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Green Food Project Curry Sub Group Report

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Contents

Summary

This document is written and owned by members of the curry subgroup. The content does not necessarily reflect the views of Green Food Project Steering Group members.

The Curry Subgroup is one of the five subgroups established within the Green Food Project with a view to looking at the challenge of increasing food production whilst simultaneously enhancing the environment. In its analysis, the Subgroup adopted a whole chain approach by examining the curry supply chain from primary production, through to consumption and waste stages. It focussed on the impacts, tensions and opportunities associated with post-farm gate production and consumption as other sub-groups were considering the environmental, social and economic impacts of primary production (e.g. of livestock, dairy etc.) including biodiversity, animal welfare. The Group gathered and evaluated evidence and information and identified and recommended priority areas for action.

The Subgroup concluded that the primary production end of the supply chain and factors influencing consumption have the largest impacts and therefore constitute priority areas to target. Post farm-gate, environmental, economic and social (including health) benefits can be delivered (amongst other things) through:

- Reformulation of products, including substitution of high impact ingredients;
- Enhanced consumer food literacy[1] and improved waste reduction behaviours. Both retailers and the food service sector can play a major role in this regard by influencing consumers and supporting a shift towards more sustainable, healthier diets.

The Subgroup therefore recommends:

- A more open collaborative dialogue on the issues of:
  - biotechnology
  - meat consumption and production;
- Promoting collaboration across the curry supply chain both horizontally i.e. between retailers and the food service, and vertically i.e. between farmers and the food sector to improve resource efficiency and reduce waste and promote uptake of healthy quality food;
- Enhancing understanding of consumer motivators, attitudes and behaviours, and awareness raising through provision of information to target environmental improvements and waste reduction in the home, food service and retail sectors;

[1] The Group has defined food literacy as consumer understanding, awareness of and engagement with food including where it comes from, how it grown and the socio-economic and environmental impacts associated the food we buy and choose to eat.

- Investments in collaborative, applied R&D, innovative science and biotechnology, knowledge transfer and its take-up into practice in livestock breeding and crop production. This could reduce inputs and impacts, and support flexible food processing and manufacturing. Consumer acceptability of new technologies has to be ensured if these are to be a viable option. Factors influencing healthy sustainable consumption and how these can be integrated also needs investigating;

- Government should develop a collaborative approach to understand and develop information around sustainable and healthy diets and how these can benefit producers, consumers and the wider environment;

- Examining what policy options are available to influence and move towards sustainable consumption and production set within the wider context of challenges posed by global hunger, malnutrition and obesity.

Section 1: Introduction

Background/context

1.1 The Foresight project on "The Future of Food and Farming: challenges and choices for global sustainability" (January 2011)[2] reports that the global food system will experience an unprecedented confluence of pressures over the next 40 years. Global population size will increase from nearly seven billion today probably to over nine billion by 2050, whilst critical resources such as water, energy and land will become increasingly scarce. The report analysed the current global food system from production to plate and laid out how it would need to change to sustainably and equitably feed a growing population. Foresight recognised the tensions between hungry populations and overfed populations, it recognised the need to reduce waste in the food system including post harvest waste, waste in food processing and production and consumer waste. The Government recognises that action is required at all stages of the global food chain and that the UK must contribute actively to the challenges posed by Foresight.

1.2 In the Natural Environment White Paper (June 2011)[3] Defra made a commitment to 'bring together Government, industry and environmental partners to reconcile how we will achieve our goals of improving the environment and increasing food production'. The Green Food Project, a joint initiative between Government, the food and farming industry, environmental and consumer organisations, is looking at the challenges that this raises in England and how any tensions can be reconciled. At a domestic scale, this project will address the findings of the Foresight report and ensure that the UK is making a contribution to the global need for food and environmental improvement.

1.3 The Curry Subgroup is one of five stakeholder groups set up within the Green Food Project to develop case studies to explore the opportunities and tensions around increasing food production and enhancing the environment. On the basis that a healthy, properly functioning natural environment is the foundation of sustained economic growth, the Subgroup has set itself the objective of using a popular national dish –'curry' - as a vehicle for teasing out the tensions, trade-offs and win-wins around combining increased food production with an improved environmental impact.

Membership

1.4 Expertise was gathered from a number of organisations, including: British Hospitality Association (BHA), BPEX - Agriculture and Horticulture Development

[2] The Future of Food and Farming: Challenges and choices for global sustainability, Project Report 2011
[3] The Natural Choice: securing the value of nature, June 2011 http://www.official-documents.gov.uk/document/cm80/8082/8082.pdf

Board (AHDB), Business Service Association (BSA),Defra, National Farmers Union (NFU), Sodexo, Sustain, Which, and WWF- UK.

Product choice

1.5 Curry was chosen by the group as a vehicle for analysis for the following reasons:

- It spans the whole supply chain including post farm gate, manufacturing, distribution, food service and consumption in the home
- It is a dish that is widely consumed within the UK and consumption of foreign/ethnic foods is expected to increase in the future
- There is a mix of ingredients in the dish and it is possible to grow many of them in the UK; it also contains global commodities (e.g. rice, spices) which enables exploration of impacts within a global context.
- There is some available evidence about the key ingredients and the dish itself to support the analysis (there was no time to commission new in-depth research)
- The dish is available in a variety of forms, e.g. fresh and frozen and consumed in the home and via out of home catering.

Evidence

1.6 The Subgroup has focused its evidence collection and analysis on a 'generic' curry dish based on Chicken Tikka Masala ingredients. Generic, because the Subgroup did not wish to constrain their thinking to a specific meat/vegetable dish but rather use the opportunity to explore consumption aspects associated with a dish that can contain both meat and vegetable components.

1.7 The evidence analysis summarised in Section 2 was used to address the questions posed by the Synthesis Subgroup (Section 3). The Group examined each part of the supply chain and identified opportunities, tensions and future trends which impact on or could influence change.

