soil erosion debt, above-ground carbon debt, and below-ground carbon debt.

Table 1: LDD indicators, their importance and environmental impact.

Land degradation debt sub-category	Importance and impact
Tree cover debt refers to the loss of forest and woodland areas due to activities like deforestation, land clearing for agriculture, urban expansion, or logging, which reduce the amount of land covered by trees.	When tree cover is lost, ecosystem services are diminished and the carbon stored in trees is often released as CO_2, contributing to overall greenhouse gas emissions and climate change. The standardised measure is hectares of tree cover loss.
Soil erosion debt refers to the loss of soil and its ability to support plant growth. Erosion occurs when wind, water, or tillage remove the top layer of soil, typically the most fertile and rich in organic matter.	This crucial layer contains nutrients, microorganisms, and organic material needed for plant growth. Patterns of erosion reduce the ability for soil to support crops, retain water, and sequester carbon. Progressive soil erosion diminishes agricultural productivity, increases vulnerability to drought, and releases greater volumes of carbon into the atmosphere. The standardised measure is in megagrams per hectare of erosion.
Above-ground carbon debt refers to the loss of carbon stored in vegetation, such as trees, shrubs, and other plants, due to land degradation activities like deforestation, logging, agriculture expansion, and fire.	When vegetation is removed or degraded, stored carbon is released into the atmosphere as carbon dioxide (CO_2). Vegetation not only captures carbon but also provides essential ecosystem services like water filtration, biodiversity habitats, and temperature regulation. When carbon-storing vegetation is lost, the ecosystem's resilience against climate change weakens, biodiversity suffers, and local climates may become more extreme. The standardised measure is in megagrams of carbon per hectare.
Below-ground carbon debt refers to the loss of carbon stored in the soil, often due to land degradation processes like deforestation, overgrazing, and unsustainable farming practices.	Soil holds a significant amount of carbon—often more than what is stored in above-ground vegetation. When soils are disturbed, the stored carbon is released into the atmosphere as carbon dioxide (CO_2), contributing to climate change. Soil carbon is critical for maintaining fertility, supporting plant growth, and regulating water cycles. Degraded soils lose this storage capacity, contributing more to global greenhouse gas levels and offering less resilience against climate-related impacts. Preserving soil carbon is thus key for both ecosystem health and climate stability, making below-ground carbon management an important factor in climate action and sustainable land use practices. The standardised measure is in megagrams of carbon per hectare.

Using these different measures of land degradation, Table 2 compares thirteen key commodities embedded in UK food consumption (selected largely due to data availability but representing 70-75% of all crops consumed in the UK[52]), expressed as % volume, as well as the labour intensity required for the production of each. For example, Table 2 shows that, in terms of soil erosion debt, 5% of all potato production consumed in the UK occurs in areas above the set soil erosion debt threshold (>10 Mg/ha - defined by the research team based on observations of the global percentiles for each indicator); and that same 5% of production accounts for 33% of AWU for potatoes. This indicates that areas above the threshold are more labour-intensive (either because yields are lower than the global average or AWU per hectare is higher).

The table shows that rice, sugarcane, and soybeans are the most common commodities with the worst ranking for the land degradation measures of soil erosion, tree cover loss, and above-ground carbon debt. Barley, wheat, potatoes, and sugar beet have the worst ranking for below-ground carbon debt.

Table 2: Land degradation, embedded commodities, and labour intensity.

	Soil erosion debt Threshold: >=10 Mg/ha				Tree cover debt Threshold: >=25 ha				Above-ground carbon debt Threshold: >=40 Mg C/ha				Below-ground carbon debt Threshold: >=20 Mg C/ha			
	Rank	Average value	% UK cons. > threshold	% AWU > threshold	Rank	Average value	% UK cons. > threshold	% AWU > threshold	Rank	Average value	% UK cons. > threshold	% AWU > threshold	Rank	Average value	% UK cons. > threshold	% AWU > threshold
Rice	1	8.9	32%	34%	1	17.9	23%	26%	1	46.6	52%	58%	9	5.2	0%	0%
Soybean	4	6.6	14%	22%	2	16.8	20%	16%	3	36.1	34%	44%	8	5.4	3%	1%
Sugarcane	2	8.7	28%	28%	3	15.4	12%	12%	2	39.4	49%	50%	13	3.5	0%	0%
Groundnuts	3	6.9	19%	20%	6	13.3	6%	6%	4	29.2	28%	37%	7	5.6	0%	0%
Maize	6	4.5	10%	28%	5	13.6	9%	11%	6	25.2	16%	33%	6	6	1%	0%
Barley	12	0.7	0%	7%	4	14	2%	2%	7	23.7	3%	4%	1	16.9	49%	35%
Potato	9	1.9	5%	33%	8	12.5	5%	13%	8	22.7	9%	27%	3	14	30%	7%
Vegetables	7	4.2	12%	24%	10	12.3	5%	9%	9	22.6	15%	28%	5	9.2	15%	3%
Sorghum	5	5.7	13%	17%	11	12.2	4%	2%	5	26.2	22%	29%	11	4.6	0%	0%
Wheat	11	1.3	2%	10%	7	12.7	1%	2%	10	21.2	3%	8%	4	12.7	30%	8%
Sugarbeet	13	0.6	0%	0%	9	12.4	4%	3%	11	21	4%	3%	2	14.3	30%	20%
Tomato	8	3.2	7%	15%	13	10.7	2%	4%	13	14.8	8%	16%	10	5.2	2%	0%
Sunflower	10	1.5	1%	14%	12	11.4	3%	3%	12	17.8	3%	22%	12	4.2	0%	0%

Note: The table includes the risk ranking (coloured box), index score (numerical ranking of crops from 1-13), average value of crop produced globally that contributes to each measure of land degradation (as per the unit provided e.g., Mg/hectare for soil erosion debt), % of crop consumed in the UK that is produced in areas above threshold for each measure of land degradation (as stated in the table, which has been defined by the research team based on observations of the global percentiles for each indicator), and % AWUs associated with the production of this crop in these areas above the threshold (with higher measures of land degradation). Areas above the threshold that are more labour-intensive could be a result of lower yields than the global average or have a higher AWU per hectare.

The analysis of climate change **hazards** and the different measures for nature loss demonstrates the varied impact of climate change across different commodities and geographical regions**. It highlights the need for food retailers to carefully map their supply chains to understand fully the impact of production of different commodities on the natural environment, the extent to which their production has an impact on climate change, the extent to which their production will in turn be impacted by climate change, and the associated impact on the livelihoods of workers involved the production of food commodities.**

Retailers can support and promote practices within their supply chains that protect and restore nature, i.e., supporting practices that promote biodiversity, restore tree cover, and improve soil health. In agriculture, such an approach requires, for example, a shift from industrial agriculture to agroecology[53]—a sustainable form of farming that applies ecological concepts that ensure agricultural systems are productive while also conserving natural resources.[54]

[52] These are rice, vegetables (including cauliflowers, broccoli, pumpkin, squash and gourds, cucumbers, gherkins, aubergine, chillies, peppers, green, leeks, other alliaceous vegetables, carrots, turnips and okra), sugarcane, maize, wheat, groundnuts, sorghum, potato, soybean, tomato, barley, sunflower, sugar beet.

[53] Food and Agriculture Organization of the United Nations (2019) *Agroecology knowledge hub.* https://www.fao.org/agroecology/overview/en/.

[54] Pretty, J., Garrity, D., Badola, H.K.; Barrett, M., Butler Flora, C., Cameron, C., Grist, N., Hepburn, L., Hilburn, H., Isham, A., et al. (2025). 'How the Concept of "Regenerative Good Growth" Could Help Increase Public and Policy Engagement and Speed Transitions to Net Zero and Nature Recovery,' *Sustainability*, 17: 849. https://doi.org/10.3390/su17030849.

To reduce the negative impact of climate change on people and avoid potential negative impacts of climate change mitigation measures, retailers must support farmers adequately to provide the necessary confidence to make this change. Such support includes training on agroecology techniques, financial support for transitions away from synthetic nitrogen fertilizers (e.g., it can take between two and three years to restore soil health), the provision of longer-term contracts to allow the time for increased investment in new ways of farming, and support for a wider range of products to reach new markets.[63]

Case study: Fresh produce, water scarcity, and indigenous rights in Ica, Peru

The Ica Valley in southern Peru is a key supplying region of UK-consumed blueberries, grapes and avocados, but faces an accelerating water crisis. Receiving just 8mm of rainfall annually, Ica depends on groundwater for over 90% of its irrigation. 55 Between 2017 and 2022, agricultural water demand surged from 373 to 483 million m³ per year, while over-extraction in 2022 alone equated to 219 Olympic-sized swimming pools daily. 56 Recharge is insufficient—some large farms require nearly six years to replace one year of water use. 57 Despite a formal ban, well drilling has increased, placing the Ica-Villacurí aquifer in terminal decline.

