
31st March

NATIONAL FOOD STRATEGY: UNDERSTANDING THE IMPACT OF CHANGING FOOD PRODUCTION AND DIETS ON FOOD PRICES AND AFFORDABILITY

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EXECUTIVE SUMMARY

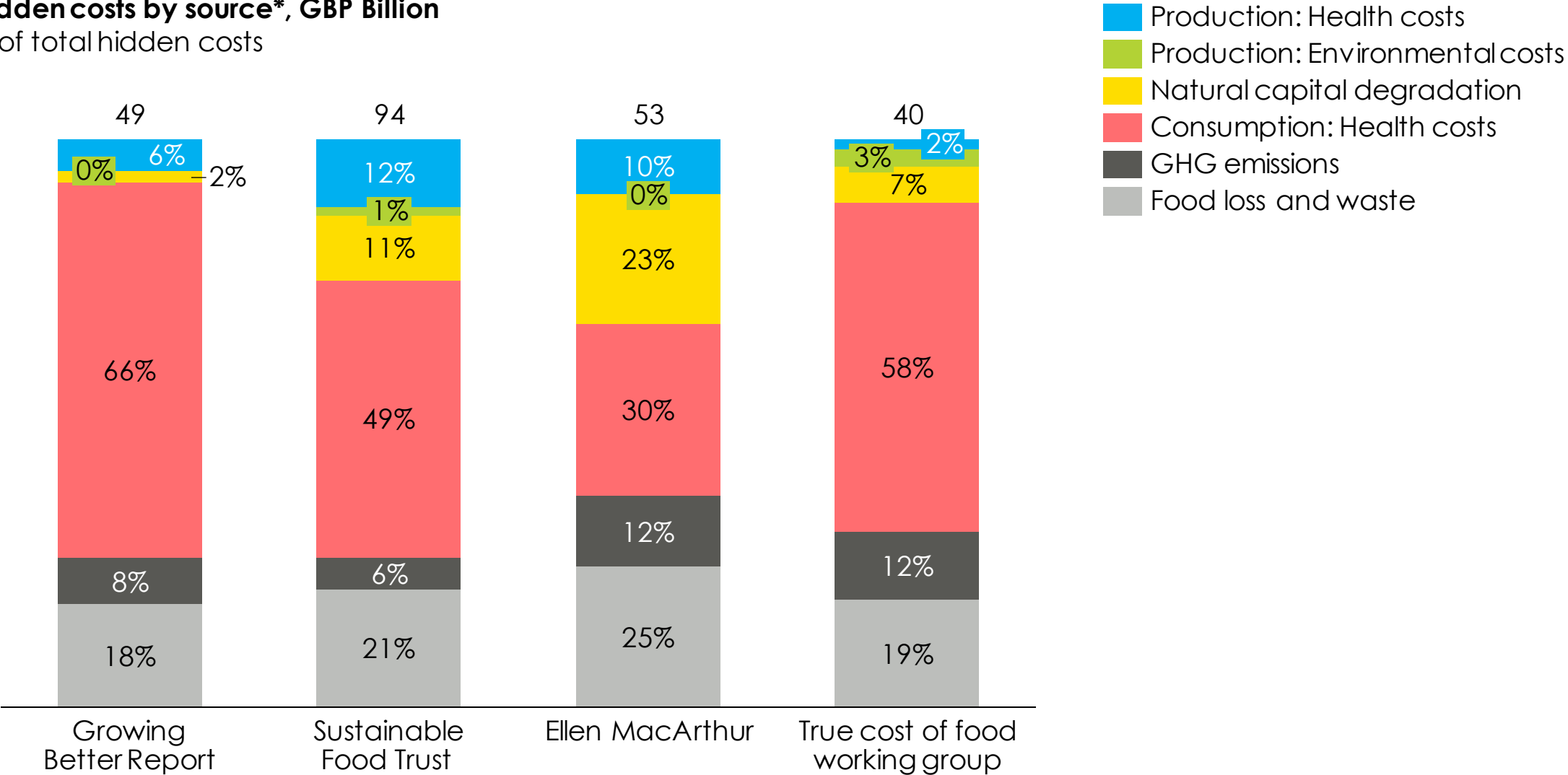
1. **The Food System has high hidden costs**, but these hidden costs **can be cut significantly by shifting towards lower-carbon, more sustainable farming practices and healthy, plant-based diets**. Neither shift alone will be sufficient, but taken together they have potential to cut farming-related emissions by 50-80%, restore nature on some agriculture land, and improve public health.
2. **Different models of sustainable farming are available that solve for different climate and nature objectives**, and all have their place. Adopting more sustainable farming practices at scale is likely to increase the price of animal products, but not plants.
3. Without a shift in diets to plant based foods, switching to better farming practices will not be enough to achieve our climate and biodiversity targets and make food affordable. Our analysis looks at two diets that can outcompete animal products, but further industry innovation and investment is required:
 - a. **Plant-based diets: these are desirable on both health and environmental grounds**. They are affordable now, but not all plant based products are competitive on taste and convenience for busy consumers, especially if cooking from scratch
 - b. **Meat mimicking' products outperform some plant based meals in taste and convenience**, and are set to fall towards price parity with meat as the category scales up
4. **Shifting to better farming practices and plant-based diets simultaneously will keep food affordable, reduce its environmental impact and improve people's health and wellbeing**

1. HIDDEN COSTS

THE FOOD SYSTEM HAS HIGH HIDDEN COSTS. THE HIDDEN COSTS OF FOOD CAN BE CUT SIGNIFICANTLY BY SHIFTING TOWARDS LOWER-CARBON, MORE SUSTAINABLE FARMING PRACTICES AND HEALTHY, PLANT-BASED DIETS

THE LARGEST 'HIDDEN COSTS' ARE HEALTH COSTS FROM CONSUMPTION

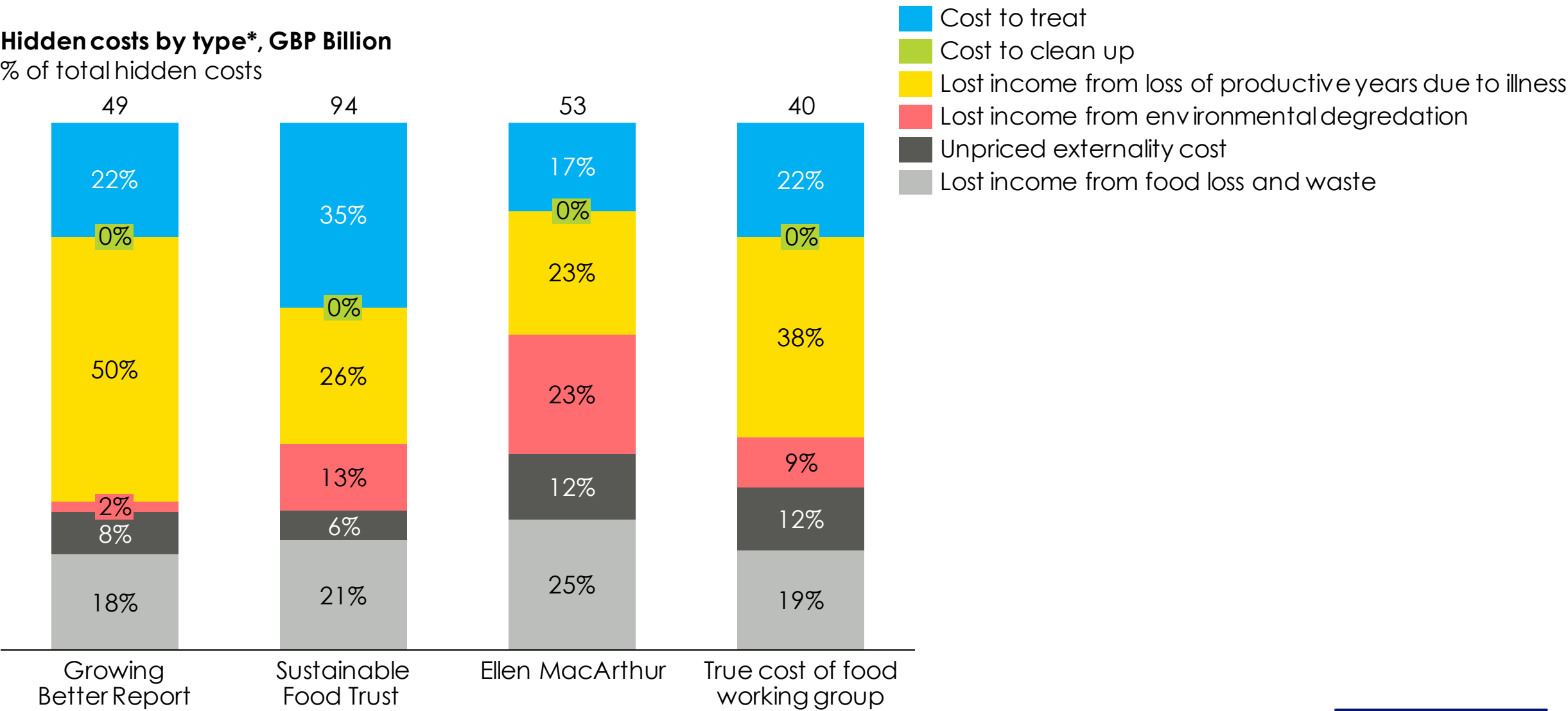
Hidden costs by source*, GBP Billion
% of total hidden costs



Source: SYSTEMIQ analysis based on FOLU (2019), Sustainable Food (2017), Ellen MacArthur Foundation (2019), WBCSD (2021)
*Detailed description on slide 33

THE LARGEST CATEGORIES ARE OPPORTUNITY COSTS AND TREATMENT COSTS DUE TO OVERCONSUMPTION OF UNHEALTHY FOOD

Hidden costs by type*, GBP Billion
% of total hidden costs



Source: SYSTEMIQ analysis based on FOLU (2019), Sustainable Food (2017), Ellen MacArthur Foundation (2019), WBCSD (2021)
*Detailed description on slide 33

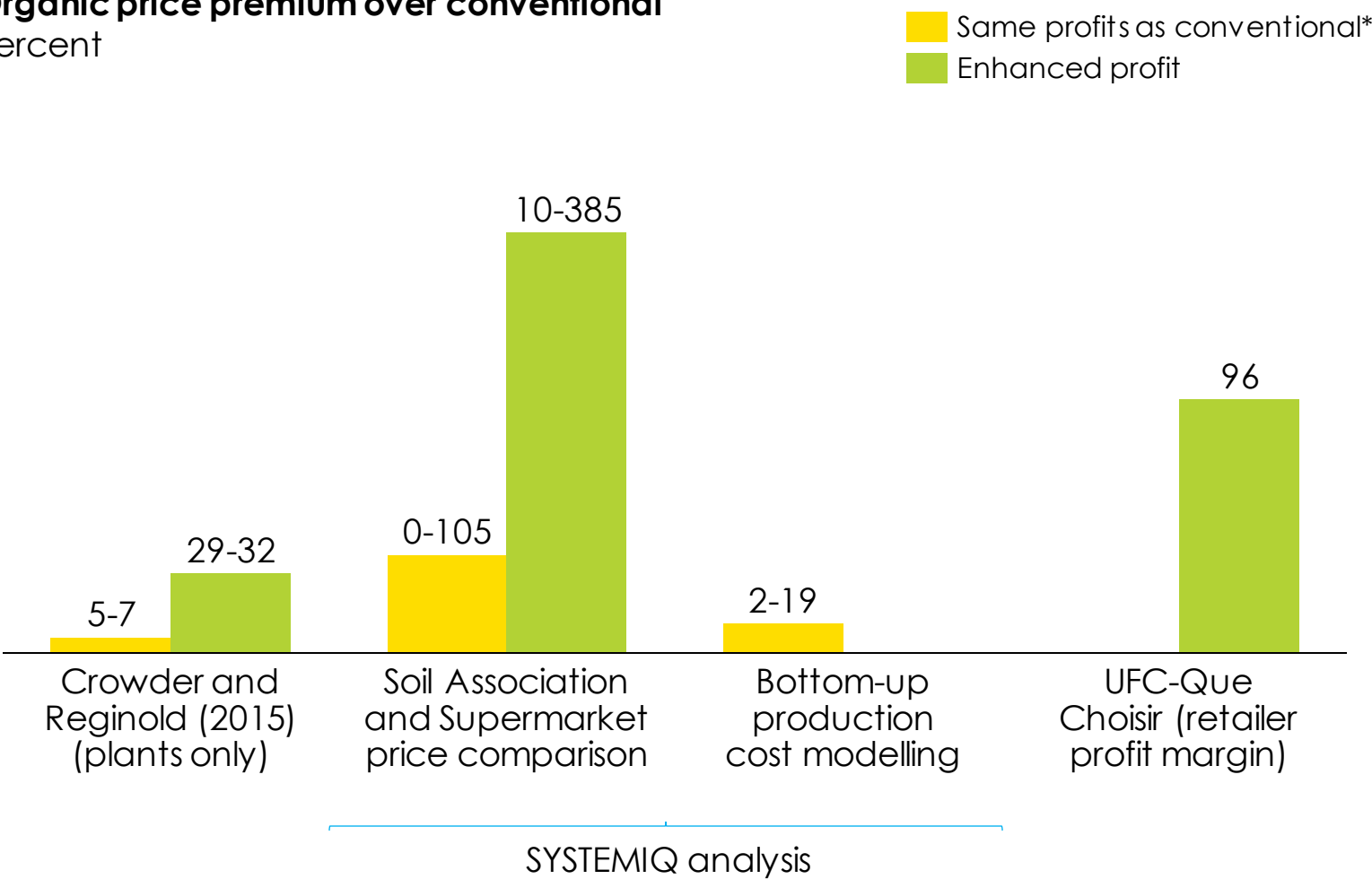
2. SWITCHING FARMING PRACTICES

DIFFERENT MODELS OF SUSTAINABLE FARMING ARE AVAILABLE THAT SOLVE DIFFERENT CLIMATE AND NATURE OBJECTIVES, AND ALL HAVE THEIR PLACE. ADOPTING MORE SUSTAINABLE FARMING PRACTICES AT SCALE IS LIKELY TO INCREASE THE PRICE OF ANIMAL PRODUCTS, BUT NOT PLANTS.

Notes: Each assumption has a range of estimates, in this document we have used the central case and assumed mark ups are passed along the supply chain in absolute terms (the 'low mark up' option). Refer to model to adjust assumptions and switch mark-up scenarios. SYSTEMIQ analysis does not include subsidies, see slide 14 to understand how ELMS could impact the price of food.

CURRENT ORGANIC FOOD PRICES DO NOT REFLECT PRICES IF LOW-INPUT SUSTAINABLE FARMING SYSTEMS WERE ADOPTED WIDELY

Organic price premium over conventional
Percent



Key Findings

- **All organic food sells at a premium to conventional, but the premium varies widely:** it is highest for meat and dairy products, especially chicken and eggs
- **Organic farming profits are typically higher than conventional farms** as this is a niche market focusing on high quality foods (~1% of most markets); this premium is likely to come down if organic food is marketed more widely
- **Production costs only explain a small part of the cost premium:** see next slide for explanation

ORGANIC PREMIUM – WHAT EXPLAINS THE DIFFERENCE?



