The Environmental Impacts of Magdalen College's Food Consumption

Analysis and Recommendations

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CONSERVATION HIERARCHY

ICCS Interdisciplinary Centre for Conservation Science

UNIVERSITY OF OXFORD

1. Abstract:

1.1. Graphical Abstract:

1.2. In Brief:

- Current patterns of food consumption contribute to the climate and ecological emergency.
- Magdalen College has set two 2030 targets, namely net carbon zero and net biodiversity gain compared to a baseline of 2021.
- Achieving these goals will require the improvement and mitigation of the environmental impacts of the food it provides.
- This report estimated the impacts of food served at Magdalen College in a one-year period. The impacts were as follows:
    - **~164,000 m^2 land**, the equivalent of 23 football pitches.
    - **~93,000 kg CO_2e**, the equivalent of driving around the equator 19 times in a new diesel car.
    - **~453 kgPO_4e** into water systems.
    - **~214,000,000 l water**, the same as 86 Olympic swimming pools.
- Magdalen could use several methods to decrease these values, including refraining from serving the most impactful foods, reducing impacts by relying on best-practice suppliers and encouraging more sustainable choices. The most extreme option (e.g., a vegetarian Buttery), could save 83% of the land use and greenhouse gas emissions currently being generated by Magdalen, assuming no change in usage.
- However, in all scenarios, biodiversity and carbon offsetting will be required to reach Magdalen's 2030 goals with respect to food consumption. These interventions will require logistical and financial effort, and careful planning to ensure that the offset is appropriately designed and implemented.
- These stages of action can be summarised by the Four Steps For The Earth framework, also known as the 4Rs – Refrain, Reduce, Restore and Renew. This approach has been developed and used by the University of Oxford.
- Next steps for Magdalen could include…
    - Informing decision making by consulting the College community and calculating costs of each strategy.
    - Implementing interventions sooner rather than later to reduce cumulative carbon and biodiversity impacts.
    - Improving data monitoring of food served at Magdalen.

Contents:

2. Introduction:

2.1. The Links Between Climate, Food and Diet:

Human activities have directly caused fundamental shifts in planetary processes, resulting in a climate and ecological emergency. Agriculture alone is responsible for 21-37% of global greenhouse gas emissions,[1] uses around half of the Earth's habitable land surface[2] and accounts for about 70% of global freshwater use,[3] alongside acting as the principal driver of biodiversity loss and causing soil degradation, water and air pollution.[4] To make things worse, around one-third of food produced for human consumption globally being wasted.[5] Overall, current agricultural practices are causing irreversible damage to the planet, and their impacts alone would prevent the Paris Agreement's[6] goal of limiting climate change to 1.5°C.[7]

However, not all diets are equally environmentally damaging. Those rich in animal-based products, such as westernised diets, tend to have much greater environmental costs than plant-based alternatives because meat requires many more inputs (e.g., land, water and energy), and creates more waste (e.g., greenhouse gases) per calorie of food produced. To put this into context, Oxford researchers[8] have calculated that shifting current diets to avoid animal-based products would reduce agricultural land use by 76% and food-related greenhouse gas emissions by 49%. Similarly, foods like coffee, palm oil and chocolate that are produced in tropical biodiversity 'hotspots' are likely to have a strong impact on biodiversity as land is cleared to grow these crops. As with many foods, switching to more sustainable suppliers is an alternative way of limiting these foods' environmental footprints.

Alongside their environmental impacts, western diets are significant contributors to the burden of diseases such as diabetes, heart disease and some cancers, through insufficient consumption of fruit, vegetables and dietary fibre, and an excessive intake of red and processed meats.[9] Hence, for both environmental and health reasons, there is a need to transform consumption patterns, particularly in developed countries where diets are among the most unhealthy and environmentally damaging.

2.2. Aims:

Magdalen College has committed to reaching net zero carbon, and net biodiversity gain compared to a baseline of 2021, by 2030 (Magdalen College, 2020). The purpose of this report is to:

1. Provide a breakdown of the environmental impacts of Magdalen's canteen.
2. Present suggested mitigation strategies.

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[1] Rosenzweig, C. et al., 2020. Climate change responses benefit from a global food system approach. *Nature Food,* Volume 1, pp. 94-97. Available at: https://doi.org/10.1038/s43016-020-0031-z

[2] Ritchie, H. & Roser, M., 2019. *Land Use.* [Online]. Available at: https://ourworldindata.org/land-use. [Accessed 3 September 2021].

[3] FAO, 2017. *Water for Sustainable Food and Agriculture,* Rome: Food and Agriculture Organization of the United Nations. Available at: https://www.fao.org/3/i7959e/i7959e.pdf

[4] Benton, T. G. et al., 2021. *Food system impacts on biodiversity loss: Three levers for food system transformation in support of nature,* London: Chatham House. Available at: https://www.chathamhouse.org/sites/default/files/2021-02/2021-02-03-food-system-biodiversity-loss-benton-et-al_0.pdf

[5] FAO, 2011. *Global food losses and food waste - Extent, causes and prevention,* Rome: Food and Agriculture Organization of the United Nations. Available at: https://www.fao.org/3/i2697e/i2697e.pdf

[6] United Nations, 2015. *Paris Agreement,* Paris: United Nations. Available at: https://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf

[7] Clark, M. A. et al., 2020. Global food system emissions could preclude achieving the 1.5° and 2°C climate change targets. *Science,* 370(6517), pp. 705-708. Available at: https://doi.org/10.1126/science.aba7357

[8] Poore, J. & Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. *Science,* 360(6392), pp. 987-992. Available at: https://doi.org/10.1126/science.aaq0216

[9] Lim, S. S. et al., 2012. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet,* 380(9859), pp. 2224-2260. Available at: https://doi.org/10.1016/S0140-6736(12)61766-8

2.3. Environmental Metrics Used:

This analysis focused on calculating the impacts in terms of agricultural land used (m^2), greenhouse gases emitted (kg CO_2 equivalents), nutrients leached into water systems (g PO_4 equivalents) and water consumption (in litres, weighted by scarcity).

2.3.1. Biodiversity:

Biodiversity ('biological diversity') refers to the variety of living organisms at all scales, from within species to whole ecosystems. Humans are entirely dependent on the 'ecosystem services' that biodiversity provides, from the generation of oxygen by plants, the production of food and clean water, to the regulation of climate and disease.

Despite this, biodiversity is declining at a rate unprecedented in human history, threatening the provision of ecosystem services. The population sizes of mammals, birds, fish, amphibians and reptiles have declined by 68% since 1970,[10] with a quarter of species in most animal groups threatened with extinction and many more to join them in coming decades.[11] Food systems are the main cause of this decline. The conversion of land for agriculture and intensification of agriculture destroy the habitats and food sources that wildlife needs to survive. In the sea, over-fishing drives biodiversity loss. To prevent future agricultural expansion and to convert some agricultural land back to a more natural state, we will need to rely on foods with higher yields per unit of land. This report uses agricultural land used (m^2) as a proxy for biodiversity impacts; this is an incomplete measure of the actual biodiversity impacts of agriculture, but alternative metrics are controversial and/or complex to use. Alongside land use, biodiversity loss is driven by climate change, eutrophication and water consumption, as discussed below.

2.3.2. Greenhouse gases and climate change:

Human activities, including agriculture, have dramatically increased the concentration of greenhouse gases in the atmosphere. This enhances the 'greenhouse effect', warming the atmosphere above pre-industrial temperatures. The consequences of climate change are wide-ranging, affecting the physical environment through increased temperatures, severe weather, sea level rise and ocean acidification. Climate change is impacting humans by driving poverty, disease and threatening food security, and causing further biodiversity loss if species cannot move or adapt to the new conditions or if their habitats are destroyed by severe weather events.

2.3.3. Phosphate and eutrophication:

Phosphate (PO_4) is added as fertiliser to agricultural systems to increase yields. Alarmingly, mined phosphorus reserves are non-renewable, and we are running out – some estimates suggest economically viable supplies will be depleted within decades, with stark implications for food security.[12] Additionally, much of the phosphate applied in agriculture is lost to the environment and ends up polluting freshwater and marine systems. Alongside nitrates (also in fertilisers), this causes eutrophication: algae thrive on the increased nutrients, die, and are decomposed by bacteria that

[10] Almond, R. E. A., Grooten, M. & Petersen, T., 2020. *Living Planet Report 2020: Bending the curve of biodiversity loss,* Gland, Switzerland: WWF. Available at: https://f.hubspotusercontent20.net/hubfs/4783129/LPR/PDFs/ENGLISH-FULL.pdf

[11] Benton, T. G. et al., 2021. *Food system impacts on biodiversity loss: Three levers for food system transformation in support of nature,* London: Chatham House. Available at: https://www.chathamhouse.org/sites/default/files/2021-02/2021-02-03-food-system-biodiversity-loss-benton-et-al_0.pdf

[12] Childers, D. L., Corman, J., Edwards, M. & Elser, J. J., 2011. Sustainability Challenges of Phosphorus and Food: Solutions from Closing the Human Phosphorus Cycle. *BioScience,* 61(2), pp. 117-124. Available at: https://doi.org/10.1016/j.jclepro.2016.07.012

deplete the oxygen in the water, leaving ecological 'dead zones' in which little can survive. (See [13] for examples from the UK).