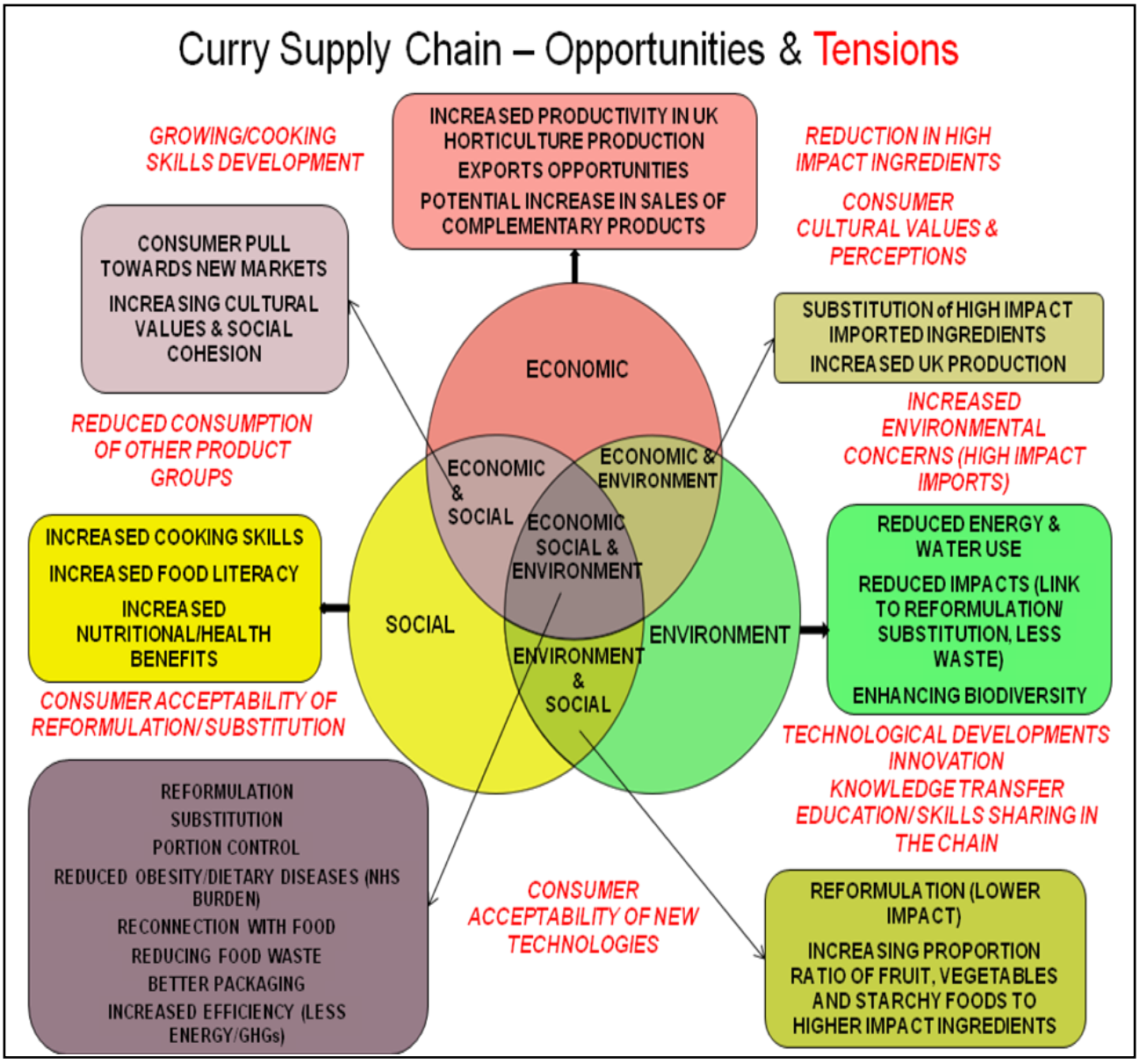
Synthesis Group questions

1.8 The Subgroup prioritised their analysis of the Synthesis Group's questions based on their relevance to factors impacting on curry production and consumption. Only those questions that have most relevance to curry have been addressed fully (Annex 1). The Synthesis Subgroup identified three price scenarios for consideration by the Subgroups in answering the questions. Those scenarios provide possible contrasting futures of how the world might look in 2050. The Curry Subgroup has chosen not to provide a set of answers for each scenario, but rather

to combine answers whilst highlighting, as and when appropriate, actions or consequences that each scenario may favour.

Approach

1.9 The Subgroup gathered evidence from external experts and Defra specialists and performed a SWOT analysis across three perspectives – social, environmental and economic, to identify where the tensions, trade-offs, win-wins and barriers to progress to increasing production and improving the environment are. An overview of the opportunities identified that apply to all (win-win-wins), some (win-wins) or each of the perspectives considered, as well as the key tensions arising is summarised in Diagram 1 and is discussed throughout this report. Product reformulation, food literacy, reducing food and packaging waste, and increased efficiency savings can deliver environmental, economic and social (including health) benefits. Nevertheless, there are tensions that need to be taken into account when considering these opportunities, particularly issues surrounding consumer acceptability of reformulation and new technologies and associated impacts on the industry.



Conclusions:

1.10 On the basis of the analysis conducted, the Subgroup concluded that the pre-farm gate part of the supply chain and factors influencing consumption have the largest impact and should be targeted to support the Green Food Projects objectives to increase production with improved environmental impact:

1.11 The primary production end of the supply chain (production of meat, rice and other key ingredients) is where the largest environmental impacts occur and there are the greatest opportunities for making productivity and environmental gains, supported by R&D and innovation (including breeding and biotechnology) to increase efficiency of crop and livestock production through increased yield and quality.

1.12 Post farm-gate, a number of coordinated actions at different stages of the supply chain have the potential to deliver environmental, economic and social benefits. These are:

- Reformulation of products, including substitution of ingredients with a higher environmental impact (e.g. rice and meat) provides an opportunity for influencing uptake of more sustainable, healthier diets through consumption of fruit, vegetables, starchy foods and smaller portions of high impact quality foods (e.g. meat, rice) which will reduce the burden on the economy due to dietary related diseases and obesity;

- Initiatives that enhance consumer (and supply chain) food literacy (i.e. knowledge of the impacts associated with the food we choose to eat, including where it comes from and how it is grown, how it can be prepared and consumed sustainably, and how we waste it) are needed to support acceptance of reformulated healthy, lower impact products. These should include provision of information, education and skills development targeting schools and in the home. A better understanding of what motivates food choices, perceptions and actual behaviours and the role of new technologies is needed to bring about change;

- Demand for out of home food consumption of convenience foods such as curry will increase. The food service sector can lead the shift to reformulated healthy, lower impact meals, supported by education, skills development and knowledge transfer, and further improvements to reducing food and packaging waste;

- There are opportunities to improve resource efficiency in the supply chain through more efficient energy use in manufacture, distribution and retail (e.g. refrigeration), and use of alternative packaging in production and food consumed out of home;

- Further improvements to waste reduction behaviours can be achieved through more efficient use of ingredients, cooking and disposal of waste by the supply chain and consumers:

- The food chain and policy makers need to rise to the challenges posed by obesity, and global hunger and malnutrition, sustainably and equitably. Changing diets and growing markets in emerging nations provide opportunities for post harvest food providers to offer nutritious, healthy and sustainable options which draw on the diversity of cuisines available. A generic curry dish offers the opportunity to look at a diverse set of ingredients, including global commodities, and to set an example by identifying the range of benefits – economic, social (including health) and environmental - that a shift to a more sustainable, healthier dish could deliver in the context of a growing UK and export market for ethnic/ foreign food.

- More radical solutions to improve production and environmental impact by 2050 are needed. Those include decarbonisation of energy initiatives, developments in biotechnology and of more sustainable protein sources, and developing better understanding of consumer behaviour, cultural and social values.

1.13 On the basis of the analysis conducted the Subgroup recommends –

- A more open dialogue on tensions associated with impacts of meat consumption and increasing production; and also the role of biotechnology in influencing change;

- Promoting cooperation across the whole supply chain, both horizontally and vertically, to realise efficiency savings, boost knowledge transfer and skills sharing and support a shift towards more sustainable, healthier diets;

- Targeting environmental improvements and waste reduction in the home, food service and retail through tackling consumption patterns (better understanding of motivations, attitudes and behaviours and awareness raising);

- Investment in collaborative, applied R&D, innovative science and biotechnology, knowledge transfer and its take up into practice pre farm-gate; investigating factors affecting consumption patterns post farm-gate.

Section 2: Evidence analysis

Overview of environmental and socio-economic evidence

2.1 The approach taken to gather evidence for this report was framed by the strength of the knowledge base on curry. The evidence base is strongest on assessing the impacts of agricultural commodities to the farm gate. There are fairly robust data on commonly consumed fruit and vegetables, cereals, meat, poultry, milk and dairy products and options for reducing emissions to air and water. Published evidence on processed foods and composite products ('meals'), and impacts of out of home consumption of curry is more limited. Due to these data limitations the Group assessed individual curry components/ingredients and examined the impacts of each stage of the supply chain (production, manufacturing, distribution retailers, food service, consumers). It gathered data on embedded energy, environmental impacts, supply and imports, supply chain resource efficiency, demand trends and influences to build up a picture of socio-economic and environmental impacts which were used to identify opportunities, tensions and trade-offs.

2.2 The analysis provided in this report is underpinned by the evidence gathered by the Subgroup which is summarised at Diagram 2. This diagram outlines facts, opportunities, risks, barriers, tensions and trends in the curry supply chain. A composite dish 'Chicken Tikka Masala' was used to frame the basis of the evidence gathered. Environmental impacts[4] associated with the production, consumption and disposal of the dish and its components were considered from a manufacturing, food service and consumer perspective. Socio-economic trends (e.g. in health, obesity) and factors influencing production and consumption of meals were also examined from a UK and global perspective including factors influencing changing markets, population, demographic and demand trends.