- High labour costs and lower yields, likely to improve over time with increase R&D and investment
- High costs of organic certification and transition require a premium



- High processing and distribution costs as the sector has not yet reached economies of scale and organic production lines need to be kept separate
- Bulk purchasing and competition may reduce these costs








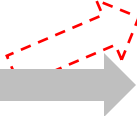







- Retailers add higher mark-ups to organic products than others which may restrict sector's appeal and hold back growth
- Study in France showed that profit margins on organic products are twice those of conventional products



- Small niche market, targeted at demographics that are willing to spend more
- Price competition and pressure to match discounters less than for staple goods

FOR THE BOTTOM-UP COST MODELLING, WE HAVE CONSIDERED THREE ALTERNATIVE FARMING SYSTEMS

Alternative Farming System*	General principles	Implications for food production	Implications for GHG emissions	Implications for biodiversity	Implications for jobs and livelihoods
<div>Current state</div> <div>Intensification</div> 	Intensify and free up land for nature or carbon farming elsewhere (or on same farm – not modelled), keeping overall production constant	 <p>Net neutral as land is restored to nature</p>	<p>44 Mt CO₂e from agriculture in the UK (~8% of total)**</p>  <p>-34 MT CO₂e (~24% for methane)</p>	 Off farm  On farm	<p>~460,000 farm workers in the UK</p>
<div>Agroecology***</div> 	Eliminate synthetic input use and restrict antibiotics, decrease stocking density in grass-based systems		 <p>May increase if replaced by imports</p>		<p>Not modelled explicitly, studies in other countries suggest that job losses in intensive meat production may be balanced by jobs created or preserved in environmental land management</p>
<div>Resource Efficiency</div> 	Reduce but do not eliminate synthetic inputs, integrate livestock into crop rotations	 <p>Shift from cereals to pulses and vegetables</p>			

10

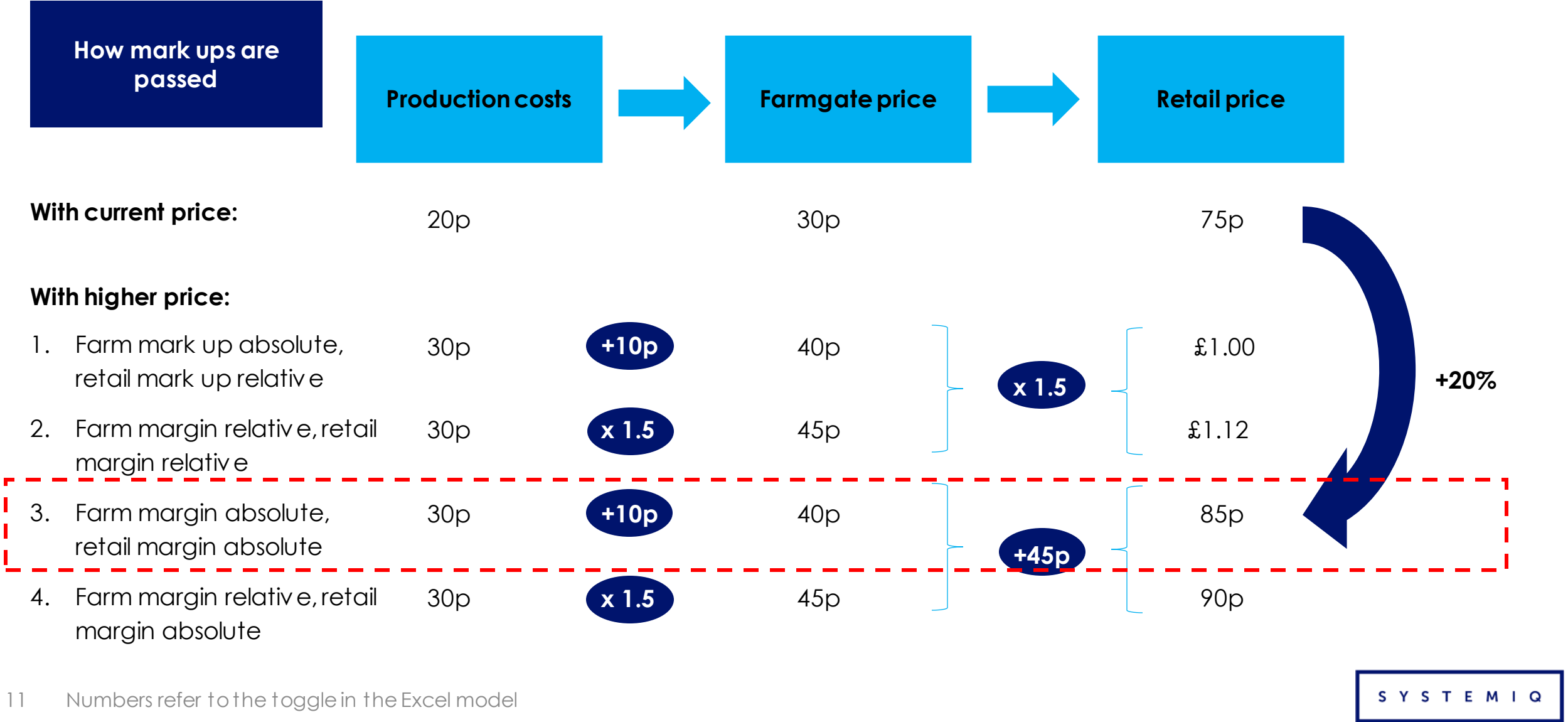
*See slide 39 for more detailed description of each farming system

**Detailed breakdown is 25Mt CO₂e from methane (livestock), 13Mt CO₂e from nitrous oxides (fertiliser), 6Mt from CO₂. See model to tweak assumptions for GHG mitigation potential

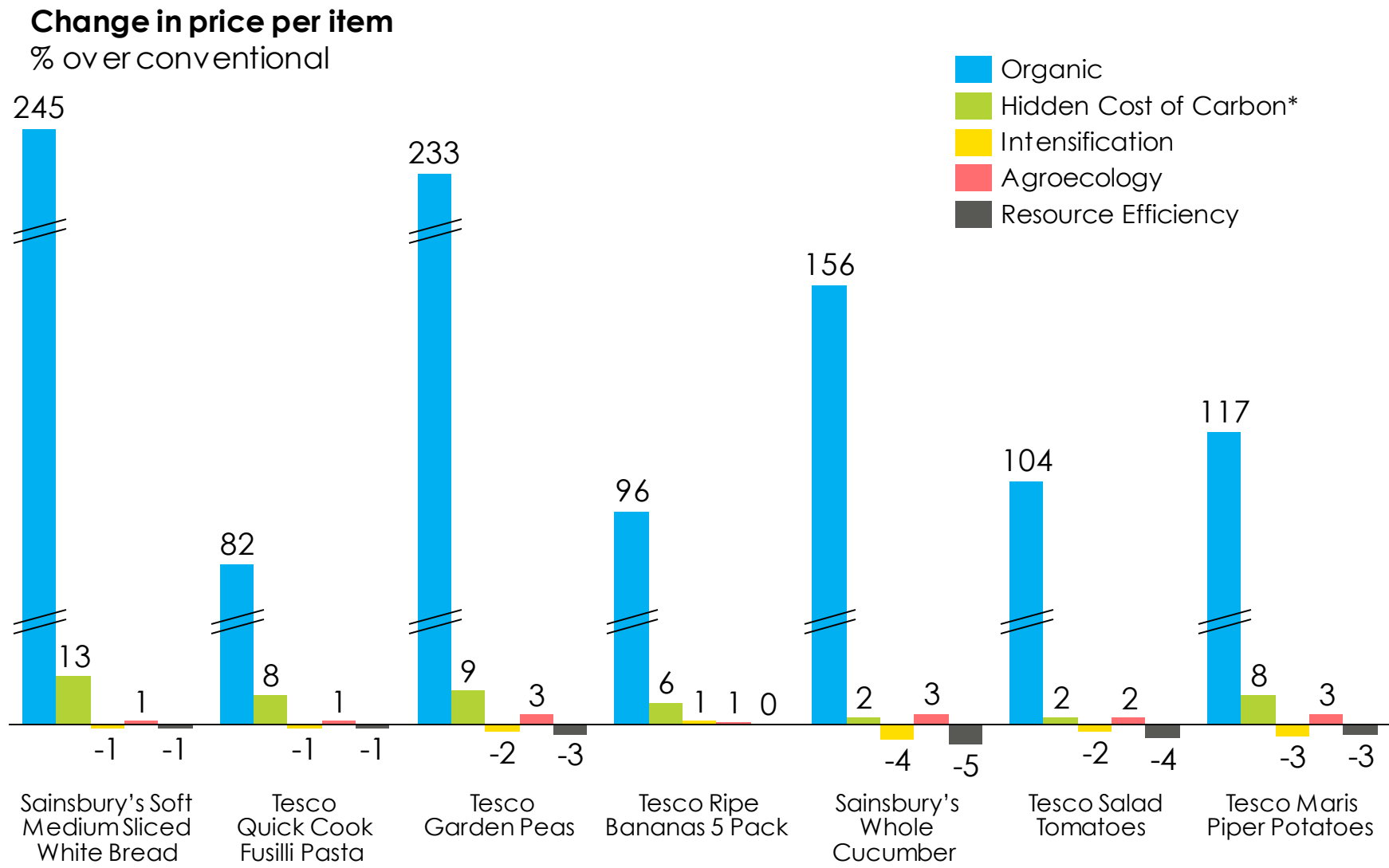
***We are using agroecology rather than organic as we are referring to changes in production practices only, not the separate branding, certification and marketing channels associated with organic food now.

SYSTEMIC

THIS ANALYSIS IS BASED ON MARK UPS BEING PASSED ALONG THE SUPPLY CHAIN IN ABSOLUTE TERMS – A ‘LOW MARK UP’ OPTION



PLANTS: ANALYSIS SHOWS THAT THERE IS LITTLE CHANGE IN FOOD PRICES FOR PLANT PRODUCTS UNDER THE DIFFERENT FARMING SCENARIOS, INCLUDING IF WE ACCOUNT FOR THE HIDDEN COSTS OF CARBON

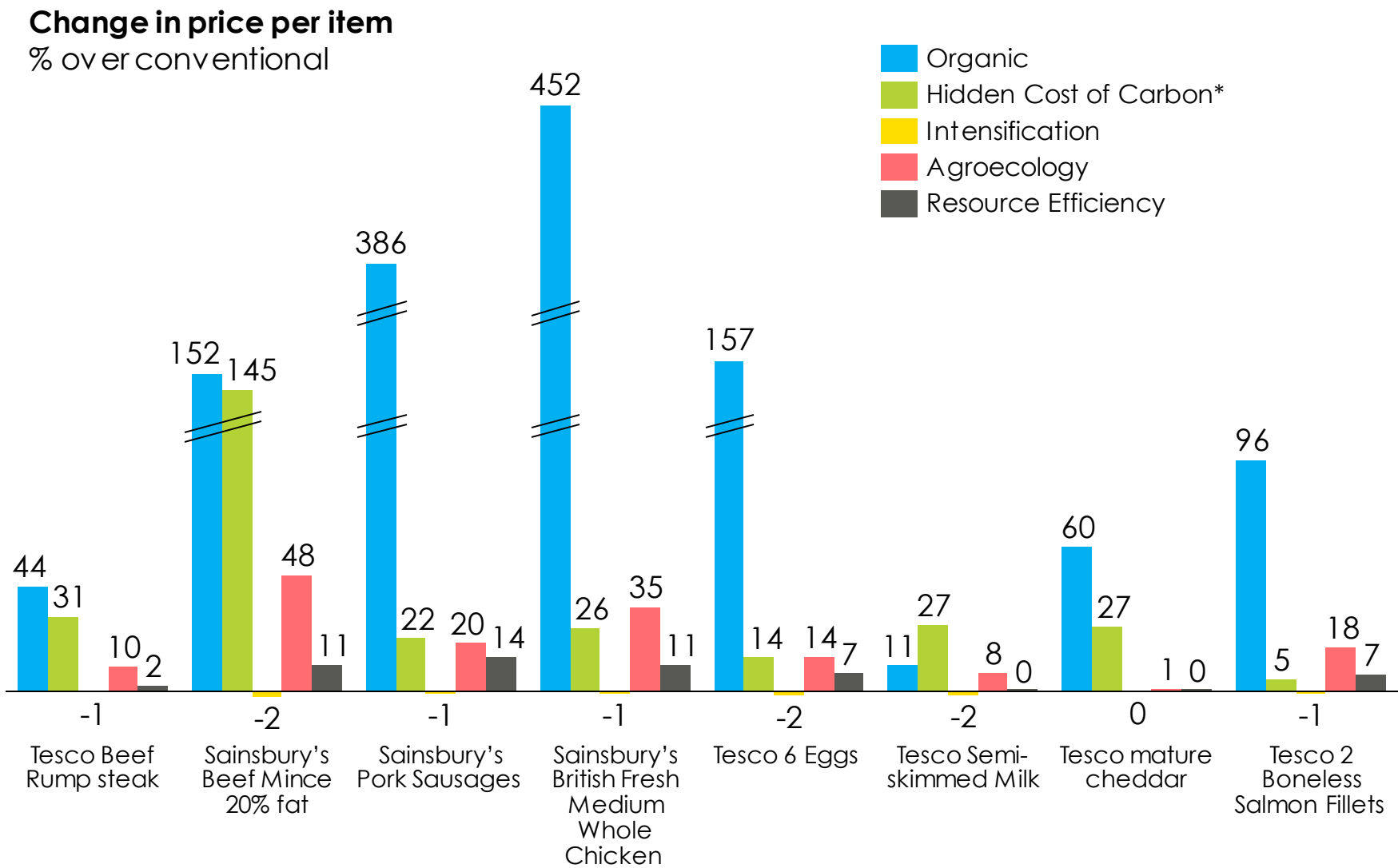


Key Findings

- **Changing farming practices does not have a significant impact on prices (+/- 5%).** This compares with an organic price premium of 100% or more for many products.
- **A hypothetical tax on the hidden cost of carbon** the price of plant products by **up to 5%**

Source: tesco.com and Sainsburys.com accessed 23 March
*Hidden Cost of Carbon calculated at £71 per tonne

ANIMALS: THE CHANGE IN PRICE IS MORE SIGNIFICANT WHEN LOOKING AT ANIMAL PRODUCTS, BUT SUBSTANTIALLY LESS THAN THE CURRENT ORGANIC PRICE PREMIUM



Key Findings

- **Agroecology increases the price of animal products between 1 - 48%** whereas organic premium is between 11-452% higher.
- **Intensification very slightly reduces the price of animal products, up to 2%**
- **Resource Efficiency increases the price of animal products between 2-14%**, with the price of dairy products remaining the same as today
- When looking at popular **ready meals** (see appendix), **the price shifts more significantly when the core ingredient includes animal products**

Source: tesco.com and Sainsburys.com accessed 23 March
*Hidden Cost of Carbon calculated at £71 per tonne

ENVIRONMENTAL LAND MANAGEMENT SUPPORT (ELMS) CAN BRING DOWN THE PRICE OF FOOD UNDER EACH OF THE FARMING SCENARIOS

ELMS Component	Description	Price impact for sustainable farm archetypes
1. Sustainable Farming Incentive	Should be accessible to everyone who farms, with simple actions to improve the environment (e.g. improved pest management)	Intensification and Resource Efficiency Subsidies for Intensification and Resource Efficiency can help to make sustainable farms more profitable and reduce the prices of food
2. Local Nature Recovery	More targeted recovery based on characteristics of local area. May involve several farms working together to regenerate nature. Should support the farmland-adapted nature outcomes in nature rich farming systems	Agroecology and Resource Efficiency Subsidies for Agroecology and Resource Efficiency can help to make sustainable farms more profitable and reduce the prices of food. This is especially relevant for agroecology where lower yields and stocking density can mean higher prices
3. Landscape Recovery	Transformation of existing farmland into high carbon capture land where food production is not a goal, e.g. rewilding.	N/A