This extraction has acute social consequences. Indigenous communities, such as the Quechua-speaking people who previously used shallow hand-dug wells are now dependent on tanker deliveries, on which 700 families are totally reliant and for which many local Indigenous people survive on as little as 10L/day, 58 which is barely enough to meet basic hygiene needs. Nitrate contamination from fertiliser use has rendered many shallow wells unsafe for consumption, while both children and agricultural workers in affected communities experience widespread cases of chronic diarrhoea due to inadequate water, sanitation, and hygiene infrastructure. One report expressed sentiments of danger and a lack of dignity for workers on a large-scale farm due to the insufficient number of toilets, no handwashing facilities and a lack of women only toilets. 59

These conditions are closely linked to the rapid, unregulated expansion of the agro-export industry in Ica and an associated lack of due diligence and human rights auditing by international buyers. In addition, former projects such as the Choclococha Dam (diverting ancient Indigenous water flows in the wider region) have proceeded without Free, Prior and Informed Consent (FPIC), violating Peru's commitments under ILO Convention 169. 60 Community voices further underline the scale of injustice: "Only the agro-exporters can reach water now." 61

Retailers committed to a Just Transition must recognise their indirect role in exacerbating these risks. This includes requiring FPIC compliance from suppliers, restricting nitrate-based fertilisers, and investing in equitable water governance. Reviving ancestral recharge systems such as Amunas canals (pre-Incan infrastructure that redirects wet-season flows into infiltration basins) offers a low-cost, community-based response to aquifer depletion. 62 Supply chain sustainability in Ica depends not only on environmental metrics but also on whether the rights and resilience of local communities are meaningfully supported.

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[55] Salmoral G, Viñarta Carbó A, Zegarra E, Knox JW, Rey D. Reconciling irrigation demands for agricultural expansion with environmental sustainability - A preliminary assessment for the Ica Valley, Peru. Journal of Cleaner Production. 2020;276:123544. doi: 10.1016/j.jclepro.2020.123544

[56] Hepworth, N.D., Postigo, J., and Safford, D., 2023. How fair is our water footprint in Peru? The role of fresh fruit and vegetable production for export in Ica's water emergency, and lessons for sustainable water use in the global economy. Water Witness, Edinburgh UK.

[57] ANA. (2017). Estudio Hidrológico del Acuífero Ica: Memoria Final. Autoridad Nacional del Agua.

[58] Global Issues. (2023). *Water Stress, a Daily Problem in the Agro-Exporting South of Peru*.https://www.globalissues.org/news/2023/07/20/34306.

[59] Hepworth, N.D., Postigo, J., and Safford, D., 2023. How fair is our water footprint in Peru? The role of fresh fruit and vegetable production for export in Ica's water emergency, and lessons for sustainable water use in the global economy. Water Witness, Edinburgh UK.

[60] *Ibid*

[61] *Ibid*

[62] BBC Future. (2021). *Why Peru is reviving a pre-Incan technology for water.* https://www.bbc.co.uk/future/article/20210510-perus-urgent-search-for-slow-water.

[63] ActionAid. (2019). *Principles for a Just Transition in Agriculture*. p.16. https://actionaid.org/sites/default/files/publications/Principles%20for%20a%20just%20transition%20in%20agriculture_0.pdf.

Section 2: The human impact of climate change and nature loss

There is an emerging consensus that climate change has many different impacts on the human rights of workers and their communities in the global food system, with a disproportionate impact on those precarious workers vulnerable due to their gender, age, and socio-economic status.[64] The analysis below details the labour intensity required for the production of key food products consumed in the UK, and related risks for these workers. Labour intensity is a feature of food production processes, which varies across products and geographies owing to differences in factor endowments (the distribution of land, labour, and capital within a country at any given time)[65] and any investments in mechanisation and automation. Where high labour intensity is concentrated in those areas with multiple and high climate risks, there are more negative climate impacts on workers and their communities.

Key takeaways:

- Some crops such as rice, vegetables and sugarcane require more human labour to produce than others. The countries contributing the greatest labour intensity for UK food consumption, across the crops analysed, are India, Pakistan, Brazil, Thailand, and Vietnam.
- These countries have medium levels of both development and climate change vulnerability, where automation and technological advances remain comparatively low, producing strong demand for labour in the agricultural sector.
- Areas with high labour intensity are disproportionately at risk of the negative impacts of climate change, and therefore as the climate crisis grows, workers in these supply chains will experience climate impacts such as heat and water stress to a greater extent.
- The labour intensity required to produce food products, particularly those produced in regions most vulnerable to climate change, should therefore be a key consideration for food retailers when developing climate adaptation and mitigation plans. Simultaneously, climate change considerations should be made as part of human rights due diligence activities.

[64] See, e.g., van Dalen, K.R. et al. (2024). 'The 2024 Europe report of the Lancet Countdown on health and climate change: unprecedented warming demands unprecedented action,' *The Lancet Public Health*, 9 (7): e495 - e522; https://www.thelancet.com/journals/lanpub/article/PIIS2468-2667(24)00055-0/fulltext.

[65] In economics, factor endowments refer to the distribution of land, labour, and capital within a country at any given time. Developing and emerging economies tend to have labour-intensive production process, while middle-income and high-income countries tend to have more capital-intensive processes.

Food supply chains and labour

Sixty percent of the food consumed in the UK is produced domestically. Around 9% of the food produced in the UK is exported, while the production to supply ratio, a broad measure of national self-sufficiency, has over the last 20 years remained at 75%.[66] This ratio indicates that UK consumers demand a mix of products that are both grown in the UK and come from outside the UK, such as tropical fruits, meats, and certain vegetables.

The composition of the supply chains for the UK food retail sector, despite the high proportion of domestic production, is truly global, with source countries across a mix of commodities and processed foods drawn from all continents. Analysis of the volume of selected commodities consumed in the UK food market shows that the **goods with the highest consumption rates (by volume) are wheat, sugarcane, sugar beet, maize, other vegetables (excluding tomatoes), and potatoes, and those with the lowest are sorghum, groundnuts (i.e. peanuts), sunflower seeds, and tomatoes** (Figure 5, left panel).[67]

Analysis of labour intensity in the production of these goods, however, shows a very different picture. Using a standardised measure of the annual number of human hours required to produce one tonne of product (annual worker units, or AWUs),[68] labour intensity is the highest for rice, followed by sugarcane, vegetables, and maize (Figure 5, right hand panel), where the highest levels of labour intensity are found in Asia.

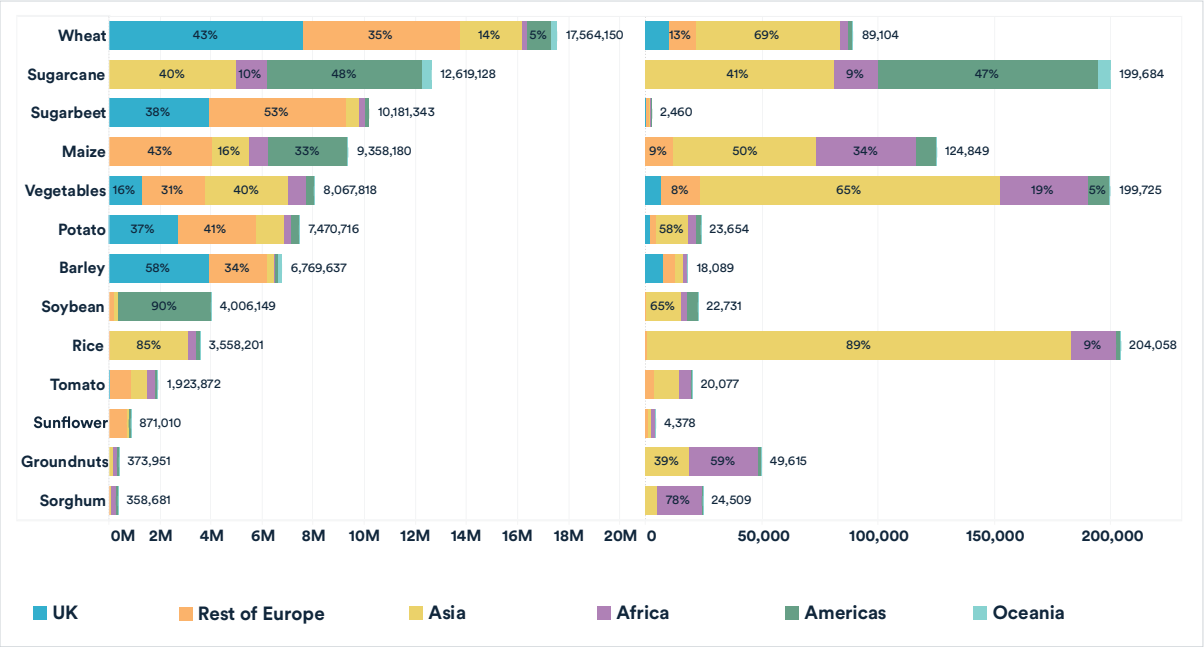
This data highlights that certain crops require more human labour to grow and produce than others, differences which vary by crop and where they are produced. Consequently, there may be a larger number of workers who are potentially impacted by climate change in these supply chains and who may be disproportionately affected by the implementation of any climate action plans in the food sector.

