TOO MUCH OF A BAD THING

The use and misuse of UK soil and land to grow sugar

FEED BACK

CONTENTS

1. GLOSSARY

AD: Anaerobic Digestion – the process of using a sealed, oxygen-free tank to convert organic matter into biogas and digestate.

ABF: Associated British Foods Plc is listed on the London Stock Exchange, and owns many popular brands, including Kingsmill bakeries, Twinings, Jordans Cereals, Ryvita, Ovaltine and Silver Spoon, as well as owning diverse array of businesses ranging from an agricultural segment to a retail segment which owns the Primark and Penneys chains.

British Sugar: The sole manufacturer of refined sugar from sugar beet in the UK, and in practice the sole buyer of the UK's sugar beet crop. Owned by Associated British Foods Plc.

DPS: Direct Payment Scheme, is an income support scheme providing subsidies as direct payments to farmers under Pillar 1 of the EU's Common Agricultural Policy (CAP).

Free sugars: All sugars added to food and drinks, as well as those naturally present in honey, syrups and fruit juices. Excludes sugars naturally present in milk and dairy products, fresh and processed fruit and vegetables and in cereal grains, nuts and seeds.

Hectare: A measurement of land area equal to 10,000 square metres, or 0.01 square kilometres.

IPCC: Intergovernmental Panel on Climate Change, an intergovernmental body of the United Nations, dedicated to providing the world with an objective, scientific view of climate change, its natural, political and economic impacts and risks, and possible response options.

NFU (National Farmers' Union) Sugar: The single entity that represents all sugar beet growers in the UK and negotiates on their collective behalf with the single processor (British Sugar).

Quota: A limited quantity of a product which under official controls can be produced, exported, or imported.

RDA: Recommended Daily Allowance.

SLCH: Soil Loss due to Crop Harvesting.

Soil tare: Loose soil and stones adhering to the roots of a crop when harvested.

Topsoil: Topsoil is the upper, outermost layer of soil, usually the top 2 inches (5.1 cm) to 8 inches (20 cm). It has the highest concentration of organic matter and microorganisms and is where most of the earth's biological soil activity occurs.

VCS: Voluntary Coupled Support, is a system of subsidies where EU countries may continue to link (couple) a limited amount of income support payments for farmers to certain sectors or products – as distinct from most EU farming subsidies which are merely tied to land area. It is designed to limit the distortion of market competition.

WHO: World Health Organisation

“When we have to make hard choices about what we grow and where we grow it, every crop has to earn its place in the field by providing real public benefits. Is growing sugar for an already oversupplied global market the best choice for Britain? Or should we be growing more of the healthy fruit and veg we really need?”

Sue Pritchard, Director – Food, Farming and Countryside Commission, RSA

“This is an important report that highlights the critical issue of how crop selection, harvesting and weather conditions can have a dramatic impact on soil health and particularly soil loss.

It demonstrates the damage being done via the example of one single crop – but sugar beet is by no means the only culprit. Across the country there is evidence of the wrong crops being harvested in the wrong way and under the wrong conditions – rapidly destroying what is vital, vulnerable and finite asset.

We now know better than ever how playing fast and loose with our soils can no longer be considered an option. Our soils store 10 billion tonnes of carbon and more water than all our rivers and lakes combined, but their ability to carry out these vital ecosystem services is under threat. The damage caused would be unacceptable for crops that generate nutritious produce. That it is being caused by a crop that is harmful to society’s overall wellbeing is unforgiveable.

We welcome this report, and urge the approach outlined in it to be applied across our entire food system so that the public health and environmental impact of the crops we grow can be considered alongside one another – and informed, ambitious and holistic choices made as a result.”

Ellen Fay, Executive Director – Sustainable Soils Alliance

2. EXECUTIVE SUMMARY

The UK has a very sweet tooth. Between us we consume around 3,690 tonnes of free sugars per day[1] and over 2.4 million tonnes of refined sugar were sold in 2017-18, with around 87% of this sold to manufacturers for processed foods, and the remaining 13% to restaurants, caterers, cafés and retailers.

The UK's sky-high per capita sugar intake comes at a heavy cost to our health, wellbeing, life expectancy - and to the NHS. Spending on the treatment of Type 2 diabetes alone comes to £8.8 billion per year. The government has sought to address the health burden of sugar consumption through the high-profile 2018 Soft Drinks Industry Levy (the 'Sugar Tax'). Policies like these, and third sector initiatives such as 'SugarSmart September'[2], are informing citizens about the need to curb our sugar intake. Yet comparatively little is known about the hidden damage UK sugar production is having on a finite and critical environmental resource: our soil.

It may therefore come as a surprise to learn that much of the sugar consumed in the UK is produced domestically, on farms growing sugar beet in some of England's prime agricultural land. Farmers in England grew 7.6 million tonnes of sugar beet in 2018, on around 110,000 hectares of land in East Anglia and the East Midlands. Far from being a marginal crop, the area of land used to grow sugar beet is comparable to the area devoted to the production of all UK vegetable crops, at around 116,000 hectares.

Growing sugar beet poses major challenges for maintaining and enhancing our topsoil. It takes 200-400 years to produce 1cm of topsoil. Yet the process of harvesting sugar beet can lift hundreds of thousands of tonnes of topsoil from UK fields every year, in the form of soil tare, which is caused by the soil clinging to the beet and machinery during harvest. All root crops involve some soil loss from crop harvesting, but sugar beet is a greater culprit than comparable crops, such as potatoes, because it is harvested later in the year, when soils are wetter and more prone to sticking to the crop and farm machinery.

> *"The area of land used to grow sugar beet is comparable to the area devoted to the production of all UK vegetable crops."*

Feedback calculates that the amount of soil lost from UK sugar beet farms during harvest varied between around 370,000 and 605,000 tonnes in the period 2014-2018, with an average soil loss per year of 489,000 tonnes[3]. The UK already loses around 2.9 million tonnes of soil per year excluding losses due to crop harvesting, which means that **sugar beet harvesting adds an additional 13-21% to the UK's annual topsoil loss per year.**

Once harvested, beet is delivered to one of four sugar beet refineries all owned by a single company, British Sugar. British Sugar is a monopoly: nearly 40 years after the state sold its stake in the company, the company remains the only buyer for the UK's sugar beet growers, negotiating a fixed yearly price with NFU Sugar, the body representing UK beet growers. We asked British Sugar to comment on our estimate on sugar beet's contribution to soil loss, but they did not respond to our request.

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1. Based on a total yearly sugar consumption of 1,346,907 million tonnes, calculated using UK population data and Public Health England estimates of average daily sugar consumption for different population groups. See appendix 1.2 for more detail on methodology.

2. https://www.sugarsmartuk.org/news/jul19_get_involved_in_sugar_smart_september_2019/

3. This calculation assumes a soil tare rate of 6.5% of yield (based on available research) and is calculated using Defra data for sugar beet yield and area under cultivation in 2014-2018. See appendix 1.1 for more detail.

Between 2014 and 2018, British Sugar produced on average 1.15 million tonnes of refined sugar from UK sugar beet per year – **two thirds more** than the World Health Organisation's (WHO) recommended allowance of free sugars per day for a year, for the whole of the UK population combined[4].

Not only does this industry produce more sugar than is good for us, the land freed up by reducing sugar beet production could provide significant healthy nutrition. **By reducing sugar beet cultivation to deliver the recommended RDA for the UK population, we could free around 40,000 hectares of land, enough to grow approximately an additional 148,000 tonnes of peas, 1.8 million tonnes of potatoes, or 3.1 million tonnes carrots[5].**

Sugar is bad for us, and it is bad for the land it is grown on. Yet amidst these challenges, **British Sugar plans to ultimately increase production by 50% of their current annual output – potentially with grave potential effects for our health, land use and soils.**

This report opens a new front in the fight to tackle our addiction to the sweet stuff. Between 2008 and 2018, the average decline in sugar consumption has been just 0.2% annually – at this rate, it would take the UK 422 years to reach the WHO and Scientific Advisory Committee on Nutrition recommended daily sugar intake[6]. Policy to address high sugar consumption through demand alone are failing. It is time to explore the potential to constrain supply of UK-grown sugar.