2.3.4. Water consumption:

Agriculture's dependence on water is triggering water scarcity in many regions – such as the drying of the Aral Sea in Central Asia, once the world's fourth largest lake – due to the removal of freshwater from rivers for irrigation.[14] Water scarcity directly affects aquatic organisms, as well as terrestrial species dependent on groundwater including crops, which suffer yield losses with insufficient water. In this report, water use is weighted by scarcity, because one litre of water from the Nile watershed does not compare to a litre from the Thames watershed, as water is much scarcer in Northeast Africa.

2.4. Mitigation Approach: the Mitigation and Conservation Hierarchy:

This report follows the Mitigation and Conservation Hierarchy as a tool to recommend mitigation steps. The Mitigation and Conservation Hierarchy provides an evidence-based, step-by-step framework to guide individuals, communities, organisations and governments to achieve environmental social governance goals. It recognises that negative impacts are inevitable, and first applies interventions that prevent harm, followed by compensatory actions, to achieve 'net positive outcomes for nature' and the climate.

The Hierarchy is being applied at the University by the Oxford Partnership for Operationalising the Conservation Hierarchy (OxPOCH). At Magdalen, the Mitigation and Conservation Hierarchy will allow the College to understand its current and past impacts relating to food consumption, outline strategies to reduce these impacts and to monitor these strategies as the College approaches its 2030 deadline.

Table 1 and *Figure 1* show the steps of the Mitigation and Conservation Hierarchy, which is based around the '4Rs': **refrain**, **reduce**, **restore** and **renew**:

Table 1: An explanation of the four steps of the Mitigation and Conservation Hierarchy, with a related example for each step.

Step	Description	Example
1. Refrain 	Avoid harmful actions as far as possible	Refrain from serving high impact foods (e.g., ruminant meat)
2. Reduce 	Minimise the impacts of remaining actions	Serve less high impact foods, switch to sustainable suppliers
3. Restore 	Make up for impacts themselves *where they are felt*.	Invest in restoring nature on the farms that food is purchased from
4. Renew 	Compensate remaining impacts (and more) through positive actions *elsewhere*	Biodiversity or carbon offsetting

[13] MacDonald, M. A., Densham, J. M., Davis, R. & Armstrong-Brown, S., 2006. Force-Feeding the Countryside: the impacts of nutrients on birds and other biodiversity: Evidence review, s.l.: RSPB. Available at: https://www.rspb.org.uk/globalassets/downloads/documents/positions/water-and-wetlands/force-feeding-the-countryside--the-impacts-of-nutrients-on-birds-and-other-biodiversity.pdf

[14] NASA, 2020. *A Dusty Day Over the Aral Sea.* [Online] Available at: https://earthobservatory.nasa.gov/images/146487/a-dusty-day-over-the-aral-sea. [Accessed 3 September 2021].

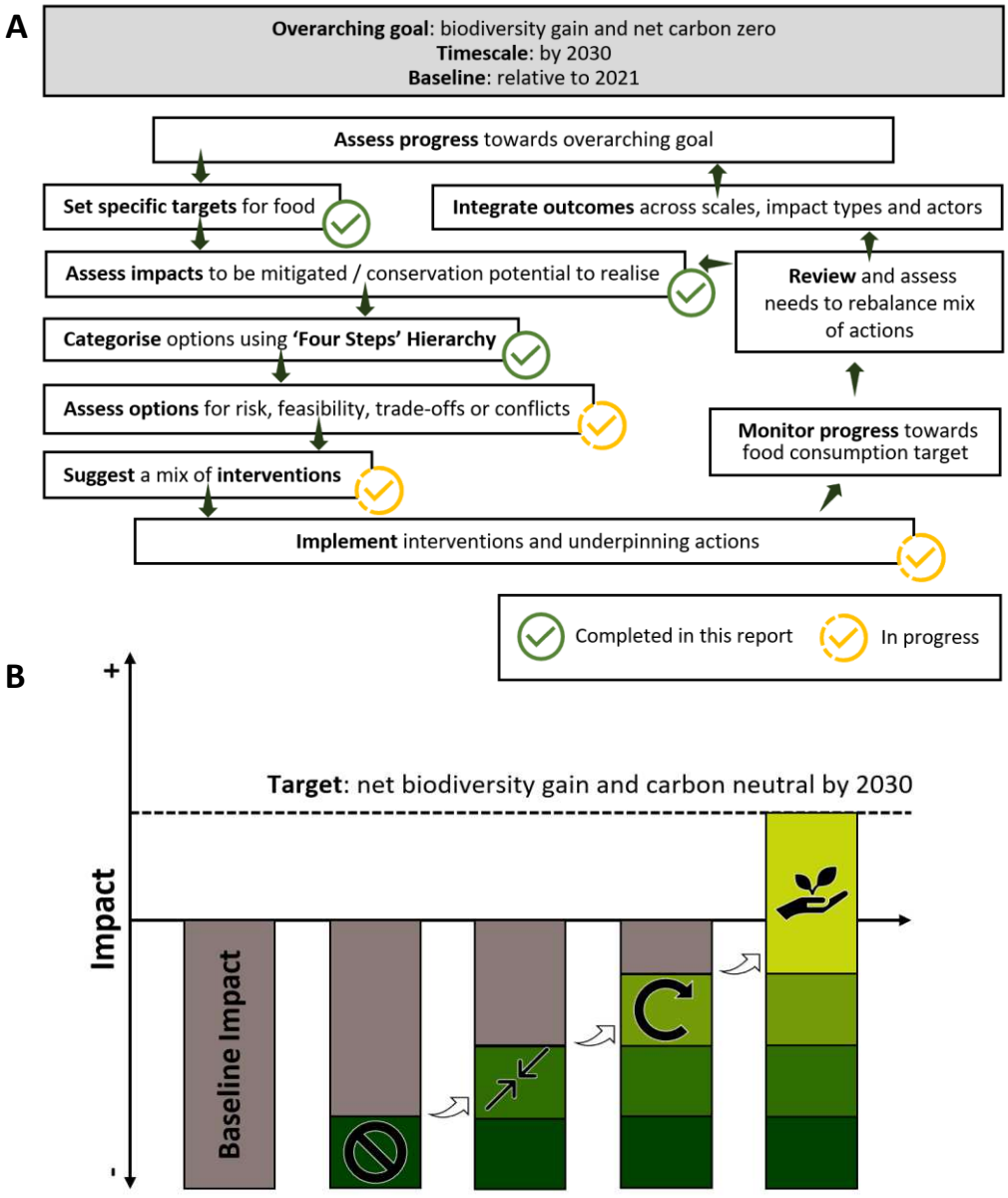

Figure 1: A: Flow chart depicting the application of the Mitigation and Conservation Pathway (green ticks indicate steps completed in this report and yellow ticks indicate steps in process). Adapted from [15]. B: Graphical representation of how the 'Four Steps' Hierarchy will allow Magdalen to reach its 2030 targets of net biodiversity gain and carbon neutrality.

3. Methods:

Estimating the environmental impact of Magdalen's food consumption involved three steps:

3.1. Collecting Data:

Due to time limitations, analysing data from an entire year was not possible. Hence, a study period comprising data from two recent, non-COVID terms (*Figure 2*) was chosen as a representative sample, which could be scaled up to estimate consumption for a whole year. Menu data from the Buttery (hall) were provided by Magdalen's catering services, and data on the main courses and desserts served were extracted. These were then matched with sales data from the College's Uniware EPoS system.

[15] Milner-Gulland, E. et al., 2021. Four steps for the Earth: mainstreaming the post-2020 global biodiversity framework. *One Earth,* 4(1), pp. 75-87. Available at: https://doi.org/10.1016/j.oneear.2020.12.011

To determine the impact from the OKB (College bar), sales data were used to extrapolate the number and type of main courses and hot drinks sold, since no menu records were kept.

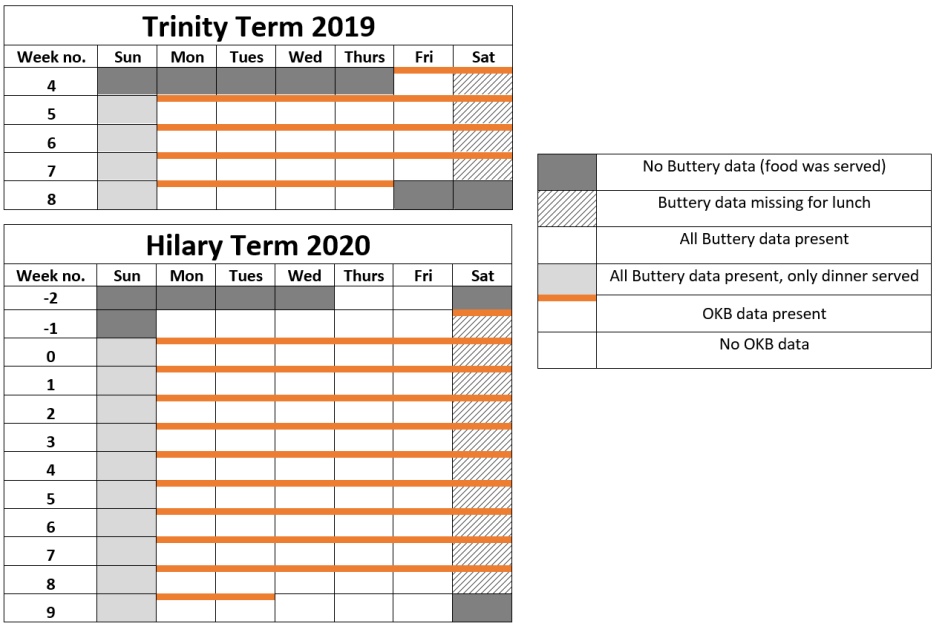

Figure 2: Data available per day of the research period.