[66] DEFRA. (2021). *Official Statistics United Kingdom Food Security Report 2021: Theme 2: UK Food Supply Sources*. The production to supply ratio represents the farmgate value of raw food production divided by the value of raw food for human consumption, which can be used to compare the value of what is produced in the UK to what is consumed. https://www.gov.uk/government/statistics/united-kingdom-food-security-report-2021/united-kingdom-food-security-report-2021-theme-2-uk-food-supply-sources.

[67] UK food consumption data taken from Croft, S., West, C., Harris, M., Egan, C., Green, J., Molotoks, A., Wood, E. and Way, L. (2023). 'Technical documentation for an official statistic in development estimating the global environmental impacts of consumption: 2023 version', *JNCC Report 746, Peterborough: Joint Nature Conservation Committee (JNCC)*, ISSN 0963 8091.

[68] Annual worker units (AWUs) are the units of measurement of the amount of human labour provided on each agricultural holding. This unit is equivalent to the work of one person working full-time for one year. Labour requirements provide insights about the total work involved (normally invisible to consumers) in the production of commodities. The labour requirement is expressed as the number of full-time workers per annum and is smaller than the total number of people employed in agriculture which includes part-time, casual, or seasonal workers.

Figure 5: Volume (left panel) and labour intensity (right panel) for selected primary goods in UK food consumption.



To illustrate this disproportionality, the research for this briefing paper shows a total of 983,000 annual worker units are required to supply the top 13 crops and vegetables consumed in the UK (75% of total UK consumption). The top five sub-national locations with higher labour intensity are in Pakistan, India, Brazil, Thailand, and Vietnam, as follows:

1. **Pakistan, Punjab: 38,400 AWU; 35% for wheat, 28% sugarcane, 14% rice.**
2. **India, Uttar Pradesh: 26,700 AWU; 37% sugarcane, 23% vegetables, 20% wheat.**
3. **Brazil, São Paulo: 24,600 AWU; 98% sugarcane.**
4. **Thailand, North: 22,800 AWU; 58% rice, 28% sugarcane.**
5. **Vietnam, Mekong River Delta: 19,000 AWU; 68% rice, 24% vegetables.**

The contrast between the volume of commodities and labour intensity in their production is a first step in understanding the likely impact of climate change on workers.

Researchers have attempted to measure country efforts to address climate change and its impact on workers.[69] For example, the 'Just Transition Score' is a high level and aggregate indicator that provides insight into the degree to which countries are taking steps to effect climate change, as well as its related socio-economic impacts. The score is measured using data on CO_2 emissions and material consumption per capita, adjusted for social progress, biodiversity, and habitat. A high score means a country is achieving higher social progress and biodiversity protection with lower CO_2 emissions and overall material footprint.[70]

Table 3 summarises these scores for the top 20 countries with the highest labour intensity (AWUs) for the most consumed products in the UK (as detailed above). The combination of the score with our labour intensity measures shows that these scores do not necessarily correlate, i.e., countries with the highest labour intensity in food production are not necessarily the most advanced in terms of their efforts to address climate change and its related societal impacts. This means that retailers formulating climate action and human rights due diligence plans will need to consider the likelihood of such plans achieving their aims across these different country contexts. For example, within the top five countries in the table, Brazil has made greater strides in mitigating climate change combined with improved social progress than either China or India. Countries with a small UK sourcing footprint may

[69] Htitich, M., Krylová, P. Harmáček, J. (2024). 'Just Transition Score: Measuring the relative sustainability of social progress,' *Environmental and Sustainability Indicators*, 23: 100440; https://doi.org/10.1016/j.indic.2024.100440.
[70] *Ibid.*

be overlooked in climate change and human rights due diligence plans where AWU metrics (measurement of the amount of human labour required for production) in fact highlight that these are potential high-impact areas for climate action and transition activities and where due diligence is needed the most.

Table 3. Just Transition scores for top 20 supplier countries by labour intensity in food.

Country	Annual Worker Unit (AWU)	AWU (%)	Just Transition Score
China	130,169	17.39%	52.1
India	121,595	16.25%	63.5
Thailand	62,168	8.31%	75.9
Pakistan	54,997	7.35%	67.3
Brazil	47,260	6.31%	80.6
Bangladesh	47,204	6.31%	72.0
Nigeria	40,228	5.38%	71.6
Vietam	37,145	4.96%	73.7
Philippines	35,285	4.71%	79.3
Myanmar	33,442	4.47%	63.3
United Kingdom	26,812	3.58%	82.8
Tanzania	17,699	2.36%	80.1
Egypt	14,944	2.00%	70.4
Türkiye	14,104	1.88%	58.2
Nepal	13,458	1.80%	76.2
Ethiopia	13,159	1.76%	73.3
Colombia	10,506	1.40%	83.5
Italy	9,861	1.32%	84.2
Niger	9,689	1.29%	72.4
Argentina	8,663	1.16%	77.8

See Annex B for further analysis of the top 20 countries by volume of food embedded in UK consumption and the associated Just Transition scores, where the top performing countries with respect to Just Transition include the UK, France, and Brazil.

Case Study: Rice Production in India

Rice is a product that has experienced a significant growth of importance for UK food retailers. The diversification of cultures in the UK has led rice to become increasingly popular in the British diet, where the percentage of rice eaten per person per week in the UK has increased by 530% since the 1970s.[71] India is the second biggest rice-producing country in the world after China and contributes about 23% of total world output.[72] India is also a top exporter of rice to the UK. The UK imported 174 million pounds worth of rice from the region in the past year.[73]

Rice is grown in almost all the states and provinces of India, but more than 86% of the total production is from West Bengal, Andhra Pradesh, Tamil Nadu, Uttar Pradesh, Bihar, Orissa, Madhya Pradesh, Punjab, and Assam states.[74] Rice production, processing, and marketing constitute the biggest industry in the country.

Impact of climate change on rice production

Rice requires high temperatures and a large water supply to grow, with approximately 2,500 litres of water required per each 1kg of rice.[75] Around 90% of rice in India is grown in the southwest monsoon season between June and September. Climate change in India has become increasingly evident and is posing a threat to the reliability and security of rice cultivation. Climate change has resulted in delayed monsoons, and unpredictable and intense rainfall, resulting in either droughts or excessive flooding. By 2100 there is expected to be a 10-14% increase in the southwest monsoon rainfall in India due to climate change, significantly raising the risk of further flooding which may have a further negative impact on rice production. Both extremes—flooding and drought—have resulted in rice crops being destroyed or exhibiting significantly lower yields. Temperatures in India have also risen, and this unusual and prolonged heat can also have an impact on yields and create difficult working conditions.

Impact of heat stress on workers

A study on 248 rice mill workers conducted during the summer of 2016 in West Bengal, India's largest rice-producing state, showed that around 75% of rice farmers were male with an average age of 39, many of whom had only achieved a primary school level education or were illiterate and most were of a lower-middle socioeconomic status.[76] The majority of these workers spent 9 hours or more a day working in rice cultivation. Rising temperatures and intense outdoor work have resulted in workers suffering from exhaustion, digestive issues, and heat stress, ultimately reducing productivity. One study, carried out during 50 days between April and June of 2011, to coincide with the harvesting period before the monsoon arrived, assessed the impact of heat stress, cardiovascular problems, and work productivity on rice farmers in India.[77] They found that of the 124 male farmers interviewed, 72% reported they felt physical pain and 40% reported their work productivity had reduced owing to increased heat.

[71] The Rice Association. (n.d.). *Rice in the UK.* https://www.riceassociation.org.uk/rice-in-the-uk.
[72] Visual Capitalist (2022) *Visualizing the World's Biggest Rice Producers* https://www.visualcapitalist.com/worlds-biggest-rice-producers/.
[73] Observatory of Economic Complexity. (2025). *Rice in the United Kingdom: bilateral trade profile for the UK.* https://oec.world/en/profile/bilateral-product/rice/reporter/gbr.
[74] Rana, M.,Naskar, S., Roy, R.,Das, D.,Das, S.. (2018). 'Respiratory Morbidity among Rice Mill Workers in an Urban Area of Burdwan District, West Bengal: A Cross-sectional Study'. *Indian Journal of Occupational and Environmental Medicine.* 22. 5. 10.4103/ijoem.IJOEM_20_18.
[75] Surendran, U., et al. (2021). 'Use of Efficient Water Saving Techniques for Production of Rice in India under Climate Change Scenario: A Critical Review.' *Journal of Cleaner Production*, vol. 309. https://doi.org/10.1016/j.jclepro.2021.127272.
[76] Rana, M., Naskar, S.,Roy, R., Das, D., Das, S. (2018). 'Respiratory Morbidity among Rice Mill Workers in an Urban Area of Burdwan District, West Bengal: A Cross-sectional Study'. *Indian Journal of Occupational and Environmental Medicine.* 22. 5. 10.4103/ijoem.IJOEM_20_18.
[77] Sahu, S., Sett, M., Kjellstrom, T. (2013). 'Heat exposure, cardiovascular stress and work productivity in rice harvesters in India: implications for a climate change future'. *Ind Health*;51(4):424-31. doi: 10.2486/indhealth.2013-0006.