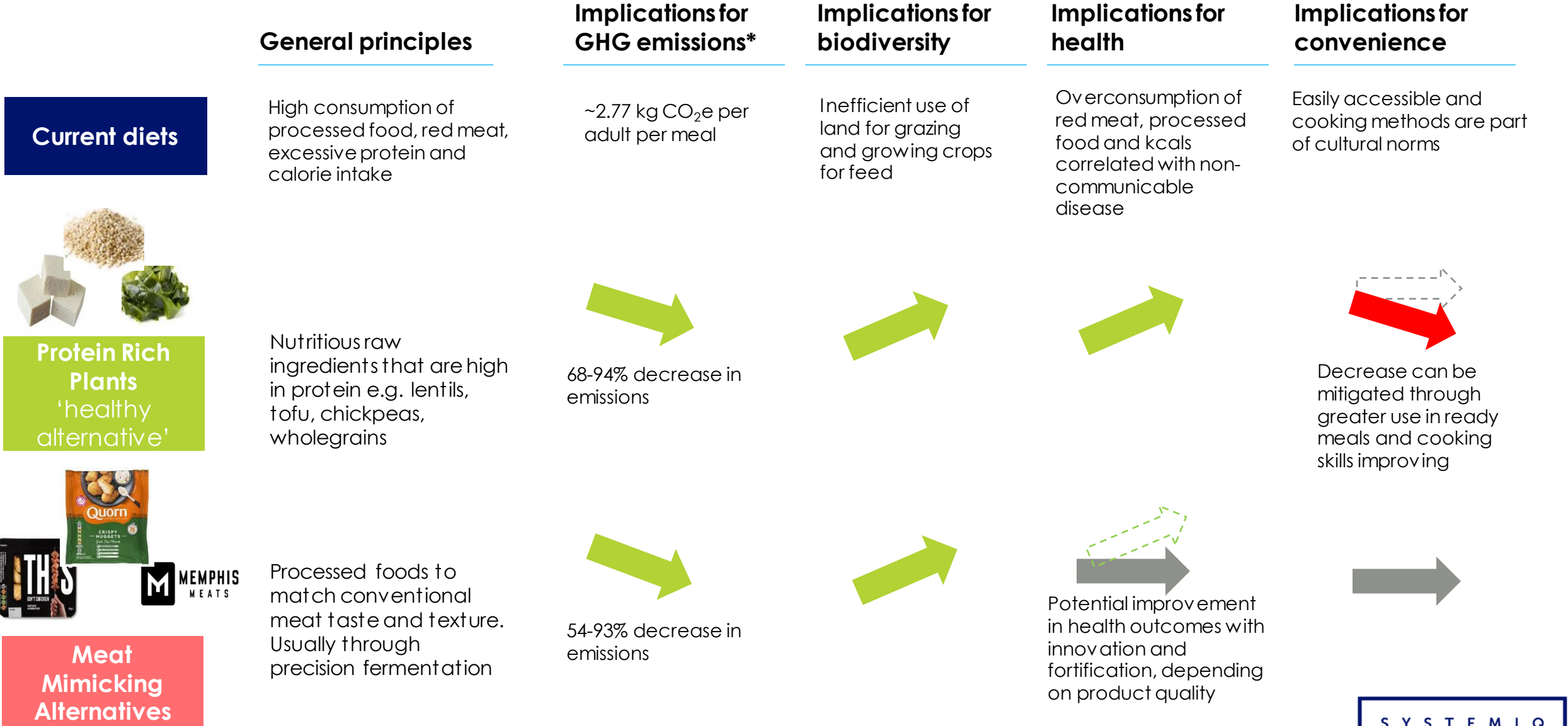
- **Current direct payments are not maximising benefits for nature and climate**, and are unfair for 3 reasons:
 1. Paying people to own land is handing out public money with little clear public gain.
 2. Most farms simply enjoy extra profit and do not need subsidy to survive.
 3. The most profitable farms tend to be the largest so they currently receive the greatest amount of public money.
- **Many farmers rely on direct payments for their business models.** Direct Payments raise all farm incomes, so 86% are 'profitable'. 38% of farms make a loss before Direct Payments
- **Redirecting subsidies** away from unsustainable farming practices, and towards those that adhere to the sustainable farm archetypes outlined in the analysis will help to **reduce food prices under each scenario**

3. SHIFTING DIETS

PLANT-BASED DIETS ARE DESIRABLE ON BOTH HEALTH AND ENVIRONMENTAL GROUNDS. THEY ARE AFFORDABLE NOW, BUT NOT ALL PLANT BASED PRODUCTS ARE COMPETITIVE ON TASTE AND CONVENIENCE FOR BUSY CONSUMERS, ESPECIALLY IF COOKING FROM SCRATCH.

‘MEAT MIMICKING’ PRODUCTS OUTPERFORM SOME PLANT BASED MEALS IN TASTE AND CONVENIENCE, AND ARE SET TO FALL TOWARDS PRICE PARITY WITH MEAT AS THE CATEGORY SCALES UP

WE HAVE CONSIDERED TWO ALTERNATIVE DIETS TO REPLACE ANIMAL PRODUCTS

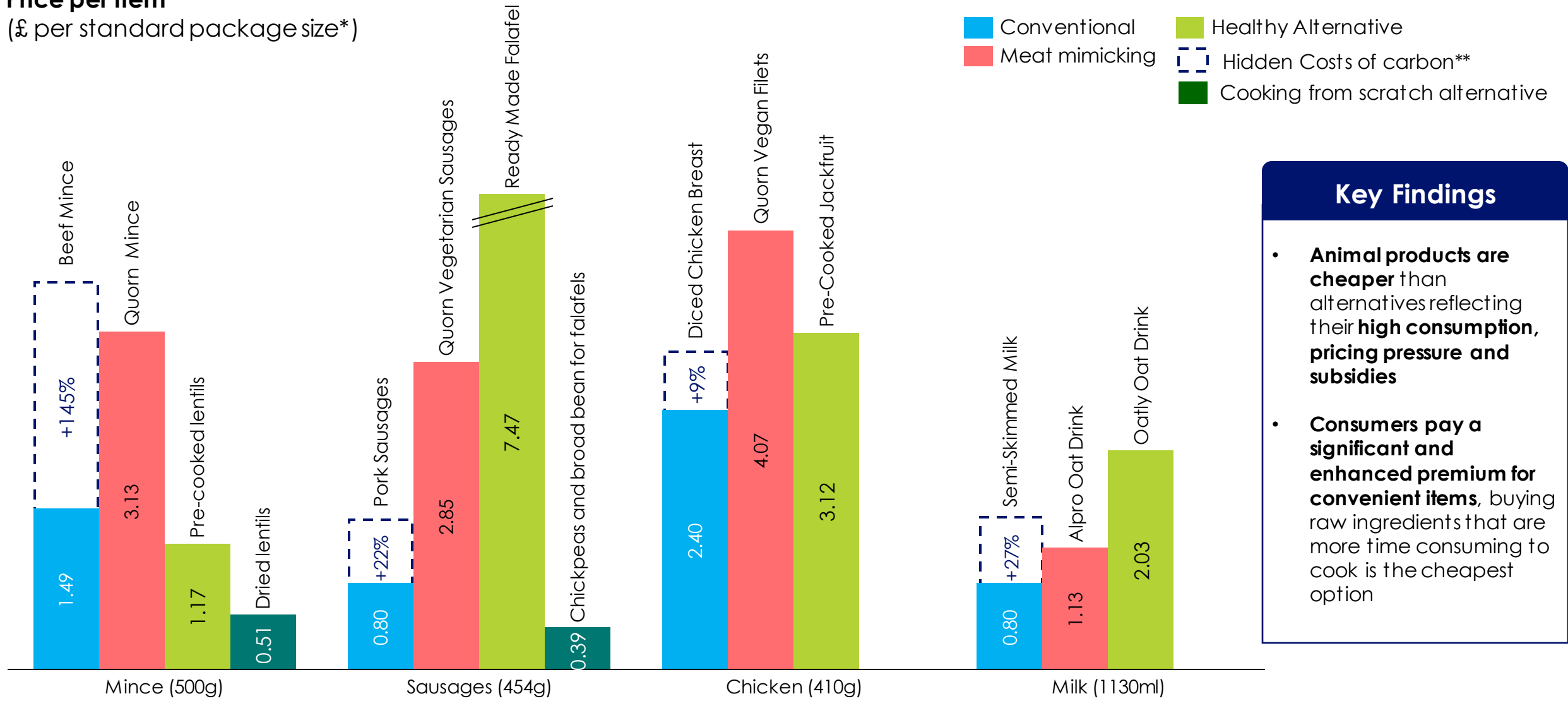


Source: Poore and Nemeck 2018; SYSTEMIQ Analysis: *average taken from modelling of 8 conventional meat based meals and their plant based alternatives

WIDELY CONSUMED ANIMAL PRODUCTS ARE CHEAPER THAN MOST PLANT BASED ALTERNATIVES AND CHEAPER THAN ALL MEAT MIMICKING ALTERNATIVES, REFLECTING THEIR HIGH CONSUMPTION AND PRICING PRESSURE

Price per item

(£ per standard package size*)



Key Findings

- Animal products are cheaper than alternatives reflecting their high consumption, pricing pressure and subsidies
- Consumers pay a significant and enhanced premium for convenient items, buying raw ingredients that are more time consuming to cook is the cheapest option

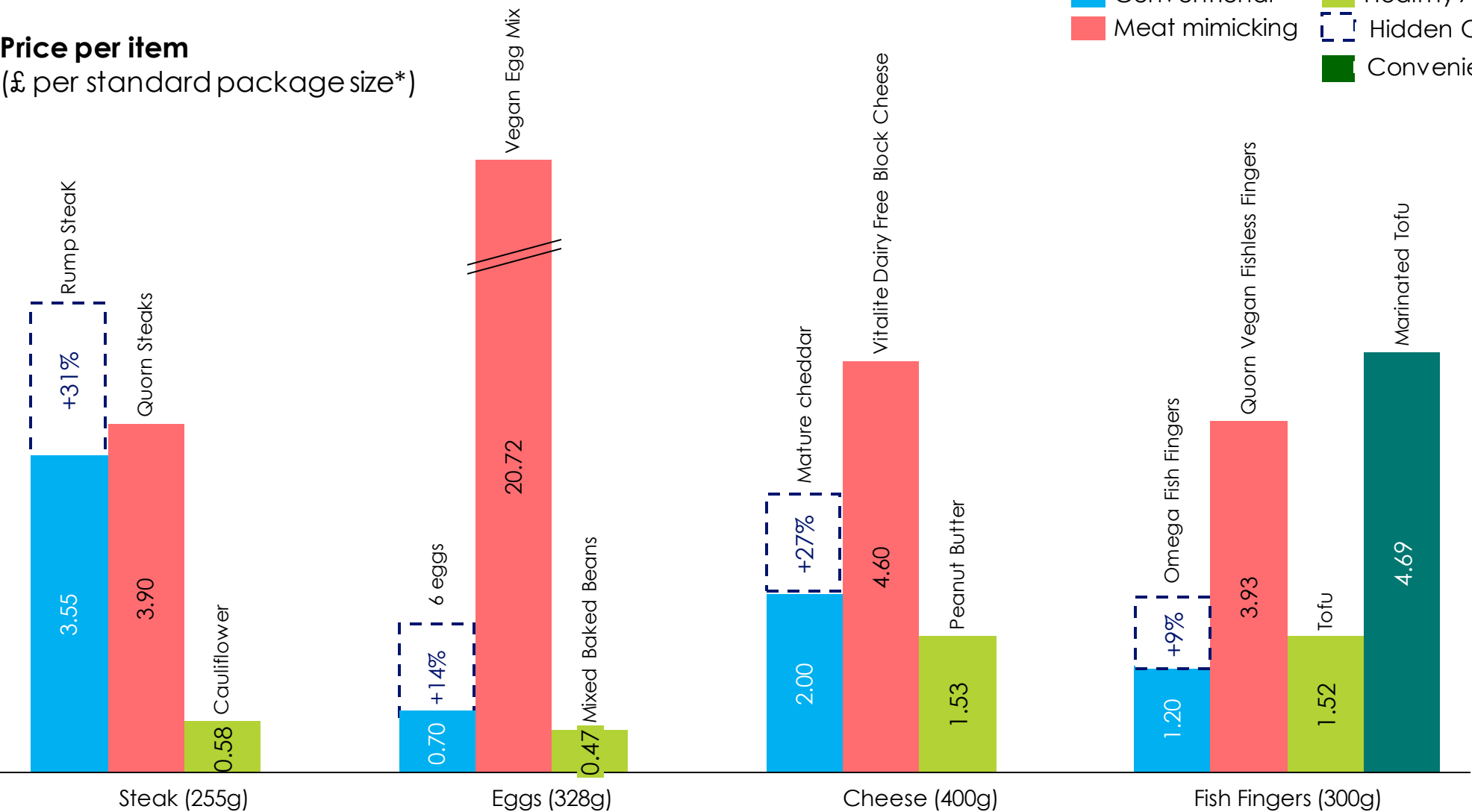
Source: tesco.com and Sainsburys.com; SYSTEMIQ analysis of 20 high salience food items

*package weight adjusted to animal product weight for comparison

**Source for carbon Poore and Nemecek 2018, priced at £71 per tonne. Hidden costs of carbon for plant products only increases 2-13% according to SIQ analysis

MEAT MIMICKING REPLACEMENTS FOR STEAK, EGGS, CHEESE AND SEAFOOD HAVE THE HIGHEST COSTS AS RESEARCH IS LIMITED

Price per item
(£ per standard package size*)

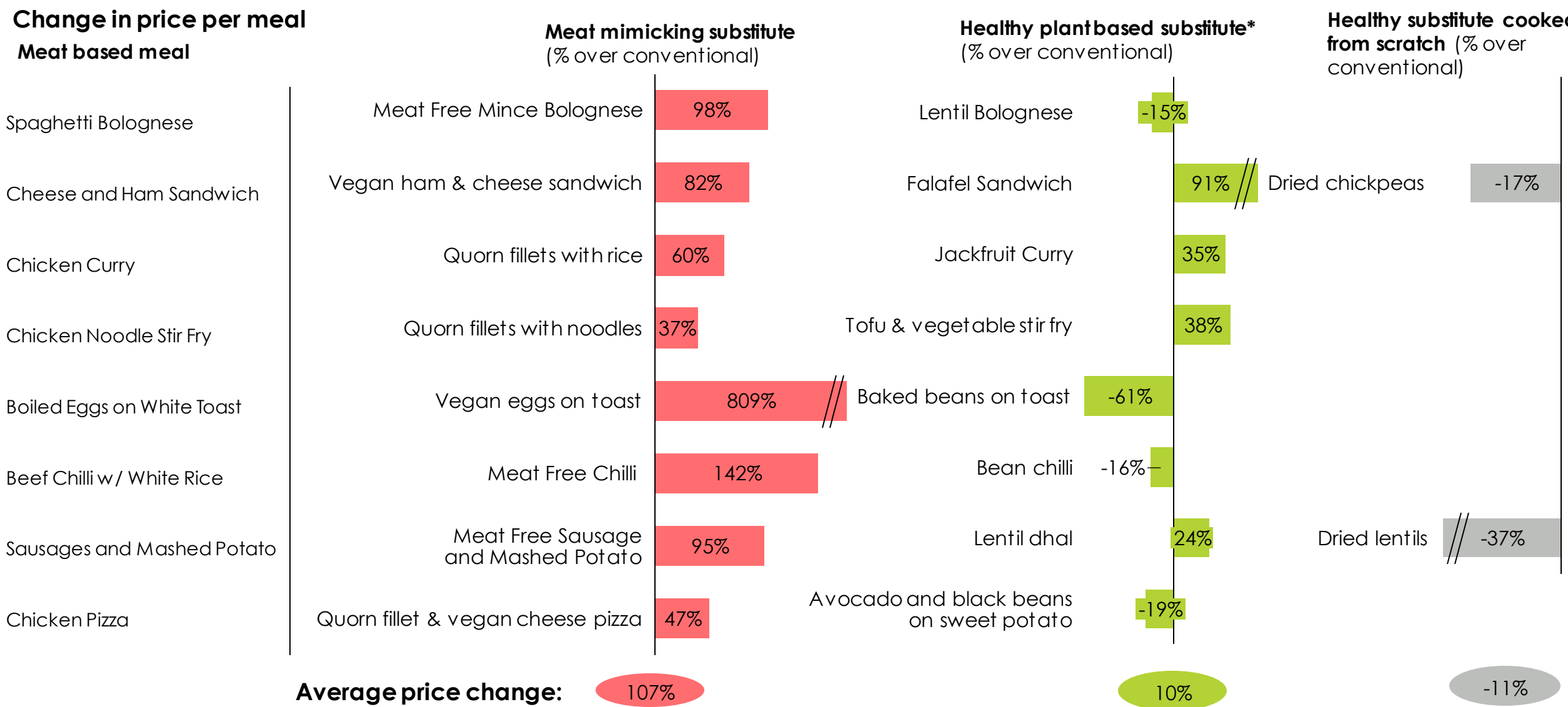


Key Findings

- Switching to a meat mimicking alternative product increases the price between 10-238% (excl vegan eggs)
- Wholecuts, eggs, cheese and seafood have had the least amount of R&D so options are limited and high in price