3.2. Estimating Impacts:

Each food item was then matched to items for which environmental impacts across the supply chain have been calculated. This involved the use of two databases, primarily the foodDB database[16] containing information on supermarket ready meals (e.g., 'Roasted Vegetable Lasagne'), supplemented by a commodity level database[17] containing individual food items (e.g., 'Tomatoes').

3.3. Scaling Up Impacts:

Having summed the four environmental impacts for each food item considered within the period, the values were scaled up to obtain data for 24 weeks of Full Term, and around 6 weeks of vacation (more-or-less representing 0th and 9th week of each term).

3.4. Note on Difficulties and Uncertainties:

There were difficulties associated with this methodology and significant omissions, meaning that the report is likely to be an underestimation of Magdalen's food consumption's impacts.

Table 2: Difficulties associated with the methodology.

Issue	Description
Not all foods consumed were considered	Items extracted from the menus were: - Buttery: main courses and desserts for lunch and dinner - OKB: main courses (sandwiches, OKB, salads, jacket potatoes etc) and

[16] Further use of the snapshots is permitted for non-commercial research only. It is a pre-condition of use of these data extracts that the foodDB team in Oxford must be notified of any published reports or papers that use data from this project. Any such published reports or papers must cite the foodDB project, using the following reference: Harrington, R. A., Adhikari, V., Rayner, M. & Scarborough, P., 2019. Nutrient composition databases in the age of big data: foodDB, a comprehensive, real-time database infrastructure. *BMJ Open,* Volume 9, p. e026652. Available at: http://dx.doi.org/10.1136/bmjopen-2018-026652

[17] Poore, J. & Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. *Science,* 360(6392), pp. 987-992. Available at: https://doi.org/10.1126/science.aaq0216

	hot drinks (tea, coffee, hot chocolate) Hence, this did not include (due to time constraints or lack of data): - Buttery: breakfasts, sides from lunch and dinner, formal halls - OKB: sweet treats (e.g., cookies) - Any days with missing menus or sales data (see *Figure 2)* - Food consumed by College staff, academics, conference attendees, interview candidates etc., or by students in student kitchens
Databases	- The foodDB database relies on ready meal proxies, which is not always appropriate (e.g., all fish is assumed to be farmed, not wild) - The database uses global mean values – the suppliers that Magdalen uses might be more or less impactful than these values - Not all foods Magdalen consumes are represented in these databases (e.g., venison was discounted)
Scaling up	- Scaling up the research period to encompass one year assumes the time-period was an accurate representation of food consumed over one year
Metrics used	- The land-use metric used only represents present-day usage associated with a particular food, and does not account for past or future natural land clearance which is associated with some foods (e.g. coffee, palm oil)

4. Food Impacts at Magdalen:

4.1. Estimated environmental impact of Magdalen's food consumption over one year:

Over one year,[18] Magdalen served approx. 50,000 main courses, 6,500 desserts and 4,500 hot drinks in the Buttery (hall) and OKB (bar). Using global mean values for calculations, this is estimated to have:

- Required **~164,000 m²** of land, the equivalent of over two and a half times the area of Magdalen's Water Meadow, or 23 football pitches.
- Released **~93,000 kgCO_2e** into the atmosphere, corresponding to a volume that would fill up a container the size of Magdalen Tower 12.7 times at atmospheric pressure (*Figure 3*), or the equivalent of driving around the equator 19 times in a new diesel car.
- Leached **~453 kgPO_4e** into water systems.
- Used **~214,000,000 l water**, the same as 86 Olympic swimming pools or 48.6 Magdalen Towers.[19]

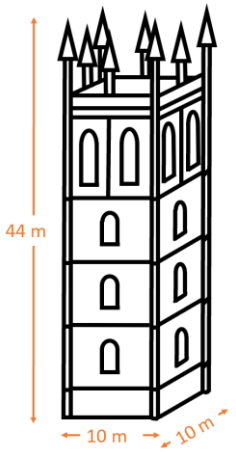

Figure 3: A container the size of Magdalen Tower.

[18] The study period was scaled up to encompass 24 weeks of Full Term and approximately 6 weeks of vacation; see Methods for foods considered.

[19] This value is weighted to take into account the region's water scarcity (using water is not necessarily bad by itself).

4.2. Impacts by dish:

The total contribution of each category to the total environmental impact over one year was quantified, shown in *Figure 4* for land use and greenhouse gas emissions.

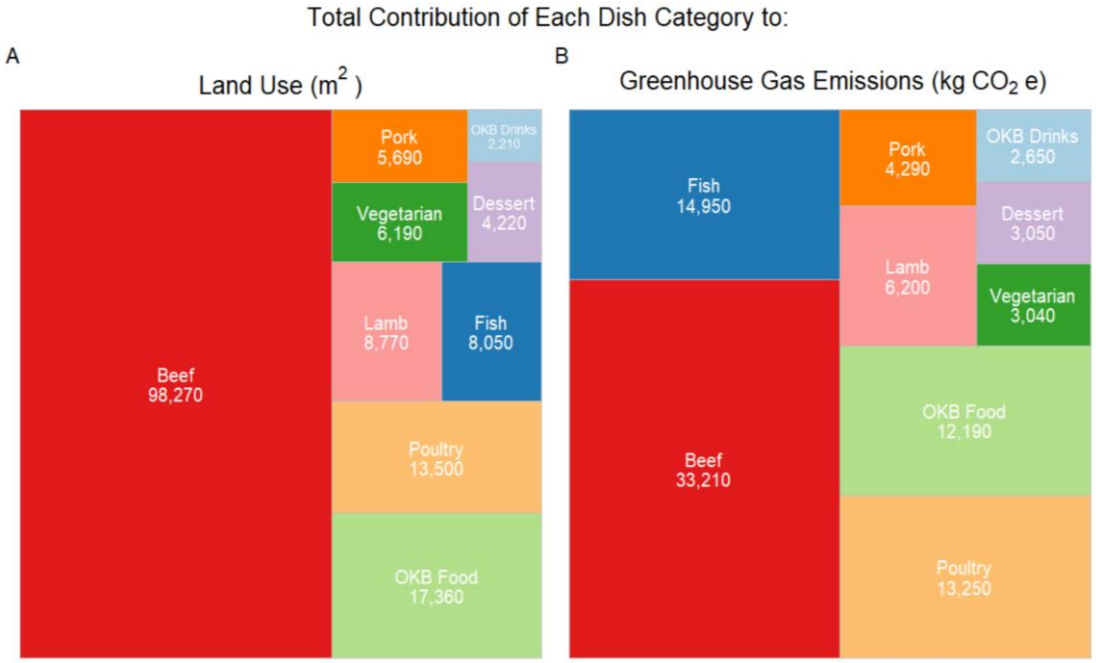

Figure 4: Total land use (A) and greenhouse gas emissions (B) accounted for by each category considered over the one year period considered.

Figure 4 immediately highlights the environmental footprint of Magdalen's beef consumption. In comparison, other animal products have smaller effects[20] while vegetarian meals are notably low impact.

However, each dish category was not sold equally, as a result of consumer preferences and menu design (*Figure 5*). Note that Magdalen serves much more beef than other colleges (e.g., roughly double that served by St Hilda's[21]).

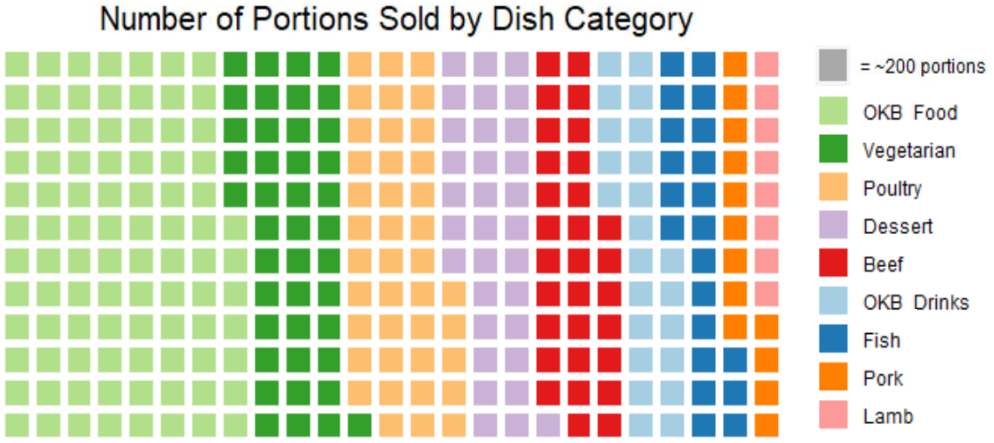

Figure 5: The number of portions of each dish category sold over one year. One square represents approximately 200 portions.

[20] The databases used to estimate the impact of fish assumes all fish is sourced from farmed aquacultural systems. However, around half of Magdalen's fish consumption is wild-caught – if this were incorporated, it would slightly reduce greenhouse gas impacts, and other impacts by around 50%.