Such a move poses the opportunity to stop the rapid erosion of UK soils, to incentivise production of healthy vegetables improving food security, and to orient agricultural policy around the twin goals of public health and planetary health. As well as reconsidering the sugar in our tea, it is time to reassess the role of sugar beet in our fields.

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4. Based on Feedback's calculations from ONS population data and WHO RDA for free sugars for different population groups, we calculated a total yearly recommended consumption of approximately 688,000 tonnes. Note the RDA and therefore the total yearly recommended consumption refers to free sugars (i.e., including sugars naturally occurring in fruit juice as well as sugar added to processed foods) whereas the average production figures for British Sugar refer to refined sugar.

5. See appendix 1.3. Based on yield data from Defra and Great British Carrots.

6. This average decline excludes the potential impact of the Sugar Levy, introduced in April 2018, for which there is not yet reliable data available.

3. INTRODUCTION

The report explores the past and present of the sugar industry in the UK, including the competition between sugar beet production and sugar made from imported sugar cane. It briefly sets out the evidence of the health impacts associated with excessive sugar consumption. We then look in detail at the little-known environmental cost of sugar beet production, especially to our soils. We compare the areas where sugar beet is grown with maps of the UK's most fertile agricultural land, in order to consider how we make best use of both our soil and our land within a healthy and sustainable food system. We also consider the by-products of sugar beet's refinement into sugar, and whether these by-products justify or mitigate the negative health and environmental impacts of the product itself. Finally, we look at the policy frameworks affecting both sugar consumption and domestic sugar production, in order to explore whether there is a role for supply-side policy to join more holistically with demand-side policy in order to deliver better health and environmental outcomes.

Throughout, we are guided by a unique perspective on the relationship between public health and nourishment, land and environmental preservation: to seek the best use of land and soils to produce the greatest nutritional value, for the least environmental costs, within a resilient food system which does not encroach on the viability of our climate, nature and biodiversity.

4. THE UK SUGAR INDUSTRY

The UK sugar industry draws on two raw materials, sugar beet and sugar cane, to produce refined sugar, sugar substitutes and related products that are used by a wide range of downstream industries. The industry is a highly regulated oligopoly, dominated by two producers – British Sugar and Tate & Lyle (IBIS World, 2019). British Sugar presides over domestically grown sugar beet processing in the UK, with Tate & Lyle processing imported cane sugar. This report is concerned with the domestic sugar beet industry.

BOX 1 – A BRIEF HISTORY OF SUGAR CANE AND SUGAR BEET

In 1493, Christopher Columbus took sugar cane to the Caribbean (Parker, 2011, p. 10). By the 17th century the British had established large-scale sugar plantations in the West Indies, making affordable sugar available to a wide public. Profits from the trade helped build the British Empire, but the trade was only able to flourish with the expansion of the Atlantic slave trade, which saw millions of African slaves brought to the Caribbean to live, work and die in the notoriously brutal conditions of the sugar plantations. By 1750 there were 120 sugar refineries operating in Britain (Sheridan, 1994, p. 30). Until the slave trade was banned in Britain in 1833, more than 12 million Africans were shipped to the New World (Lovejoy, 1982)— with one of the primary destinations being sugar plantations. Sugar came to account for up to 22% of the calories Britain consumed, whilst production of timber, sugar and cotton in the colonies contributed 25 to 30 million "ghost acres" of productive land to Britain in the year 1830 – roughly double the size of Britain's own total arable land (Pomeranz, 2001, p. 275). Low wages and exploitative conditions in sugarcane plantations often continue to this day (Campbell, 2008; ILO, 2017).

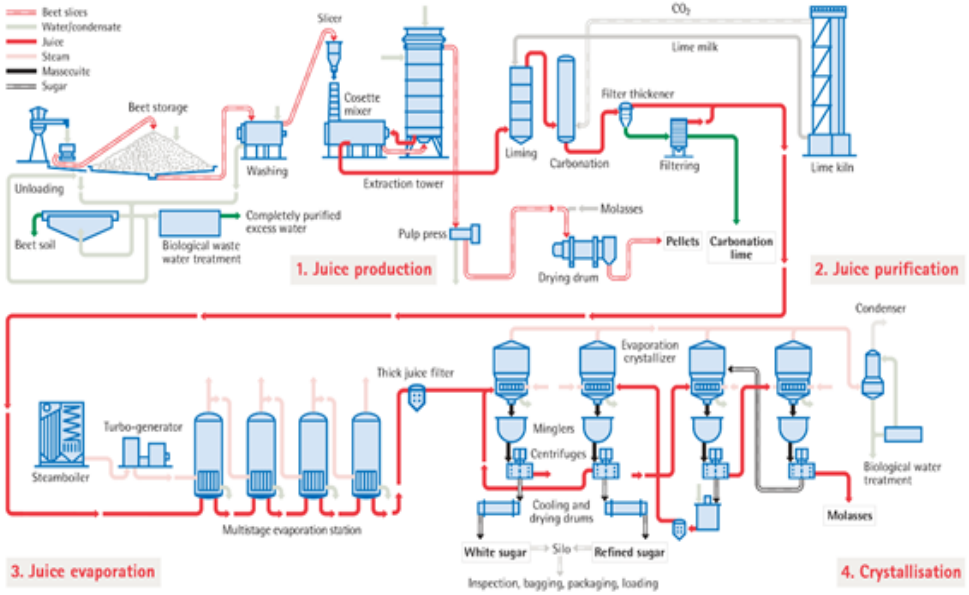
The cultivation of sugar beet as an alternative to cane was pioneered in Germany in the early nineteenth century, and rapidly spread across Europe such that beet became the main source of European sugar consumption by the end of the century (Fairtrade Foundation, 2013, p. 4). The first sugar beet factory was built in the UK in 1912 in Norfolk, with the industry expanding in the 1920s when 17 processing factories were built following war-time shortages of imported cane sugar – including one factory in Scotland (British Sugar, 2019e).

Source: Wikipedia, Creative Commons

The UK's sugar beet is entirely grown in East Anglia and the East Midlands by around 3,500 growers. Prices for beet are set through a bargaining process between British Sugar, the monopoly buyer for the crop, and NFU Sugar, the single entity which represents all sugar beet farmers in the UK and bargains on their collective behalf (British Sugar, 2017, p. 10). In 2018, UK sugar beet production was 7.6 million tonnes, worth £246 million (Defra, 2019a, p. 47)[7]. As a result, the UK is the 10th largest producer of sugar beet in the world (FAOSTAT, 2019).

The sugar is processed in British Sugar's four refineries: Cantley near Acle; Wissington near King's Lynn; Bury St Edmunds in Suffolk; and Newark in Nottinghamshire (British Sugar, 2017). Nearly all sugar beet grown in the UK is for human consumption, with several by-products from the production process. These include animal feed, made from the pulp once the sugar has been extracted, and biogas from the remaining product and waste.