Source: tesco.com and Sainsburys.com; SYSTEMIQ analysis of 20 high salience food items
*package weight adjusted to animal product weight for comparison
*Source for carbon Poore and Nemecek 2018, priced at £71 per tonne. Hidden costs of carbon for plant products only increases 2-13% according to SIQ analysis of 20 high salience foods

WHEN LOOKING AT POPULAR MEALS, MEAT MIMICKING ALTERNATIVES TEND TO BE MORE EXPENSIVE THAN MEAT, HOWEVER SWITCHING TO HEALTHIER MEAL SUBSTITUTES IS MORE AFFORDABLE AND NUTRITIOUS




*Convenient option selected: ready cooked falafel, pre-cooked lentils, beans and jackfruit in a can

Source: tesco.com and Sainsburys.com; SYSTEMIQ analysis of 15 popular meals


MARKET DISRUPTING TECHNOLOGY, LIKE MEAT MIMICKING FOODS, WILL OFTEN ENTER THE MARKET AS A PREMIUM PRODUCT, BUT THE PRICE WILL COME DOWN OVER TIME AS TECHNOLOGY ADVANCES AND MANUFACTURING COSTS DECLINE

Examples from other sectors:



Electric cars

- 2008 Tesla launched the ‘Roadster’– state of the art **premium product** at **\$100,000**, appealing to a niche audience
- Over time further investment bought costs down, allowing for cheaper models and increasing sales
- 2020 Model 3 market price of **\$40,000**, with a target of a **\$25,000** car by 2023

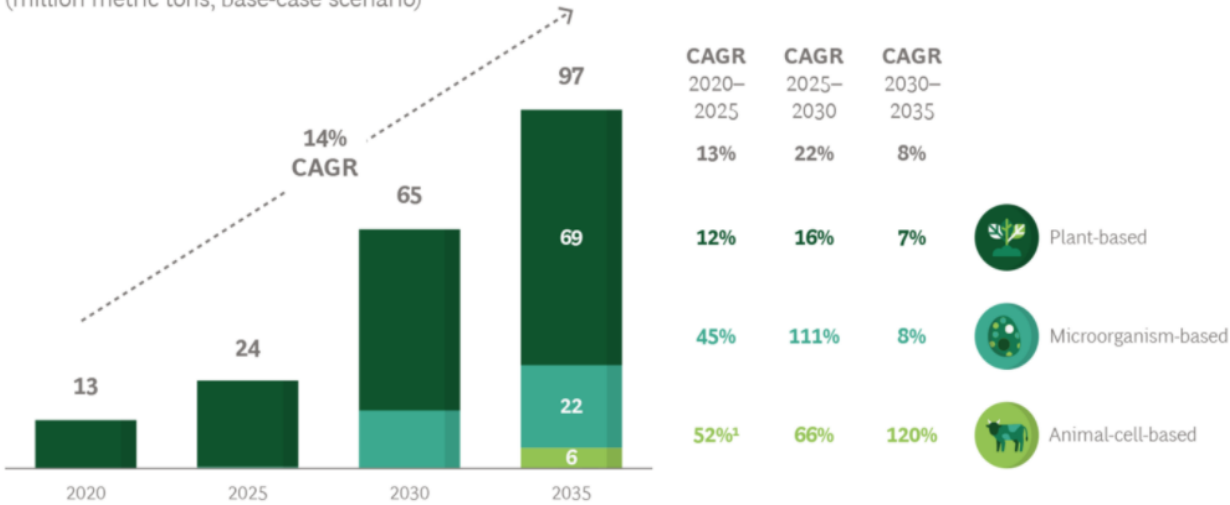


Solar Panels

- Since 2010 the cost of installing solar PV has dropped 82% making it affordable to the mass market
- Solar now **costs less than keeping many existing coal plants in operation**

Forecasts for the meat mimicking sector:

Consumption of alternative proteins by protein source (million metric tons, base-case scenario)



	Plant based & Microorganisms		Cultured meat: animal cell-based	
Price Parity Estimates:				
	2020	Price Parity 2030		
Production facility	\$450m	\$250m		-44%
Costs per kg of meat	\$100/kg	\$5.66/kg		-94%

SOME BRANDS WILL REMAIN PRICED AT A PREMIUM, BUT OTHERS WILL COPY THE TECHNOLOGY TO PRODUCE AN AFFORDABLE ALTERNATIVE WITH THE SAME PURPOSE

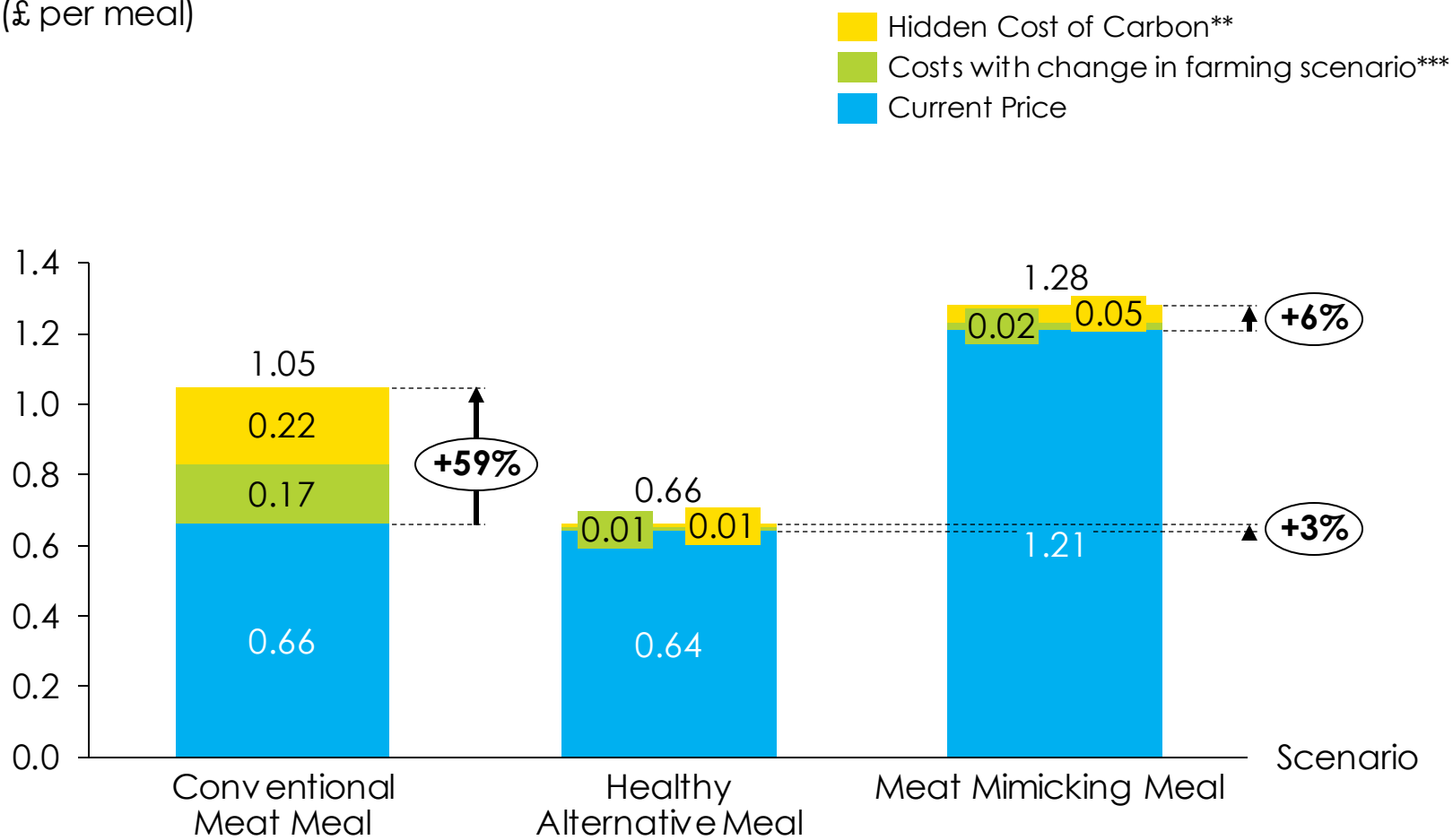
Smartphones	Oat Milk	Ice Cream	Sunglasses
 <p>Apple iPhone starting from £399</p>	 <p>Alpro Oat Drink £1.6 0.3g protein per 100ml</p>	 <p>Magnum Classic 4x 110ml £3.20</p>	 <p>Rayban sunglasses £130</p>
 <p>Alba 4 £29.95</p>	 <p>Tesco own brand £1 0.5g protein per 100ml</p>	 <p>Sainsbury's Icecream 4x110ml £1.35</p>	 <p>Boots sunglasses £20</p>

4. SWITCHING FARMING PRACTICES AND SHIFTING DIETS

SHIFTING TO BETTER FARMING PRACTICES AND PLANT-BASED DIETS SIMULTANEOUSLY WILL KEEP FOOD AFFORDABLE, REDUCE ITS ENVIRONMENTAL IMPACT AND IMPROVE PEOPLE'S HEALTH AND WELLBEING

SWITCHING FARMING SCENARIO AND ACCOUNTING FOR HIDDEN COSTS INCREASES THE PRICE OF MEAT BASED MEALS SIGNIFICANTLY BUT NOT PLANT BASED ALTERNATIVES

Average price of 8 representative meals*
(£ per meal)



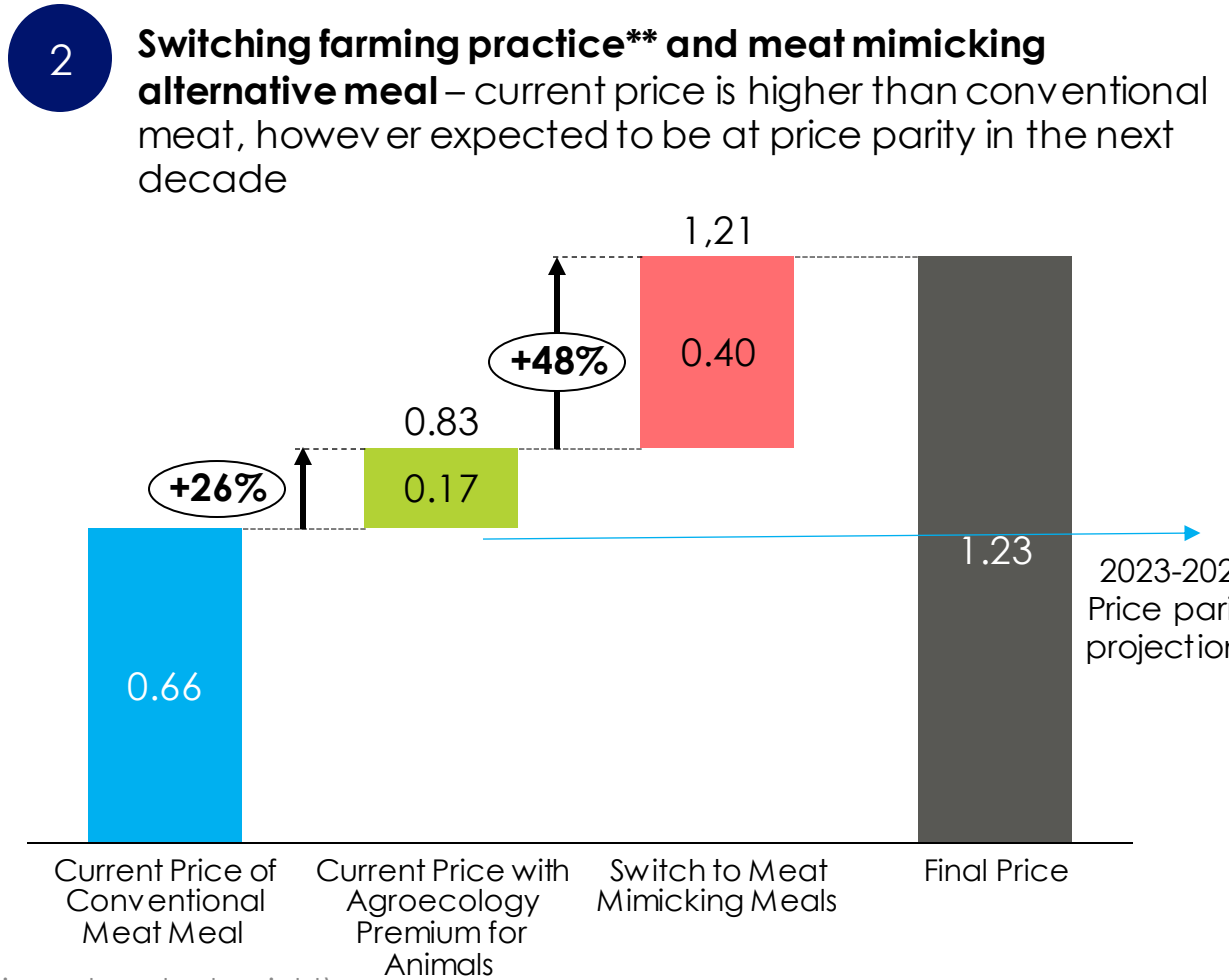
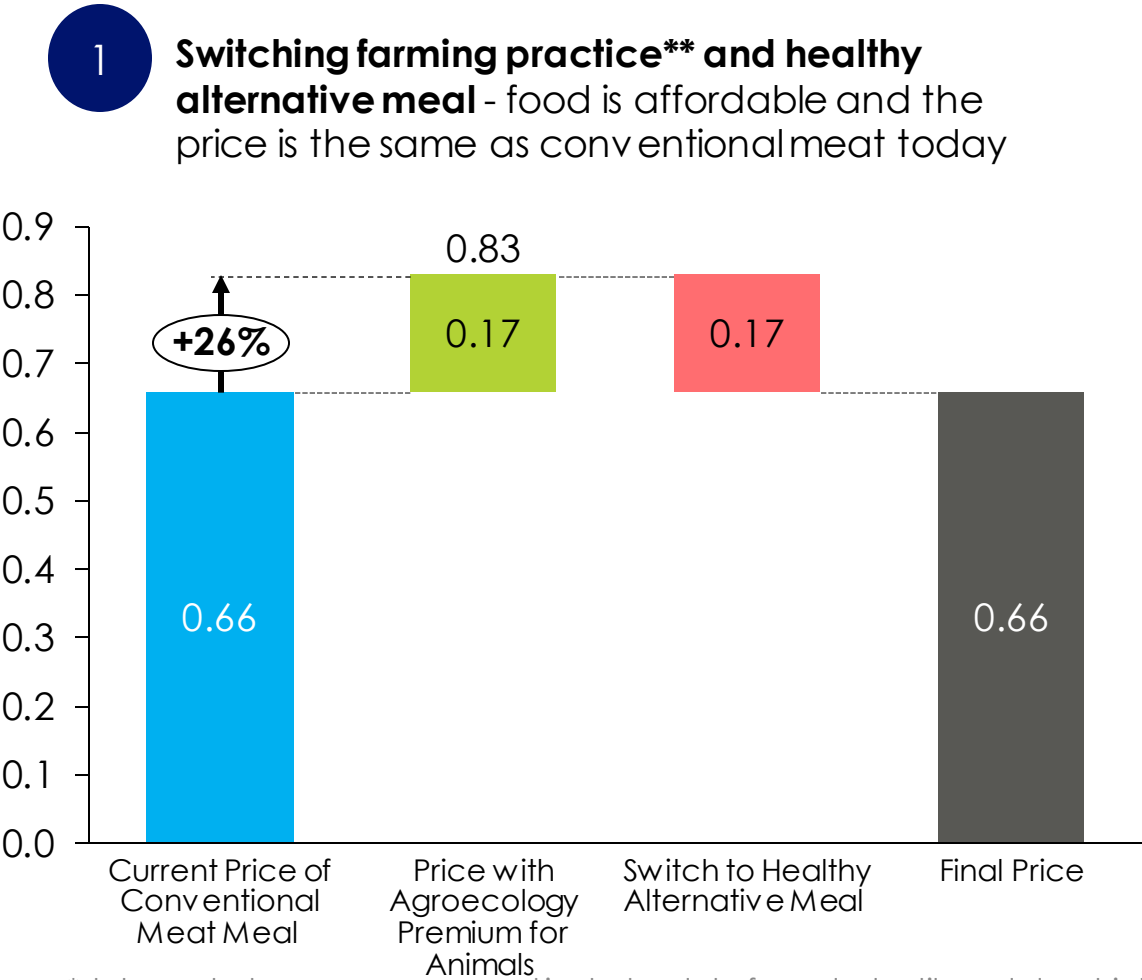
Key Findings