[21] Gray, N., 2020. A Guide to Understanding and Reducing the Environmental Impact of Food at St Hilda's, Oxford: s.n. Available at: https://www.iccs.org.uk/sites/www.iccs.org.uk/files/inline-files/Hilda%27s Handbook_final.pdf

Hence, the impacts of each dish category per portion should be considered:

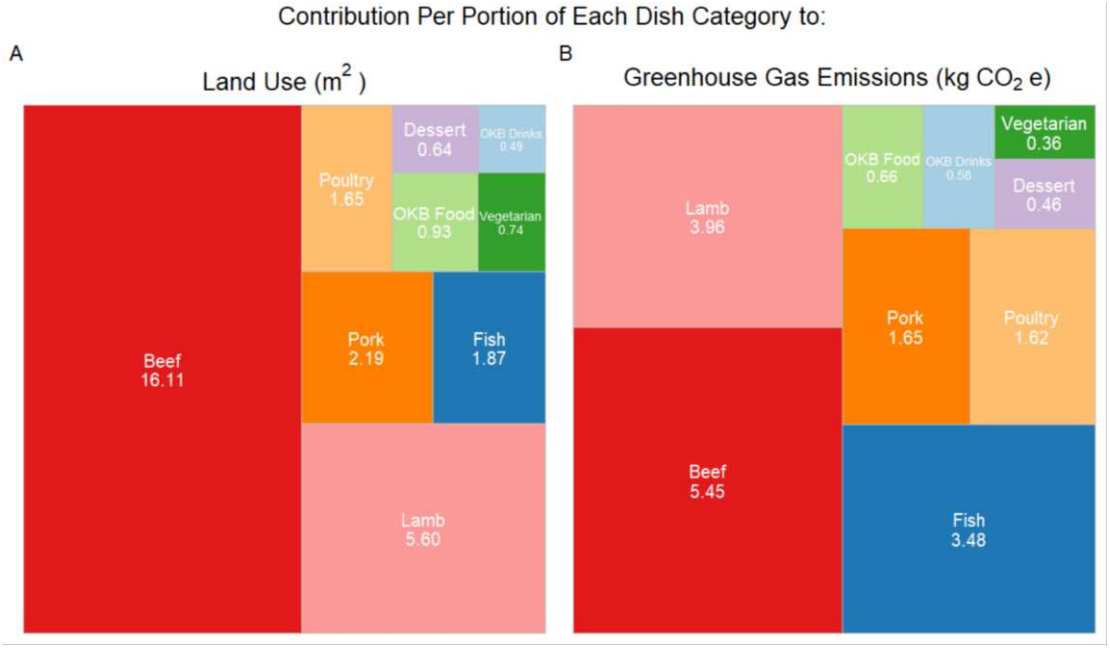

Figure 6: The average land use (A) and greenhouse gas emissions (B) accounted for by one portion of each category considered. Note that portion sizes differ.

In *Figure 6*, beef's impact remains clear. While beef makes up 19.6% of main courses sold in the Buttery, it uses 70.0% of the land and emits 44.3% of the greenhouse gases accounted for by Buttery main courses. The impacts of hot drinks look small on this graph because portion sizes are much smaller than for the other categories – in fact, an average OKB hot drink emits just over the amount of greenhouse gases accounted for by 100 g of beef. It also becomes apparent that the other meat categories (notably lamb) have a small total impact only because they are consumed less frequently, with the opposite being true for poultry. Comparatively, vegetarian main courses have very little impact, as does the food sold in the OKB.[22]

4.3. Possible Measures to Reduce Impact:

Many of these recommendations were extracted from the World Resources Institute Playbook for Plant-Rich Diets[23] and the Behavioural Insights Team's Menu for Change.[24] This section is organised with respect to the Mitigation and Conservation Hierarchy steps outlined in section 2.4 above.

4.3.1. Refrain: Avoid harmful actions as far as possible:

Refraining from serving high impact food types has the potential to greatly reduce Magdalen's environmental impact, relieving pressure from the compensatory stages. However, some of these options may be badly perceived, which could cause 'leakage' (consumers simply buying high-impact food or beverages elsewhere instead of eating in College) or could cause consumers to choose higher impact options (e.g., consumers might be willing to choose a high-dairy vegetarian option, but switch to a meat option if the high-dairy meal is not available).

In this section:

[22] Full data results are available in supplementary materials.

[23] Attwood, S. et al., 2020. *Playbook for Guiding Diners Toward Plant-Rich Dishes in Food Service,* Washington, DC: World Resources Institute. Available at: https://files.wri.org/d8/s3fs-public/19_Report_Playbook_Plant-Rich_Diets_final.pdf

[24] Park, T., 2020. *A Menu for Change: Using behavioural science to promote sustainable diets around the world,* London: The Behavioural Insights Team. Available at: https://www.bi.team/wp-content/uploads/2020/03/BIT_Report_A-Menu-for-Change_Webversion_2020.pdf.pdf

Table 3: The contents of the Refrain section.

Target	Approach
Meat	Refrain from serving meat, replace with plant-based alternatives
	Refrain from serving highest impact meats, replace with poultry alternatives
	Refrain from serving any meat on one additional day per week
Other environmentally damaging products	Refrain from serving hot drinks
	Refrain from serving the most impactful desserts
	Refrain from serving the most impactful vegetarian main courses

1. **Refrain from serving meat and replace with plant-based alternatives:**

Figure 7 shows the different scenarios by which Magdalen could refrain from serving meat, and the estimated savings on total land use and greenhouse gas emissions.

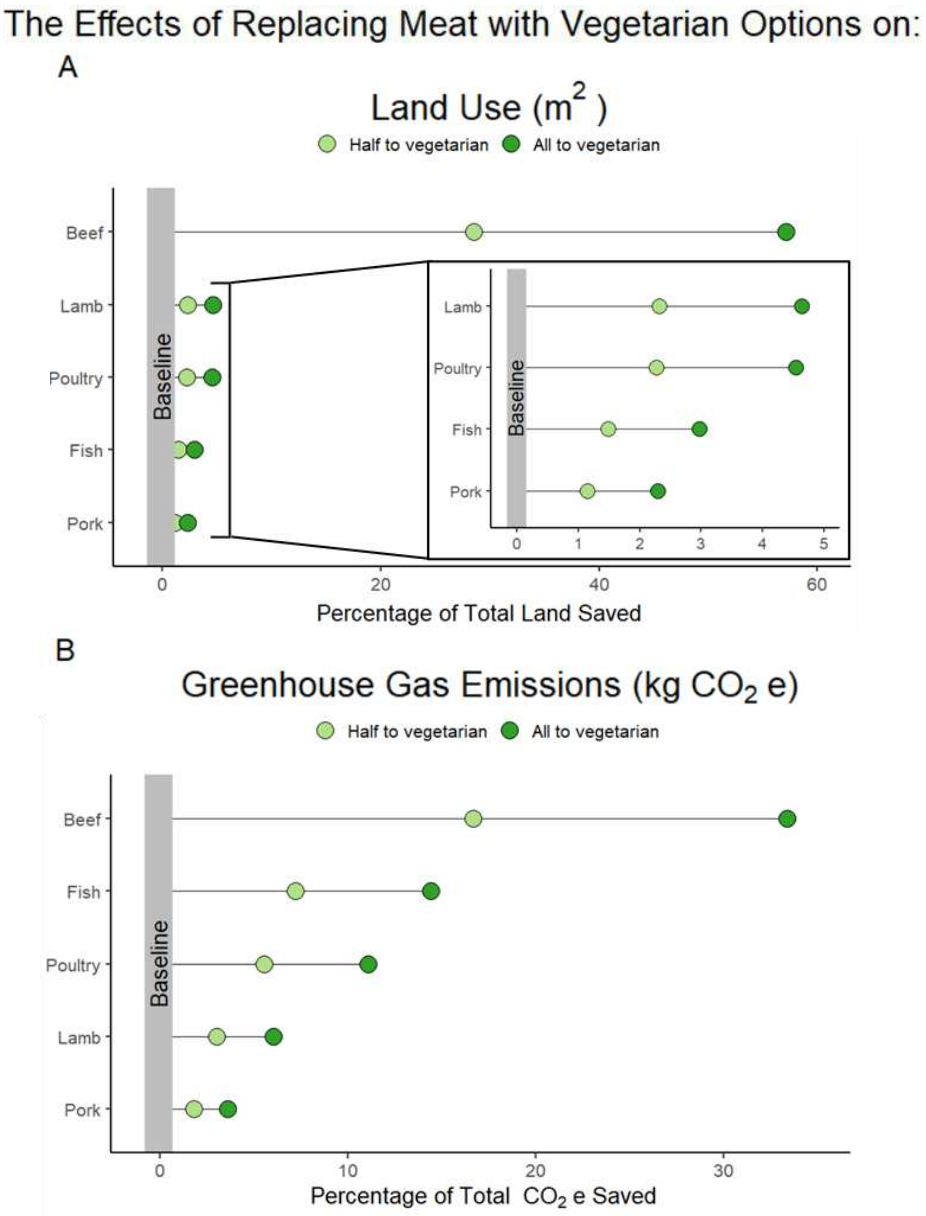

Figure 7: The effects of replacing all or half of meat Buttery main courses with vegetarian options on land use (A) and greenhouse gas emissions (B).