Sugar production diagram



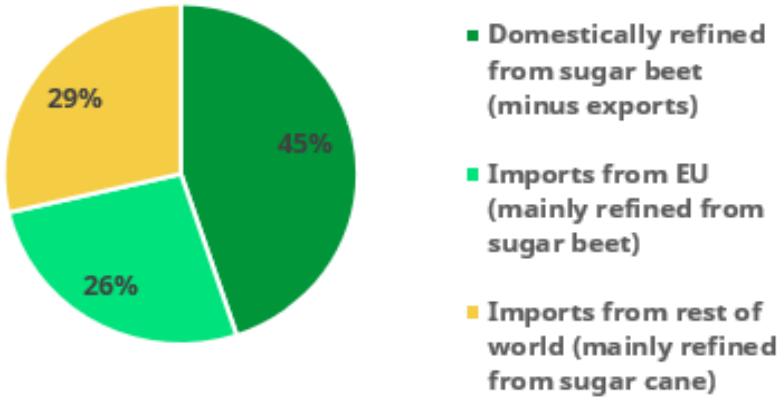
After processing, British Sugar produced around 1.08 million tonnes of sugar in 2018 (the average refined sugar production from sugar beet between 2014 and 2018 was 1.15 million tonnes[8]), around 300,000 tonnes of which is exported, and the rest consumed domestically (Defra, 2019a, p. 47). Between 15-33% was exported annually between 2014 and 2018 (Defra, 2019a, p. 47). In addition to British Sugar's domestic production, 950,000 tonnes of sugar is imported into the UK: roughly half from the EU mainly as refined sugar made from beet, and half from the rest of the world mainly as raw cane sugar processed by Tate and Lyle (Defra, 2019a, p. 47), though

7. This was a decrease in volume by 15% from 8.9 million tonnes in 2017, but value increased by 7.4% (Defra, 2019a). Crop output in 2018 was impacted by heat and drought, resulting in lower yields (Defra, 2019a, p. 15) – for sugar beet, yields were 69t/ha, down 17% from the record high of 83t/ha the previous year (Defra, 2019a, p. 47). The value increase was entirely down to a price increase of 26% compared with 2017 which partially offset the decrease in production, rising to £32.30 per tonne (Defra, 2019a, p. 47).

8. See appendix 1.2.

some is imported as confectionary (Richardson and Winkler, 2019, p. 5). Of the 2.4 million tonnes of refined sugar purchased in the UK – both beet and cane - an estimated 87% is in manufactured food and drink, while the remaining 13% is purchased through restaurants, cafes and caterers or as raw sugar through retailers (Richardson and Winkler, 2019, p. 5). As well as sales to manufacturers, British Sugar sells its sugar directly to the UK public under the brand Silver Spoon.

Figure 1: Source of total UK sugar supply (five year average 2014-18, refined sugar basis)



Source: (Defra, 2019a, p. 47)

Note: This figure excludes imports of pre-processed foods containing sugar. In 2017, 0.28 million tonnes sugar in the form of confectionary was imported into the UK (Richardson and Winkler, 2019, p. 5).

State support and the sugar beet industry

The sugar beet industry has benefited from both considerable state support from the British government in the early to mid-20th century, and ongoing support from EU agricultural and trade policy.

British Sugar's position as the monopoly buyer and processor of all sugar beet grown by the UK's 3,500 sugar beet farmers can be traced back to the state's intervention in 1936 to amalgamate thirteen separate sugar beet companies into the British Sugar Corporation under the Sugar Industry (Reorganisation) Act (British Sugar, 2019e). Following eleven years of subsidies which had already cost the treasury £42 million and went mainly to sugar manufacturers (Ginn, Goodman and Langlands, 2012), the government acquired a 36% stake in British Sugar and gained control of the corporation in order to continue to support the sugar industry (Parliament HC Deb, 1936). The Sugar Industry Bill was framed by some with the purpose "of preventing sugar production from getting any bigger than it was and is now," (Parliament HL Deb, 1936 Lord Hastings) – an aim that was not achieved. Further making the case for state support was the view that sugar was at that time considered "an essential article of diet for human life. The human frame cannot exist without sugar," (Parliament HL

Deb, 1936 Lord Hastings). However, many were opposed to the Act on the grounds that it was poor value for taxpayer money: in addition to the £42 million in subsidies, the state also had to pay £5 million for the capital value of the takeover (Parliament HL Deb, 1936 Lord Strabolgi).

The government sold its share of the British Sugar Corporation in 1981 and in 1982 the company became 'British Sugar' plc (NFU, 2013). S&W Berisford took over the company until 1991 when it was bought by the current owner, Associated British Foods (ABF) for £880 million (Thelwell, 2007). ABF is listed on the London Stock Exchange, and owns many popular brands, including Kingsmill bakeries, Twinings, Jordans Cereals, Ryvita, Ovaltine and Silver Spoon, as well as owning diverse array of businesses ranging from an agricultural segment to a retail segment which owns the Primark and Penneys chains. ABF Sugar is a group of businesses which are part of ABF, who in addition to British Sugar also operates sugar production facilities in Spain and North East China. Wittington Investments Ltd owns a 54% stake in ABF, and is itself 79.2% owned by the Garfield Weston Foundation, with the remaining 20.8% owned by members of the Weston family (Whittington Investments, nd).

British Sugar's control of the sugar beet industry as a listed corporation is unusual in Europe – most of the seven companies that produce almost 85% of EU sugar are producer cooperatives (Agriculture Stratégies, 2019).

BOX 2 – TATE & LYLE AND SUGARCANE

As a legacy of Britain's colonial past, the UK has the biggest cane sugar processing industry in Europe. Tate & Lyle was founded in 1859, and in 2013, the Tate & Lyle site in Silvertown still supplied 40% of Europe's entire demand for sugar cane (Kvist, 2013). Producing an end-product chemically identical to beet sugar, cane sugar is imported from the tropics in raw form. Tate & Lyle has two UK refineries operating in East London. In 2010, Tate & Lyle sold its UK sugar refineries to the Florida-based American Sugar Refineries Inc (ASR) which still trades under the Tate & Lyle name. In addition to sugar the company is a major manufacturer of other bulk sweeteners, acidulants, industrial starches and animal feeds (corn gluten meal). Sales in 2018/19 financial year were £2.8 billion (profits £240 million) with 4,100 employees worldwide (Tate & Lyle, 2019).

From its imperial heyday, Tate & Lyle's fortunes have waned in recent years. EU agriculture and trade policy has favoured beet growers and processors, with import tariffs on sugar cane set prohibitively high. Common Agricultural Policy regulations that were designed by the EU to boost beet sugar production in 19 EU countries have inflated Tate & Lyle Sugar's raw cane sugar bill by £34 million in 2015 alone, resulting in a £21 million loss to the company (Clark, 2017). As a result, Tate & Lyle have had to downsize by 50% since 2009 and their Silvertown refinery is operating at barely half capacity. Tate & Lyle were thus a vocal campaigner for Brexit (Mason, 2017), with the management writing an open letter to its workforce encouraging them to vote Leave.

5. THE HEALTH IMPACTS OF UK SUGAR CONSUMPTION

On average, the UK population consumes a lot of sugar – around 1.35 million tonnes per year[9] , or 56g per day per person of free sugars (Public Health England, 2015c)[10], which is around 14 teaspoons' full. Adults consume around twice their recommended daily level of free sugars, and children and teenagers consume around three times higher (Public Health England, 2015b, p. 11). 87% of adults, 99% of secondary school children and 100% of primary school children exceed the recommended level of daily sugar intake (The Food Foundation, 2017, p. 10). Yet, 39% of adults believe they consume "not too much" sugar or "not much at all" (YouGov, 2019): as well as a sweet tooth, we clearly have a blind spot when it comes to sugar.

"On average, UK adults consume twice their recommended daily allowance of free sugars."

There is a direct relationship between high sugar diets and poor health outcomes, including Type 2 diabetes (Basu et al., 2013; Aguirre, Mytton and Monsivais, 2015; Imamura et al., 2015) (Public Health England, 2015b, p. 9; Barber, Baker and Foster, 2017, p. 3) which costs the British taxpayer £8.8 billion annually (NHS England, 2016, p. 4). Sugar is also a contributor to excess calorie consumption, leading to weight gain and health problems such as heart disease and some cancers (Public Health England, 2015b, p. 9; HM Government, 2016, p. 4; NHS, 2018). There is a well-established link between sugar consumption and tooth decay (Moynihan and Petersen, 2004), and 46% of 15 year olds in England, Wales and Northern Ireland have obvious signs of tooth decay (NHS, 2011, 2015).