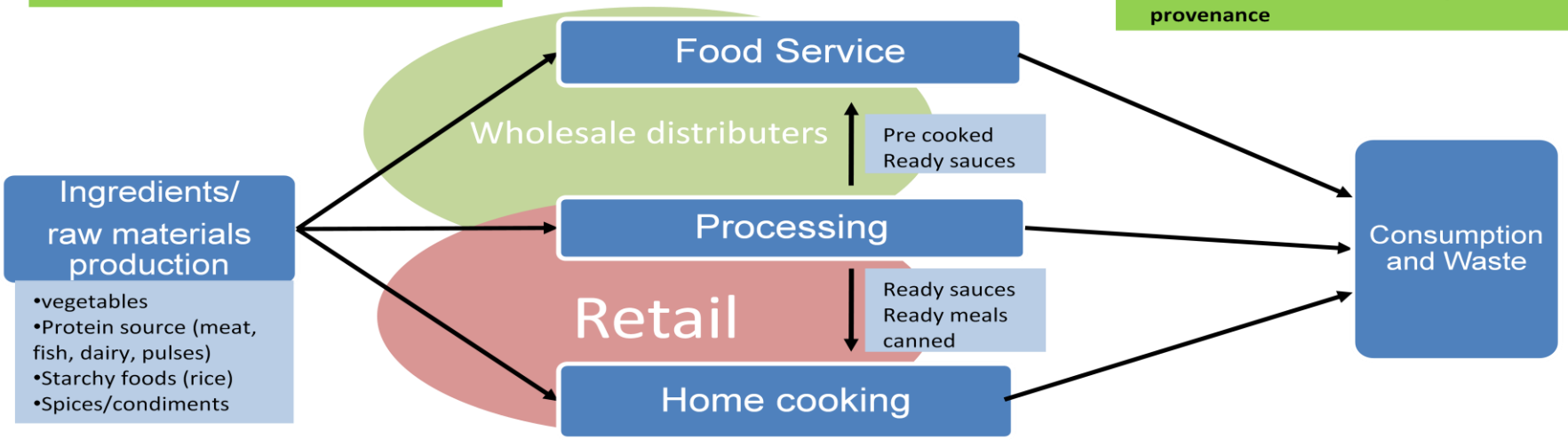
[4] Such as resource use (energy, water), waste, GHG emissions, land–use, biodiversity.

Curry supply chain – impacts and tensions, trends and opportunities

- Reformulation – **reduce use of high impact ingredients; increase use of home grown ingredients**
- Innovation through breeding, agronomy, novel technologies to **reduce impacts of primary production.**

- **More efficient technologies** for cooking, processing and supply chain refrigeration.
- **Raised awareness/Best practice** - More widespread water and energy metering to improve resource use efficiency.

- **Improve product shelf life** –
- Intelligent packaging
- Packaging materials with lower impacts over their lifecycle.
- **Raised awareness and improved skills – health, nutrition, reduced impacts, provenance**



- **Reducing environmental impacts from farming (meat, rice)**–(GHG, water and air pollution, natural resource use)
- **Imported ingredients essential**
- **Rising commodity prices by 2050**
- Increased demand and fair distribution of food (hunger vs. obesity).
- Concerns about animal health and welfare

- **Reliance on packaging** – glass jars (sauces) plastics (ready meals).
- **High energy demand for processing and refrigeration: vs volatility**
- **Supply chain resilience** – dependency on energy and fuel
- **Limited data /metering in the food service sector** = low awareness of impacts

- **High food and packaging waste (processing, out of home, at home)**
- Packaging – uses non recyclable plastics.
- **Food safety/regulatory barriers/shelf life**
- Cultural preferences/consumer acceptance - new technologies, ingredients and processing.

- Estimates of the total value of the UK curry market (including over 12,000 restaurants) vary, ranging from £3.5 billion to £4.3 billion.
- **Consumer demand** – more convenience, healthy food

- UK chilled and frozen ready meals market grew by 23% from 2006 to 2011, to a forecast £2.4 billion – 20% are Indian.
- Further growth (19%) by 2015.

- Asia-Pacific is fastest growing market for ready meals
- **Long-term global rise in westernised diets/convenience food consumption**
- Demographic shifts - inc sales of convenience foods
- **Overseas gwth - Limited by lack of cold storage/preservation**

Ingredients – raw materials

2.3 Primary production is responsible for the greatest environmental impacts associated with curry, with the greatest contribution being associated with impacts from meat products[5].

2.4 Beef and sheep can be produced using lower quality land which is not suitable for arable crops, and their production supports grasslands which may deliver other environmental benefits such as soil protection or supporting biodiversity. Chicken is generally the meat type produced with lower impacts (closely followed by pork). It has considerably lower GHG emissions than beef or lamb since it generates very low enteric or gut methane emissions and is very efficient at converting feed into meat [6]. However, poultry and pig production depends on availability of feedstuffs grown elsewhere which may have inherent impacts (crops produced on arable land). As a common accompaniment to curry, rice is a staple part of global diets and is environmentally intensive due to its GHG emissions (methane and carbon dioxide) [7]. High use of water in its production also contributes to its negative environmental impact, and nitrogen and phosphorus losses impact on water quality and aquatic ecosystems [8]. Lastly, primary production uses considerable amounts of land (over 70% in the UK) and can have a significant impact on biodiversity both through land management (cropped land can provide specific habitats and support biodiversity) and land use change.

2.5 Tomatoes are a commonly used ingredient in many curry dishes. Energy requirements for tomato production depend on the method of growth, with tomatoes grown outdoors in warm counties (5.4 MJ/kg) requiring considerably less energy than UK tomatoes grown in heated greenhouses (95 MJ/kg). Onions and garlic, other key ingredients, require less energy in production (2.9MJ/kg) [9]. This illustrates the considerable differences between production systems. Energy use in cultivation is not the only factor to consider when assessing the energy requirements of crops, e.g. energy use can be reduced by the use of waste heat where it is available.

2.6 Spices, a key component of curry, are present in small quantities (e.g. chillies, turmeric, paprika, coriander, pepper, anise, fennel, cardamon), and the majority of these must be imported from South America, Asia and China, adding to the

[5] Roy, Nei et al (2009). A Review of life cycle assessment (LCA) on some products. Journal of Food Engineering. 90(1):1-10

[6] Defra, 2006. Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities. Defra project report IS0205

[7] Wang, Xia et al (2010) International Journal of Sustainable Development and World Ecology 17(2) 157-61.

[8] Rob Lillywhite, 2012

[9] Roy, Nei et al, 2009

environmental burden of the dish and its reliance on imported ingredients [10]. It is worth noting that coriander is now produced in significant quantities in the UK.

2.7 Dairy ingredients (cream, yoghurt, butter) occur in some curries and these have a high environmental impact due to their high energy consumption during their life cycle (12.1-23.5 MJ/kg) and methane emissions from livestock.

2.8 Oil is also a commonly used ingredient of curry and has a relatively high environmental impact (21.7 MJ/kg).

2.9 Curry (including side dishes) has a very variable composition[11] , however in a typical dish rice may contribute to over one third of the total dish/ followed by chicken/meat (approx 20-30%), and tomato etc.[12].