- **Healthy protein rich meals are cheaper than conventional meals**, even before changes in farming practices or carbon taxes are considered
- **A meat-based meal increases costs by 59%** when both are farmed agroecologically and hidden costs of carbon are accounted.
- **Alternatives only increase by 3-6%**
- **Meat mimicking meals come close to cost parity with conventional meat** when both are farmed agroecologically and hidden costs of carbon are accounted
- **The cost of meat mimicking meals is forecast to fall significantly** as the category reaches economies of scale in the next decade¹

*data excludes vegan eggs, and includes data from dry lentils and dry chickpeas
**Cost of carbon applied on top of agroecology at £71 per tonne;
***Price with Agroecology which is the farming scenario that raises the price the most
1) Source: Boston Consulting Group 2020, meat mimicking products to reach cost parity between 2023-2025

SWITCHING FARMING PRACTICES INCREASES THE COSTS OF MEAT-BASED MEALS, HOWEVER SWITCHING TO HEALTHY ALTERNATIVES MEANS PRICES REMAIN LOW AND AFFORDABLE. MEAT MIMICKING COSTS REMAIN HIGH BUT ARE EXPECTED TO DECREASE TO PRICE PARITY AS THE INDUSTRY SCALES

Average price of 8 representative meals*
(£ per meal)



24 *data excludes vegan eggs, and includes data from dry lentils and dry chickpeas (prices at cooked weight)

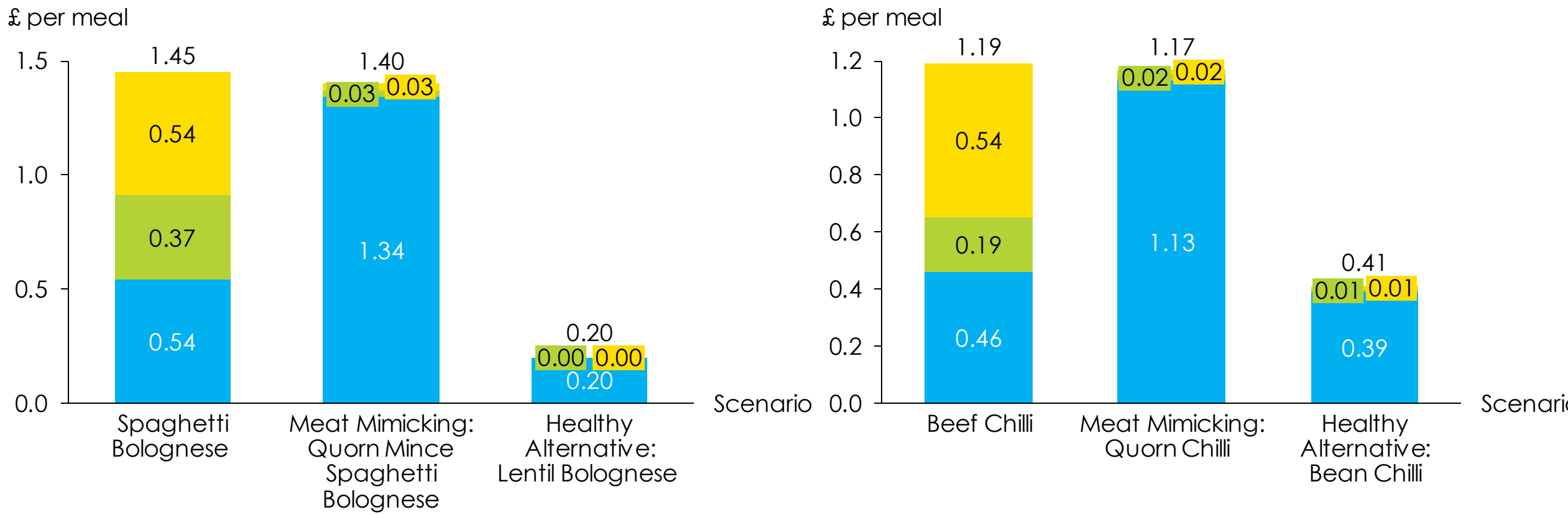
**Price with Agroecology which is the farming scenario that raises the price the most

1) Source Boston Consulting Group 2021

1) BEEF BASED MEALS ARE AT COST PARITY TO MEAT MIMICKING ALTERNATIVES WHEN SWITCHING FARMING SCENARIOS AND ACCOUNTING FOR HIDDEN COSTS. HEALTHY ALTERNATIVES REMAIN SIGNIFICANTLY CHEAPER

Average price of beef-based meals
(£ per meal)

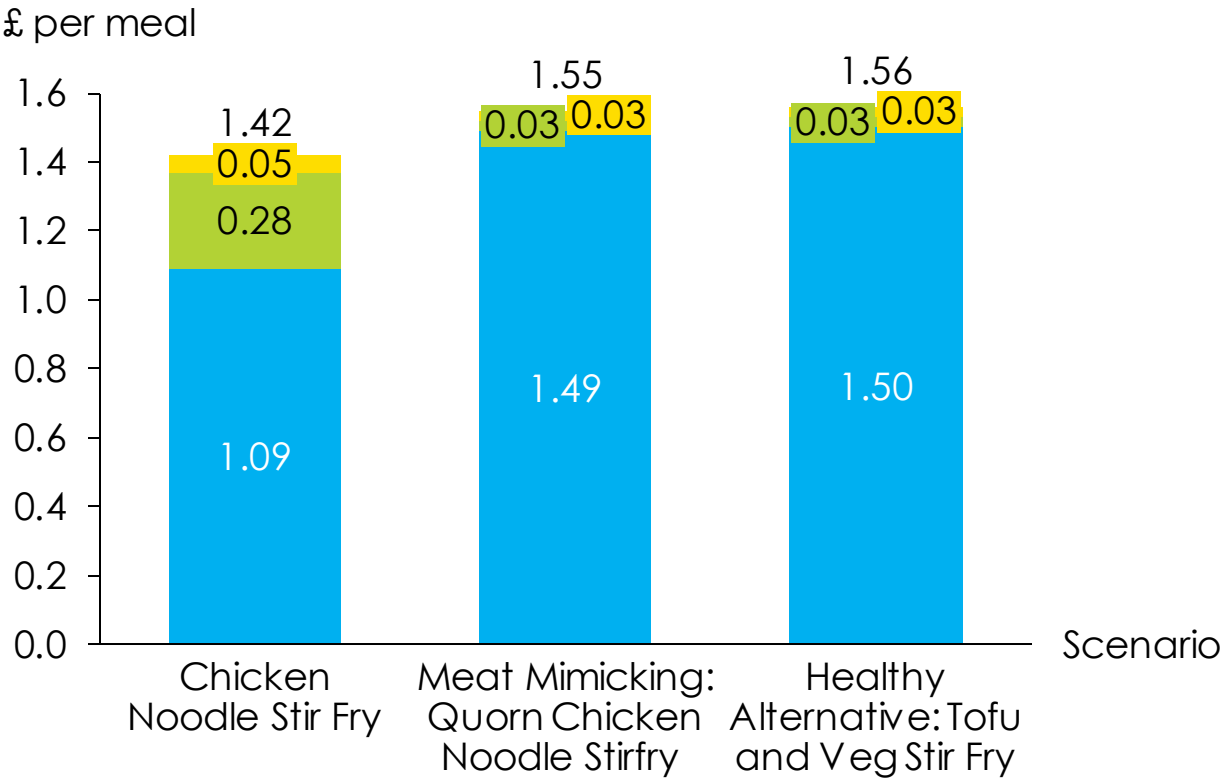
Hidden Cost of Carbon*
Costs with change in farming scenario**
Current Price



25 *Cost of carbon applied on top of agroecology premium at £71 per tonne
**Price with Agroecology which is the farming scenario that raises the price the most

2) CHICKEN BASED MEALS ARE NEAR COST PARITY WHEN SWITCHING FARMING SCENARIOS AND ACCOUNTING FOR HIDDEN COSTS. JACKFRUIT AND TOFU ARE CURRENTLY EXPENSIVE BECAUSE THEY REMAIN A NICHE INGREDIENT IN THE MARKET

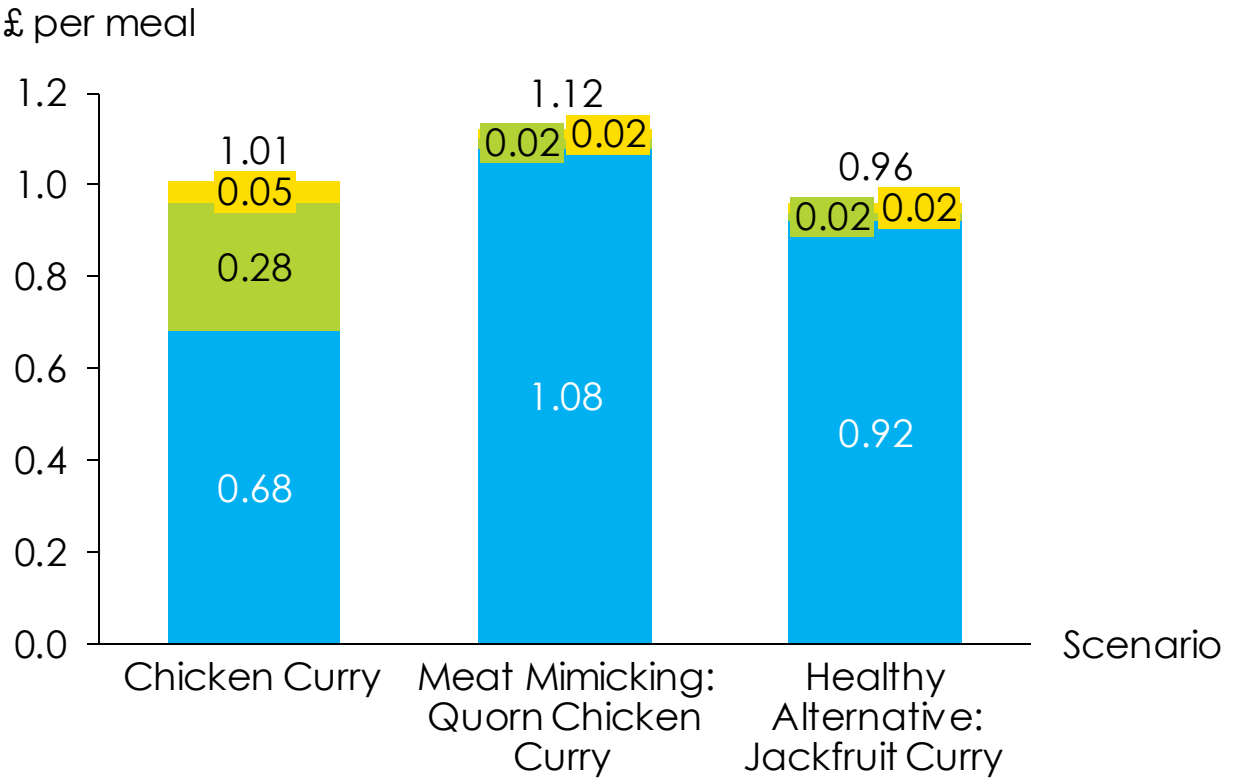
Average price of chicken-based meal
(£ per meal)



Hidden Cost of Carbon*

Costs with change in farming scenario**

Current Price

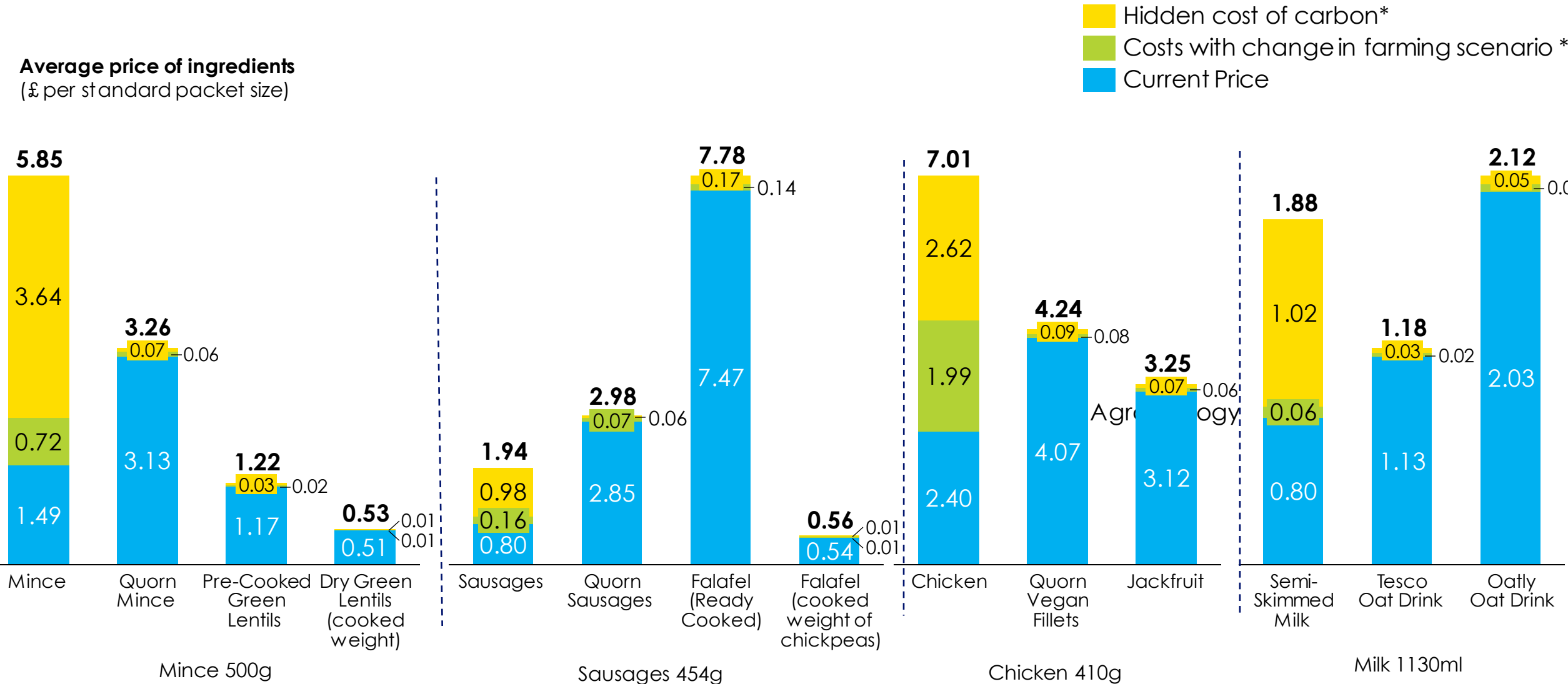


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*cost of carbon applied on top of agroecology premium at £71 per tonne