Insecure livelihoods

In 2023, over 50% of India's workforce was employed in agriculture, of which a significant number work in rice production. An increase in temperature, droughts, and flooding have led to reduced rice yields and reduced profits. Ritu Bharadwaj, a principal researcher at the International Institute for Environment and Development (IIED), described climate change as a 'stress multiplier,' reiterating that recurring droughts and extreme weather events worsen financial pressures that farmers are already experiencing. The IIED have even linked the increasing number of farmer suicides in recent years to financial burdens impacted by climate change. Farmers often take loans from banks and then from informal lenders, often with interest rates over 50% during the cultivation season to be able to afford their expenses and support themselves. Ganpatram Bedha, a 66-year-old farmer said, "I take one loan to repay another. If I don't do that, the bank will take away my land."[78] Many costs have increased for farmers, especially irrigation costs due to the lower volumes of rainfall. Coupled with reduced incomes, these lending patterns have continued cycles of indebtedness whilst increasing farmers' financial and emotional burdens.

With climate change reducing the ability to earn a stable income, many people are moving to the cities to work in more reliable industries. The share of the Indian workforce in agriculture in India has decreased from 75% to less than 50%.[79] Women are mostly left with farming work as men migrate, a trend the World Bank calls the 'feminization of agriculture.'[80] Older women are being left with highly intensive farming work, increasing their vulnerability to heat stress and long-term health problems.

[78] Context Thomson Reuters Foundation (2023). *Climate-Stressed Indian Farmers Seek to Escape Debt and Suicide*. https://www.context.news/climate-risks/climate-stressed-indian-farmers-seek-to-escape-debt-and-suicide.
[79] Data on employment comes from the Employment Unemployment Surveys (EUS) from 1973 to 2012 and the Periodic Labour Force Surveys (PLFS) from 2017 to 2024 from the National Sample Survey Office (NSSO). https://www.dataforindia.com/agriculture-shift/.
[80] World Bank. (2017). *Implementing the World Bank Group's gender strategy—From analysis to action to impact: Follow up note & action plan* (Report No. 112972) https://documents1.worldbank.org/curated/en/207211487843624375/pdf/112972-WP-P160179-PUBLIC-GFADRFollowUpNoteWBGGenderStrategy.pdf.

Initiatives to support farmers

While farmers are facing many financial pressures, the Indian Government has introduced initiatives to provide financial support to farmers and to promote sustainable farming practices, such as:

- Direct Financial Support through the Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) scheme, which transfers 6,000 rupees (approx. £51) to farmers' bank accounts in 3 separate instalments annually;[81]
- Minimum Support Prices (MSP's) guarantee minimum prices for 22 specific crops set by the Indian Government to support farmers, including rice;[82]
- Financial subsidies for the installation of micro-irrigation systems through the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) scheme, which increase water use efficiency by 55% for small farmers and 45% for other farmers;[83]
- Crop insurance, provided through the Pradhan Mantri Fasal Bima Yojana (PMFBY) scheme, offers protection to farmers from losses due to weather events including droughts and flooding.[84]

Despite these different measures, however, it has been suggested that these agricultural subsidies help consumers more than farmers in India.[85]

Techniques to mitigate and reduce climate change impacts from rice production include:

(1) Alternate Wetting and Drying (AWD, a water-management technique used in rice farming, in which rice fields are alternately flooded then dried out); (2) System of Rice Intensification (SRI, a sustainable farming method that reduces water and improves soil health);[86] (3) Integrated Pest Management,[87] fertiliser management, and the provision of access to clean drinking water and Personal Protective Equipment (PPE) for workers.

Each of these methods may have impacts on workers, e.g., they may require worker upskilling/training or may incur costs for the workforce, which should be considered ahead of implementation. See Annex C for further discussion on the environmental and human impacts of these different mitigation methods.

[81] National Portal of India (n.d.) *PM-Kisan Samman Nidhi* https://services.india.gov.in/service/detail/pm-kisan-samman-nidhi
[82] Ministry of Agriculture & Farmers Welfare. (2025). *Crops under MSP*. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2112407
[83] Ministry of Agriculture & Farmers Welfare. (2024). *Micro Irrigation*. https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2003188#:~:text=The%20Department%20of%20Agriculture%20&%20Farmers,farmers%20under%20the%20PDMC%20scheme.
[84] MyScheme. (2025). *Pradhan Mantri Fasal Bima Yojna (PMFBY)* https://www.myscheme.gov.in/schemes/pmfby.
[85] Buchholz, K. (2024). *Producers vs. Consumers: Who Do Ag Subsidies Support?* https://www.statista.com/chart/23733/agricultural-support-by-country-producers-consumers/.
[86] SRI 2030. (2022) *What is SRI?* https://www.sri-2030.org/what#what-is-sri.
[87] For further info on IPM, see Northern Ireland Department for Agriculture, Environment and Rural Affairs https://www.daera-ni.gov.uk/articles/integrated-pest-management.

Worker vulnerability to climate change impacts

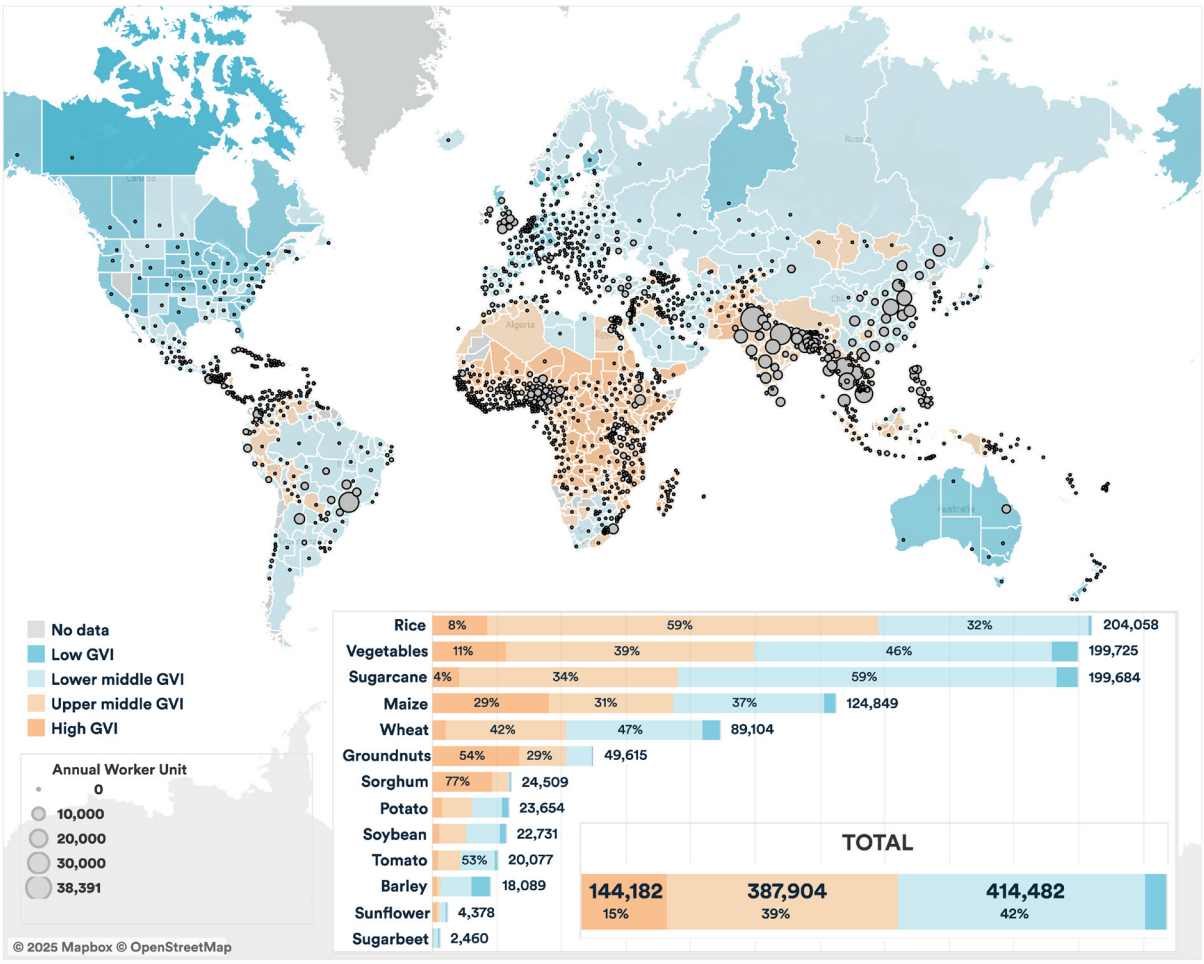
Labour intensity in the production of specific crops can then be further analysed and compared to levels of worker socio-economic vulnerability i.e. the extent to which workers may be vulnerable, due to their socio-economic status, to the impacts of climate change.