2.10 Table 1 shows the embedded energy and environmental impacts associated with typical Chicken Tikka Masala ingredients:

		Embedded energy (MJ/kg)	CO_2e (kg/kg)	Eutrophication (kg PO_4e/kg)	Acidification	Water footprint (litre/kg)
Ingredients	**Rice**	14.2	1.5	0.14		3,400
	Chicken	39.7	3.1			3,900
	Tomato	5.4	0.2			213
	Onion	2.9	0.4			330
	Cream	12.1				702
	Yogurt	19.4				520
	Spices	-	0.8			

Table 1- The embedded energy and environmental impacts associated with Chicken Tikka Masala ingredients; Data Source:Rob Lillywhite and Carla Sarrouy, personal communication, 2012

[10] The UK imports approx 46,000 tonnes spices per annum (for all industries) – Lillywhite, R (personal communication)
[11] University of Leeds. Nutritional Analysis of Commonly Consumed South Asian Foods in the UK. FSA project N10038.
[12] This is consistent with the MAFF Food Portion Sizes Handbook, although that data is quite old (1993) and no accurate, recent data were found to confirm it.

Supply and imports

2.11 Defra sources[13] suggest that the UK is completely dependent on imports for rice and spices, whilst less than 20% of all tomatoes supplied to the UK are domestically produced. Around half of onions supplied are home grown, whilst the UK produces 70% of total UK yoghurt supply and is fully self sufficient in cream. The UK produces around half of all UK cauliflower and broccoli supply and around 85% of total potato supply in the UK. Home grown mushrooms account for around 40% of total UK supply whilst being almost self sufficient in carrots and cabbages.

Manufacturing/ Processing

2.12 **There are not large differences in impacts associated with the production of different types of products: chilled ready meals, frozen ready meals and canned ready meals.** Processing uses little energy compared to the primary production stage. Packaging is identified as a key area in terms of improving efficiency in manufacture. Table 2 shows it can have a significant impact on environmental performance since some materials such as glass and aluminium have high embodied energy values. The method of production of commercial curries (chilled-ready meal v/s frozen v/s canned) influences energy use at different stages of manufacture although overall energy analysis seems to be similar.

Contents	**TM sauce** **Sauce**	**Chilled Ready-Meal** **Sauce, chicken, rice**	**Frozen Ready-Meal** **Sauce, chicken, rice**	**CTM Canned** **Sauce, chicken**
Raw ingredients	5.5	13.3	13.3	13.3
Packaging	12.0	2.2	2.2	5.0
Manufacturing	1.5	2.0	2.0	1.5
Logistics	0.2	0.5	0.5	0.2
Total	19.2	18.0	18.0	20.0

Table 2- Energy analysis for different commercially produced Tikka Masala Sauce products (MJ/kg); Data Source: Analysis of the energy use and environmental impacts associated with the production of Chicken Tikka Masala, Rob Lillywhite and Carola Sarrouy, personal communication, 2012

[13] Agriculture in the UK 2011. Estimates for chicken are complex due to the level of processing. We generally import chicken breasts to meet UK demand whilst exporting other parts of the chicken.

Distribution/ logistics (including energy use in refrigeration)

2.13 **Distribution uses little energy compared to the primary production stage. However, transport of chilled foods is the largest contributor of energy use in the food chain due to refrigeration (contributing up to 47% of total impacts).** Direct GHG emissions from refrigerant gases also contribute to negative environmental impacts associated with refrigeration in the food supply chain[14].

Consumption – demand trends and influences

2.14 Curry is a dish that is widely consumed within the UK and is increasing in popularity. The value of the UK curry market is difficult to measure, since it depends on definition and data source used. However, it is estimated to have a total value of around £4billion, of which eating out accounts for £3.6billion [15]and Indian ready meals and ready to cook meals account for around £400 million[16]. Home-cooking of curry was not included in these figures since it is difficult to estimate.

2.15 Despite the lack of evidence on curry as a dish, there are trend data available for key curry ingredients[17]. Mintel estimates the value of retail sales of chicken in 2011 to be £2.3billion, showing an increase of 28% since 2006[18] in real terms. In the same period, the UK retail rice market has grown by 66%, now valued at £440 million[19] and naan bread sales accounted for £60 million[20] in the same time period. Latest estimates from Mintel value the cream market at £300 million[21] in 2010, growing by 8% between 2005 and 2010, and the domestic yoghurt market at £1.8 billion[22] in 2011, expanding by 21% between 2006 and 2011. Estimates for the retail value of tomatoes in the UK are around £625 million[23], whilst retail onion and shallot sales are valued at around £300 million[24]. Curry paste had estimated sales of £15 million in 2011, while curry powder had estimated sales of £7million[25].

2.16 Future consumer trends indicate that both foreign/ethnic foods and ready meals are expected to grow to meet rising consumer demand for convenience foods. Global Industry Analysts predict that the world market for ready meals is projected to exceed $81 billion by 2015. Rising employment of women, an increase in

[14] An examination of the global warming potential of refrigeration in the food chain: developing marginal abatement cost curves, Defra FO0107 (2011)
[15] Spice Business trade magazine
[16] Prepared Meals and Meal Kits 2011, Mintel Report. Note, this is an estimate of the UK Indian ready meal and ready to cook market, which includes curry as well as other products. This is the closest estimate possible.
[17] These estimates will not solely be for the consumption of curry.
[18] Meat, Poultry and Fish 2011, Mintel Report
[19] Pasta, Rice and Noodles 2011, Mintel Report
[20] Bread and Baked Goods 2012, Mintel Report
[21] Dairy Drinks, Milk and Cream 2011, Mintel Report
[22] Yoghurt and Desserts 2011, Mintel Report
[23] British Tomato Growers Association
[24] Fruit and Vegetables 2012, Mintel Report
[25] Table Sauces and Seasoning 2011, Mintel Report

disposable income and increasing Westernization of food habits across emerging counties are leading factors in driving demand for convenient meal options. However, preference for local diets and religious influences reducing beef and pork consumption are mitigating the growth of meat-based ready meals[26].

2.17 Predicted population growth and demographic changes will influence consumer demand. In the UK, the 24-34 year olds and the over 55s, one-person households, and certain socio-economic groups will gain most share in the population. Coupled with demand for healthier/convenient foods, this is expected to drive the increase in sales of ready meals. However, although Mintel forecasts that UK sales of chilled ready meals will continue growing in value to 2015, once this growth is adjusted for inflation, sales will actually be declining in real terms [27].

2.18 In addition to the ready meal forecasts, Mintel[28] expects no growth in the UK retail rice market between 2011 and 2016 whilst estimating roughly 1% growth (in value terms) in the UK retail chicken market. The yoghurt market is expected to decline to £1.7 billion in 2015. Forecasts for other ingredients are currently not available.

2.19 England has amongst the highest levels of adult obesity in Europe. 62.8% of adults, and 30.3% of children (aged 2-15) are overweight or obese[29], and the resulting costs (e.g. through increased incidence of type 2 diabetes, heart disease and cancer) to the NHS exceed £5bn per annum[30]. There are also costs to society and the economy more broadly associated to a reduction in productivity which have been estimated to cost the wider economy in the region of £16bn in 2007, with a potential rise to just under £50bn in 2050 if increases in obesity rates were to continue unchecked[31]. To assist in addressing this problem, the Government published Healthy Lives, Healthy People: A call to action on obesity in England, in October last year. This sets out how obesity will be tackled in the new public health and NHS systems, and the role of key partners, including large food retailers and manufacturers[32].

