Food 2030
Life Cycle Analysis and The Role of Quorn Foods within the New Fundamentals of Food Policy

SUMMARY DOCUMENT

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EXECUTIVE SUMMARY

There are growing calls for a paradigm shift in thinking and a 21st century food policy built around the new fundamentals of sustainability, health and security.

HM Government have now (Jan 2010) published their strategy for food – *Food 2030.* This strategy is structured around 6 core issues for the food system which shows Quorn to be well aligned with at least three of these. This offers the opportunity to develop a strategy for growth that embraces these new fundamentals of food policy.

This report summarises the drivers within the debate and goes on to recommend the Quorn R and D platforms that are needed in order to align with the core strategic principles of Food 2030.

Central to this will be a the need for a deeper understanding of the role that mycoprotein can play in helping to (i) address the public health concerns associated with diet and health and (ii) being part of the considerations of sustainability by developing robust evidence to satisfy the current intuitive belief that Quorn is environmentally more benign than the meat equivalent.

Lifecycle analysis has demonstrated the enormous complexity involved in developing robust evidence, but tantalisingly suggest that Quorn mince may be 5 - 10 times better in its embedded greenhouse gas (GHG) content than meat, and that Quorn pieces may contain up to half the embedded GHG of the poultry equivalent. Further analysis also suggests comparative advantage opposite water consumption.

Analysis has revealed a surprisingly large contribution of embedded GHG that comes from the use of egg albumen in the production of Quorn foods. Removal of egg from Quorn would approximately halve the GHG.

Energy consumption appears higher for the production of Quorn when compared with meat and this needs to be addressed, although there is some uncertainty about the data for meat and in fact there may be minor advantage for Quorn vs beef if the so-called cutting yield for meat is factored in. Overall, the Quorn advantage in embedded GHG content is derived more from the absence of lifecycle ruminant methane and the interaction of nitrogenous component in manure and fertiliser with the nitrogen cycle producing the potent GHG dinitrogen oxide during animal husbandry.

More work is needed to develop the model and in particular to convert secondary data (literature values) to primary data (facts), as well as extending the system boundary beyond Stokesley factory gate and into a wider range of products. This should also include comparisons with consumer cooking methodologies and in this way will continue to build a robust body of evidence that describes the environmental impact of Quorn foods.

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1. Food Policy

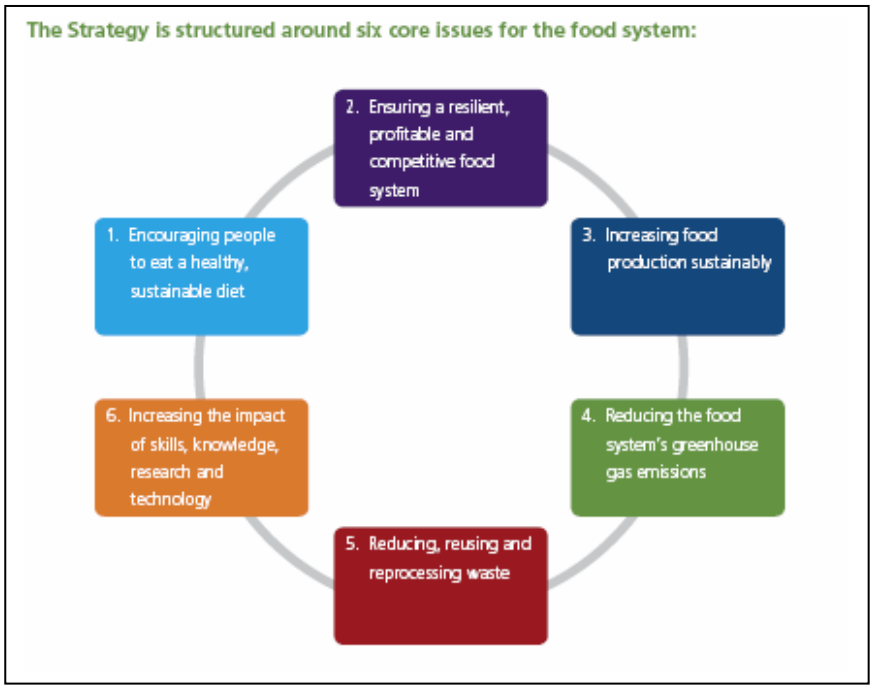
The work of the FAO and Boyd Orr in the mid 20th century looked to Industry and Food Science to develop and produce cheaper and nutritious food at both pace and at volume and in order to feed a divided and malnourished nation. In the UK, this was enshrined in the Agriculture Act of 1947.

We live still within this legacy. However, there have been growing calls for a paradigm shift in thinking and a 21st century food policy built around new fundamentals that tackle the big challenges of sustainability, security and health, and that provide a more joined up food policy[1].