As well as having some of the highest levels of sugar consumption in the world, the UK is also the largest consumer of processed food in Europe, with around half the calories consumed per person per day coming from ultra-processed foods (Monteiro et al., 2018) – a category of foods typically high in sugar. 26.9% of the UK population is currently obese, making it the most obese country in Western Europe (OECD, 2017, p. 24). Obesity is predicted to cost the NHS £9.7 billion per year by 2050, with wider costs to society and business projected to reach £49.9 billion per year (Public Health England, 2017).

The Scientific Advisory Committee on Nutrition, which advises Public Health England and other UK government organisations, proposed in 2015 that free sugar intake (all sugars added to food as well as those naturally present in honey, syrups and fruit juices) should account for no more than 5% of dietary calories, equivalent to 30g for adults, 24g for 7-11 year olds and 19g for 4-6 year olds (Public Health England, 2015b, p. 35). This is in line with WHO's recommendations to ideally keep free sugar intake to 5% of less of daily energy intake (Willett et al., 2019, p. 459). Meeting this target would require a 50% reduction in UK sugar consumption and save the NHS over £500m a year (author calculations and Public Health England, 2015b, p. 5). For comparison, this amount represents ten times the £50 million paid by British Sugar in tax every year (British Sugar, 2017, p. 8). Reducing sugar consumption to RDA levels would also save a great number of lives (see Table 1).

9. See appendix 1.2.

10. This average was calculated through combining the data from (Public Health England, 2015c, p. 22 Table 2) for different ages and genders with UK demographic data available at (ONS, 2019) to create a weighted average.

Table 1: Average outcomes over 25 years for achieving 5% energy intake for sugar

YEARS TO ACHIEVE TARGET	DEATHS AVERTED*	TOOTH DECAY CASES AVOIDED	TOTAL NHS COST SAVING (£M)**
5	77,300	6,030,000	14.4
10	68,300	5,101,000	12.1
15	57,600	4,310,000	9.9

Source: (Public Health England, 2015b, p. 14)

* Number of deaths that do not occur due to reductions in the health issues associated with higher intakes of sugar. The majority of these savings relate to the costs of conditions caused by obesity.

**Amount saved by the NHS due to reductions in health conditions associated with higher intakes of sugar. Includes both caries healthcare cost saving and comorbidities of obesity healthcare cost saving.

5. THE ENVIRONMENTAL COST OF UK SUGAR PRODUCTION

Beneath the well-known health impacts of sugar, there is another story: the effects of sugar beet production on the health of our soils and lands.

An introduction to soil fertility and erosion

Soil is fundamental to our survival, the basis of agriculture. Topsoil is the outermost 5-20cm layer of soil and has the highest concentration of organic matter and microorganisms. In mild climates it takes about 200-400 years to form 1cm of soil, which can take thousands of years to recover if its fertility is lost, and is therefore considered a non-renewable resource (Osman, 2013, p. 14). Soil also stores carbon which is released when it is degraded – carbon loss from soil has dramatically increased in the past 200 years (Sanderman, Hengl and Fiske, 2017). The IPCC estimates that globally soil erosion from agricultural fields is "currently 10 to 20 times (no tillage) to more than 100 times (conventional tillage) higher than the soil formation rate" (IPCC, 2019, p. 3).

> *"Soil is a non-renewable resource: it takes between 200 and 400 years to form 1cm of soil."*

Total soil erosion in England and Wales has been estimated at 2.9 million tonnes per year (Graves et al., 2015, p. 407). This includes the loss of vital minerals which support food production: approximately 18,000 tonnes of nitrogen, 38,000 tonnes potassium, nearly 5,000 tonnes phosphorous and 225,000 tonnes of carbon is lost annually from English and Welsh soils (Graves et al., 2015, p. 407).

Soil degradation comes at a high cost: it is estimated to cost the economy of England and Wales £1.2 billion every year in lost ecosystem services, such as lost agricultural output and flood damage (Graves et al., 2015). The estimated cost to UK farmers is £305m per year (Defra, 2018b, p. 14) attributable to yield losses and their mitigation, for example the application of fertilisers. Costs are likely to extend well into the future, jeopardising our very ability to grow high quality food.

6. SUGAR BEET AND SOIL

Farmers frequently use deep-rooted crops, like sugar beet or potatoes, after shallow-rooted crops (e.g. wheat) in order to improve soil structure as part of a crop rotation. However, while all soil cultivation has implications for soil fertility and carbon, root crops like beet and potatoes are particularly implicated in Soil Loss due to Crop Harvesting (SLCH) (Ruysschaert et al., 2004).

SLCH occurs when soil clings to the root or tuber as it pulled from the ground and effectively refers to the direct removal of soil from fields. Parlak (2019) estimates that SLCH of root crops ranges globally from 1.81 to 4.55 tonnes per hectare per harvest for different crops. The nutrients removed alongside the soil are also often overlooked – for instance, a study of sugar beet farms in Turkey found considerable loss of nutrients like nitrates from the soil as a result of SLCH, as well as significant greenhouse gas emissions from fertiliser production required to replace these nutrients (Parlak, 2019, p. 98). In fact, SLCH may cause comparable levels of soil loss to water and tillage erosion, when soil is washed away by rains, or disturbed and blown away during tilling or ploughing (Ruysschaert et al., 2005, p. 318).

Sugar beet harvesting drives disproportionately high soil loss because it is harvested in autumn and winter when soils are wetter, causing more damage to the soil structure and more soil to stick to crops and farming equipment. A literature review of soil loss from process, showed that late harvesting on wetter soils provides greater risks of soil compaction and erosion from water runoff (Environment Agency, 2007, p. 29).

This adds up to huge soil losses directly attributable to sugar beet production. A more recent study estimated that across the EU, total SLCH from sugar beet harvesting is currently around 9.6 million tonnes per year, across a harvested area of 1.9 million hectares (Panagos, Borrelli and Poesen, 2019, p. 495) – representing an average of about 5 tonnes of soil lost per hectare. The study estimated that SLCH for sugar beet in the UK was around 562,800 tonnes per year in 2000-2016 with a slightly lower average than the rest of the EU at 4.2 tonnes per hectare[11]. This represents a 30% decrease compared to the period 1987-1999, but a still considerable volume (Panagos, Borrelli and Poesen, 2019, p. 495).

In addition to the challenge posed by late harvesting, sugar beet is planted in the spring,

11. This compared with an average 2.7 tonnes per hectare for potatoes in the UK – so sugar beet is approximately 55% worse for SLCH per hectare than potatoes in this study. Potatoes overall contributed an estimated 397,300 tonnes of soil loss due to crop harvesting compared with the 562,800 tonnes SLCH from sugar beet.

leaving land uncropped and sometimes uncultivated over the preceding winter. This, combined with the relatively "open" nature of the crop over the growing season, also contributes to wind and water erosion and siltation of watercourses (Renwick and Revoredo-Giha, 2005, p. 10).

British Sugar has encouraged farmers to adopt measures to minimise the impact of sugar beet on soil quality such as increasing cropping interval and decreasing cropping concentration (Götze et al., 2017). However, as will be demonstrated below, this mitigation has only been able to limit the negative impacts to some degree – with considerable soil still lost, especially during harvesting.

Erosion-prone silt loam soil of a sugar beet field in Central Belgium (Panagos et al., 2016)

How much soil is lost during the beet harvest?

Every year, thousands of tonnes of soil are removed from fields where sugar beet is grown. Estimating the amount of soil loss attributable to beet harvesting is difficult given data is not collected at a farm level. However, some studies have estimated soil tare – the soil harvested from the field alongside the beet - to be as high as 30% of the total harvested weight for European beet (Hashem et al., 2015, p. 3). In the UK it is likely that soil tare is much lower due to a combination of improved harvesting practices, disincentives imposed by British Sugar (e.g. financial penalties for excess soil weight on delivered beet) and the concentration of beet farms on drier soils in East England. British Sugar report that the rates of soil loss associated with sugar beet declined from 15.2% in 1987 to 6.5% in 2001 – though there was no clear downward trend between 1994-2001 (Quine et al., 2006, p. 9). Variations in rainfall can affect soil tare from year to year (Quine et al., 2006, p. 11).