2.20 From a global perspective, the Foresight project on the 'Future of Food and Farming: Challenges and choices for global sustainability' reports that approximately three billion people worldwide have suboptimal diets[33]. 925 million people worldwide experience hunger (lacking access to major macronutrients), and approximately a billion are thought to suffer from 'hidden hunger', in which important micronutrients (such as vitamins and minerals) are missing from their diet, with consequent risks of physical and mental impairment. In contrast, a billion people are substantially over-consuming, spawning a new public health epidemic involving

[26] Global Industry Analysts – http://www.prweb.com/releases/ready_meals_market/frozen_ready_meals/prweb3830874.htm
[27] Prepared Meals & Meal Kits 2011, and Chilled and Frozen Ready Meals 2010 - Mintel Reports
[28] In constant prices, that is, adjusted for inflation
[29] Department of Health, 2011, Health Survey for England 2010
[30] Department of Health, 2011. Healthy lives, healthy people: a call to action on obesity in England
[31] Foresight report, Tackling Obesities: Future Choices project; Department of Health, 2007
[32] http://responsibilitydeal.dh.gov.uk/our-partners/
[33] The Future of Food and Farming: Challenges and choices for global sustainability, Project Report 2011

chronic conditions such as type 2 diabetes and cardiovascular disease. The project report therefore concludes that actions need to be taken across the global food system to ensure a global population of 9 billion people by 2050 is fed sustainably and equitably. Global trade offers the opportunity of nutritious, healthy and sustainable diet choices which draw on the range of cuisines and cultural diets. This diversity provides a range of solutions which can both offer sustainable and balanced options for emerging nations and western consumers alike; recognising the sustainable choices of ingredients and the issues linked to resource scarcity when sourcing raw materials.

Waste

2.21 Waste is one of the key contributors to environmental impacts post-farm gate along with consumption of high impact raw materials and ingredients such as those highlighted in section 2. No data are available specifically for curry, however there are data on waste generation at home and in the food service sector. UK households contribute most to food and drink waste generating approximately 7.2 million tonnes per year, most of which is avoidable. This is equivalent to 20 million tonnes of GHG emissions per year and represents a household spend on food that ends up wasted of £12 billion per year, or around £50 per household per month[34]. Water footprint of avoidable household waste is equivalent to nearly 6% of UK water requirements[35]. Government is working through WRAP to tackle the issue and influence consumer behaviour via a number of initiatives such as the 'Love Food Hate Waste' campaign, and there are opportunities to build on these initiatives to influence waste reduction behaviours in the future.

2.22 In 2009, UK pubs, hotels, restaurants and quick-service restaurants produced just over 3.4 million tonnes of waste, including 600,000 tonnes of food waste[36]. 400,000 tonnes of this food waste is avoidable, demonstrating considerable opportunity for waste prevention. This could be achieved through improvements in ordering, menu design, staff training and measurement of what is wasted. WRAP is developing a new voluntary agreement to help hospitality and food service sector businesses reduce their food and packaging waste and manage it more sustainably[37].

[34] WRAP New estimates for household food and drink waste in the UK 2011
[35] Food Statistics Pocket Book
[36] http://www.wrap.org.uk/downloads/The_Composition_of_Waste_Disposed_of_by_the_UK_Hospitality_Industry_FINAL_JULY_2011_GP_EDIT.c234d4ba.11675.pdf page 65
[37] www.wrap.org.uk/hospitaltiy

Section 3: Synthesis Group questions and scenarios

What specific post-production actions (in particular considering waste and transport) could lead to higher value/less environmentally damaging food reaching the consumer?

3.1 The Subgroup recognises that the primary production end of the supply chain represents the largest source of environmental impacts. Consequently, effort needs to focus around addressing impacts pre-farm gate (from production of meat, rice and other key ingredients), through more efficient use of inputs (e.g. water, fertiliser etc.), supported by R&D and innovation to develop technological solutions to improve productivity with reduced environmental impact. Some of these issues are being explored by the dairy and wheat sub-group.

3.2 The Subgroup recognises that the primary production end of the supply chain represents the largest source of environmental impacts. Consequently, effort needs to focus around addressing impacts pre-farm gate (from production of meat, rice and other key ingredients), through more efficient use of inputs (e.g. water, fertiliser etc.), supported by R&D and innovation to develop technological solutions to improve productivity with reduced environmental impact. Some of these issues are being explored by the dairy and wheat sub-group.

3.3 Post farm-gate, the Subgroup has identified a number of actions at different stages of the chain that offer the potential to deliver environmental, as well as economic and social benefits. In considering the opportunities available post farm-gate, the Subgroup has acknowledged that there are tensions surrounding the issue of meat consumption and the pursuit of increasing production/ productivity in the UK livestock and poultry sectors.

Manufacturing

3.4 The diversity of ingredients used in curry and how it is prepared present opportunities to improve its environmental performance through reformulation (See Annex 2 for example of reformulated curry), processing and preparation efficiencies (e.g. in manufacture) and food preparation out of home (food service sector).

3.5 These include –

- **Modifying the type or selection of meat to reduce the environmental impact of the dish** (i.e. chicken has lower embodied impacts than pork, and pork has lower impacts than beef or lamb. However, there are trade-offs as production of beef and lamb requires less arable land, whereas, cooked chicken used in manufacturing and catering is often imported from countries such as Brazil and Thailand (transport

impacts). UK production also relies on imported soya which has environmental impacts associated with land-use change, biodiversity loss and indirect emissions);

- **Modifying the proportion ratio of meat to other ingredients** towards a higher proportion of starchy foods and fruit and vegetables (lower impact ingredients) in a meal[38], which is also in line with the Eatwell Plate guidance on healthy diets;

- **Reducing the use of rice** by replacing with other high-starch ingredients that have lower impacts (such as barley, wheat-based products which are not fried) whilst retaining nutritional/health benefits ;

- **Increasing consumption of UK produced ingredients.** There is potential to increase the use of home grown ingredients (e.g. potatoes, wheat, rape seed oil) emerging from long term changes in weather patterns potentially enabling production of some traditionally imported ingredients domestically (e.g. some vegetables, herbs and spices that are currently marginal in the UK). However, water availability for irrigation in the UK may limit the opportunities for production in the longer-term.

- **Reformulation of products** to include a greater proportion of vegetables and substitution of rice with lower impact carbohydrates provides not only environmental benefits, but also social and economic benefits. Increasing consumption of reformulated, healthier meals, may reduce the economic burden on the NHS arising from increasing levels of dietary-related heart disease and obesity.

3.6 Reformulation of products to include a greater proportion of vegetables and substitution of rice with lower impact carbohydrates provides not only environmental benefits, but also social and economic benefits. Increasing consumption of reformulated, healthier meals, may reduce the economic burden on the NHS arising from increasing levels of dietary-related heart disease and obesity.

3.7 Efficiencies in manufacturing of commercially produced curries could be achieved through investment in R&D and innovation to:

- **optimise efficiency and yield in production** (e.g. livestock, tomatoes etc.), improved raw material quality, leading to less waste in processing and use post farm-gate;

- **optimise packaging design** to improve impacts and waste management options through the use of intelligent packaging whilst ensuring food safety (e.g. alternatives to glass and aluminium (foil) that deliver lower impacts - cardboard and polylactic acid and substitute pouches). However there are also benefits associated with glass (costs and ability to use existing sterilising operations), and recycling of glass to help reduce environmental impacts is easily understood by consumers;

3.8 Other opportunities include-

[38] Livewell: a balance of healthy and sustainable food choices, WWF 2011

- Utilising **sustainable sourcing policies** for key ingredients (e.g. palm oil) – this is also relevant to the food service sector;

- Further developing and incentivising the use of **recyclable/compostable packaging** for use in food service/out of home eating (e.g. takeaway serving dishes) to meet waste reduction targets;

- **More efficient energy and water use** in cooling, storage (raw materials), processing and cooking systems. There are significant synergies between reducing energy and water use, since a considerable amount of energy is required for dewatering, heating and chilling large volumes of water in processing;

- **Improving efficiency in the chilled food supply chain.** Chilled foods such as curry ready meals are a major contributor in terms of impacts due to high energy use associated with refrigeration in manufacture, retail and distribution [39]. Other impacts include waste arising from poor product forecasting demands, short product shelf life, and consumer waste arising from packaging), R&D and innovation coupled with better supply chain interaction provide opportunities to reduce these impacts through the development of more flexible, responsive supply chains and low impact refrigeration systems;

- **Working with the supply chain to communicate clear date labelling** and storage information to influence behaviour and minimise waste post retail and in the home.