In Jan 2010 HM Government published a new strategy for food - *Food 2030*[2] which will be supported by work led by the Govt Chief Scientist Prof John Beddington into Global Food and Farming Futures (the Foresight Report[3]) and The UK Cross Government Food Research and Innovation Strategy[1] .

In his foreword to this report [2], Gordon Brown talks about (i) the need to produce more food but without damaging our natural resources, (ii) the need to feed more people globally many of whom want or need a better diet and (iii) the need to tackle increasing obesity and encourage healthier diets. In addition, all of this needs to be carried out in the light of the increasing challenge of climate change while delivering continuous improvement in food safety.

The strategy itself is anchored around six core strategic issues (below).



Mycoprotein would seem to be extraordinarily well placed within this debate aligning well with at least three of the six core issues identified by HM Government, namely; (i) reducing the food system's greenhouse gas emissions (ii) encouraging people to eat a healthy and sustainable diet and (iii) increasing the impact of skills, knowledge, research and technology.

1.1.1 Reducing the Food System's Greenhouse Gas Emissions.

The FAO[4] now predict that between 2001 and 2050 global meat and milk consumption will double. At present, nearly 60 billion animals are used globally to produce meat, milk and eggs. This figure could rise to 120 billion by 2050.

Such a marked upsurge would have an overwhelming impact on climate change and the environment, as well as fuelling epidemics of obesity and heart disease within the industrial nations and emerging economic powers.

The FAO 2006 report, *Livestock's Long Shadow*[5], recognises that animal production is a major contributor to greenhouse gas (GHG) emissions measured as $CO_{2(e)}$. This is a higher share than transport. In this report, the FAO state that livestock production is responsible for:

- *37% of global methane emissions (methane has a global warming potential (GWP) 23 times higher than CO_2).*
- *65% of global nitrous oxide emissions (with a GWP 296 times higher than CO_2)*
- *9% of global CO_2 emissions.*

In addition, 64% of ammonia emissions originate in livestock production and contribute to air, soil and water pollution, acid rain and ozone damage[4].

Livestock production accounts for 70% of all agricultural land and 30% of the world's surface land area. This is increasing, with 70% of previously forested land in the Amazon occupied now by cattle pasture and crops for animal feed. This erosion of the rainforest has a marked effect on carbon sequestration and thus a negative impact on the carbon cycle and with 20% of pasture land degraded because of overgrazing, compaction and erosion.[5]

The predicted doubling of global animal production by 2050 will generate huge increases in livestock-related GHG emissions in the coming decades. Nitrous oxide emissions are projected to increase by 35 – 60% by 2030 due to increased manure production and use of nitrogen fertiliser [6] with new industrial farms for pigs and poultry set to raise global emissions of methane from pig slurry and nitrous oxide from poultry manure.[7]

In a House of Commons statement of written evidence statement Compassion in World Farming [4] have argued that meeting the challenges of livestock's impact of the environment through 'industrial farming' of animals is simply not sustainable. Industrial livestock production not only pollutes the environment but is extremely wasteful in its use of land, water and fossil fuel energy. It also threatens food security

as several kilos of cereal are required as feed in order to produce 1 kilo of edible meat, with over 40% of the world cereal harvest and 90% of the global soya crop grown for animal feed.

Implications for Quorn:

We must verify the intuition that our conversion of starch to protein by fermentation is more environmentally benign than the conversion of feed to animal protein and so allow Quorn to take its place within the debate about reducing the greenhouse gas emissions of the food system by offering consumers a meat alternative.

1.1.2 Encouraging People to Eat a Healthy Sustainable Diet

In the face of mounting evidence and its implications[8], the debate around food policy is now entering the public consciousness. The Times (Oct 27th 2009) led with an article from Lord Stern titled *'Climate chief: give up meat to save the planet'*[9]. In addition, Nov 25th 2009 saw a series of articles published in the Lancet[10] calling for strategies to influence public health through a 30% reduction in the UK production of livestock leading to reductions not only in GHG emissions but also the consumption of saturated fats . These conclusions were widely reported by the media .

Food 2030 reports that poor diet is estimated to be responsible for a third of all cancer and a further third of all cardiovascular disease. In addition, the Industrial world lives in what has been called an obesogenic environment, further increasing the risk of Type II diabetes , CVD and some forms of cancer. Left unchecked, projections show radical increases in the years ahead with 40% of the population obese by 2025 and 60% by 2050[2].