Using the Global Vulnerability Index (GVI),[88] which is a composite index that measures socio-economic vulnerability, our analysis shows that 15% of total full-time equivalent workers (144,000 AWU) are in locations with high socio-economic vulnerability, 40% in locations with upper-middle level vulnerability, 42% in locations with lower-middle levels of vulnerability, and 4% in locations with low levels of vulnerability.

Figure 6 shows that labour intensive production processes (illustrated in the figure as the larger circles) are often located in regions of the world where workers have higher levels of socio-economic vulnerability (displayed as orange on the map). For example, the map shows that rice production has both high labour intensity in South Asia (See also case study on India above) and high levels of worker vulnerability. This means that workers in the production of rice in India/South Asia may be less likely to cope with, and therefore be more vulnerable to, climate change impacts than those in Latin America.

These country and commodity differences, and different levels of worker vulnerabilities, need to be considered in the development of climate adaptation and mitigation plans, and in human rights due diligence.

Figure 6: Labour intensity for primary goods by level of global vulnerability to climate change.



[88] The Global Vulnerability Index (GVI) combines seven major socio-economic dimensions of vulnerability, including economy, education, health, the position of women, governance, demography, and infrastructure into a scale ranging from 0 (low vulnerability) to 100 (high vulnerability). See https://globaldatalab.org/gvi/.

Section 3: Climate change and modern slavery

Key takeaways:

- There are many clear links between the different dimensions of climate change and modern slavery. This is being more formally recognised across institutions such as the UN.
- It is estimated that 12.2 million workers in conditions of modern slavery are engaged in environmentally degrading activities, a significant proportion of which lay within the food supply sector.
- The linkages are understood to be a circular relationship, with many of the effects of climate change exacerbating the vulnerabilities of modern slavery. Modern slavery tends to be more prevalent in areas of cultivation and wider food processing activities that affect climate change in areas such as fisheries, fields, forests, and factories
- There is a double burden on workers in food supply chains who face both the adverse effects of climate change and expanding risks of modern slavery.
- Existing research illustrates this relationship across the world in countries such as Brazil, Cambodia, Costa Rica, Ethiopia, Gabon, Gambia, India, Kenya, Malaysia, Mexico, Morocco, Myanmar, New Zealand, Paraguay, Peru, the Philippines, and Spain.

Many of the dimensions of climate change considered above have additional complex relationships with modern slavery. These were made clear by UN Special Rapporteur on Human Rights and Climate Change at COP29 and have been included in her report to the 56th Session of the UN Human Rights Council.

> **"Significant guidance has been elaborated to ensure consideration of vulnerable human rights holders, which, read together, contributes to clarify intersectionality in climate change adaptation… The Special Rapporteur [on] trafficking in persons, especially women and children clarified that States, in the context of climate change, must recognize and effectively prevent the increased risks of exploitation faced by internally displaced persons and ensure effective protection for them and host communities… and that they integrate measures to prevent human trafficking arising in the context of climate change in their action plans, programmes and measures relating to women, peace and security.** [89]

There is a current estimate that 12.2 million workers who are in conditions of modern slavery are engaged in environmentally degrading activities, [90] where the production of the food supply comprises many of these activities.

Climate change and nature loss, in turn, increase vulnerability to modern slavery, while modern slavery tends to be more prevalent in areas of cultivation and other areas of food production that affect climate change, including across fisheries, fields, forests, and factories. [91] Moreover, these relationships are deeply embedded in global supply chains, where *'workers in these supply chains are doubly burdened – by the adverse effects of climate change and the risk of modern slavery.'* [92]

Figure 7 is a representation of these complex relationships, where modern slavery is present across different food groups within agricultural production. Various processes of production can lead to a range of direct consequences that affect land, soil, tree cover, etc. and outcomes that drive climate change, such as increased CO_2 emissions, excess freshwater use, increased levels of biochemicals, and an increase in what are known as 'novel entities,' which are newly introduced substances and materials that humans release into the environment. Examples of such novel entities with potential negative impacts include organic pollutants, genetically modified organisms (GMOs), nanomaterials, and microplastics. [93] Climate change itself can lead to slow onset events, such as drought, more immediate hazards, such as extreme weather events, and different adaptive responses. Climate change also increases risks across a range of vulnerabilities that are linked to an increase in the risk of modern slavery such as loss of livelihoods, food insecurity and forced migration. There is thus a circular relationship from modern slavery in agriculture through to climate change and back to modern slavery.

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[89] Morgera, E. (2024). *Report of the Special Rapporteur on the promotion and protection of human rights in the context of climate change: 56th session of the UN Human Rights Council, 18 June – 12 July 2024* (UN Doc. A/HRC/56/XX). United Nations. https://documents.un.org/doc/undoc/gen/g24/101/67/pdf/g2410167.pdf. See para. 42, 52, and 56, in particular.

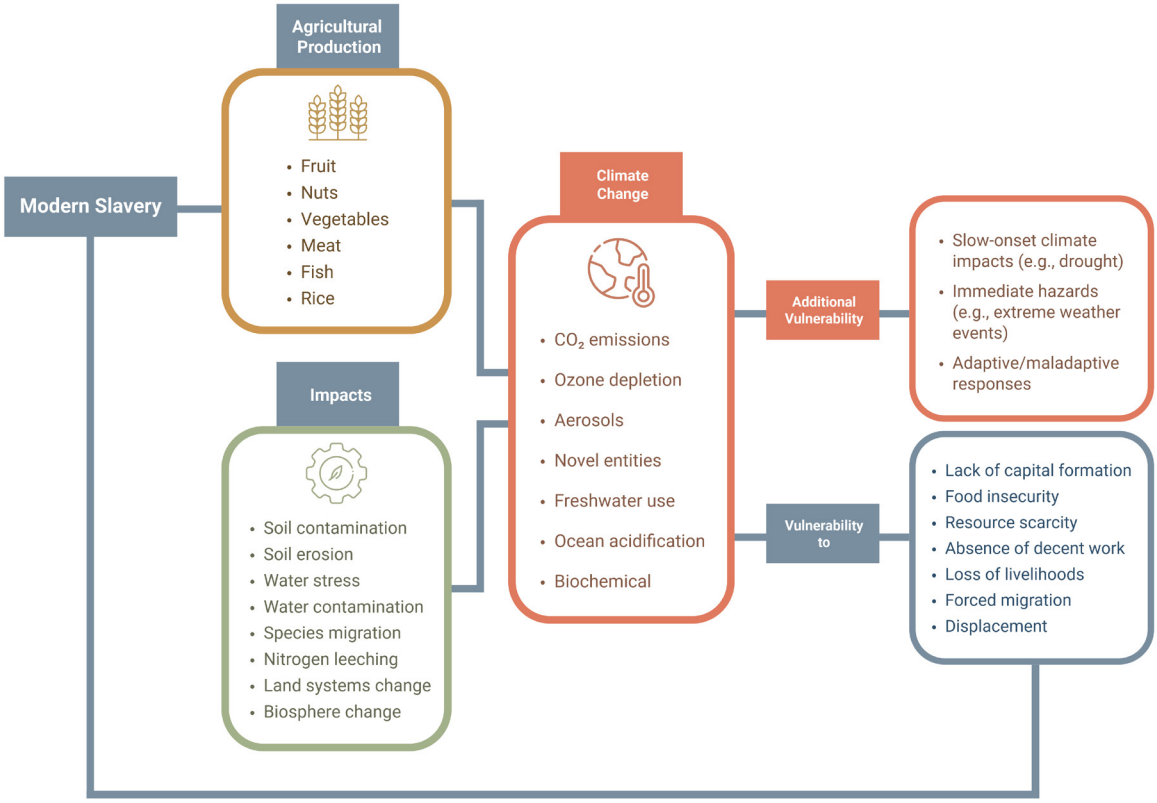
[90] Decker Sparks, J.L., Boyd, D.S., Jackson, B., Ives, C.D., Bales, K. (2021). 'Growing evidence of the interconnections between modern slavery, environmental degradation, and climate change,' *One Earth*, 4 (2): 181-191, https://doi.org/10.1016/j.oneear.2021.01.015.

[91] See, e.g., Jackson, B., Decker Sparks, J.L., Brown, C., and Boyd, D. S. (2020). 'Understanding the co-occurrence of tree loss and modern slavery to improve efficacy of conservation actions and policies,' *Conservation Science and Practice*, 2 (5): e183; https://doi.org/10.1111/csp2.183; Brown, D., Boyd, D. S., Brickell, K., Ives, C. D., Natarajan, N., and Parsons, L. (2021). 'Modern slavery, environmental degradation and climate change: Fisheries, field, forests and factories,' *Environment and Planning E: Nature and Space*, 4(2), 191-207. https://doi.org/10.1177/2514848619887156; Decker Sparks, J.L., Boyd, D.S., Jackson, B., Ives, C.D., and Bales, K. (2021). 'Growing evidence of the interconnections between modern slavery, environmental degradation, and climate change,' *One Earth*, (4)2: 181-191; https://doi.org/10.1016/j.oneear.2021.01.015; Jackson, B., and Decker Sparks, J. L. (2020). 'Ending slavery by decarbonisation? Exploring the nexus of modern slavery, deforestation, and climate change action via REDD+,' *Energy Research and Social Science*, 69: 101610. https://doi.org/10.1016/j.erss.2020.101610.