Distribution/logistics

3.9 A number of opportunities have been identified around –

- **Local sourcing of UK-produced ingredients can minimise transport emissions but does not necessarily reduce the overall environmental impact of food production;** local food chains can be less efficient [40]. Locality or seasonality should not be used as an indicator of environmental impacts of ingredients, since transport can represent a small proportion of total impacts which occur primarily in primary production as a result of the interaction between the production system and the local environment [41];

- **Efficiency savings** can be made in chilling/refrigeration in manufacture, transport and retail to reflect increasing trend in chilled ready-meals – supported by investment in R&D and innovation;

[39] Project FO0210 (2008). Evidence on the role of supplier-retailer trading relationships and practices on waste generation in the food chain.
[40] Project FO0104 (2009). Investigating the practicalities and benefits of local food production and identifying any unidentified effects and trade-offs
[41] Does consuming seasonal foods benefit the environment? Insights from recent research (2011). Nutrition Bulletin 36, 449-453.

- **Creating an environment** (regulatory, improved consumer/supply chain awareness) which is **supportive of the best available science and technologies** (such as breeding, biotechnology including GM) to optimise resource efficient production of key curry components (including meat, rice) which are acceptable to consumers.

Food service

3.10 There are opportunities around -

- Encouraging **investment in more efficient capital equipment** (ovens, refrigerators/freezers) supported by technical innovation and R&D, to reduce refrigeration emissions and support more efficient production of food prepared for consumption outside the home [42];

- Influencing behaviours up and down the supply chain to be more efficient through **incentives to develop better metering and bench-marking on energy and water use**. Raising awareness of choice of raw ingredients, how they are purchased, stored and cooked can reduce impacts in the catering SME businesses (e.g. turning ovens off, smaller freezers, less frying etc.).

Consumption

3.11 Consumer choice, values, societal issues and behaviour play a significant role in the way food is purchased, prepared, stored and wasted and drives pull through the supply chain. Influencing consumer behaviour coupled with acceptance of new, safe technology would help drive change towards consumption of higher value, less environmentally damaging food. In particular -

- Consumer choice is affected by what is available, affordable and accessible. Price is the key influence on consumer choice[43],[44],[45]. Supermarkets and other food suppliers have an influential role in editing consumer's choices and influencing their behaviour. Health issues are also a key consideration for consumers[46]. This presents opportunities for retailers and suppliers to influence consumer behaviour towards adopting more sustainable, healthier options.

- Evidence shows that environmental concerns are not a key influencer of consumer choice – consumers have a low understanding of the impacts of production, purchasing, cooking and disposal of food[47]. Therefore working with the supply chain to develop opportunities and incentives to promote and raise awareness of growing,

[42] Defra project FO0411 highlights opportunities for environmental improvement in the food service sector to address environmental 'hot spots' associated with ingredient and food storage and methods of meal preparation
[43] IGD data
[44] Estimating Food and Drink Elasticities 2011, University of Reading
[45] This study is based on UK household consumption from Living Costs and Food Survey. Results do not take account of eating out.
[46] Defra projects EV02045; EV0510
[47] Defra projects EV02045; EV0510

cooking and enjoying food and its health and well-being benefits could influence pro-environmental behaviours in consumers. Food growing activities in schools also has been shown to have a positive impact on student horticulture and scientific knowledge, and can also improve their environmental awareness[48];

- Consumer acceptance of nutritionally balanced reformulated dishes with a lower environmental impact (e.g. modifying the balance of meat and alternative protein sources) will help support greater uptake of fruit, vegetables and starchy ingredients, which will, in turn, deliver social (health), economic (including supporting the UK Horticulture sector) and environmental benefits;

- Research shows the evidence base around sustainable diets is under-developed [49]. More evidence is needed to increase understanding of sustainable diets from an environmental, social and economic perspective to provide information to enable consumers and the supply chain to make informed choices towards encouraging sustainable consumption and avoiding food waste;

- Research shows that wasted energy from methods of cooking (e.g. ovens) is an important factor contributing to environmental impacts in the home with smaller portion sizes and microwave cooking resulting in the least amount of GHGs and waste[50]. Consequently, raising awareness and influencing behaviour to change cooking and eating habits represent opportunities to achieve environmental and health improvements;

- Consumer acceptance of new technologies (e.g. nanotechnology, GM,) may significantly influence sustainability of agricultural production to meet rising population demand for food

3.12 Cultural values and societal issues also have a significant influence on behaviours, for example consumer acceptability of dishes with lower meat content, and related perceptions of quality. Some consumers may judge the quality of a dish and/ or the value for money derived from a dish by its meat content, which may influence their ability to switch to alternatives. Any attempt to change these behaviours would need to address the social factors associated with food choices including the characteristics of the societal sectors, their ability and willingness to change. Activity would need to be informed by improved understanding of what motivates consumer food choices and food behaviours. Work to improve this understanding has already begun, for example in Defra's food synthesis review [51], however significant gaps

[48] NFER 2012. Food Growing Activities in Schools, a report for Defra.
[49] Final report for Defra project FO0430 - Evidence to define the sustainability of a healthy diet (http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17393&FromSearch=Y&Publisher=1&SearchText=FO0430&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description)
[50] Defra project FO0409
[51] White, P., Sharp, V., Darnton, A., Downing, P., Inman, A., Strange, K., and Garnett, T. (2009). *Food Synthesis Review: A report to the Department for Environment, Food and Rural Affairs.* The Social Marketing Practice et al. Defra, London.

remain in the evidence base and these would need to be addressed as part of any process to develop effective strategies to change consumer behaviour.

Trade-offs

3.13 There are a number of trade-offs that need to be considered in light of the post-farm gate options and consumer behavioural trends that have been outlined so far. These are: -

- Potential for substitution of imported ingredients through increased opportunity to grow vegetables in the UK (due to product reformulation and change in climate patterns) can reduce reliance on imports. This may lead to a reduction in emissions associated with transport (e.g. shipping) but may increase demand on water use domestically (water stress in some areas) and, depending on the land use replaced, increase energy use and exacerbate impacts on biodiversity, water, air and soil quality.

- The expansion of the curry market (including food service sector) worldwide to meet global demand trends may lead to an increase in consumption of accompanying/ complementary products (e.g. naan bread), pushing production of these complements up domestically. Conversely, it may lead to an increase in energy, water and other inputs (including fertilisers) use associated with their production.

- An increase in consumption domestically (reflecting forecasted growth in the UK chilled ready meal and ethnic cuisine markets [52], and an upward trend in one-person household numbers, the 25-35 age ranges, and over 55s age ranges in the UK) and worldwide, will lead to an increase in production and associated economies of scale, and bring about export opportunities. Conversely, it may also lead to higher impacts on the environment, including an increase in packaging waste going to land-fill.

- Although curry consumption will be partially driven by population growth, expansion of the curry market may lead to a reduction in consumption of other more sustainable food types as some of the growth is attributed to changing tastes. Changing tastes may impact all elements of the food sector including the food service industry, ready meals through to home-cooking.

- Public health outcomes (i.e. obesity and other diet related diseases) may be adversely affected by increased consumption of curry, particularly take-aways, unless those curries can become healthier through reformulation, alternative cooking and preparation methods (e.g. less oil use in frying, reduced amount of sauces, reduced saturated fat and salt content).

[52] Prepared Meals & Meal Kits 2011, and Ethnic Cuisine 2009 - Mintel Reports

How to address the trade-offs?

Overcoming the negatives

3.14 Encouraging R&D and technological innovation, knowledge transfer and its uptake into practice throughout the supply chain is a key factor in driving change. Consumer pull through the supply chain also drives change. Therefore influencing behavioural change and consumer acceptance of new technologies will be important in promoting uptake of healthy foods. Collaboration, education, skills development and skills sharing throughout the supply chain will too be important to support a step change towards reformulation of products and substitution.