It is evident that replacing all beef mains with vegetarian options would be the most effective intervention, cutting 57.1% of land used and 33.4% of greenhouse gases emitted, though this would likely be badly perceived. The 'half to vegetarian' interventions are more likely to be well received – this could in part be achieved by always offering only one meat-based main course and two vegetarian options on the menu, rather than the opposite.

2. **Refrain from serving the more impactful meats and replace with poultry alternatives:**

In this less extreme scenario, the Buttery could instead replace beef mains with poultry mains, which would still achieve reductions of 53.7% and 25.1% in land use and greenhouse gas emissions respectively (*Figure 8*). Perception of this intervention would likely be better, particularly if only half of beef were replaced (this would simply make Magdalen's menus more in line with other colleges').

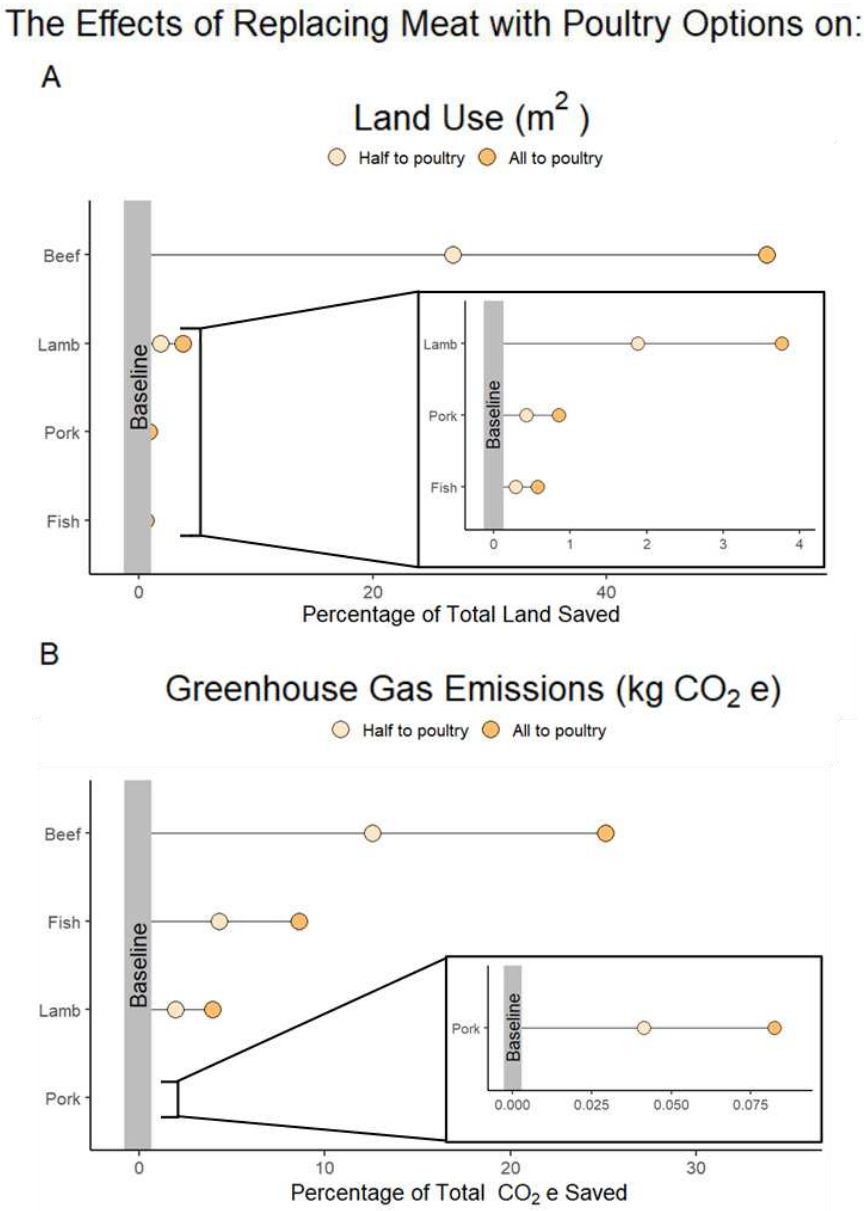

Figure 8: The effects of replacing all or half of meat Buttery main courses with poultry options on land use (A) and greenhouse gas emissions (B).

3. **Refrain from serving any meat on one additional day per week:**

This intervention would reduce Magdalen's land use by 11.9% and its greenhouse gas emissions by 11.4%. As discussed below in the reduce section, it would be best to keep this day 'silent' (do not advertise it), or if it must be advertised, use an alternative name to 'meat-free', such as 'green' or plant-based' to avoid connotations of incompleteness of the meal and abstinence from meat.

4. **Refrain from serving hot drinks:**

As shown in *Figure 6* above, hot drinks have higher impacts than we might expect. By removing the drinks machine in the OKB, Magdalen would reduce its total land use by 1.35% and greenhouse gas emissions by 2.86%. However, this is likely to be badly perceived and would probably lead consumers to buy these drinks elsewhere (e.g., Taylors or Pret a Manger), thereby not reducing impacts and potentially increasing them. Hence, it would probably be best to focus instead on reducing the impacts of hot drinks, by serving brands with an environmental commitment, particularly since there is a substantial difference between the more and less sustainable coffee, tea and hot chocolate suppliers.

5. **Refrain from serving the most impactful desserts:**

Desserts have quite different impacts depending on their ingredients, as shown in *Figure 9*.[25] Switching from all chocolate-based desserts to fruit-based would cut dessert emissions by 34.6% and 22.9% for land use and greenhouse gas emissions respectively. From total emissions, this would save 0.68% of total land use and 0.75% of total greenhouse gases.

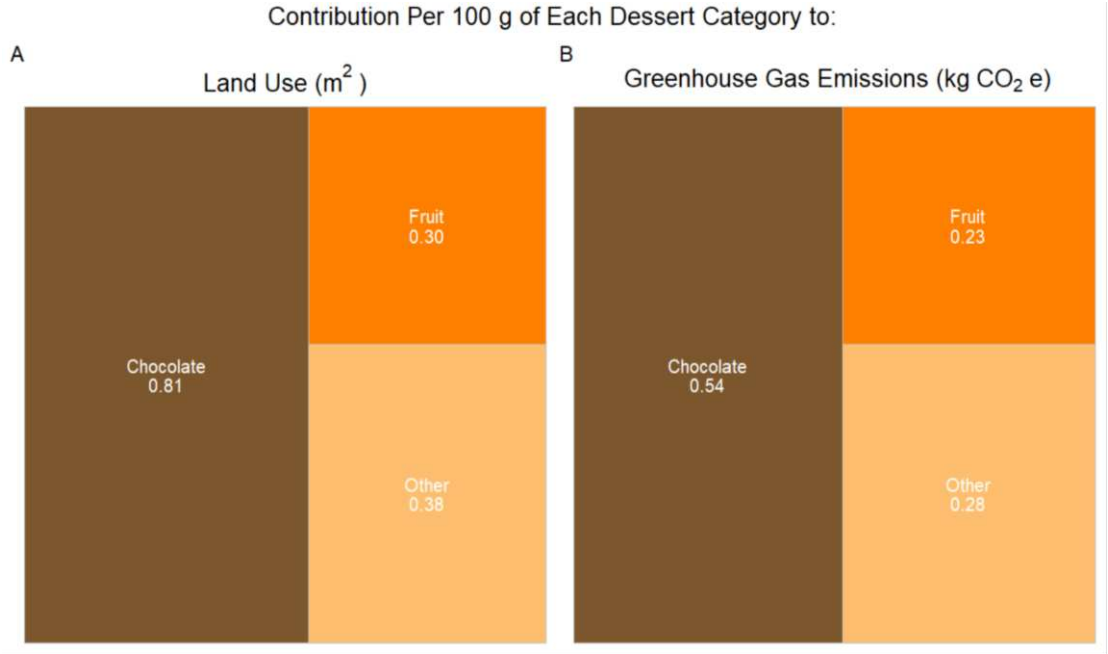

Figure 9: The average land use (A) and greenhouse gas emissions (B) per 100g of chocolate-based, desert-based and 'other' desserts.

6. **Refrain from serving the most impactful vegetarian main courses:**

As with desserts, vegetarian meals have different impacts depending on their ingredients (*Figure 10*).

[25] The 'Other' desserts category refers to desserts based around ingredients like toffee, pecans, ginger etc.