[92] Wang, Y. and Lotfi, M. (2024) 'How climate change and modern slavery interact in the supply chain: A conceptual model development through a systemic review,' *Business Ethics, the Environment, and Responsibility*, 2; https://doi.org/10.1111/beer.12722; Jackson, B., Weir, E., and Brotherton, V. (2024). 'Integrating Policies Addressing Modern Slavery and Climate Change, Research Report' *Modern Slavery and Human Rights Policy and Evidence Centre and Rights Lab*https://www.nottingham.ac.uk/research/beacons-of-excellence/rights-lab/resources/reports-and-briefings/2024/february/integrating-policies-full-report.pdf.

[93] Rejeski, D., Leonard, S., and Libre, C. (2018). 'Novel Entities and the GEF: Background Paper', *Environmental Law Institute* https://www.eli.org/sites/default/files/eli-pubs/stap-gef-novel-entities-report-2018.pdf.

Figure 7. Climate change, modern slavery, and agricultural production.[94]



Research shows that this circular relationship operates in many countries across the world, such as in Brazil, Cambodia, Costa Rica, Ethiopia, Gabon, Gambia, India, Kenya, Malaysia, Mexico, Myanmar, Morocco, New Zealand, Paraguay, Peru, the Philippines, and Spain. For example, rice production in Kenya has a high risk of forced labour, and its production faces challenges including biodiversity loss, deforestation, loss of vegetation, soil contamination, surface water pollution, floods and loss of livelihoods, as well as the use of swamps previously used for other agricultural products.[95] There is a similar pattern evidenced for rice production in the state of Pará in Brazil, which has affected indigenous groups through land dispossession and displacement, increased biodiversity loss, soil contamination, water pollution and degradation, loss of livelihoods, exposure to agrochemicals, and increased conflict.[96]

[94] Adapted from Jackson, B., Brotherton, V., Blackstone, N.T., and Decker Sparks, J.L. (2021). 'Modern slavery, environmental degradation and climate change: present and future pathways for addressing the nexus: Roundtable Report', *Nottingham: Rights Lab, with assistance from the World Wildlife Foundation and Alliance 8.7*, https://www.nottingham.ac.uk/research/beacons-of-excellence/rights-lab/resources/reports-and-briefings/2021/august/modern-slavery-environmental-degredation-and-climate-change.pdf. See also, Wang, Y. and Lotfi, M. (2024). 'How climate change and modern slavery interact in the supply chain: A conceptual model development through a systemic review,' *Business Ethics, the Environment, and Responsibility*, 10-12; https://doi.org/10.1111/beer.12722.

[95] Global Atlas of Environmental Justice. (2023). *Yala Swamp, Large scale farming, Kenya*. https://ejatlas.org/conflict/yala-swamp-large-scale-farming-kenya.

[96] Global Atlas of Environmental Justice. (2022). *Rice monocultures and land conflicts with Quilombola communities in the Marajó archipelago, Pará, Brazil*, https://ejatlas.org/conflict/rice-plantations-in-the-marajo-island-para.

An illustrative example in the production of fruits and vegetables, is found in the Southern Cardamom REDD+[97] Project (SCRP) in Koh Kong Province, Cambodia, which has been criticised by Human Rights Watch, where there are high rates of deforestation, illegal logging, land dispossession, displacement, and the loss of traditional knowledge, practices, and cultures. The project has altered local community relations to ancestral lands, which lives in continuous fear of being subjected to law enforcement by the REDD+ project staff. The loss of livelihoods increases the risks of work insecurity, labour absenteeism, firings, unemployment, and the criminalisation of local livelihoods. Tensions in the area have resulted in increased militarization and police presence and violations of human rights.

Traditional practices of swidden agriculture (i.e., leaving large swaths of land bare for periods of time for the soil to recover) are increasingly being compromised, which undermines community livelihoods as they are highly dependent on agricultural yields. Stopping these swidden practices risks unsustainable extraction and depletion of natural resources, while increasing the risks of modern slavery.[98]

The production of soybeans in San Pedro, Paraguay has been linked to biodiversity loss, deforestation, loss of vegetation cover, and reduced ecological and hydrological connectivity[99]. In particular, the community of Colonia Barbero has been struggling against the monoculture expansion of soybean production and has criticized the company *Desarrollo Agrícola del Paraguay* (DAP) fors employing almost no local labour whilst using strong agrochemicals, polluting neighbouring plantations and the wider community. The pollution associated with their use of pesticides and mechanization techniques resulted in reports from locals over the negative impacts on their health and the health of their children, other crops and their livestock. The wider impacts of this include loss of livelihoods and risk of malnutrition, potentially resulting in an increased vulnerability to modern slavery.

Finally, the Fazenda Estrondo in Brazil is an agricultural complex for soy production, which gained notoriety for alleged land grabbing and incidences of labour exploitation and illegal deforestation. There has been biodiversity loss and vegetation cover degradation, as well as large-scale disturbance of hydro and geological systems, yielding reduced ecological and hydrological connectivity. Increased levels of desertification and drought have led to increased food insecurity, surface water pollution, air pollution from fires, and genetic contamination. The land now suffers from erosion and increased contamination has killed birds and trees and caused skin rashes within the population. The loss of livelihoods, malnutrition, lack of work security, labour absenteeism, firings, and unemployment have raised the risks of modern slavery.[100]

[97] REDD+ (Reducing Emissions from Deforestation and forest degradation in Developing countries) is a framework established as part of the UN Paris Agreement. The '+' stands for additional forest-related activities such as sustainable management, conservation and enhancement of forest carbon stocks.
[98] Global Atlas of Environmental Justice. (2024). *Southern Cardamom REDD+ Project, Cambodia* https://ejatlas.org/conflict/southern-cardamom-redd-project.
[99] Global Atlas of Environmental Justice. (2023). *Resistance to soy monoculture expansion in Colonia Barbero, San Pedro, Paraguay*. https://ejatlas.org/conflict/resistance-to-soy-monoculture-expansion-in-colonia-barbero-san-pedro.
[100] Global Atlas of Environmental Justice. (2023). *Geraizeira communities against land enclosure through Fazenda Estrondo, Bahia, Brazil*. https://ejatlas.org/conflict/soy-expansion-and-violent-land-grabbing-at-fazenda-estrondo-bahia-brazil.

Section 4: Concluding recommendations for food retailers

As discussed in this briefing paper, the global agrifood sector is a significant contributor to climate change, and in turn experiences the many consequences of it. Crop yields are being reduced, and food security is at risk as the climate changes. Wider environmental damage and nature loss are also resulting from harmful and unsustainable agricultural practices. It is imperative that actors within the food sector, from growers and harvesters to suppliers and retailers, take steps to address and mitigate the damage caused to the environment if the collective ambition to achieve net zero by 2050, and significantly reduced emissions by 2030, is to be met.

The analysis in this report provides a break-down of the different impacts that climate change will have on nature, the environment, and on those working in food supply chains. It has sought to show that different foods will be impacted by climate change in different ways depending on their geographical location, and that the production of each crop will require differing levels of labour intensity for their production. Workers across food supply chains, due to their socio-economic status, but also depending on the mitigation and support measures provided by employers/governments/civil society, will be able to cope with the impacts of climate change to greater or lesser degrees.

This analysis, whilst not exhaustive, has attempted to show that there is no 'one size fits all' when it comes to developing a Just Transition in the food sector. Food retailers, when developing plans to adapt and mitigate climate change and conduct human rights due diligence, need to be cognisant of the nuance in current and projected climate and worker impacts across each of their supply chains, at different tiers.

Whilst this briefing paper has not sought to review and critique UK food retailers' efforts to understand and address human rights impacts for workers and their communities as part of their climate transition work, our analysis has highlighted a number of steps that all retailers should be taking, as a minimum, as they develop strategies to adapt and mitigate climate change. Collective action is a necessary facilitator for sustainable impact, of which partnerships and collaborative initiatives between retailers and wider stakeholders are essential. As such, the following recommendations could be implemented by retailers individually or in collaboration with others.

1. Map and prioritise risk

Food retailers should map their supply chains to identify products, sourcing regions and workers most at risk to the impacts of climate change and nature loss, adhering to the principles of risk mapping set out in the United Nation's Guiding Principles on Business and Human Rights (UNGPs)[101] (including identifying risks to workers by sector, nature of work, type of worker, employment relationships and labour market dynamics; assessing workers' ability to access rights to freedom of association and collective bargaining; and ranking risks by severity, scale and responsibility).

- Due diligence should consider the current climate impacts as well as forecasting future impacts as global temperatures rise.
- Consideration should be given to all aspects of the food production cycle (farming, harvesting and catching, transporting, processing, packaging, distributing, cooking, and waste disposal).
- Risk assessments and mapping should include analysis of regions most likely to be impacted by climate change, the number of workers likely to be affected, and the different ways in which their livelihoods and communities may be affected.
- Given the high number of products that retailers sell, mapping all supply chains will have serious resource implications. Retailers should therefore prioritise key products sourced from the most climate vulnerable regions.
- This mapping exercise will need to be repeated on a regular basis to account for the changing nature of the climate crisis, and the changes in practice across the food sector.