3.15 The Subgroup has identified specific actions that can be taken to prevent or mitigate negative consequences arising from the pursuit of increasing productivity whilst simultaneously enhancing environmental performance, these are:

3.16 Pre-farm gate:

- New technologies (e.g. 'precision farming' to increase efficiency of fertiliser and agro-chemicals use) and improved techniques (e.g. improved slurry and manure application methods, better livestock fertility management to reduce culling rates and herd replacement rates, improved feed conversion by livestock, wider use of integrated crop protection). These need to be supported by knowledge exchange and knowledge transfer (including farming skills) to ensure take-up into practice;

- UK-centric plant breeding, husbandry research and knowledge transfer to facilitate the introduction of crops not currently grown in the UK that could be successfully grown by 2050, as well as improved varieties of existing crops;

3.17 Post-farm gate:

- Reformulation of products/ substitution of high impact imported ingredients to promote increased fruit and vegetables consumption. Influencing behavioural change and promoting uptake of healthy foods, in collaboration with the supply chain will be important to support this step change;

- Reconnecting consumers with food ingredients, how they are grown, where they come from through maximising opportunities to promote growing and cooking skills in education and to adult consumers – in collaboration with food producers, suppliers, retailers, and food providers;

- Providing and communicating information on the socio-economic and environmental impacts of consumption choices;

- Increasing use of intelligent packaging materials with lower impacts throughout the supply chain, use of packaging materials that are designed for both their functionality in use and disposal (e.g. materials easy to reuse, recycle or convert into energy);

- Use of more efficient technologies in cooling, processing, storing and cooking systems (including reducing reliance on carbon-based energy); use of more widespread water and energy metering with the former particularly relevant to the food service sector;

3.18 Cross Cutting – whole food chain

- An open dialogue on the impacts associated with meat consumption and increasing production, and the tensions that these cause;

- The provision of incentives to promote the decarbonisation of the food chain energy supply. Low carbon energy will be key to increasing resource efficiency and reducing the GHG impacts of the supply chain.

- Exploring the technological potential for industrial scale production of synthetic proteins/ alternative meat protein sources, subject to them being efficient, safe and acceptable to consumers . This may help to mitigate pressure on land and inputs for livestock production whilst potentially providing a cheap source of balanced protein which can provide a replacement for processed meat, free of animal welfare issues.

- Increase waste prevention, by building on existing initiatives and establishing partnerships with redistribution charities such as FoodCycle and FareShare, which redistribute surplus to those in need. Food unfit for human consumption could, in some cases, be fed to livestock - while there are strict controls on catering waste, some elements of the curry supply chain, where they come from premises with appropriate procedures to keep them separate from animal-by-products, can be fed to livestock. Use of food unsuitable for human consumption in anaerobic digesters and as animal feed would grant strong economic, environmental and social benefits over disposal to landfill and ensure that the resources used for food production are not completely wasted. These foodstuffs could include vegetables or some bread.

What are the implications of your proposed actions for existing initiatives by government, the private and third sectors, or for future interventions?

Implications for existing initiatives

3.19 The Subgroup believes that existing initiatives (as outlined in question 3 such as regulatory changes, voluntary agreements) can support the proposed actions and will help accelerate the process towards increasing productivity and enhancing environmental protection. In particular:

- More resource efficient forms of farming and enhanced biodiversity protection can be achieved through, Entry Level Stewardship/ Higher Level Stewardship schemes, CAP reforms and the exploitation of the R&D benefits under CAP;

- Raising awareness through provision of clear information will continue to help consumers make informed choices to reduce environmental impacts including waste, and stimulate retailers/ food service sector to do likewise;

- There is potential for greater partnership between farmers and the food sector to generate more market focus by producers and wider collaboration between supermarkets/ retailers and the food service sector to utilise supply chains more effectively and sustainably.

3.20 It is difficult to state how acceptable the identified trade-offs between increasing production and impacts are. The extent to which any negative consequences can be mitigated depends on the development and acceptability of new technologies and innovative solutions, as well as availability of skills that will enable investment in technologies and innovation (as outlined in previous sections). The risk presented by poor returns on investments in solutions that may boost innovation may also represent a huge deterrent to producers and the supply chain.

3.21 Current use of natural resources and current levels of emissions could be used as a baseline against which the effect of any changes to increase production can be assessed as a lever for investment.

What is the most radical development that could affect your test case in the next 40 years?

3.22 The subgroup did not identify one radical development during its discussions; the following radical changes would each have significant impacts on the test case in differing ways.

3.23 Low carbon energy will be key to reducing the GHG impacts of the supply chain in the future. However, it is important to couple this work to decarbonising energy supply. The DECC Carbon Plan (December 2011) outlines the overall strategic objectives of a low carbon UK economy. This addresses the decarbonisation of electricity supply and heat production – with low carbon electricity being a possible future option substituting for current fossil fuel based heating systems. DECC are expected to publish further details of their Heat Strategy in the spring.

3.24 Biotechnology has the potential to provide the opportunity to reduce environmental impacts and increase production while meeting a rising demand from the market (this is against a background of rising price commodities by 2050) provided its potential uses are accepted by consumers. Also, there is potential to deliver varieties of lower impact crops with improved nutritional value and potential to replace higher impact foods.

3.25 Development of more sustainable protein sources, such as synthetic protein, livestock with lower GHG emissions and balanced plant-based protein sources, will deliver environmental benefits and help to support the uptake of more sustainable diets. Nevertheless, this will need to be in line with consumer acceptability.

3.26 Developing a better understanding of consumer behaviour, cultural and social values will help bridge the gap between consumer opinion on what products they would ideally purchase, and the purchasing behaviour they actually demonstrate [53]. Choice-editing schemes by retailers/ other food suppliers would also evoke a step-change, e.g. promoting consumption of reformulated products/ dishes.

Price scenarios

3.27 As mentioned at the outset, the analysis provided thus far applies to each of the price scenarios proposed by the Synthesis Subgroup. Nevertheless, it is clear that a scenario with decreasing agricultural prices and relatively high input costs [54] or where agricultural prices are highly volatile [55] may deter businesses from investing in new technologies due to the risks associated with poor returns on investment. Conversely, a scenario where agricultural prices rise but input costs do not[56] may foster investment in technological development.

[53] Defra, Attitudes and Behaviours around Sustainable Food Purchasing
[54] Synthesis Sub-group, Key Trends and Projections, Scenario A
[55] Synthesis Sub-group, Key Trends and Projections, Scenario B
[56] Synthesis Sub-group, Key Trends and Projections, Scenario C

Section 4: Conclusions and Recommendations

Conclusions

Consumers

4.1 Consumer behaviour plays a significant role in the way food is purchased, prepared, stored and wasted, and thus needs to be targeted. Actions should focus on –

- Reformulation of products to influence uptake of more sustainable, healthier diets through consumption of fruit, vegetables, starchy foods and smaller portions of high impact quality foods (e.g. meat, rice). This will reduce environmental impacts and the burden on the economy due to dietary related diseases and obesity;

- Promoting food literacy to engage consumers with food production and the environment, and to raise awareness of how food is grown (i.e. fruit and vegetables) and the impacts associated with its production and food choices. This can be achieved through provision of information, education and skills development targeting schools and in the home;

- Improving understanding of what drives and motivates consumer food choices, perceptions and actual food behaviours, and bridge the gap between consumer opinion on what products they would ideally purchase, and the purchasing behaviour they actually demonstrate;

- Understanding more about sustainable and healthy diets, building on developing evidence, tools and models such as the Livewell Plate [57] to assess impacts;

- Influencing choice of ingredients in the food service, supply chain and in the home through substitution of high impact ingredients (e.g. rice/meat) with low impact ingredients (e.g. wheat based products and other fruit and vegetables);

- Enhancing cooking skills to promote the use of healthier and more sustainable food preparation and storage options (e.g. microwave v/s frying methods, ingredients);

- Reducing consumer food waste through efficient ingredients sourcing, information on how to use leftovers, improved storage guidance and a greater understanding of best before dates and freezer use.