For the purposes of this report, we have assumed soil tare at 6.5% of total beet harvest. **Based on this assumption, the annual soil loss from the sugar beet harvest varies between around 370,000 and 605,000 tonnes per year, with an average loss between 2014 and 2018 of 489,000 tonnes.**

Table 2: Estimated soil loss from harvesting sugar beet[12]

UK SUGAR BEET	2014	2015	2016	2017	2018	5 YR. AVG.
Area (thousands ha)	117	84	80	107	110	99
Yield (tonnes per ha)	80	74	71	83	69	76
Soil loss from harvest (tonnes per ha)	5.2	4.8	4.6	5.4	4.5	4.9
Soil loss from harvest (thousand tonnes)	605	404	370	580	495	489

12. See appendix 1.1 for further information on methodology.

Given the annual soil erosion rate in the UK, excluding SLCH, is 2.9 million tonnes (Defra, 2019f, p. 110)[13], this means that **sugar beet harvesting is adding between 13-21% to the UK's annual topsoil loss, just from soil removed during harvest**[14]

From topsoil to TOPSOIL

What happens to soil removed from sugar beet fields is an important question. Some will be lost in transport, but Graves et al (2011) estimate that British Sugar receives around 450,000 tonnes of soil with the sugar beet it purchases from UK farmers, which is roughly consistent with the estimates in Table 2. Graves et al further estimate that during sugar beet harvesting 1-2 tonnes of soil per hectare may be removed with the crop by farm machinery (Graves et al., 2011 Appendix C). **If accurate, these estimates represent the loss of about 1% of the topsoil of beet fields per century (Graves et al., 2011 Appendix C) – in other words, the steady removal of a vital, non-renewable resource.**

British Sugar process the soil they receive with the raw sugar beet, and sell around 200,000 tonnes of it a year as a commercial by-product under the brand name TOPSOIL (British Sugar, 2019b) – see Box 4. The discrepancy between the estimated 489,000 tonnes of soil on average going into British Sugar's refineries, and the 200,000 tonnes of TOPSOIL the company sells is likely to be due to the removal of aggregate and water in the preparation process for TOPSOIL.

13. Stones >2mm are removed, the soil is pumped to settlement lagoons during the sugar beet processing period between September to February, and then the topsoil is excavated from the lagoons during the spring and summer, dried naturally over a 2 year period and finally blended to create the final product (British Sugar, 2019b).British Sugar claim that only around 4,800 tonnes of stones are received with the sugar beet crop every year, which they sort and then market for engineering, road-building and construction projects (British Sugar, 2019c).

14. Note that here we are comparing SLCH to all other UK soil erosion from non-SLCH sources. In addition to this, there are some other crops which cause high SLCH, though sugar beet seems to cause the largest volumes – for instance, potatoes in the UK overall contributed an estimated 397,300 tonnes of soil loss due to crop harvesting compared with the 562,800 tonnes SLCH from sugar beet (Panagos, Borrelli and Poesen, 2019).

BOX 4 - TOPSOIL

British Sugar are the UK's largest supplier of topsoil to builders and landscapers (British Sugar, 2019a). Topsoil is created when the sugar beet is cleaned, and soil and water is pumped to settlement lagoons, soil is excavated from the lagoons, dried over a two-year period, then blended to create the final topsoil product. In addition to soil, British Sugar receive around 4,800 tonnes of stones, which are sorted and sold for engineering, roadbuilding and construction projects. TOPSOIL is currently produced at each of British Sugar's four refinery sites in East England – in Newark, Wissington, Bury St Edmunds and Cantley (British Sugar, 2019a). Despite marketing their topsoil as a sustainable 'Co-Product', British Sugar's business model is effectively converting some of the best agricultural soils in the country into products for industries like landscaping, thus removing these soils from the agricultural system. Topsoil is not so much a co-product, as the very basis of production. For more on British Sugar by- and co-products of sugar production, see the section 'Redefining 'waste' – the value of co-products in sugar beet processing'.

Pesticides, productivity and organic sugar beet farming

Sugar beet farming is highly reliant on pesticides to deliver the high yields which make production financially viable, placing the industry at odds with moves to regulate pesticides harmful to wildlife such as bees (see Box 5). Since EU bans on neonicotinoid insecticides threatens to reduce sugar beet productivity (Meredith and Dann, 2017) and with major efficiency improvements already achieved, it begs the question how British Sugar will grow volumes and profitability in future years. Organic sugar beet farming provides an alternative to the use of pesticides but has not become commercially viable as it delivers relatively low yields (Tzilivakis, Jaggard, et al., 2005, p. 356). In May 2003, UK grown organic beet sugar was "launched" to the food industry (NFU, 2013). However, this never took off, with records showing that between 2011-17 an extremely small land area, about 0.1% of UK sugar beet production peaking at a mere 147 hectares in 2012, was farmed organically (Defra, 2019d) and in 2018 no sugar beet was farmed organically in the UK (Defra, 2019e, p. 6). However the UK does market some organic sugarcane imports (Draycott, 2006, p. 26). A spokesperson for the Landworkers' Alliance at a protest outside British Sugar's factory in Bury St Edmunds in 2015 said "You can't grow organic sugar beet in this country and get it processed, and for the beet that is grown, all the profits end up with ABF shareholders anyway. We want the profits to go to local communities." (Case, 2015).

BOX 5 - SUGAR LOBBYING AND PESTICIDE USE

In spring 2018, the European Commission and 76% of EU Member States decided to ban three highly bee-toxic neonicotinoid insecticides. The International Confederation of European Beet Growers (CIBE), which includes NFU Sugar, heavily lobbied EU institutions to oppose the ban on neonicotinoids, because their business model relies heavily on preventative uses of pesticides (PAN Europe, 2018). In spite of this lobbying, the law was eventually passed – but sugar beet lobbying has already successfully resulted in Romania introducing a derogation (exemption from the law) for the use of neonicotinoids for their sugar beet farmers from March 2019, with the Belgian Minister of Agriculture giving indications that he is also supportive of a derogation for Belgian sugar beet growers (PAN Europe, 2018). Further exceptions could be made for the sugar beet industry in future. The UK has resisted this for now - in 2018, ABF said that NFU Sugar and British Sugar were "disappointed by the UK Government's decision to reject the emergency application for the use of neonicotinoids as a seed treatment from next year", with ABF labelling the decision "ill-founded and disproportionate" (ABF, 2018, p. 24).

7. SUGAR BEET AND LAND USE

Agricultural land is a scarce resource globally, and the ever-expanding agricultural frontier is the number one cause of deforestation and destruction of vital ecosystems which are essential to both avert the climate crisis and to protect biodiversity. It is therefore essential that we use valuable agricultural land to grow crops that provide good nutritional value and support public health.