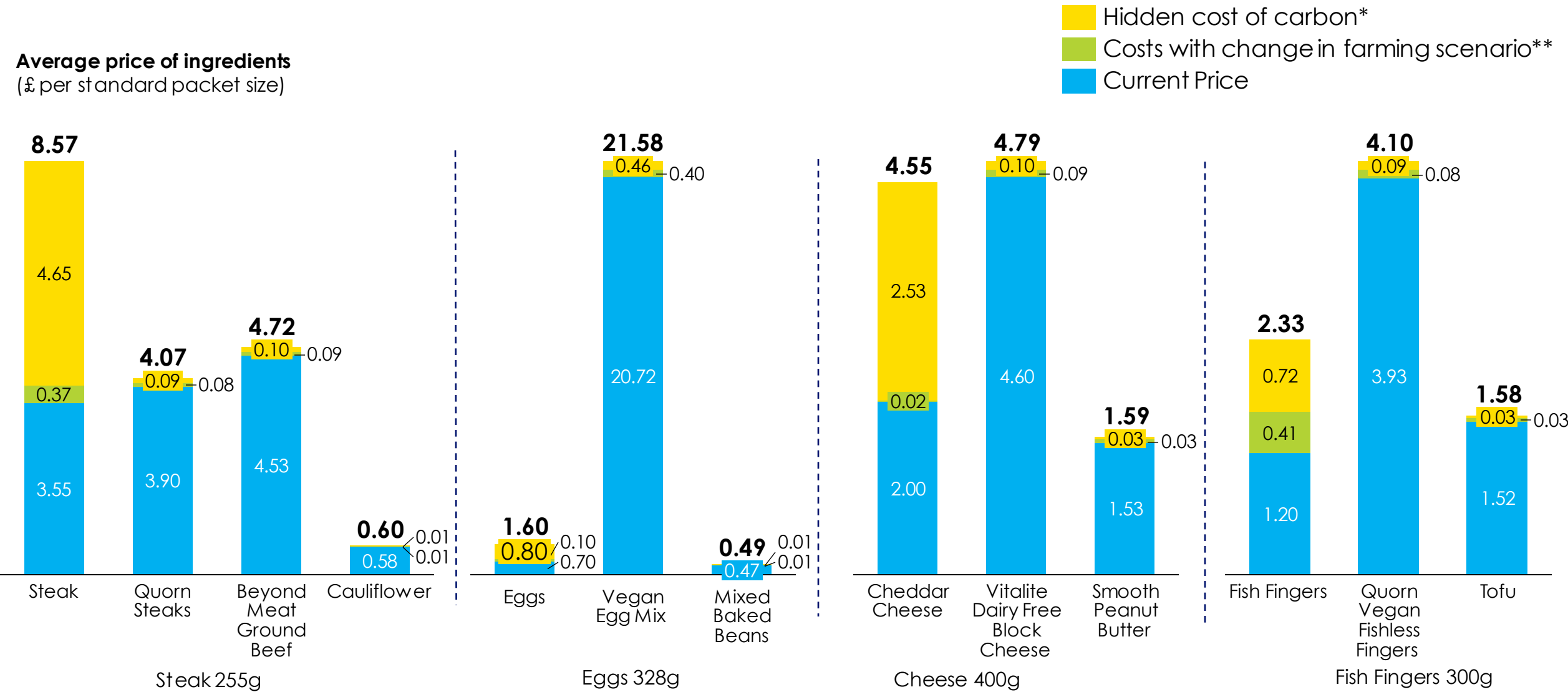
**Price with Agroecology which is the farming scenario that raises the price the most

WHEN LOOKING AT INDIVIDUAL INGREDIENTS, HEALTHY PROTEIN RICH PRODUCTS ARE THE MOST AFFORDABLE, OFTEN REMAINING CHEAPER THAN MEAT PRICES TODAY



27 *cost of carbon applied on top of agroecology premium at £71 per tonne
**Price with Agroecology which is the farming scenario that raises the price the most

MEAT MIMICKING REPLACEMENTS FOR STEAK, EGGS, CHEESE AND SEAFOOD HAVE THE HIGHEST COSTS AS RESEARCH IS LIMITED, BUT HEALTHY PROTEIN RICH REPLACEMENTS REMAIN THE LOWEST COST



28 *Cost of carbon applied on top of agroecology premium at £71 per tonne
**Price with Agroecology which is the farming scenario that raises the price the most

CONCLUSION: SUSTAINABLE FARMING PRACTICES AND HEALTHIER DIETS ARE AFFORDABLE. IN FACT, WE CAN'T AFFORD NOT TO ADOPT THEM

- Without a shift in diets to plant based foods, switching to better farming practices will not be enough to achieve our climate and biodiversity targets and make food affordable.
- On the other hand, dietary change without changing farming practices is a missed opportunity to fix carbon in the soil and restore nature.
- As the number of plant-based meals and meat mimicking alternatives grows, and their price falls, a more sustainable and healthy food system is within reach. It is up to us to grasp it.

APPENDICES

HOW THE MODEL WORKS

Summary: Ag & Diets

- Price for conventional animal products vs. alternatives with an agroecology premium and hidden cost of carbon
- Change in carbon emissions of animal products and plants under agroecology

Price of conventional products and meals under agroecology premium, and accounting for hidden cost of carbon

Price of meat mimicking and healthy alternative products (standard package size) and meals (price per portion)

Summary: Agriculture

- Change in price of food with Organic and Carbon Tax, and under the 3 farming scenarios. Agroecology and carbon tax price on meal archetypes
- Sensitives for variables under each farming scenario
 - Low, Central or High case for assumptions
 - Mark-up scenario

Current Food Prices

Organic vs conventional current market price comparison

Carbon Tax

Price of food accounting for hidden cost of carbon

- Price of carbon

Farm Archetypes

Profit and Profit margin for conventional farming, Intensification, Agroecology and Resource Efficiency

Current Farm Economics

Data on farm output, farmgate price, variable and fixed costs, farmer income

- Variable and fixed costs
- Average lifespan for livestock

GHG Abatement

Emissions mitigation potential under each farming scenario (CH₄, N₂O, CO₂)

- Assumptions on impact of practices on emissions
- *Stocking density and lifespan linked to assumptions in 'summary-agriculture tab'*

Summary: Diets

Difference in price between animal, meat mimicking and healthy alternative products and meal archetypes (unit price and % change over conventional)

Meal Archetypes

Price, protein and kcal content comparison of popular meals and representative alternatives, and carbon footprint of meals

Price of Ingredients

Price, protein and kcal content comparison of high salience animal products compared to healthy plant-based alternatives

Meat Mimicking Ingredients

Price, protein and kcal content comparison of private label vs branded meat mimicking products (% change and new unit price)

APPENDIX A: HIDDEN COSTS

DESCRIPTION OF HIDDEN COST CATEGORIZATION AND SOURCE

Hidden costs by source:

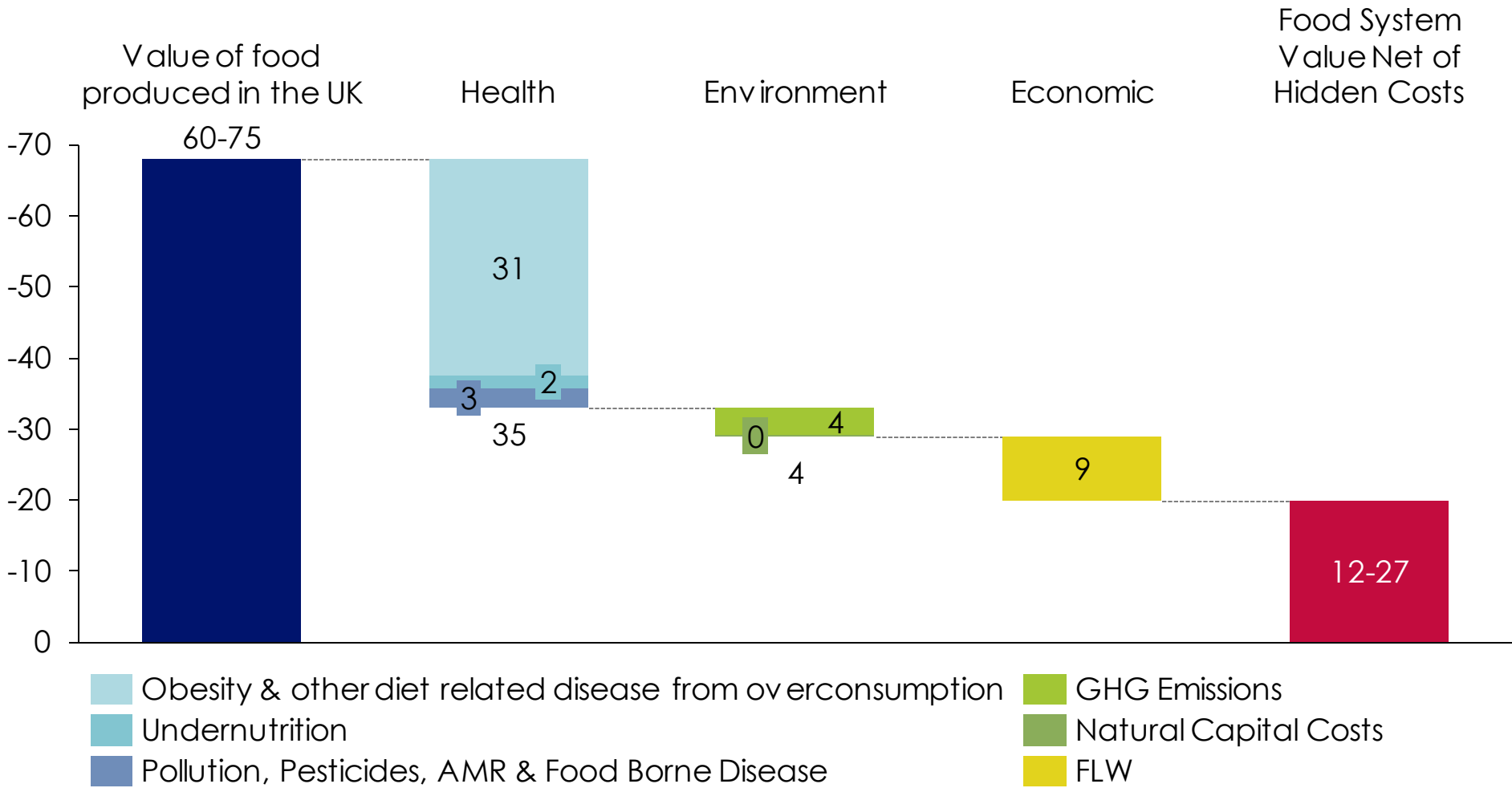
- **Production: health costs.** Includes treatment and income lost from air and water pollution, AMR and Food borne diseases
- **Production: environmental costs.** Cost to clean and income lost to water and soil pollution
- **Natural capital degradation.** Income lost to water over-abstraction, soil erosion and degradation, biodiversity
- **Consumption: health costs.** Treatment and income lost to diet related illness
- **GHG emissions.** Social cost of GHG emissions on farm and from transit and retail, Social cost of carbon adjusted to \$100 per tonne (£71 per tonne).
- **Food loss and waste.** Value of food loss and waste pre and post consumer

Hidden costs by type:

- **Cost to treat:** Costs associated with treating illness caused by production and consumption
- **Cost to clean up:** Costs associated with cleaning up pollution and environmental damage
- **Lost income from environmental degradation:** Opportunity costs associated with environmental damage
- **Unpriced externality cost:** Social or environmental costs that are not currently reflected in the price of food. For example GHG emissions.
- **Lost income from food loss and waste:** Opportunity costs associated with food lost or wasted across the value chain

WHAT ARE HIDDEN COSTS IN THE UK – GROWING BETTER METHODOLOGY

GBP billion, 2018 prices



Hidden cost of imports

Using the same hidden cost values for food produced in the UK, Imports increase the hidden costs of GHG emissions, natural capital degradation, Health costs from food production and food loss and waste pre consumer by \$7bn

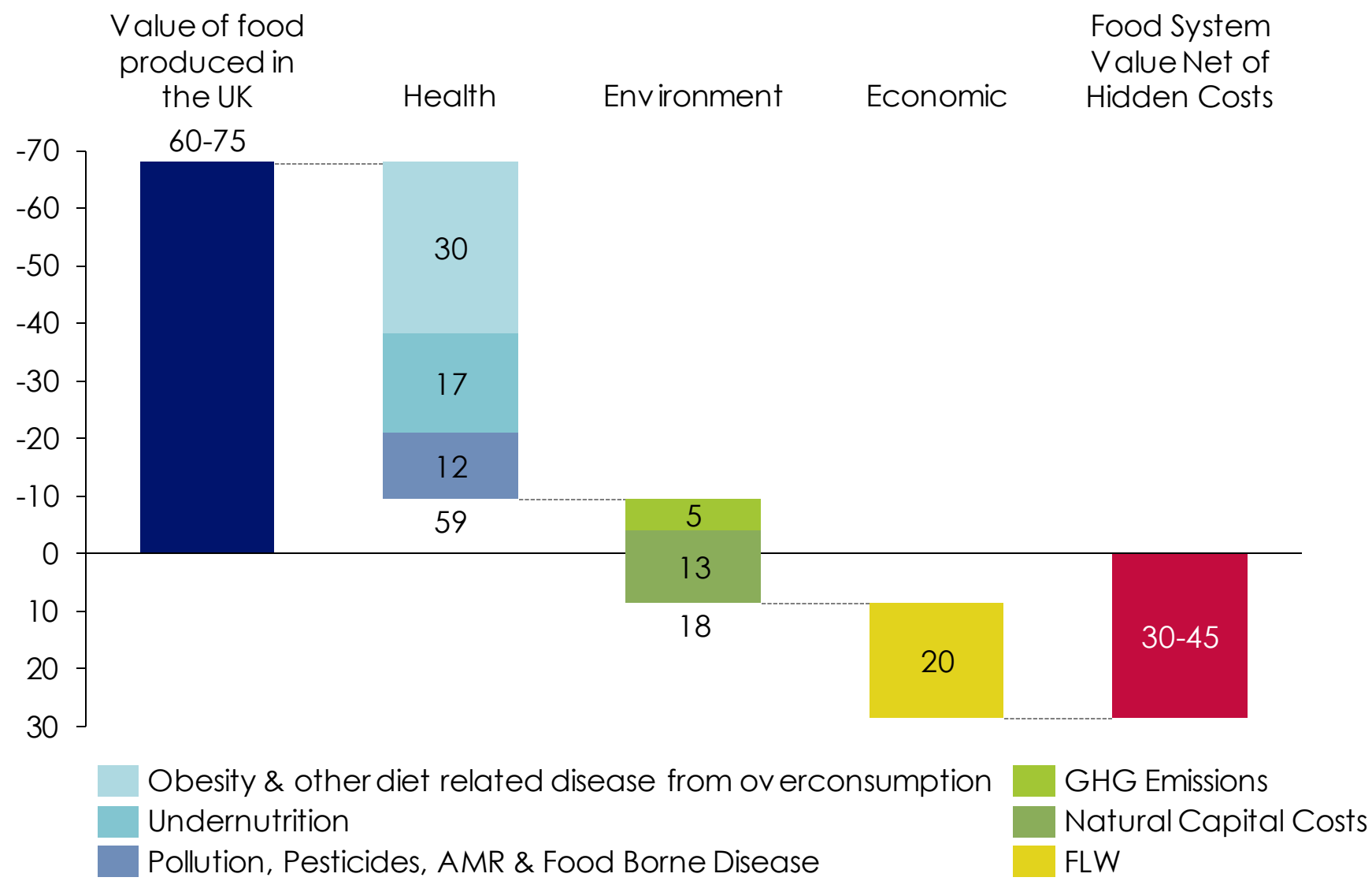
When compared to the total value of food **consumed** in the UK to \$84bn-\$99bn, the value of net hidden cost increased to \$28-43bn

Including hidden costs of imports does not impact the proportion of opportunity costs, which remains the largest proportion of costs.

Note that if we were to tweak the imports to focus on palm oil then there could be a greater difference.

WHAT ARE HIDDEN COSTS IN THE UK – SUSTAINABLE FOOD TRUST METHODOLOGY

GBP billion, 2018 prices



Hidden cost of imports
Using the same hidden cost values for food produced in the UK, Imports increase the hidden costs of GHG emissions, natural capital degradation, health costs from food production and food loss and waste pre consumer to \$24bn. When compared to the total value of food **consumed** in the UK to \$84bn-\$99bn, the value of net hidden cost increased to \$-24bn.

Including hidden costs of imports does not impact the proportion of opportunity costs, which remains the largest proportion of costs.

Note that if we were to tweak the imports to focus on palm oil then there could be a greater difference.