[57] Final report for Defra project FO0430 - Evidence to define the sustainability of a healthy diet (http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&ProjectID=17393&FromSearch=Y&Publisher=1&SearchText=FO0430&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description)

Manufacturers, Retailers and Food Service

4.2 Retailers and the food service sector in particular can lead the shift to reformulated healthy, lower impact products/ meals, and using more UK-produced ingredients as part of dishes (e.g. domestically grown wheat based products for rice; UK produced herbs) supported by education, skills development and knowledge transfer, and further improvements to reducing food and packaging waste;

4.3 Reducing waste by working with suppliers to produce flexible specifications to maximise use of raw ingredients suitable for consumption, and by improving ordering and raw materials/ ingredients forecasting, menu design, staff training, consumer education and measurement of what is wasted;

4.4 Energy and water use in cooling, storage, processing and cooking systems also need to be managed more efficiently. Alternative packaging in production and food consumed out of home should be used.

Farmers

4.5 Improvements to crop and livestock production (including more efficient use of natural resources (e.g. phosphate, water, oil), nitrogen fertiliser and better feed conversion ratios) are needed to reduce their impacts on the environment, yield losses and waste due to pests, diseases etc.;

4.6 There is a need to understand what is meant by less but ‘better’ meat and explore how producers can be rewarded for producing livestock whilst reducing the impact on the environment.

4.7 More radical solutions to improve production and environmental impact by 2050 are needed. Those include decarbonisation of energy initiatives, developments in biotechnology and of more sustainable protein sources, and developing better understanding of consumer behaviour, cultural and social values (including radical choice editing).

Recommendations

4.8 A more open collaborative dialogue on the issues of meat consumption and production, and on how producers can be rewarded for producing less but quality meat with less impact. Also, an open debate on the role of biotechnology is needed to influence change;

4.9 Promoting cooperation across the curry chain both horizontally between retailers and the food service, and vertically between farmers and the food sector is paramount. This will support a more coordinated approach to promoting UK production and generating more market focus by producers, to supporting a more efficient use of resources and the use of sustainably produced ingredients, to improving education, knowledge transfer and skills sharing in the supply chain and raising awareness of food and where it comes from;

4.10 Targeting environmental improvements and waste reduction in the home, food service and retail through better understanding of consumer motivators, attitudes and behaviours (purchasing and consumption) and provision of information to raise awareness of use (including cooking), storage and disposal;

4.11 Investment in collaborative, applied R&D, innovative science and biotechnology, knowledge transfer and its take-up into practice (e.g. demonstration activities) is needed in livestock breeding and crop production to reduce inputs and impacts, and support flexible food processing and manufacturing. Consumer acceptability has to be ensured if these are to be a viable option. An open public debate around the role of new technologies and potential trade-offs is therefore essential. Factors influencing healthy sustainable consumption and how these can be integrated also needs investigating.

4.12 Changing behaviour requires a generational shift and needs a more sustained framework to drive change. Government should facilitate bringing together different supply chain players to develop a collaborative approach to invest in actions to drive change including to understand and develop information around sustainable and healthy diets and how these can benefit producers, consumers and the wider environment.

4.13 Examining what policy options are available to influence and move towards sustainable consumption and production.

Annex 1

Synthesis Subgroup's questions

The Curry Subgroup has prioritised the Synthesis Subgroup's questions to focus on the end product category rather than pre-farm gate aspects. Only those questions relevant to the post-farm gate end of the supply chain have been addressed fully in this report. Specifically -

1. What specific post-production actions (in particular considering waste and transport) could lead to higher value/less environmentally damaging food reaching the consumer?

   a) Will consumer behaviour be a required driver for change?

   b) And if so, will consumer behaviour need to change to deliver the outcome?

   c) What are the trade-offs?

2. Looking at the trade-offs identified between increasing productivity and improving environmental performance:

   a) Is there potential to avoid or mitigate the negatives? (For example through skills development, new technologies, improved techniques or changes in land use)

   b) How might the negatives be off-set with other actions you have identified?

   c) How acceptable are these trade-offs likely to be?

   d) Where might future technological development mitigate the negatives? How might they make the impacts worse?

3. What are the implications of your proposed actions for existing initiatives by government, the private and third sectors, or for future interventions? For instance how might your actions be supported or accelerated by:

   a) changes to institutional structures (international and domestic)

   b) legislative, fiscal or regulatory change (for example how should we shape the future Common Agricultural Policy)

   c) incentives to change behaviour

   d) education, awareness, guidance, training (educate consumers and retailers)

   e) knowledge transfer and extension services

   f) voluntary agreements (reduced waste; service sector voluntary agreement)

g) research and development (development of innovation and new technologies for cooling, storage, processing systems)

h) market creation (e.g. the carbon trading scheme, payments for ecosystem services)

4. What is the most radical development that could affect your test case in the next 40 years? What might drive this change? And would it create new pressures or bring new opportunities:

a) For enhancing the environment

b) For increasing food production

Annex 2

Recipe for reformulated curry (as served at final subgroup meeting)

Sodexo Development Chefs Wan Mak and Rodney Zeiler were given the challenge of producing a curry which reflected the challenges and conclusions of the subgroup's work. This curry was served at the final subgroup meeting. The challenges addressed included reducing salt, the amount of fat and dairy product in the recipe (by substituting coconut milk with fresh tomatoes); substituting protein sources (for example, by introducing chickpea flour into the roti), and reducing the dependence on less sustainable products – e.g. rice and meat. Feedback indicated that the quality and taste of the meal was not diminished as a result of these changes.

Chicken Dhansak (serves 5)

200g mixed lentils (green and brown)

500g chicken (light meat, deboned/skinless, from an approx 1kg whole chicken)

10 black peppercorns

8 cloves

1"piece cinnamon

1/4 tsp grated nutmeg

1" piece of mace

2 large bay leaves

1 star anise

3 dry red chillies

1 tbsp cumin seeds

1 tbsp coriander seeds

1 tsp sesame seeds

1 tsp turmeric powder

40g fresh coriander leaves

Small bunch mint leaves (20g)

1 tbsp tamarind paste

1 tbsp garlic

1 tbsp fresh, crushed ginger

2 tbsps rape seed oil

Garnish with fresh coriander

1 litre chicken stock (without salt, see sub recipe)

Chicken Stock

150g Celery

50g Leeks

50g Onions

1 Bay leaf

50g carrots

500g Chicken Bones

Chickpea Roti (serves 6)

125g plain flour

100g chickpea flour

1 tsp of rapeseed oil

150ml hot water

Nutrition Information for Chicken & Lentil Curry with Chickpea Roti (per portion)

Kcal	Sugar	Fat	Saturated Fat	Salt
468	4.68	13.75	1.34	0.34

Spinach, Pea & Sweet Potato Curry (Serves 5)

500g Orange Fleshed Sweet Potatoes

200g Spinach

200g Peas

100g fresh chopped tomatoes

250 ml vegetable stock

1 Onion finely sliced

2-3 tsp Madras Curry Powder

10 curry leaves

2 cardamom pods

1 fresh bay leaf

1 star anise

1 cinnamon stick

30g fresh ginger

2 cloves garlic, crushed

1 tbsp rapeseed oil

Garnish with chopped coriander

Nutrition Information for Spinach, Pea & Sweet Potato Curry with Chickpea Roti

Kcal	Sugar	Fat	Saturated Fat	Salt
329	10.98	8.55	0.94	0.86