2. Encourage social dialogue

Retailers should cultivate opportunities to engage with workers and producers, and associated and representative organisations, across their supply chains to better understand the risks and opportunities associated with climate change and nature loss, ensuring that the voices of the most vulnerable workers i.e. women, children, migrant and seasonal workers, contract and agency workers and other marginalised groups, are heard. Retailers should make an organisational level commitment to supporting freedom of association and collective bargaining in their supply chains e.g., by developing and signing a Global Framework Agreement with a relevant international trade union federation, e.g., International Union of Farmworkers (IUF).[102]

- Dialogue with workers or their representatives in the regions most impacted by climate change should be prioritised.
- Consideration should be given to utilising NGO and trade union support to facilitate this engagement with workers, as well as utilising existing worker collectives/forums.
- For dialogue to be meaningful, retailers must be prepared to adopt and implement recommendations received. Decision-making should be transparent through engagement with suppliers, producers and workers.

[101] United Nations. (2011). *Guiding Principles on Business and Human Rights.* https://www.ohchr.org/sites/default/files/documents/publications/guidingprinciplesbusinesshr_en.pdf.
[102] International Union of Farmworkers. (2020). *Agreements.* https://www.iuf.org/what-we-do/global-agreements/.

3. Conduct human rights impact assessments for climate change mitigation and adaptation activities

Retailers should carry out impact assessments of any potential changes to working practices, procurement practices and sourcing approaches on workers and their rights, including the impact of a 'responsible exit' from suppliers and geographical regions. Where potential negative consequences or human rights impacts are identified, steps should be taken to mitigate these, including by retailers either individually or in collaboration with other actors e.g., retailers may support the provision of education or skills training, or financial support and compensation, to workers to help them adapt to changing practices.

- Retailers should carry out evaluations that assess potential and actual human rights risks, and that put mitigation strategies in place.
- Retailers should follow OECD guidance on responsible disengagement where it is deemed that disengagement with a particular supplier is the best course of action.
- Retailers should consider the broader community when implementing climate transition activities since many crops have indirect industries that rely on food retailer business, such as locally sourced packaging, agrochemicals, engineers and exporters who are local and even the benefits business brings to local charities.
- Responsible exit and disengagement processes are fraught with difficulties concerning supplier sustainability and unintended consequences that need to be carefully managed.

4. Evaluate and report on the human rights impacts of their climate mitigation and adaptation activities

Retailers should not only evaluate and report on the activities undertaken to address climate change in their supply chains, but also on the impact these activities had on workers and their human rights, and the steps that have been taken by the business to address any negative impacts. Affected workers and local communities should be consulted as part of these evaluations. Simultaneously, evaluation and reporting on human rights due diligence should include potential climate change impacts. Retailers should encourage the practice of sharing any 'lessons learned,' providing examples of both successes and failures in their climate transition work from which other retailers and businesses can learn.

- Retailers should support the development of, and access to, grievance mechanisms for workers within their supply chains.
- Retailers must be open to feedback from aggrieved workers, and open to assessing links to and responsibility for grievances to ensure appropriate actions are taken.
- Retailers must be prepared to remediate harms that are directly linked to their supply chain. Remediation may include investment to restore soil, access to natural resources and address other climate issues, or the financial and social support needed to restore livelihoods. Responsibility for remediating harms may fall to multiple actors, e.g., several retailers that source from the same supplier/grower.

Annex A: International regulatory frameworks

The international environmental regime has become increasingly grounded in a combination of non-binding and binding instruments covering air and marine pollution, emissions, nature loss, and biodiversity, including the:

- 1972 Stockholm Declaration
- 1979 Geneva Convention on Transboundary Air Pollution
- 1985 Helsinki Protocol on the Reduction of Sulphur Emissions
- 1985 Vienna Convention on the Protection of the Ozone Layer
- 1988 Sofia Protocol concerning the Control of Emissions of Nitrogen Oxides and Their Transboundary Fluxes
- 1992 United Nations Framework Convention on Climate Change (UNFCCC)
- 1997 Kyoto Protocol
- 2009 Copenhagen Accord
- 2015 Paris Agreement

These instruments are complemented by the work of the Intergovernmental Panel on Climate Change (IPCC) and recurring global meetings of the Conference of Parties (COP1-29) operating under the auspices of the UNFCCC which have set targets for states to achieve net zero by 2050 and significantly reduced emissions by 2030.

Alongside a strict focus on the environment, increasingly since the 1972 Stockholm Declaration there have been efforts to combine attention both to the environment and human rights, such as provisions in the 1981 African Charter on People's and Human Rights, the 1989 San Salvador Protocol to the American Convention on Human Rights, the United Nations Millennium Development Goals (2000-2015) and the United Nations Sustainable Development Goals (2015-2030). At the international level there has then been a process of convergence over the past forty years between the international environmental regime and the international human rights regime, which align with the emergence and increasing acceptance of the concept of a Just Climate Transition.

Evolution of the international human rights regime

The international human rights regime comprises a body of international legal instruments that have codified and made legally binding an expanding set of human rights, including civil, political, social, economic, and minority rights. Beginning with the non-binding but historically fundamental 1948 Universal Declaration of Human Rights, the international regime has expanded its core instruments and optional protocols, such as the:

- 1966 International Covenant on Civil and Political Rights (ICCPR)
- 1966 International Covenant on Economic, Social and Cultural Rights (ICESCR)
- 1966 International Convention on the Elimination of All Forms of Racial Discrimination (CERD
- 1979 Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW)
- 1984 Convention Against Torture and Other forms of Cruel, Inhuman, or Degrading Treatment or Punishment (CAT)
- 1989 Convention on the Rights of the Child (CRC)

The regime is grounded in state ratification of the various instruments, which obliges them to respect, protect, and fulfil their human rights commitments and to adhere to the human rights principles of universality and inalienability, indivisibility, interdependence and interrelatedness, equality and non-discrimination, participation and inclusion, and accountability and the rule of law.

Outside these core international human rights instruments, there are additional instruments that have a direct bearing on the Just Climate Transition:

- 1989 International Labour Organization (ILO) Indigenous and Tribal People's Convention (C-169)
- 1990 International Convention on the Protection of the Rights of All Migrant Workers and Members of Their Families
- 2006 Convention on the Rights of Persons with Disabilities (CRPD)
- 2007 Declaration on the Rights of Indigenous Peoples (DRIP)

State participation in the international human regime varies from near universal ratification (> 95% of all UN states) of the Convention on the Rights of the Child (CRC) to lower rates of ratification (< 90%) for the other core instruments, where states parties are subject to monitoring from treaty bodies and other UN human rights mechanisms based in New York and Geneva. Since 1948, the international human rights regime has thus expanded in breadth (more countries participating) and depth (more human rights protected formally).

In addition to the international human rights regime, there are regional human rights regimes in Europe, the Americas, and Africa. In Europe, the United Kingdom is party to the 1951 European Convention on Human Rights (ECHR), the obligations under which were brought into domestic law through the 1998 Human Rights Act. The UK also passed the Modern Slavery Act 2015 (MSA), which addresses different slavery, forced labour, and human trafficking practices within the UK for national and foreign victims, with a specific provision requiring private companies with an annual turnover of more than £36 million to publish public Modern Slavery Statements on their efforts to combat modern slavery and ensure transparency in their supply chains.[103]

Human rights and environmental due diligence

The international environmental regime and the international human rights regime have traditionally been based on treaties between states and thus rely on state power and commitment for their effective implementation. The role of private actors has only recently been addressed through efforts that have evolved from voluntary codes of conduct under the auspices of bodies such as the UN Global Compact (UNGC), to greater attention on corporate responsibilities under the auspices of the UN Guiding Principles on Business and Human Rights (UNGPs), to the more recent promulgation of mandatory due diligence laws, such as the European Union's 2024 Corporate Social Responsibility Due Diligence Directive (CSDDD).[104]

Across these developments has been the recognition of the scale, reach, financial resources, and power of large transnational corporations (TNCs), many of which have revenues and annual turnover that is larger than the annual gross domestic product (GDP) of many countries. In international human rights, the international treaty system has historically subsumed private corporations under the state obligation to protect human rights, or the obligation to prevent third parties from violating human rights. The latest legal developments, however, recognise that private corporations should bear these responsibilities alongside the duties of states.

[103] For further information, see Comstock, A. (2022). 'Committed to Rights: UN Human Rights Treaties and Legal Paths for Commitment and Compliance', *Cambridge: Cambridge University Press*; Landman, T. and Garrington, C. (2022). 'The Rights Track: Sound Evidence on Human Rights and Modern Slavery', *London and New York: Anthem Press*, p. 8.
[104] Directive (EU) 2024/1760 of the European Parliament and of the Council of 13 June 2024 on corporate sustainability due diligence and amending Directive (EU) 2019/1937 and Regulation (EU) 2023/2859.