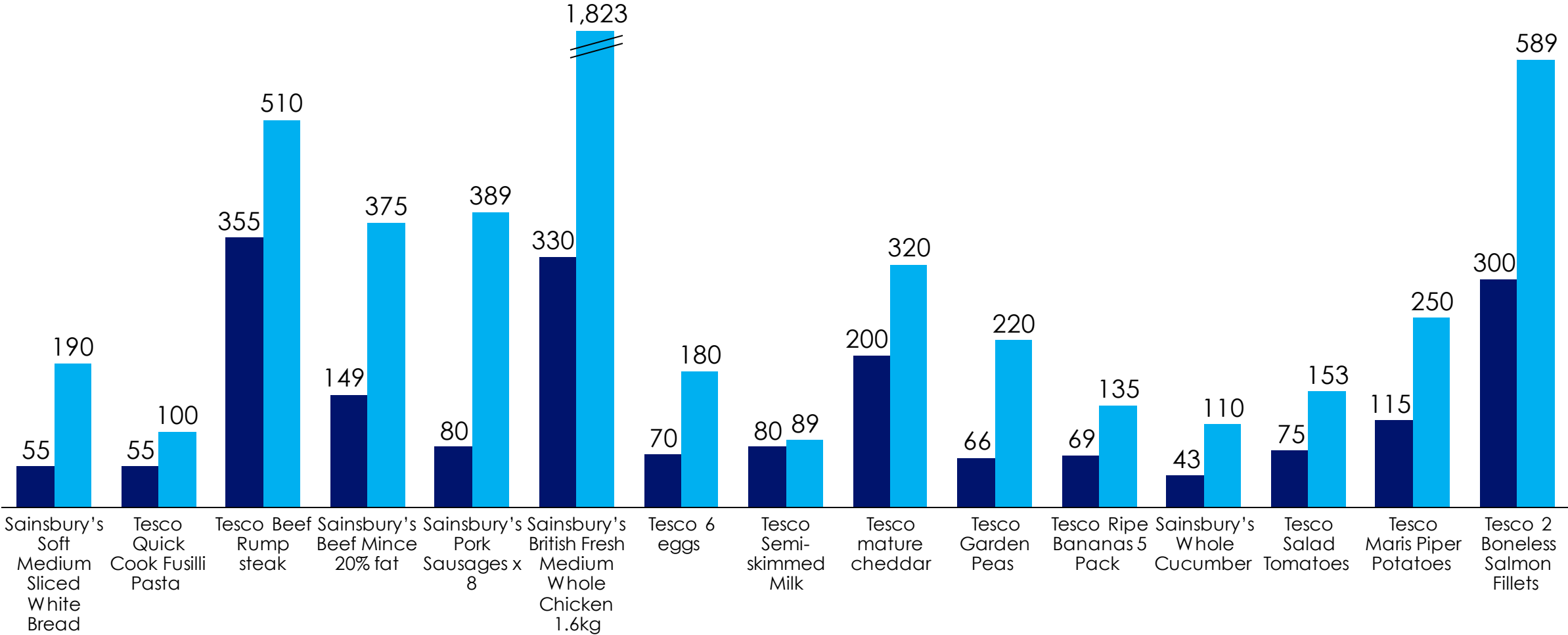
Source: Sustainable Food Trust, 2019; SYSTEMIQ analysis
*some calculations excluded for comparison purposes

APPENDIX B: SWITCHING FARMING PRACTICES

A SUPERMARKET PRICE COMPARISON SHOWS AN ORGANIC PREMIUM OF 10-450%

Supermarket own brand prices
Pence per items

Own brand
Own brand organic

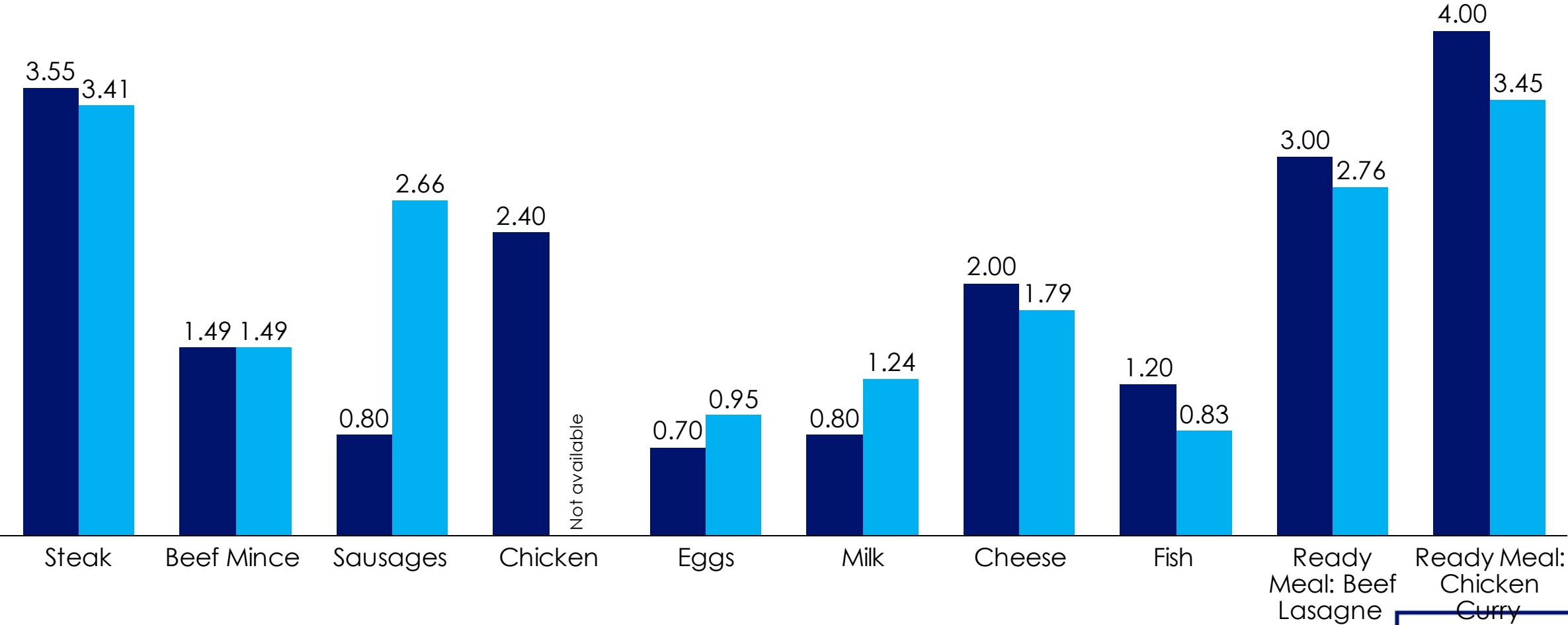


Source: tesco.com and Sainsburys.com accessed 23 March
Premium range calculated using the average for plant and animal premiums

FOR MOST ANIMAL PRODUCTS THERE IS NOT A HUGE DIFFERENCE IN PRICE BETWEEN PRIVATE LABEL AND BRANDED




Supermarket private label and branded prices*
£ per items

Private Label
Branded



*Cheapest branded item chosen from tesco.com and Sainsburys.com

WE HAVE CONSIDERED THREE ALTERNATIVE FARMING SYSTEMS

	General principles	Implications for food production	Implications for climate and nature	Implications for jobs and livelihoods
<div>Intensification</div> 	<ul style="list-style-type: none">Intensify production with low carbon technologies and free up land for other sectors (or on same farm – not modelled)	<ul style="list-style-type: none">Stable or increased, depending on how much land is taken out of production	<ul style="list-style-type: none">Emissions intensity reduced with potential for carbon sequestration off farm, net effect depends on land use change and exports.Animal welfare concerns	<ul style="list-style-type: none">Continued specialisation and farm consolidation may reduce farming jobs (not modelled)Payment not available for areas of land that are left to biodiversity
<div>Agroecology</div> 	<ul style="list-style-type: none">Eliminate synthetic input use and restrict antibiotics, decrease stocking density in grass-based systems	<ul style="list-style-type: none">Reduced especially for intensive cereal and vegetable cropsIncreased lifespan of animals alongside reduces stocking density means there is less kg of product per farm	<ul style="list-style-type: none">Emissions reduced but intensity may increase given longer lifespan of animalsRisk from a rise in imports of cheap unsustainably produced animal productsReduces risk of production health and environmental costs	<ul style="list-style-type: none">On-farm diversification may create more jobs (not modelled)
<div>Resource Efficiency</div> 	<ul style="list-style-type: none">Reduce but do not eliminate synthetic inputs, integrate livestock into crop rotations	<ul style="list-style-type: none">Stable overall with change in product mix (e.g., shift from cereals to pulses and more diverse vegetables)	<ul style="list-style-type: none">Emissions reduced with potential for carbon sequestration on farmReduces risk of production health and environmental costs	<ul style="list-style-type: none">On-farm diversification may create more jobs (not modelled)

KEY ELEMENTS OF THE ‘INTENSIFICATION’ SCENARIO

- Jules Pretty definition: a process or system where yields are increased without adverse environmental impact and without the cultivation of more land.
- The following table highlights the findings from the Climate Change Committee commissioned by the Scottish Rural College (SRUC), drawing on DEFRA's on-going project Delivering Clean Growth through Intensification

Low Carbon Technologies	Method	Description	Environmental Benefits
	Livestock breeding	Select animals with beneficial traits (health, fertility, methane), lower emission and increase profits	8% abatement potential
	Livestock diets	Animal feed and additives that reduces emissions but also improves feed conversion efficiency	36% abatement potential
	Livestock health	Preventative measures: Changing housing to reduce stress and exposure to pathogens, vaccination, improved screening, and antibiotics	15% Abatement potential
	Waste management	Anaerobic digestion, Covering Slurry Tanks	16% Abatement potential
Releasing land for other sectors*	Crops and soils	Grass and legumes, cover crops, grass leys	25% Abatement potential
	Crop yields	Management practices via soil structure, planting periods, tillage, crop nutrition and crop protection. And special planning for efficient land use Tech and innovation – crop breeding	Raise productivity and reduces nutrient, land and water footprint. Releases land for nature conservation or other use ~0.5-0.6m ha by 2035
	Livestock density	Utilization through grazing at the right time	Raise productivity and reduces nutrient, land and water footprint. Releases land for nature conservation or other use ~0.5-0.6m ha by 2035
	Moving horticulture indoors	Vertical farming	Raise productivity and reduces nutrient, land and water footprint. Releases land for nature conservation or other use ~7,000 ha released by 2035

Potential downfalls of Intensification - why it is not the only solution:

- Biodiversity loss on farm
- Use of agrochemicals/ Antibiotics to fight disease
- Fertiliser inputs remain constant – Nitrogen emissions
- Higher risk of climate and disease shocks
- Animal welfare implications
- Farmer livelihoods lost, where land is spared for nature income could be lost
- Potential for increased labour costs

Source: The Climate Change Committee <https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Agriculture-land-use-land-use-change-forestry.pdf>. Jules Pretty <https://www.routledge.com/Sustainable-Intensification-of-Agriculture-Greening-the-Worlds-Food-Economy/Pretty-Bharucha/p/book/9781138196025>

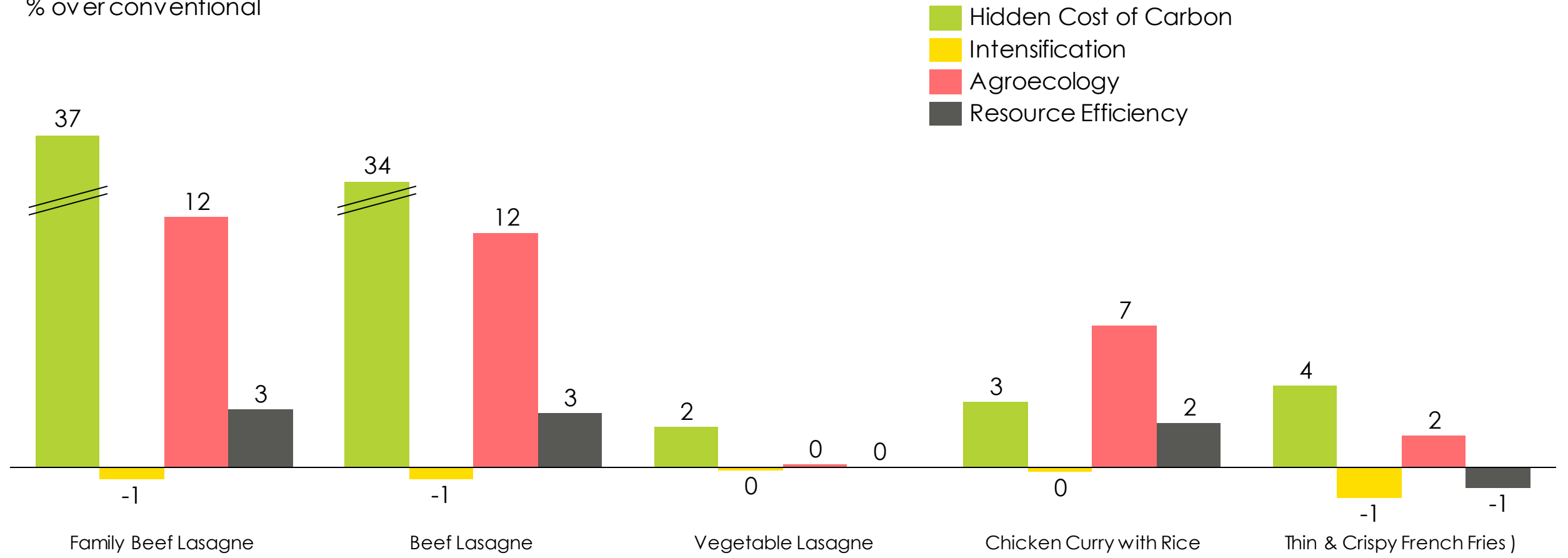
*Intensification alongside shift in diets releases the most amount of land to nature, 3 million ha by 2035

RANGE OF ASSUMPTIONS FOR EACH SCENARIO:

Scenario	Conventional	Intensification:	Agroecology	Resource Efficiency:
	Based on current prices	Model change in farmgate/consumer prices		
Basis and source of scenario	Current market prices (using conventional as a baseline and branded organic as a special case)	Climate Change Committee	IDDDRI/ Food Farming and Countryside C; Farm Survey Data 18/19; Ponit et al 2012, Organic Yields; Soil Association; Life span – various sources, see current farm economics in model	SYSTEMIQ/Soil Capital EU soil report
Crop yields	2018/2019 DEFRA farm accounts	Increase by 10%, 15% or 20% per ha vs current conventional yields	Decrease by 0, 20% or 40% per ha vs current conventional yields	Constant per ha
Livestock density	2018/2019 DEFRA farm accounts	Increase by 5%, 10% or 15% heads per ha and farm	Decrease by 20%, 30%, or 40% in heads per ha and farm Decrease by 50% salmon per m3 and farm	Decrease 10%, 15% or 20% in heads per ha and farm
Animal lifespan	Current age of slaughter	Constant	Broilers: 50%, 60%, 70% Cattle: 40%, 50% or 60% cattle Pigs: 90%, 100% or 110% Salmon: 10%, 20% or 30% <i>Applied to kg per farm</i>	Broilers: 20%, 30% or 40% Cattle: 15%, 25% or 35% cattle Pigs: 40%, 50% or 60% Salmon: 5%, 10% or 15% <i>Applied to kg per farm</i>
Variable cost for crops (seeds, fertilisers, crop protection, etc)	2018/2019 DEFRA farm accounts	Increase by 10%, 15% or 20% per ha Constant per box (bananas)	Decrease by 10%, 30% or 50% per ha. Constant per box (bananas)	Decrease by 10%, 15% or 20% per ha. Constant per box (bananas)
Variable costs for animals (purchased and homegrown feed/ fodder, vet fees and medicines)	2018/2019 DEFRA farm accounts	Constant per animal, increase per farm	Increase 10%, 15% or 20% in feed costs for pigs, chickens and salmon Decrease 0%, 30%, 60% for cattle and dairy cows as largely grass fed	Increase 5%, 10% or 15% in feed costs for pigs, chickens and salmon Decrease 0%, -15%, -30% for cattle and dairy cows as largely grass fed
Fixed cost (includes labour and machinery)	2018/2019 DEFRA farm accounts	Constant per ha and farm, decrease per animal (livestock), per box (banana)	Constant per ha and farm, increase per animal (livestock) and per box (banana)	Constant per ha and farm, increase per animal (livestock) and per box (banana)

THE PRICE OF READY MEALS SHIFTS MORE SIGNIFICANTLY WHEN THE CORE INGREDIENT INCLUDES ANIMAL PRODUCTS

Change in price per item*
% over conventional



*Change in price calculated just using core ingredient , vegetable lasagne uses potato as proxy
Source: Iceland.com accessed 23 March