Education will play a vital role in reconnecting us with how and where our food is produced and in knowing how to cook and prepare healthy and nutritious foods. Indeed, since 1993 Quorn has had an active relationship with school meal authorities and professionals and is now the only recognised healthy eating brand on school menu's. Over the last 20 years Marlow Foods have continuously supported the development of a greater understanding of health and nutrition at a school level. We have provided learning/class-room materials for all aspects of the curriculum from science and technology and the development of a 'new' food to more recently live practical sessions with children creating their own healthy meal solutions.

Marlow Foods have created a wide range of materials over the years to highlight the importance of nutrition when considering what foods we eat. Over recent years we have provided learning materials aimed at primary school children to over 5,000 schools using many new learning materials in order to better engage with youngsters.

Marlow Foods have also been at the forefront of developing new nutritious menus for the school meals service up and down the country. We have provided a home economist service that can work at the highest level in an authority right through to support at a school level offering help, advice, demonstrations, training, tastings and also healthy eating talks to parents and children. This approach we know has made a real difference in winning children (and cooks) to the fact that healthy dishes don't have to be boring.

HM Government in their Food 2030 report recognise that consumers can help develop a lower carbon food system by creating demand for food with a smaller environmental footprint. The role of business is highlighted in playing a central role through advertising, innovation and influencing consumer choice as although proportionally small, the number of consumers concerned about the impact of their food on the climate is growing.[19,20]

However, the exact definition of what constitutes a sustainable diet remains controversial. Sustainability must embrace many attributes, including health, nutrition, access, affordability, mode of production, sustainability of supplies, transport, water, and support for developing countries. Defining a healthy and sustainable diet will give consumers clear and consistent information on the impact of what they chose to eat and whilst evidence of what constitutes a sustainable diet is still developing we must provide robust evidence where we can to support consumer's choices based on their values.

Implications for Quorn:

We must continue to establish Quorn as a better for me choice, communicating the health and nutritional benefits of a diet rich in mycoprotein, improving the salt and sat fat profiles where necessary in our food, developing natural flavours and continuing to invest in establishing both cause and effect of the relationship between mycoprotein and (i) satiety and (ii) hypocholesterolaemia whilst working with KOL's both to gain traction with our story and also to be a part of the debate that defines sustainability.

1.1.3 Increasing the Impact of Skills Knowledge, Research and Technology.

Research and Technology will become increasingly important as we all learn to use the finite resources available sustainably to produce ever more food for the growing global population.

There can be few better examples of success with food research and technology than 'the Quorn Story'. Quorn's heritage lies with the 1960's altruism of J Arthur Rank and his search for a cheap way to convert starch to protein in order to address a perceived 'protein gap' in the world. And whilst Quorn is not a technical panacea for meeting the varied and complex challenges in the current debate, Quorn's future may well lie within the new fundamentals of food policy and sustainability and with the continued investment in research and technology to drive, protect and improve what we have created.

A major part of this will be a coherent R and D strategy aligned to *Food 2030* and based on innovation platforms. These are discussed in Section 4.

2. Life Cycle Analysis

The objectives for this study were thus:

(1) Develop detailed process maps from resources to the consumer for both meat and mycoprotein consumption;

(2) Provide a qualitative analysis of each process in terms of environment impact;

(3) Identify available data for each stage of the processes and assumptions that would be required in a full quantitative analysis;

(4) Identify potential problems with respect to the mycoprotein process;

(5) Assess the possibility of determining an estimate of the impacts depending on the information available in the relevant literature;

(6) Decide whether or not there is significant justification to continue to a detailed numerical analysis, and if so to what level.

This work has been largely been carried out in conjunction with the Institute of Energy and Sustainable Development at De Montfort University.

3. Comparison of Quorn Production against Meat Production

From the complex agricultural model developed by Williams et al. (2006)[17] it is possible to estimate the global warming, acidification and eutrophication potentials associated with the agricultural aspects of both meat and Quorn production. Using this tool also provides a consistent approach for the production of both foods. It should be noted that the beef and chicken production figures used in the model are based on UK profiles for commodity production, and the calculations do include the production of feed that originates from overseas (such as soya bean production in South America and maize grain production in the USA). For the production of mycoprotein and its subsequent processing into Quorn products, only the production of carbon dioxide (CO_2) from energy and water consumption has been estimated in this initial phase. Therefore, the most telling comparison that can be made at this stage is that associated with the carbon footprint of each production. Once validated and analysed in greater detail, this would provide the starting point for completing a carbon footprint based on PAS 2050 (BSI 2008) designed to assess the product life cycle of greenhouse gas (GHG) emissions. A number of case studies, including Boots, Tesco and Pepsico, that have used this approach are available on the Carbon Trust website (http://www.carbontrust.co.uk/publications/publicationdetail?productid= CTC744).[18]

3.1 Initial LCA Model Conclusions

From the current available data, initial estimates suggest that tonnes of CO_2 equivalents released per tonne of product (ending at the storage of the products prior to distribution and consumption) are: 14.3t CO_{2e} per tonne of beef; 6.8t CO_{2e} per tonne of Quorn mince (reduced to 6.1t CO_{2e} if steam production is not included); 4.1t CO_{2e} per tonne of chicken; and 5.6t CO_{2e} per tonne of Quorn pieces (reduced to 5.2t CO_{2e} if steam production is not included). For both Quorn products, pieces and mince, the production of

mycoprotein contributes 3.1t CO_{2e} and the rest is generated from the processing of the mycoprotein into Quorn products.