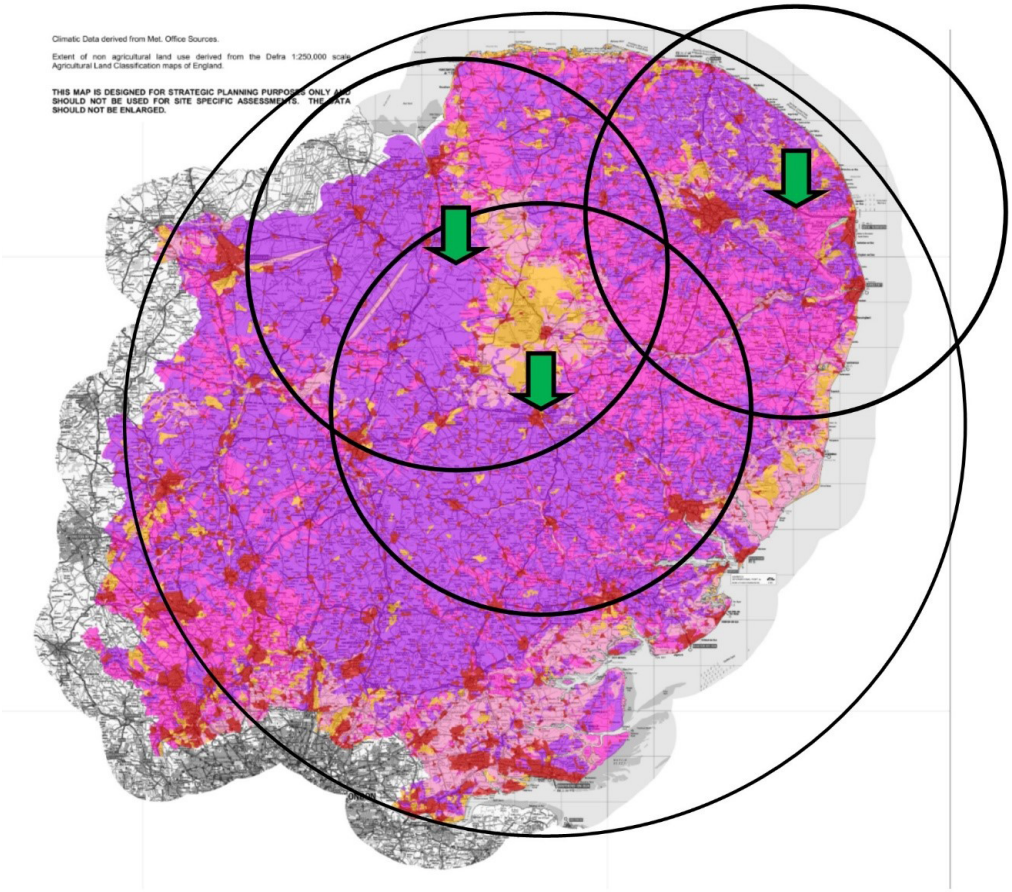
Currently, the UK produces approximately half of the food we consume, and we import £11.1 billion worth of fruit and vegetables per year (Gov.uk, 2019). Despite this, in 2018, 110,000 hectares of UK agricultural land was used to grow sugar beet, roughly the same as the 116,000 hectares of land used for the production of all UK vegetable crops (and additional 35,000 hectares was used for all fruit crops) (Defra, 2019a, p. 6). There are approximately 5.8 million hectares of cropland in the UK, 5.1 million hectares of which is in England (Harwatt and Hayek, 2019, p. 7), meaning that sugar beet accounts for approximately 1.9% of UK cropland or 2.2% of England's cropland.

Moreover, sugar beet is currently largely grown on England's finest horticultural soils: soils which could be used to grow many other types of crop, including crops that could supply more of the nation's nutritional requirements. Figures 2a and 2b show the location of British Sugar's four refineries located in East Anglia and the East Midlands, set against data from Natural England classifying the soil quality in the area. The diagrams show that soils across the regions where British Sugar refineries are located are classified as having a high or moderate likelihood of being the 'best and most versatile' agricultural land (Natural England, 2017b, 2017a). British Sugar state that the average distance sugar beet travels between farm and refineries is 28 miles (British Sugar, 2019d).

Figures 2a and 2b: Soil classification of UK sugar beet growing area (East Anglia and East Midlands regions) (Natural England, 2017b, 2017a). Locations of British Sugar's

four factories are indicated with green arrows. According to British Sugar, the average distance between sugar beet farms and their factories is 28 miles (45km) (British Sugar, 2019d) – the thicker lined circles indicate a 45km radius around the factories, and the thinner lined circles have a radius of 90km to indicate farms within a range of twice the average distance. Particularly for the three East Anglia factories, a considerable quantity of the sugar beet farms are therefore likely to be grown on agricultural land categorised as 'best and most versatile' (indicated in purple).

East Anglia:



Predictive BMV Land Assesment © Defra

- High likelihood of BMV land (>60% area bmv)
- Moderate likelihood of BMV land (20 - 60% area bmv)
- Low likelihood of BMV land (<= 20% area bmv)
- Non-agricultural use
- Urban / Industrial

Figure 2a

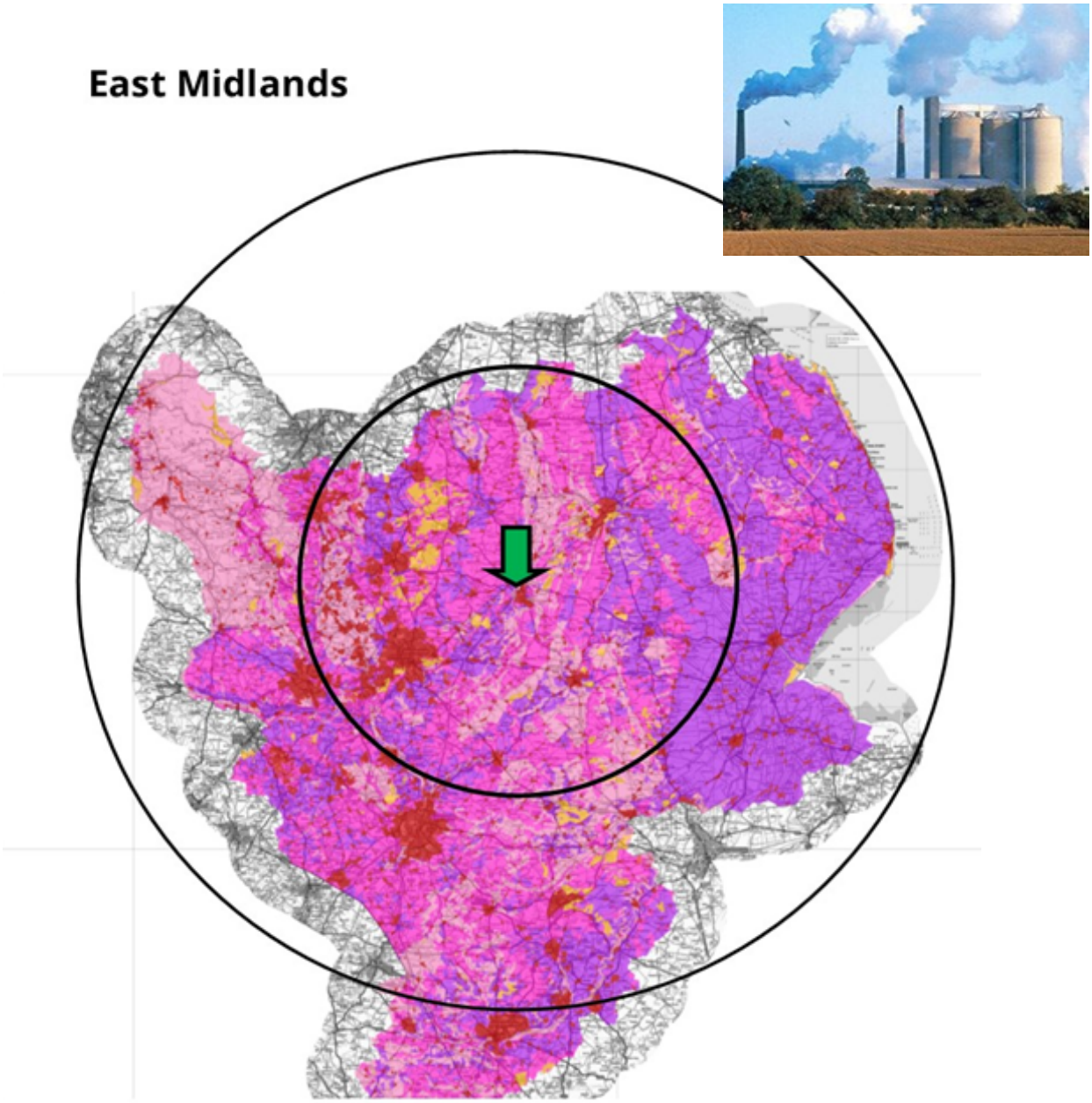

East Midlands
Predictive BMV Land Assesment © Defra
High likelihood of BMV land (>60% area bmv)
Moderate likelihood of BMV land (20 - 60% area bmv)
Low likelihood of BMV land (<= 20% area bmv)
Non-agricultural use
Urban / Industrial

Figure 2b

Land devoted to agricultural production should provide the highest quality nutrition, while causing the least environmental damage (see Box 6). From this perspective, growing 7.6 million tonnes of sugar beet (in 2018) is a poor use of our best and most versatile lands.