APPENDIX C: SHIFTING DIETS

THERE ARE THREE BROAD CATEGORIES OF HIGH-PROTEIN ALTERNATIVES TO MEAT PRODUCTS

Nutritious raw ingredients

Sustainable high welfare meat

Livestock farming in harmony with landscape



Insects

Edible insects such as crickets & mealworm



Sustainable ocean protein

Bi-valves such as oysters and muscles, seaweed



Protein-rich plants

Pulses, wholegrain, ancient grains, nuts and seeds



Companies are experimenting with nutritious raw ingredients as consumers increasingly demand 'natural' 'hero' & 'clean' ingredients

- 40% of consumers use ancient wholegrains at least once a week, 20% of those are willing to pay a premium
- European demand for seaweed food products could reach EUR2,094 million by 2030
- Insect's protein market is est. at \$1 billion, with a particularly strong Asian market. 1/3 of UK consumers think we will be eating insects in 2029

Plant based alternatives

Packaged products and ready meals

Lentil burgers or ready meals



Traditional processed products

TOFU and Tempeh



Blended products

50% meat 50% plants



- Retailers are increasingly adding plant-based products to their shelves, and launching their own white-label products.
- Expanding product ranges through new and exciting blends is drawing in new consumers, boosting sales, and meeting flexitarian desire to discover new flavours whilst benefitting health and the environment

'Meat mimicking' alternatives

Textured meat-mimickers

Made from textured soy, wheat or myco-protein



Fermented meat mimickers

Made from fermented myco-protein or algae



Cultured meat

Cultures genetically identical to meat



- Precision biology and fermentation can formulate new and superior food products and ingredients that maximise on health, taste, quality and environmental impact
- The costs and pace of these techs. is rapidly falling
- A record \$435M has been invested into fermentation in 2020
- Cell-cultured meat is very close to surpass the nutritional profile of conventional meat, it is expected to enter the retail market in 2-4 years

PRICE PARITY AND MARKET PROJECTION ESTIMATES

Plant-based meat market projections				
Source	Market size	By year	Share of meat market	Geography
Statista	\$26.77bn	2025		Global
Polaris Market Research	\$35.4bn	2027		Global
MarketsandMarkets	\$28bn	2025	2%	Global
Grizzle	\$34bn	2030	10%	USA
Bernstein	\$41bn	2030	12%	USA
RethinkX	\$100bn	2030	50% (beef only)	USA
Boston Consulting Group	\$290bn	2035	11%(if technological innovation and regulation pathways are optimised that could reach 22%)	
J.P. Morgan	\$100bn	2035	7%	Global
A.T. Kearney	\$370bn	2035	23%	Global
ING	£6.4 billion	2025		Global

Cost parity projections		
Source	Cost parity by year	Market share
RethinkX	2030 - 5x cheaper	
RethinkX	2025 - 10x cheaper	
GFI	2030 -cultured meat	
Boston Consulting Group	2023 - Soy, pea and other plant based protein	11%, potential for 16-22% with increased investment and policy regulation
Boston Consulting Group	2025 - Microorganism based proteins like fungi and yeast	

OUR ANALYSIS COMPARES CONVENTIONAL MEAT WITH MEAT MIMICKING AND HEALTHY PLANT BASED ALTERNATIVES

Conventional Ingredient	1) Meat Mimicking – retailer own brand	2) Meat Mimicking – branded	3) Healthy Alternative*
Tesco Beef steak	Tesco Plant Chef Fake Steak	Quorn Peppered Steaks or Beyond meat ground beef	Cauliflower
Sainsburys Beef mince	Tesco Plant Chef Meat Free Mince	Quorn Mince	Pre-Cooked Lentils or dried lentils
Sainsburys Sausages	Tesco Plant Chef Caramelised Onion Meat Free Bangers 350G	Quorn Vegetarian Sausages	Ready Cooked Falafel or Chickpea to cook from scratch
Sainsbury's Diced Chicken Breast	Not available yet	Quorn Vegan Fillets	Pre-Cooked Jackfruit
Tesco 6 Eggs	Not available yet	Follow Your Heart Vegan Egg Mix (Available on Farm Drop)	Pre-Cooked Baked Beans
Tesco Omega Fish Fingers 10 Pack	Plant Pioneer Fishless Fingers (6 fingers)	Quorn Vegan Fishless Fingers 10 pack	Tofu
Tesco Semi-Skimmed Milk	Tesco Oat Drink	Alpro Oat Drink	Oatly Oat Milk
Tesco Mature Cheddar	Not available yet	Vitalite Dairy Free Block Cheese	Peanut Butter

*Healthier alternatives are based on recognizing a need for more vegetables and wholegrains in the diet, and are not seeking to be meat mimicking or like-for-like for the conventional products/meals. Nutritional content will be analyzed to ensure sufficient protein content and lower sodium/fat/sugar content

POPULAR CONVENTIONAL MEAT-BASED MEALS CAN ALSO BE REPLACED EITHER WITH MEAT MIMICKING ALTERNATIVES, OR WITH MORE NUTRITIOUS PROTEIN RICH MEALS

Conventional Meal	1) 'Meat Mimicking Meal'	2) Healthier Alternative*
Spaghetti Bolognaise	<ul style="list-style-type: none">• Tesco Plant Chef Meat Free Mince• Pasta	Lentil Bolognaise <ul style="list-style-type: none">• Lentils• Wholewheat Pasta
Cheese & Ham Sandwich	<ul style="list-style-type: none">• Vitalite Dairy Free Block Cheese• White Bread	Falafel & Humous Sandwich with wholegrain bread <ul style="list-style-type: none">• Falafel• Houmous• Wholemeal Bread
Chicken Curry	<ul style="list-style-type: none">• Quorn Vegan Fillets• White Rice	Jackfruit Curry with wholegrain rice <ul style="list-style-type: none">• Jackfruit• Brown Rice
Chicken Stir Fry	<ul style="list-style-type: none">• Quorn Vegan Fillets• Noodles	Tofu and Vegetable Stir Fry <ul style="list-style-type: none">• Tofu• Vegetables
Eggs on toast	<ul style="list-style-type: none">• Follow Your Heart Vegan Egg Mix• White Bread	Baked Beans on wholegrain toast <ul style="list-style-type: none">• Backed Beans• Brown Bread
Beef Chilli	<ul style="list-style-type: none">• Tesco Plant Chef Meat Free Mince• White Rice	Bean Chilli with wholegrain rice <ul style="list-style-type: none">• Black Beans• Brown Rice
Sausages and Mashed Potato	<ul style="list-style-type: none">• Tesco Plant Chef Caramelised Onion Meat Free Bangers 350G• Potato	Lentil dahl with wholegrain rice <ul style="list-style-type: none">• Lentils• Brown Rice
Chicken and Mushroom Pizza w / cheese	<ul style="list-style-type: none">• Quorn Vegan Fillets• Vitalite Dairy Free Block Cheese• Pizza Base	Avocado and black bean stuffed sweet potato <ul style="list-style-type: none">• Black beans• Avocado• Sweet potato

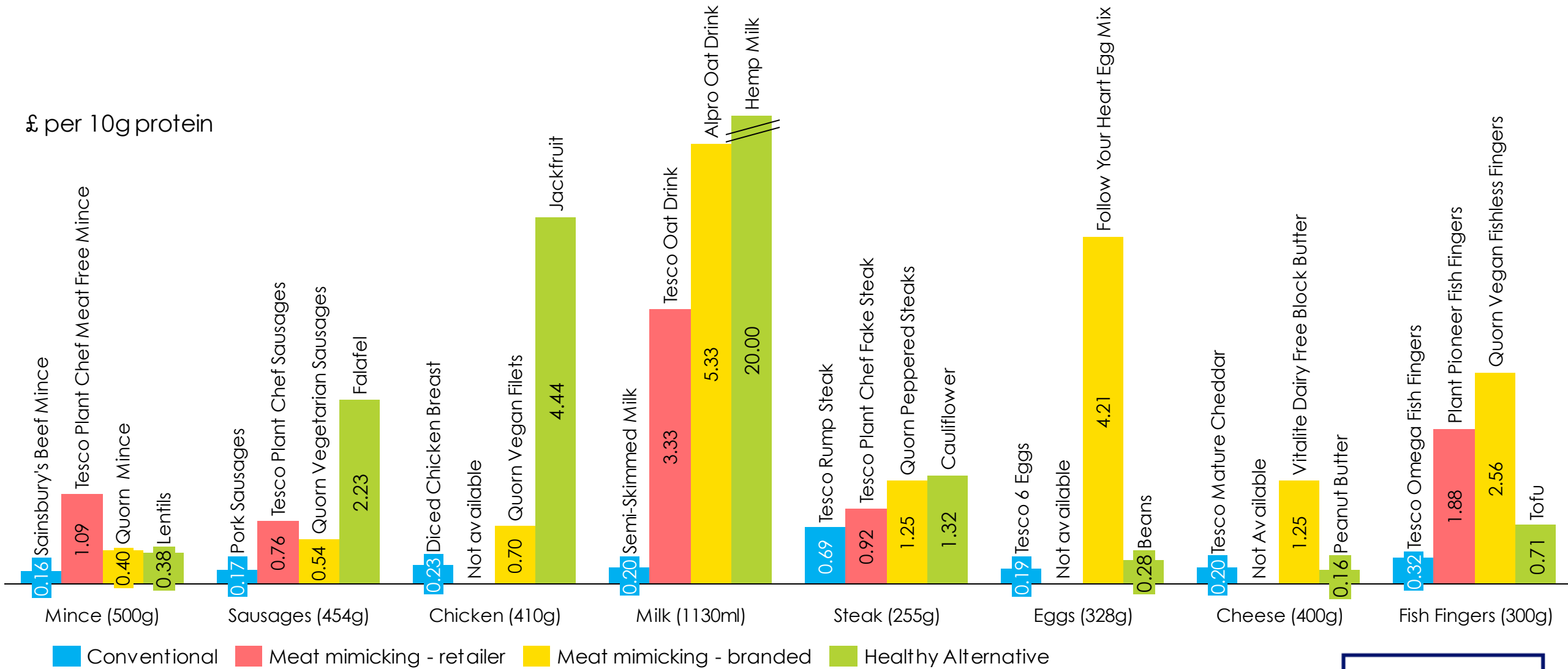
47 * Healthier alternatives are based on recognizing a need for more vegetables and wholegrains in the diet, and are not seeking to be meat mimicking or like-for-like for the conventional products/meals. Nutritional content will be analyzed to ensure sufficient protein content and lower sodium/fat/sugar content

WE HAVE DISCUSSED FOUR OPTIONS FOR ASSESSING THE CHANGE IN PRICE WHEN SHIFTING DIETS

Way to measure	Benefits	Drawbacks
Per ingredient or meal (£ per g) - <i>Modelled for ingredients & meals</i>	Solves for practicality	You do not get a food understanding of nutritional content
Per gram of protein (£ per 10g of protein) - <i>Modelled for ingredients & meals</i>	Solves for nutritional content, people are very conscious of their protein intake	Protein is not the best way to measure beneficial nutrients because on average most people overconsume protein by 1/3 High protein does not mean high nutrition
Per calories (£ per 100kcal) - <i>Modelled for ingredients & meals</i>	Solves for energy, especially for manual workers	Kcals is not the best way to measure beneficial nutrients because we consume too many calories High kcal does not mean high nutrition
Per gram of fibre (£ per g of fiber) - <i>Not modelled</i>	Solves for nutritional content and satiety. Meat will have very little, and plants will show up higher and more favourable (cheaper)	Fiber a less familiar measurement and/or concern for most people

CONVENTIONAL MEAT IS CURRENTLY THE CHEAPEST WAY TO CONSUME PROTEIN, HOWEVER WE OVERCONSUME MEAT BY 1/3, AND OTHER NUTRIENTS LIKE FIBRE SHOULD BE OF GREATER CONCERN. THE PRICE OF MEAT MIMICKING HIGH PROTEIN FOODS ARE ALSO LIKELY TO COME DOWN OVER TIME

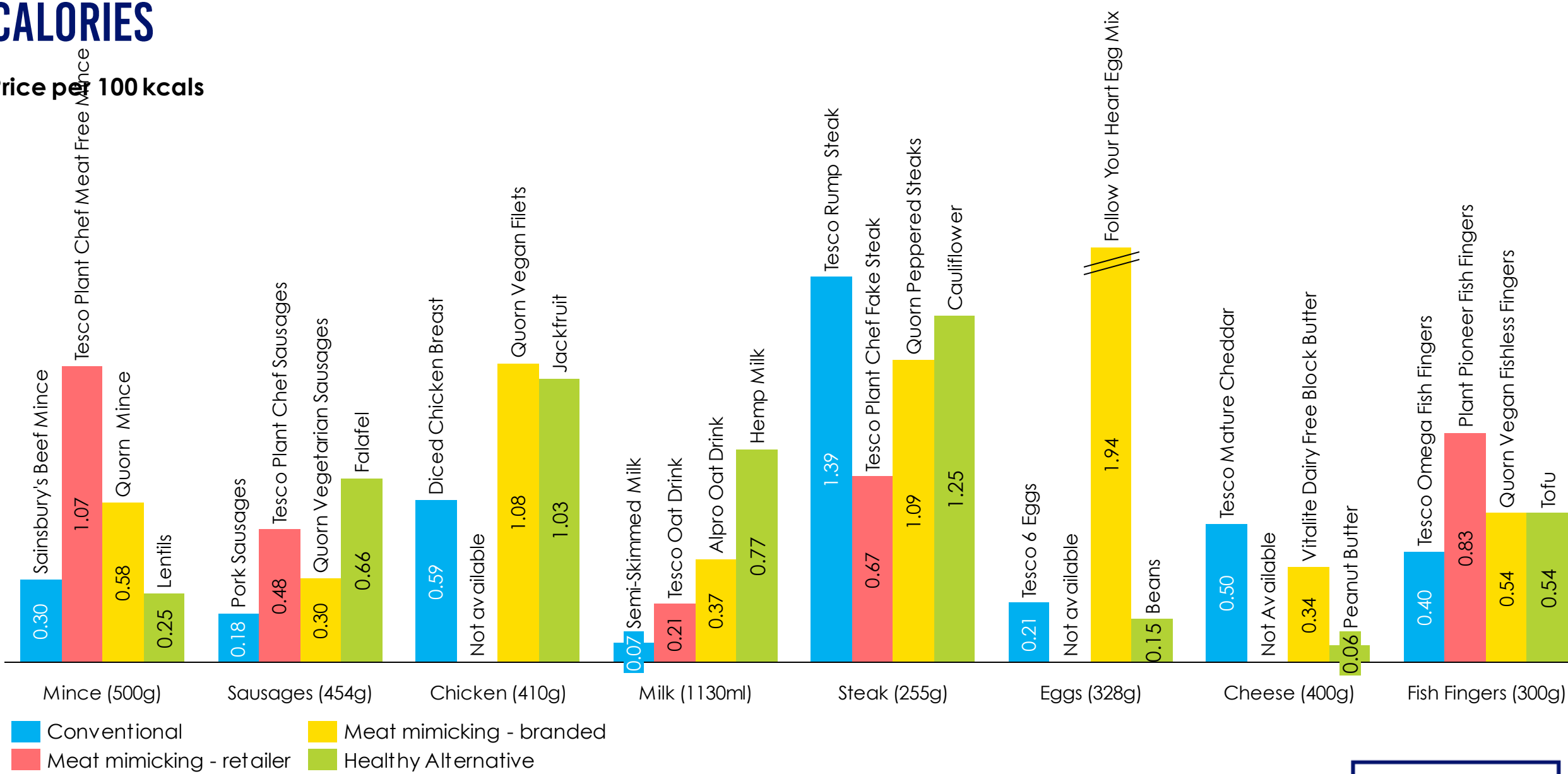
£ per 10g protein



Source: tesco.com and Sainsburys.com

CONVENTIONAL MEAT AND HEALTHY ALTERNATIVES TEND TO BE THE CHEAPEST SOURCE OF CALORIES

Price per 100 kcals



Source: tesco.com and Sainsburys.com