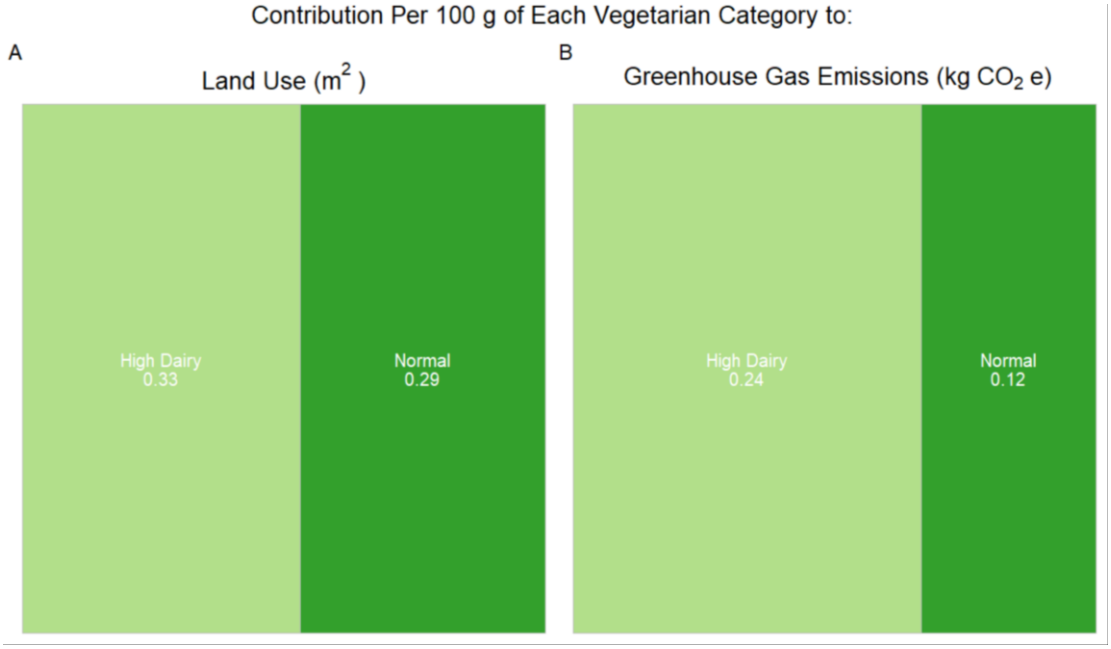

Figure 10: The average land use (A) and greenhouse gas emissions (B) per 100g of vegetarian main courses that are particularly high in dairy and those that are not.

Switching all vegetarian main courses with high dairy content (e.g. cheese-based) to those without would cut vegetarian main courses' emissions by 2.3% for land use and 15.1% for greenhouse gases (this equals 0.08% of total land use and 0.49% of total greenhouse gases). However, this intervention may backfire – consumers may be less likely to pick vegetarian options at all if they do not contain dairy.

4.3.2. Reduce: Minimise the impacts of remaining actions:

In this section:

Table 4: The contents of the Reduce section.

Target	Approach
Suppliers	Reduce impacts by switching to more sustainable suppliers
Food waste	Reduce food waste
Meat content	Reduce meat content in dishes
Increase attractiveness of low-impact foods	By changing composition of meals
	By smart placement of low-impact options in the displays
	Through menu design
	Through advertising, communications and events
	By providing a financial incentive
	Through encouragement by staff

1. Reduce impacts by switching to more sustainable[26] suppliers:

Switching to a sustainable beef supplier would evidently have a strong effect on its environmental footprint, reducing Magdalen's total land use by 48.3% and greenhouse gas emissions by 18.3% (*Figure 11*). Additionally, switching to sustainable fish and poultry suppliers would save 13.5% and 6.0% of total land use and greenhouse gas emissions. For hot drinks, a sustainable supplier reduces

[26] 'Sustainable' suppliers were assumed to be represented by the lower fifth percentile of global suppliers.

their impacts to 47.7% and 82.2% of mean suppliers' for land use and greenhouse gas emissions.

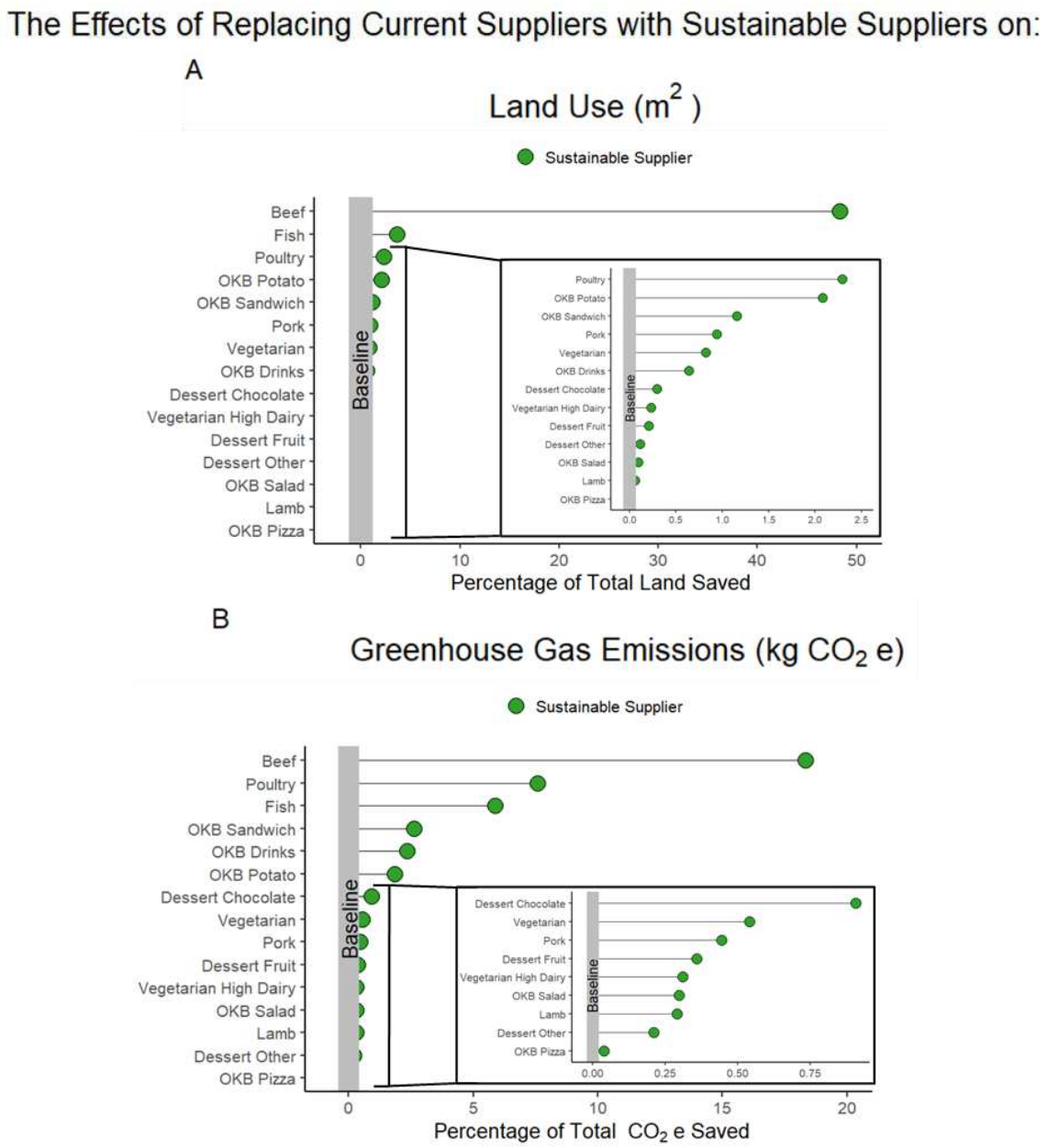

Figure 11: The effects of replacing mean suppliers with sustainable suppliers on land use (A) and greenhouse gas emissions (B); note that Magdalen already uses reasonably sustainable suppliers.

These interventions will have financial costs associated – this is significant as Magdalen's catering services already work within very tight margins, which currently limit how much they source from best-practice suppliers. However, if Magdalen were to replace high-impact meat with vegetarian (or poultry) options, this could save money that could then be spent on sourcing from sustainable suppliers. Note that Magdalen already sources its food through Foodbuy,[27] which have a focus on reducing their carbon emissions and a goal of net carbon neutrality by 2030 (biodiversity goals appear

[27] Foodbuy, n.d. *Sustainability.* [Online] Available at: https://www.foodbuy.co.uk/sustainability/. [Accessed 13 October 2021].

more limited).[28]

Switching suppliers will require careful consideration on a case-by-case basis, as the nature of the product dictates what should be prioritised. For instance, limiting greenhouse gas emissions of vegetables can often be achieved by sourcing locally (air-freighted products are particularly bad). However, this does not apply for products grown in heated greenhouses in the UK but cultivated in unheated greenhouses or open fields in Europe, such as tomatoes, peppers, cucumbers and aubergines. For example, tomatoes grown in unheated greenhouses in Spain have a 30 times lower impact, and those grown in open fields in Italy have a 78 times lower impact, than those grown in heated greenhouses in the UK – even including the additional road transportation required.[29] For beef, it is most important to switch to grass-fed beef (Pasture for Life[30]) to limit its land use and thus its impact on biodiversity. Coffee is best when it is 'shade-grown' Bird Friendly.[31]

It is noteworthy that even well-known certifications (such as Fairtrade or Rainforest Alliance-UTZ) have been criticised for not guaranteeing a lower environmental impact. For example, a meta-analysis of studies looking at the consequences of certification in the tropics found that only 36% of certified farms had significantly positive environmental impacts compared with non-certified farms, with the remaining 64% showing no significant difference.[32] Hence, relying on certifications to reduce impacts has a higher degree of environmental risk than refraining from serving those foods in the first place, and those used must be chosen carefully.

In terms of the environmental consequences of organic farming, there is a consensus that organic farms support higher biodiversity on and around the farms than conventional ones (e.g., 30% more species on average[33]), while the evidence on greenhouse gas emissions and eutrophication caused is mixed.[34] However, as yields tend to be 19-25% lower than in conventional farms, the increased biodiversity supported is counterbalanced by the additional land required to produce the same amount of food,[35] this is particularly problematic for foods from regions of high biodiversity (e.g. the tropics). Overall, at least some organic foods do not deserve their eco-friendly reputation.