BOX 6 - REDEFINING PRODUCTIVITY

"Productivity" is often narrowly defined as profit produced per acre – side-lining considerations of sustainability and human health and prioritising high yields in the immediate term over sustainable yields of healthy food in the longer term. Feedback recommends that the government measure farming productivity as nutritional value (in the sense of contributing to a diverse and healthy diet, rather than pure calories) consumed per acre, balanced against the environmental impact of a crop (Feedback, 2018). This formula accounts for the relative environmental impact of different food production, including levels of waste and the global environmental footprint of food production. Using this formula, agricultural policy should incentivise a diverse portfolio of food production based on sustainable and nutritious dietary guidelines such as the Barilla Center's Double Pyramid (Barilla Center for Food & Nutrition, 2016). In addition to being hard-wearing on soils, higher volumes of food waste by weight occur for sugar beet than any other crop at farm level – 347,000 tonnes or 3.9% of production is ploughed back into the field and 89,000 tonnes or 1% of production is sent to animal feed (WRAP, 2019, pp. 7–8).

Based on productivity data from DEFRA it is possible to map the projected land use for the UK if the population met the WHO RDA for added sugars: 688,000 tonnes of free sugars per year compared to current consumption of 1.35 million tonnes. This would entail a roughly 40% reduction in the area of land used to grow sugar beet, or around 40,000 hectares. **This land could produce an additional 148,000 tonnes of peas, or 1.8 million tonnes of potatoes, or 3.1 million tonnes carrots[15].**

Table 3: Potential production of peas, potatoes or carrots reduction in agricultural land used for sugar beet based on RDA for added sugars across UK population

	PEAS (MODELLED)	POTATOES (MODELLED)	CARROTS (MODELLED)
Area (hectares)	39,946	39,946	39,946
Yield, 5-year average (tonnes per hectare)	3.7	46.4	77.8
Volume of harvested production (tonnes)	147,800	1,853,494	3,107,799
Portions (80g) per person per year	28.5	356 (or 154 potatoes, 150g each)	596

Data taken from Defra (2018b), with carrot yield data from http://britishcarrots.co.uk/carrot-production-facts/. Calculation by authors.

15. See appendix 1.3.

This would result in greater protein production from available land, and a vast improvement in provision of vitamins and minerals, creating a better balance of nutritional content in our agricultural output. For instance, according to Feedback's calculations, potatoes produce roughly 581,000g protein per hectare, and peas produce roughly 123,000g, compared to virtually zero protein for sugar beet[16]. Domestic production of vegetables contributed to around 53% of the total UK supply, and domestic production of fruits contributed 16.7% of the total UK supply in 2018 (Defra, 2019c) – with the rest of UK consumption relying on imports. Hence, **shifting land from sugar beet to vegetable production would help improve UK food security whilst improving health.**

There is a global shortage of fruit and vegetable production. Globally in 2015, 81 countries representing 55% of the global population had average fruit and vegetable availability above WHO's minimum target (Mason-D'Croz et al., 2019). The study states that "increasing the supply of fruits and vegetables is crucial to achieving recommended consumption levels" and must be complemented by efforts to change consumer behaviour (Mason-D'Croz et al., 2019). By 2050, between 0.8 and 1.9 billion people could live in countries with average fruit and vegetable availability below 400 g/person per day (Mason-D'Croz et al., 2019).

Redefining 'waste' – the value of by-products in sugar beet processing

Much of the sugar beet mass that is harvested is not edible to humans. In line with this, the 1.08 million tonnes of processed sugar produced in British Sugar factories is about 14% of the 7.6 million tonnes of sugar beet grown on British land in 2018 (Defra, 2019a, p. 47). To make use of the remainder, British Sugar has developed co-products, or by-products, for other markets. In contrast, other crops which could be grown on the land used for sugar beet, such as potatoes and other vegetables, are mostly entirely edible by humans, with lower volumes of co-products created.

The main by-products of sugar beet production are animal feed, bioethanol and energy (and topsoil, explored in the previous chapter). Taking each of these by turn, it is important to consider whether the development of by-products mitigates the damage sugar beet production does to soils and human health.

16. Author's calculation based on nutritional data from (Public Health England, 2019a) for the protein per 100g of Sugar, white (17-063) – 0g per 100g sugar, Peas, raw (13-438) – 6.9g per 100g peas, and Potatoes, old, microwaved, flesh and skin (13-494) - 2.6g per 100g potatoes. We then calculated the average yield in tonnes per acre from Defra statistics for the total production volumes and acreage for different products (Defra, 2019a) – and combined this with the nutritional data to arrive at nutrition produced per acre.

Around 500,000 tonnes of animal feed is produced from the pulp leftover after sugar is extracted from the beet, and sold through a British Sugar subsidiary, Trident Feeds (British Sugar, 2019c). This is around 7% of the 7.6 million tonnes of sugar beet harvested. However, meat is an environmentally inefficient means of food production, we should be reducing meat production alongside demand for animal feed. 85% of the UK's total agricultural land footprint is associated with meat and dairy production, but only 48% of its total protein and 32% of the UK's total calorie consumption derive from livestock products (de Ruiter et al., 2017). Moult et al. (2018) estimate that using food as animal feed mitigates a maximum of 41% of its production emissions depending on the product, compared with around 100% if it is consumed directly as human food. Since sugar beet contains no protein, sugar beet in animal feed also does not reduce demand for imported soya for animal feed, linked with deforestation in South America.

Moving down the list of co-products, British Sugar produce up to 64,000 tonnes (80 million litres) of bioethanol per year, produced by fermenting beet co-products, which is then integrated into unleaded petrol blends (British Sugar, 2019c). However, the environmental credentials of biofuels have increasingly been challenged. By factoring in the GHG costs of land requirements – the lost opportunities for storing carbon that the land would offer were it not being farmed - Searchinger et al. (2018) find that many biofuels (including ethanol from sugarcane) are worse for Climate Change than fossil fuels, and considerably worse than renewable alternatives such as solar (Searchinger et al., 2018, p. 251). Defra estimates that over the past 10 years, between 3-10% of sugar beet area – 457,000 tonnes of sugar beet grown across 5,500 hectares in 2017/18 was used specifically to grow bioethanol for fuel (Defra, 2019b).

In 2016, British Sugar invested £15 million in a new Anaerobic Digestion (AD) plant at their Bury St Edmunds site, which is expected to use around 97,000 tonnes of pressed pulp leftover after sugar processing each year to generate methane and digestate (British Sugar, 2019c), around 1% of the 7.6 million tonnes of sugar beet harvested. The methane is fed into a combined heat and power plant to generate electricity, with the plant exporting 38GWh of electricity to the national grid annually, and the digestate is used in the local farming area for both soil conditioning and fertiliser replacement (British Sugar, 2019c). However, AD recoups only a small percentage of the energy for many products.

While making use of by-products in environmentally supportive ways is a positive aim both environmentally and commercially, use of by-products should be considered at best a mitigation of the negative effects of waste production as a result of a manufacturing process. It should not justify the production of the main product in the first place, especially where the industry is highly damaging to both our health and the environment – this would be to let the tail wag the dog[17]. It is therefore highly wasteful that much of sugar beet production are by-products, when this land could provide far more human nutrition growing vegetables.