The EU's CSDDD brings together many of the concerns, commitments, requirements, and principles found in both the international human rights regime and the international environmental regime. Paragraph 16 of the preamble of the CSDDD states:

> **This Directive aims to ensure that companies active in the internal market contribute to sustainable development and the sustainability transition of economies and societies through the identification, and where necessary, prioritisation, prevention and mitigation, bringing to an end, minimisation and remediation of actual or potential adverse human rights and environmental impacts connected with companies' own operations, operations of their subsidiaries and of their business partners in the chains of activities of the companies, and ensuring that those affected by a failure to respect this duty have access to justice and legal remedies. This Directive is without prejudice to the responsibility of Member States to respect and protect human rights and the environment under international law.**

This text melds together state and non-state responsibility for sustainability transitions that minimise adverse impact of all company operations across their supply chains with regard to the environment and human rights. Its articles further specify that companies should have due regard for actual and potential human rights and environmental adverse impacts.

The United Kingdom is not a member state of the European Union; however, private corporations in the UK are supportive in large part for the introduction of mandatory due diligence laws like the CSDDD. The logic behind their support is that they would prefer a level playing field for all businesses such that no one company could avoid due diligence activity and any associated penalties for knowingly causing adverse impact on the environment or human rights. Independent crossbench peer Baroness Lola Young of Hornsey introduced the Commercial Organisation and Public Authorities Duty (COPAD) Bill in the last parliament (2019-2024), but after the 2024 general election, it has not been allocated a space for further deliberation.

For further reading on this topic, see:

- Krajewski, M. (2023). 'Mandatory Human Rights Due Diligence Laws: Blurring the Lines between State Duty to Protect and Corporate Responsibility to Respect?,' *Nordic Journal of Human Rights*, 41 (3): 265-278;
- Mende, J. (2023). 'Corporate Human Rights Responsibilities: Rethinking the Public-Private Divide,' *Nordic Journal of Human Rights*, 41 (3): 255-264; and,
- Ethical Trading Initiative. (2016). *Human Rights Due Diligence Framework*, London: Ethical Trading Initiative, available online: https://www.ethicaltrade.org/insights/resources/human-rights-due-diligence-framework.

Annex B: Just Transition score for top 20 countries by volume of food

Table B1: Top 20 countries by volume of food embedded in UK consumption and the associated country Just Transition scores.

Country name	Production embedded in UK consumption (ton)	(%)	Just Transition Score
United Kingdom	19,488,804	30.45%	82.8
France	6,049,458	9.45%	84.7
Brazil	4,981,840	7.78%	80.6
China	3,989,551	6.23%	52.1
India	3,303,598	5.16%	63.5
United States of America	2,871,725	4.49%	66.3
Ukraine	2,581,525	4.03%	79.5
Germany	2,448,295	3.82%	82
Argentina	2,204,596	3.44%	77.8
Poland	2,193,145	3.43%	80.6
Spain	1,921,154	3.00%	86
Netherlands	1,844,429	2.88%	77.3
Pakistan	1,762,375	2.75%	67.3
Thailand	1,582,767	2.47%	75.9
Türkiye	1,479,214	2.31%	58.2
Russian Federation	1,357,100	2.12%	70.1
Canada	1,143,808	1.79%	69.2
Egypt	1,042,278	1.63%	70.4
Vietnam	883,828	1.38%	73.7
Bangladesh	879,675	1.37%	72

Note: The score is measured using data on CO2 emissions and material consumption per capita, adjusted for social progress, biodiversity, and habitat. **A high score means a country is achieving higher social progress and biodiversity protection with lower CO2 emissions and material footprint.**

The table shows that efforts to address climate change and its societal impact are much stronger in the top countries by volume of food consumed (UK, France, and Brazil), while there is more limited progress in the next three countries (China, India, and the United States). The volume measures and their relationship to Just Transition scores exhibit a similar relationship as those for labour intensity (see Table 3).

See Htitich, M., Krylová, P. Harmáček, J. (2024). 'Just Transition Score: Measuring the relative sustainability of social progress,' *Environmental and Sustainability Indicators*, 23: 100440; https://doi.org/10.1016/j.indic.2024.100440.

Annex C: Climate mitigation measures in India's rice production

Techniques applied in the context of India's rice production to mitigate and reduce climate change impacts

Name	Method	Environmental Impact	Human Impact	Human Considerations
Alternate Wetting and Drying (AWD)	Alternate Wetting and Drying (AWD) is a water-management technique used in rice farming, in which rice fields are alternately flooded then dried out instead of constant flooding.	Reduces methane gas emissions by 30-70% without reducing yield.[105] Saves 30% of water required for rice farming.[106] Can increase nitrogen oxide emissions.	Less irrigation results in more groundwater supply for human use. Reduces the cost of irrigation.	Need for workers to be trained on AWD Techniques.[107, 108] Lack of financial incentives to make the switch to AWD (requires specific equipment).
Integrated Pest Management Program (IPM)	Involves practices to manage pests in an environmentally friendly manner whilst minimising health risks.[109] Includes practices to reduce the use of pesticides or to make pesticide use more effective.	Reduces pesticide pollution into the air, soil and water.	Reduces pesticide residue on crops minimising health risks.[110] Reduces pesticide costs for famers.	Requires workers to be trained on pest management techniques. Initial outlay costs are expensive.[111]
Fertiliser Management	Practices to make fertiliser treatments more effective, maximising yield and minimising environmental impact or reducing fertiliser use.	Reduced nitrogen oxide emissions. Reduced use of fertilisers can help prevent soil degradation.	Less risk of nitrogen pollution in the water. Reduced use of fertiliser results in lower costs for farmers.	Requires training. High quality or more sustainable fertilisers may be more expensive, and therefore unaffordable, for farmers.

[105] Climate & Clean Air Coalition. (2016). *Alternate Wetting and Drying Infographic.* https://www.ccacoalition.org/resources/alternate-wetting-and-drying-infographic.
[106] *Ibid*
[107]BBC News. (2023). *Back to the future for India's rice farmers.* https://www.bbc.co.uk/news/business-66323991.
[108] *Ibid*
[109] For further info on IPM, see Northern Ireland Department for Agriculture, Environment and Rural Affairs https://www.daera-ni.gov.uk/articles/integrated-pest-management.
[110] Practice Greenhealth. (2006). *10 Step guide to implementing an Integrated Pest Management Program.* https://practicegreenhealth.org/sites/default/files/pubs/epp/10Step_IPM_111910.pdf.
[111] *Ibid*

Access to clean drinking water	Water stations provided on rice fields to enable workers to drink water regularly.[112]	Reduces dehydration and heat stress in workers.	Reduces dehydration and heat stress in workers.	Water stations are not widely available in some areas in India.
Personal Protective Equipment (PPE)	Protective equipment to help shield rice farm workers from direct sun e.g., protective broad-brimmed hats cooling vests, head lamps to farm during evening (cooler hours).[113]		Reduces heat stress in workers.	Farmers may have to buy their own PPE, which for some may be unaffordable.
System of Rice Intensification (SRI)[114]	SRI is a sustainable farming method which focuses on techniques to reduce water use (often implements AWD), transplant young seedlings only, optimise space and improve soil health.	Reduces methane emissions up to 85%. Saves 30% of water required for rice farming.	Increases yield by 20-50% therefore increases income.[115] Reduces cost of irrigation, fertilisers and pesticide. Reduced workload for women as less seedlings are planted due to optimised spacing.	Skilled labour intensive initially. Lack of awareness on benefits of SRI. Lack of knowledge on SRI implementation. Lack of financial subsidies, availability of credit or reasonable support price.[116]

[112] Sahu S, Sett M, Kjellstrom T. (2013). 'Heat exposure, cardiovascular stress and work productivity in rice harvesters in India: implications for a climate change future'. *Ind Health*. 51(4):424-31.
[113] *Ibid*
[114] SRI-2030 (2023) *What is SRI?* https://www.sri-2030.org/what#what-is-sri.
[115] Behera, Soumya & Ghosh, Souvik & M., Esakkimuthu & Rakesh, Rayirala & Tripathy, Harihara & Rajasri, Simadri. (2024). 'IMPACT OF SRI ON FARMING OUTCOMES: Opportunities And Constraints Of Farmers In Odisha'. *PLANT ARCHIVES*. 25. 972-5210. 10.51470/PLANTARCHIVES.2025.v25.supplement-1.283.
[116] *Ibid*

Suggested further reading

Abram. S. et al. (2022). 'Just Transition: A Whole-Systems Approach to Decarbonisation,' *Climate Policy*, 22:8, 1033-1049.

Morena, E., Krause, D., and Stevis, D. (2022). *Just Transitions: Social Justice in the Shift Towards a Low-Carbon World*, London: Pluto Press.

Morrison, J. (2024). *The Just Transition: A Systems-Thinking Approach to Managing Climate Action*, London: Palgrave.

Stevis, D. (2023). *Just Transitions*, Cambridge: Cambridge University Press.

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rightslab@nottingham.ac.uk

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