2. Reduce food waste:

It should be noted that Magdalen already has good strategies in place to reduce food waste. There are a number of ways Magdalen could maintain and improve on this:

- Offer smaller portions at lower cost to accommodate those with small appetites.
- Continue using the UPAY booking system for hall meals to minimise food waste (though this

[28] Compass Group, 2020. *Sustainability Report 2020,* s.l.: s.n. Available at: https://www.compass-group.co.uk/media/4925/compass_sustainability_report_2020.pdf

[29] Frankowska, A., Jeswani, H. K. & Azapagic, A., 2019. Environmental impacts of vegetables consumption in the UK. *Science of the Total Environment,* Volume 682, pp. 80-105. Available at: https://doi.org/10.1016/j.scitotenv.2019.04.424

[30] Pasture for Life, 2021. *Certified 100% grass-fed beef, lamb and dairy products.* [Online] Available at: https://www.pastureforlife.org. [Accessed 4 September 2021].

[31] Smithsonian's National Zoo, n.d. *Where to Buy Bird Friendly Coffee.* [Online] Available at: https://nationalzoo.si.edu/migratory-birds/where-buy-bird-friendly-coffee. [Accessed 7 September 2021].

[32] DeFries, R. S. et al., 2017. Is voluntary certification of tropical agricultural commodities achieving sustainability goals for small-scale producers? A review of the evidence. *Environmental Research Letters,* 12(3), p. 033001. Available at: https://doi.org/10.1088/1748-9326/aa625e

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[34] Meemken, E. & Qaim, M., 2018. Organic Agriculture, Food Security, and the Environment. *Annual Review of Resource Economics,* Volume 10, pp. 39-63. Available at: https://doi.org/10.1146/annurev-resource-100517-023252

[35] This has grown into the 'land sharing vs land sparing' debate, a discussion of which would be beyond the scope of this report.

may face criticism from students in the future as it is rather unpopular).
- Continue to donate any excess foods to local charities when there is any, or
- Sell excess food cheaply through apps like Too Good to Go,[36] which is already widely used by students.
- Continue to flash freeze excess food that can be served in subsequent meals.

3. Reduce amount of meat in dishes:

Some of the meat in main courses could be replaced with vegetables or meat-alternatives, or plant-meat blended products (e.g., beef and mushroom burger blends). Reducing the amount of meat and replacing it with vegetable-based products would have similar impacts on land use and greenhouse gas emissions as those shown in *Figure 7.*

4. Increase attractiveness of low-impact foods:

These interventions aim to nudge consumers to choose plant-based foods, by making them sound more appealing, normal and easy to adopt, as promoted in [37].

Table 5: The various ways in which Magdalen could increase the attractiveness of low-impact foods.

Approach	Intervention
By changing the composition of meals (reformulating dishes or broadening the selection)	Improve flavour, texture and appearance of low-impact foods – this could involve extra training, as well as buying necessary equipment. This will be key to coax college members to make more sustainable choices.
	Maintain the new wider variety of plant-rich dishes at a given meal: there is a greater chance that consumers will pick a low-impact option if there is more choice, since they are more likely to come across something they really want.
	Extend plant-based alternatives to encompass new options that have recently become popular, since consumers are likely to choose brand names they have enjoyed elsewhere. Examples include Beyond Meat[38] (burgers served at Byron) and Impossible Foods[39] (burgers launched at Burger King) – both brands also sell other products like sausages and meatballs.
By smart placement of low-impact options in the displays	Put plant-based options first in the displays – this draws attention to them and prevents consumers from walking by without even considering them. When this was trialled at Magdalen, it worked extremely well to increase the uptake of plant-based options (preparation to ensure the vegetarian options will not run out will be required).
	Increase display space taken up by plant-based dishes – experiments[40] show that if consumers look at a food item for longer (no matter the reason), they are more likely to choose it.
Through menu	Promote low-impact food using tempting language on menus. Words

[36] Too Good To Go, n.d. The #1 Anti-Food Waste App. [Online] Available at: https://toogoodtogo.org/en/. [Accessed 7 September 2021].
[37] Park, T., 2020. *A Menu for Change: Using behavioural science to promote sustainable diets around the world,* London: The Behavioural Insights Team. Available at: https://www.bi.team/wp-content/uploads/2020/03/BIT_Report_A-Menu-for-Change_Webversion_2020.pdf.pdf
[38] Beyond Meat, 2021. *Bring Beyond Meat to Your Menu.* [Online] Available at: https://www.beyondmeat.com/food-service/. [Accessed 4 September 2021].
[39] Impossible Foods, 2021. *Sell Impossible.* [Online] Available at: https://impossiblefoods.com/sell-impossible. [Accessed 4 September 2021].
[40] Gidlöf, K., Anikin, A., Lingonblad, M. & Wallin, A., 2017. Looking is buying. How visual attention and choice are affected by consumer preferences and properties of the supermarket shelf. *Appetite,* Volume 116, pp. 29-38. Available at: https://doi.org/10.1016/j.appet.2017.04.020

design	highlighting flavour, cooking methods, appearance and geographic origins are most effective. Some real-world examples and increase in sales in various restaurants in the US and UK (from [41]): • *Mild and Sweet Chickpea and Potato Curry* (replacing *Chickpea and Potato Curry*) +108% in sales • *Melt in the mouth Gnocchi with Mushroom, Fresh Spinach and Creamy Parmesan Sauce* (replacing *Gnocchi with Mushroom, Fresh Spinach and Creamy Parmesan Sauce*) +14% • *Cuban Black Bean Soup* (replacing *Low Fat Vegetarian Black Bean Soup*) +13%
	Avoid language highlighting meals are vegetarian or healthy options – these are consistently shown to decrease uptake. Magdalen currently uses '(v)' to signify meals are vegetarian, which is thought to work better than 'vegetarian' or 'meat free' – but could trial labelling foods that contain meat, rather than the other way around. An example (from [42]): • *Zesty ginger-turmeric sweet potatoes* (replacing *Cholesterol-free sweet potatoes*) +41%
	Consider eco-labelling to communicate environmental impacts of different foods – this is thought to work well in educated, green-orientated demographics.[43] Alternatively, colour-coding menu items could be used (see [44]).
	List the least impactful options first on menus – consumers are most likely to choose default options, no matter how environmentally conscious they are.[45]
	Ensure menus are clearly posted in the Buttery so that diners know what they are choosing and do not just pick familiar meat options (i.e., ensure the menu always appears on the screen).
Through advertising, communications and events	Run promotions through advertising, social media and competitions. These could tie in with local, national and international campaigns, and should communicate a 're-branding' of plant-based foods as the desirable norm and focus on positivity and pride.
	Make use of freshers' week to establish new norms in new intakes.
	Offer free samples / taste-testing events (this could be done as part of unrelated Magdalen events to ensure high attendance).
	Introduce vegetarian formal halls.
By providing a financial incentive	Increase the price difference between low- and high-impact meals.
	Run price promotions on low-impact dishes.
	Run cross-product promotions (e.g., 'meal deals') on plant-based foods and

[41] Wise, J. & Vennard, D., 2019. *It's All in a Name: How to Boost the Sales of Plant-Based Menu Items.* [Online] Available at: https://www.wri.org/insights/its-all-name-how-boost-sales-plant-based-menu-items. [Accessed 30 August 2021].

[42] Turnwald, B. P., Boles, D. Z. & Crum, A. J., 2017. Association Between Indulgent Descriptions and Vegetable Consumption: Twisted Carrots and Dynamite Beets. *JAMA Internal Medicine,* 177(8), pp. 1216-1218. Available at: https://doi.org/10.1001/jamainternmed.2017.1637

[43] Schwartz, D., Loewenstein, G. & Agüero-Gaete, L., 2020. Encouraging pro-environmental behaviour through green identity labelling. *Nature Sustainability,* 3(9), pp. 1-7. Available at: https://doi.org/10.1038/s41893-020-0543-4

[44] Brunner, F., Kurz, V., Bryngelsson, D. & Hedenus, F., 2018. Carbon Label at a University Restaurant – Label Implementation and Evaluation. *Ecological Economics,* Volume 146, pp. 658-667. Available at: https://doi.org/10.1016/j.ecolecon.2017.12.012

[45] Campbell-Arvai, V., Arvai, J. & Kalof, L., 2012. Motivating Sustainable Food Choices: The Role of Nudges, Value Orientation, and Information Provision. *Environment and Behavior,* 46(4), pp. 453-475. Available at: https://doi.org/10.1177%2F0013916512469099

	side dishes or desserts or use loyalty stamp cards (this would work particularly well in the OKB and would probably be popular with students)
Through encouragement by staff	Provide serving staff with knowledge and talking points so they can encourage consumers to pick low-impact foods.

4.3.3. Restore: Make up for impacts themselves where they are felt:

It is important to note that Magdalen should not use offsetting as a substitute for reducing emissions directly – offsetting comes at much higher environmental risk. Choosing the right offsetting initiatives requires careful consideration[46] to ensure that the project is making a real difference – this also includes the project's broader social consequences (e.g. a clean cookstove project could reduce emissions and simultaneously alleviate poverty and improve household air quality, but a hydropower project might displace the local population and flood valuable agricultural land or natural ecosystems[47]).

1. **Biodiversity restoration:**

Invest in habitat restoration and rewilding in farms that food is being directly purchased from. This could also include providing expertise from the College community.