These initial estimations suggest that Quorn mince may have a significantly lower CO_2 emission rate than the production of beef, whereas the production of pieces is comparable to that associated with poultry production. However, it should be noted that these are estimates for the Quorn products due to the missing primary data. With more detailed and accurate information from suppliers it will be possible to make a more comprehensive assessment of the contribution of Quorn products to the release of CO_2 (see section 5.2).

One general observation is that the production of Quorn products tend to be more energy intensive than beef or chicken products; Quorn mince is around 1.8 times more energy intensive than beef production and Quorn pieces approximately three times more energy intensive than chicken production. However, if animal cutting yield is factored in then Quorn mince has a minor advantage.

Water consumption for Quorn mince is ca 66% of that shown for the beef, and Quorn pieces as 75% that of poultry.

3.2 Use of Primary Data and Refining the Model

Converting secondary data and associated assumptions into primary data will be central to building a robust model.

In an attempt to understand the benefits this might bring , we have worked with Sanovo (Egg) and Cargill (Glucose) and primary data have been obtained which have been used to build on the DMU analysis. The Cargill data show a significant improvement compared with the literature values used in Section 3.1. This improvement is driven by the many in-built factory efficiencies that the no literature study would capture (Cargill Personal Communication).

In addition. it should also be noted that the Williams data refer to the functional unit as per te of carcass dead weight. If we assume a 50% cutting yield than the CO2(e) for the edible meat effectively doubles per tonne. However, this ignores any economic benefit from ‘divert streams’.

Using these new data sources we can construct a simplified LCA and which demonstrates the upside potential that might exist.

This analysis suggests a level of embedded GHG of ca 3200kg CO2(e)/te for pieces and 3700 kg/CO2(e) for mince. In addition, if the boundary is drawn to include a factor for the cutting yield (50%), then the CO2(e) for Quorn pieces becomes half that of poultry and for beef approximately 9 times better.

On this basis, the water consumption for mince drops to ca 30% that of the meat equivalent , 37% of that for poultry, and energy consumption becomes roughly at parity for beef.

The models developed are still full of assumptions and secondary or missing data. There is much more work to do in order to develop robust models for QTI, but there appears to be significant benefits when compared with meat.

We must note however, that the complexity of our supply chain especially when pasteurisation is involved will impact the LCA for other products.

We will need also to expand the model to include the consumer preparation and cooking where Quorn is likely to have further advantage over meat due to significantly reduced losses on cooking, and where cooking time is less for Quorn mince and pieces in particular.

4. Conclusions and Next Steps

Quorn is well placed within the strategic imperatives outlined by HM Government in its Food 2030 publication.

Initial analysis of the LCA for the production of Quorn mince shows important advantage versus the meat equivalent. Further refinement of the model to incorporate Supplier data suggests significant advantage for both pieces and mince, and as such moves some way to satisfying the intuitive belief that the production of Quorn mince environmentally more benign than the meat equivalent.

These are exciting times for mycoprotein and in order to secure future technical and commercial advantage we need to define and invest in a series of R and D platforms that create robust evidence based conclusions that we can communicate with authority opposite the strategic direction set out in *Food 2030.*

R and D Platforms for Growth

1. Underpin our science and technology to understand how texture, flavour and key nutrient benefits are created based on mycoprotein and so drive breakthrough change and consumer acceptability.

2. Focus on our consumers and align the execution of our new product development to meet their needs and the Quorn brand values.

3. Underpin and extend our knowledge of the nutritional benefits of a diet rich in mycoprotein through robust evidence based clinical study.

4. Deepen our understanding of the lifecycle analysis of the production of Quorn foods relative to the meat equivalent, and invest in programmes to drive down the levels of embedded greenhouse gasses (GHG) within our supply chain. This must include our overall energy consumption as a part of the CRC (the mandatory emissions trading scheme that begins April 2010).
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5. Reduce our dependency of key GHG contributors such as egg albumen and challenge the technical paradigms that exist within process technology, evolving new and improving processes that drive us closer to *Food 2030.*

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