4.3.4. Renew: Compensate remaining impacts (and more) through positive actions elsewhere:

1. **Biodiversity restoration offsetting:**

Purchase or engage in biodiversity offsetting to mitigate remaining biodiversity impacts of food. As above, this could also include lending expertise.

2. **Carbon offsetting:**

Purchase carbon offsetting to mitigate remaining greenhouse gas impacts of food.

3. **Proactive actions:**

These are actions that do not necessarily mitigate impacts directly attributable to Magdalen, but will help Magdalen achieve positive environmental impacts overall.

- Improve monitoring of food procurement and waste.
- Increase Magdalen-based education and research into food systems and their environmental impacts.
- Launch a Magdalen vegetable garden, which could host gardening sessions as Welfare events.
- Educate the College community (particularly students) on how to cook low-impact foods through cooking guides, competitions and workshops.
- Encourage students to cook in College if not eating in Hall by improving kitchen facilities where necessary, as eating more home-cooked meals has been linked to a more plant-rich diet.[48]
- Engage with other Oxford colleges and other universities to share practices, tools and knowledge

[46] Offsetting certifications (such as Gold Standard or VCS) aim to ensure that projects meet rigorous criteria.
[47] Carbon Offset Guide, n.d. *How carbon offset programs address social and environmental harms.* [Online] Available at: https://www.offsetguide.org/high-quality-offsets/how-carbon-offset-programs-address-social-and-environmental-harms/ [Accessed 16 October 2021].
[48] Mills, S. et al., 2017. Frequency of eating home cooked meals and potential benefits for diet and health: cross-sectional analysis of a population-based cohort study. *International Journal of Behavioural Nutrition and Physical Activity,* 14(1), p. 109. Available at: https://doi.org/10.1186/s12966-017-0567-y

on increasing the sustainability of food consumption, in the UK and overseas – this can lead to greater sustainability, at lower costs, with positive social outcomes.

4.3.5. Possible Mitigation Strategies:

As outlined above, there is a wide range of interventions available to Magdalen College to allow it to achieve its biodiversity and carbon targets. These interventions are grouped in *Table 6* into five strategies with different levels of risk (financial, social and environmental).

Table 6: A description of each possible mitigation strategy.

Strategy		Description
A	Extreme	This (hypothetical) scenario asks how far Magdalen could mitigate its impacts by refraining and reducing. It requires Magdalen to: - Replace all meat main courses with low-impact vegetarian alternatives - Replace all high-impact desserts with fruit-based alternatives - Serve no coffee (remove the coffee machine from the OKB) - Buy 100% environmental best-practice produce - Mitigate remaining impacts through restoration and offsetting
B	Refrain-focused	This scenario reduces Magdalen's impacts primarily by avoiding high-impact foods. It requires Magdalen to: - Replace all ruminant meat and fish main courses with low-impact vegetarian alternatives - Replace half of high-dairy vegetarian main courses with lower-impact vegetarian alternatives - Replace all high-impact desserts (e.g. chocolate based) with fruit-based alternatives - Serve no coffee (remove the coffee machine from the OKB) - Buy 50% best-practice produce - Mitigate remaining impacts through restoration and offsetting
C	Mixed	This scenario applies a combination of refrain and reduce approaches. It requires Magdalen to: - Replace all ruminant meat main courses with vegetarian alternatives - Replace 20% of pork, poultry and fish main courses with vegetarian alternatives - Replace half of high-dairy vegetarian main courses with lower-impact vegetarian alternatives - Replace all high-impact desserts with fruit-based alternatives - Serve half the amount of coffee (limit hours on coffee machine in the OKB) - Buy 50% best-practice produce - Mitigate remaining impacts through restoration and offsetting
D	Reduce-focused	This scenario does not cut out any food category, focussing on reducing. It requires Magdalen to: - Replace half of ruminant meat main courses with poultry alternatives - Replace 20% of pork, remaining poultry and fish main courses with vegetarian alternatives - Replace half of high-impact desserts with fruit-based alternatives - Buy 50% best-practice produce, with 100% for beef and lamb - Mitigate remaining impacts through restoration and offsetting
E	Nudge-based	This scenario mitigates impacts with the lowest infringement on consumer choice. It requires Magdalen to: - Use behavioural nudges to replace 10% of meat main courses with low-impact vegetarian alternatives

		- Buy 100% best practice produce - Mitigate remaining impacts through restoration and offsetting

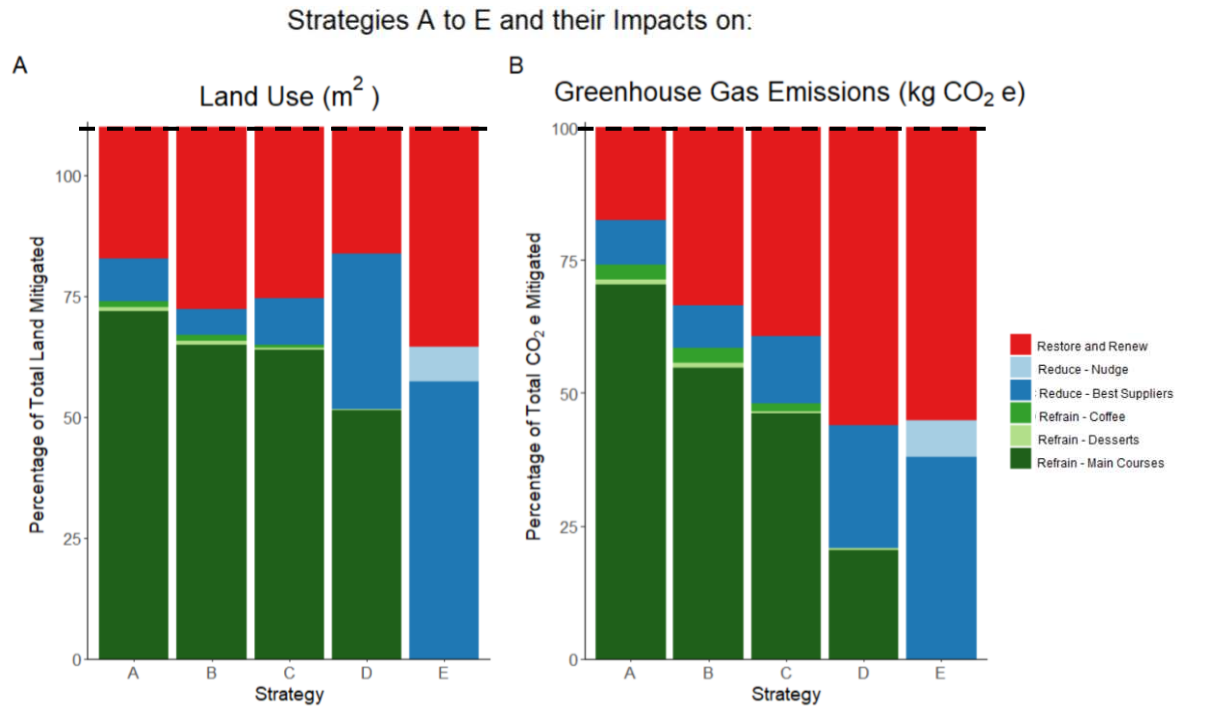

Figure 12: How strategies A to E are split up between different steps of the Mitigation and Conservation Hierarchy. Dashed line shows Magdalen's 2030 target.

Figure 12 compares strategies A to E for land use (*A*) and greenhouse gas emissions (*B*). The strategies are represented by vertical bars, stretching from 0% (no baseline impacts mitigated) to 110% for land use (representing Magdalen's goal of net biodiversity gain by 2030) and to 100% for greenhouse gas emissions (representing net carbon zero by 2030). The colours represent the various categories of intervention applied in each strategy.

The strategies depicted in *Figure 12* highlight that reaching Magdalen's 2030 targets will be complex and will require logistical and financial effort. It is also clear that while preventative (refrain and reduce) actions could cut up to 82.7% and 82.6% land use and greenhouse gases respectively, compensatory measures involving financial investment (restore and renew, some of reduce) will be necessary to reach Magdalen's goals.

Additionally, cost and environmental and social risk are not evenly spread across the strategies. Generally, softer strategies (e.g., E) may not allow Magdalen to achieve their goals in practice. This is because it relies heavily on interventions with high environmental risk: behavioural changes are difficult to predict, might take time to become established and could reach a saturation point, where additional 'behavioural nudges' no longer affect consumer choice. Moreover, relying on best-practice produce will be expensive, and its impacts will have a high degree of uncertainty due to the limited effectiveness and transparency of many certifications. Overall, while interventions based on changing consumers' behaviours have their place in helping Magdalen to reach its 2030 targets, refraining and reducing high-impact foods will be critical in minimising environmental and financial risk.

4.3.6. Next steps:

Reducing the environmental impacts of Magdalen's food will require implementation of interventions, which should involve a College-wide conversation about which actions to choose and form part of our

strategy (like those in *Figure 12*). The strategy should include active review and management of the College's progress to meet their overarching goals of net carbon neutrality and biodiversity gain by 2030. This review process should encompass representation from all stakeholders who use the Buttery and OKB – the JCR, MCR, SCR and College staff. The College could publish annual reviews that track metrics and progress publicly, so that other colleges or institutions can follow Magdalen's example and to provide an incentive and accountability in meeting our goals.

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