17. Particular care must be taken if the profits from the by-product make the production of the main product financially viable, where this would not be the case otherwise.

8. POLICIES FOR SUGAR DEMAND AND SUPPLY

To date, UK actions to curb sugar consumption have focused on demand-side measures and overlooked the possible role of supply-side policies restricting sugar production and imports. Rather than being penalised for its high impact on health and the environment, sugar beet production has been largely encouraged through a range of policies, including agricultural subsidies. This has had the effect of lowering the price of sugar, contributing to an increase in the prevalence of sugar in manufactured foods – and potentially undermining the effectiveness of demand-side policies focused on price, like the UK Sugar Tax. In this chapter, we outline how integrating more supply-side restrictions on UK sugar production could be integrated into a holistic combination of demand and supply chain measures to meaningfully reduce UK sugar production, for the benefit of our health and environment.

> *"The average decline in sugar consumption over 10 years has been just 0.2% annually (Public Health England, 2019b) – at this rate, it would take the UK 422 years to reach the WHO and Scientific Advisory Committee on Nutrition recommended daily sugar intake."*

Demand-side policies

Despite the very clear signals that sugar consumption must reduce dramatically, public health officials have hitherto failed to drive sufficient change to public diets. In addition to the Sugar Tax (see Box 7), policy measures have included awareness-raising activities such as the 'Change 4 Life' sugar swap campaign (Public Health England, 2015a) and a voluntary target for food and drinks manufacturers to reduce added sugar levels in the products which contribute most to a child's sugar intake by 20% by 2020 (HM Government, 2018, p. 13). However, demand-focused measures have had an extremely marginal effect on overall sugar consumption. There has been a very slight reduction in the contribution that free sugars make to total calories consumed, which translates to just 1% less over the last 10 years, only rising to a 4% reduction in younger age groups who are targeted specifically by health policy efforts (Public Health England, 2019b). **The average decline in sugar consumption over 10 years has been just 0.2% annually (Public Health England, 2019b) – at this rate, it would take the UK 386 years to reach the WHO and Scientific Advisory Committee on Nutrition recommended daily sugar intake[18].**

The potential of supply-side measures to reduce consumption

An excess of domestic supply often has major impacts on domestic consumption. For instance, huge subsidies to corn in the US have helped lead to vast surpluses, which US industry has found commercial outlets for: processing corn into large volumes of High Fructose Corn Syrup (itself a sugar substitute, now ubiquitous in US foods), using it as biofuel, and distributing it as food aid through the Word Food Programme supplies according to US strategic interests (Patel, 2013).

18. See appendix 1.5 – note that this reduction does not factor in the potential impact of the Sugar Levy, which came into effect in April 2018 and for which there is no current data on impact on consumption across the population.

BOX 7 - THE SUGAR TAX

Despite vociferous objections by the sugar and food manufacturing industry, a levy on sugar in soft drinks was introduced by the government in 2018 – the 'Sugar Tax' – in order to encourage manufacturers to reformulate products with lower sugar content. The Sugar Tax imposes a charge on all soft drinks containing more than 5g of artificial sugar per 100ml, with manufacturers due to pay 18p per litre for drinks containing between 5-8 grams of sugar and 24p per litre for drinks containing 8 grams. This policy has had some positive effects, with up to 50% of soft drinks (by volume) undergoing reformulation in order to bring sugar levels below 5g per 100ml (Marriage, 2018). Although a review of the levy's effectiveness has not yet been published, Richardson and Winkler (2019, p. 6) cite a government estimate of 45,000 tonnes for the amount of total refined sugar removed from soft drinks per year since the levy was introduced. This represents only around 4% of the 1.08 million tonnes of refined sugar produced by British Sugar from sugar beet in 2018 (and an even smaller percentage of the total sugar consumed in the UK including cane sugar). Moreover, it is likely that this policy measure will not have reduced overall sugar consumption by even this small amount, because soft drinks only account for a minority of UK sugar consumption (about 17% of children's daily sugar intake), and people often engage in so-called "sugar swaps" – thinking "I'm drinking diet soda so it's ok to have cake" (Strawbridge, 2012). This has led many campaigners to call for an extension of the sugar levy to cover other products (Action on Sugar, 2018).

In the UK, every year British Sugar produces 40% more than the quantity of sugar needed to supply the entire UK population's Recommended Daily Allowance of free sugars according to WHO health guidelines[19]. A plentiful supply of cheap sugar encourages manufacturers to formulate high-sugar foods and undermines health policies aimed at reducing sugar intake. But in the face of the need for less, not more, British Sugar have plans to expand. If British Sugar grow their sugar beet production by an additional 50%, this risks further lowering sugar prices – potentially offsetting the Sugar Tax, and even increasing the amount of sugar in some processed foods as manufacturers reformulate products in line with decreased prices.

Moreover, British Sugar has stated that the end of the EU sugar regime in October 2017 represented an opportunity to increase its production (British Sugar, 2017, p. 10). While the company states that its growth strategy is one of market share gains rather than increased consumption (2019, private discussion between British Sugar and Feedback), domestically British Sugar refineries already produce significantly more than the UK's demand would be if consumption came in line with WHO RDAs. Therefore, even if they had 100% of the UK market, they would not be able to grow their business without significantly growing either domestic consumption or exports. With 70% of its product sold domestically (Defra, 2019a, p. 47), and as strong EU and international sugar production continues, it is clearly in British Sugar's interests to maintain a strong domestic market. Healthy profits for British Sugar mean an unhealthy UK population.

19. See appendix 1.3.

Sugar supply-side policy to date

Agricultural policy to date has largely boosted sugar production and lowered prices. Alongside other agricultural crops, sugar beet production in the UK has been governed by EU-level policy frameworks.

Under the EU's Common Agricultural Policy, sugar beet production (in common with all agricultural production) is supported by the Direct Payment Scheme (DPS) which provides income support based on agricultural land area rather than output. In addition, payments linking the production of certain crops including sugar beet still exist in the form of voluntary coupled support (VCS), with national governments free to apply a share of their DPS budget to such schemes. This discretion is commonly used to protect crops on which national farming regimes are reliant for income, rather than for dietary reasons. 4.3% of the available VCS budget (€177m) is awarded to EU sugar beet farmers annually which is nearly as much as the 5% awarded for fruit and vegetables (European Commission, 2017b), despite the vastly different health outcomes. The award of VCS schemes to growers who would otherwise be unprofitable artificially inflates the production of sugar beet with a downward impact on pricing, creating a favourable market for food producers (Smit et al., 2017, p. 7). Income subsidies for UK sugar beet total around €29m per year (Richardson and Winkler, 2019, p. 13), representing a 10% subsidisation rate (the percentage of the production value paid out in subsidies), a questionable use of public money.

In addition to the subsidy regime, until recently EU sugar beet was governed by production quotas designed to constrain sugar beet and isoglucose production (a sweetener made from maize), balanced by a minimum price threshold ensuring that it remained attractive enough for EU farmers to produce to quota. Imports of both refined sugar and raw (cane) sugar are restricted by tariff rate quotas, with prohibitively high tariffs applied above the quota level (although under preferential arrangements, tariff-free imports of raw sugar are permitted from African, Caribbean and Pacific countries and other lower-income countries). These policies restricted the volume of sugar in the European market whilst at the same time protecting the EU sugar beet industry, contributing to an over-supply in comparison to recommended sugar intake. The EU sugar regime kept EU prices well-above world prices creating a reliable and relatively stable source of income for farmers which has manifested in a consistent output and low pricing volatility compared to other crops (Davies, Heffernan and Bell, 2015, p. 8). Figure 4 illustrates this low volatility in the UK, where average prices have remained relatively stable for the last 20 years at around £27 per tonne (including bonuses) with a standard deviation of just 2.8. Whilst the price per tonne is low for sugar beet compared to alternatives crops, price per hectare is very competitive due to the high yield, exceeding all alternative cereal crops.

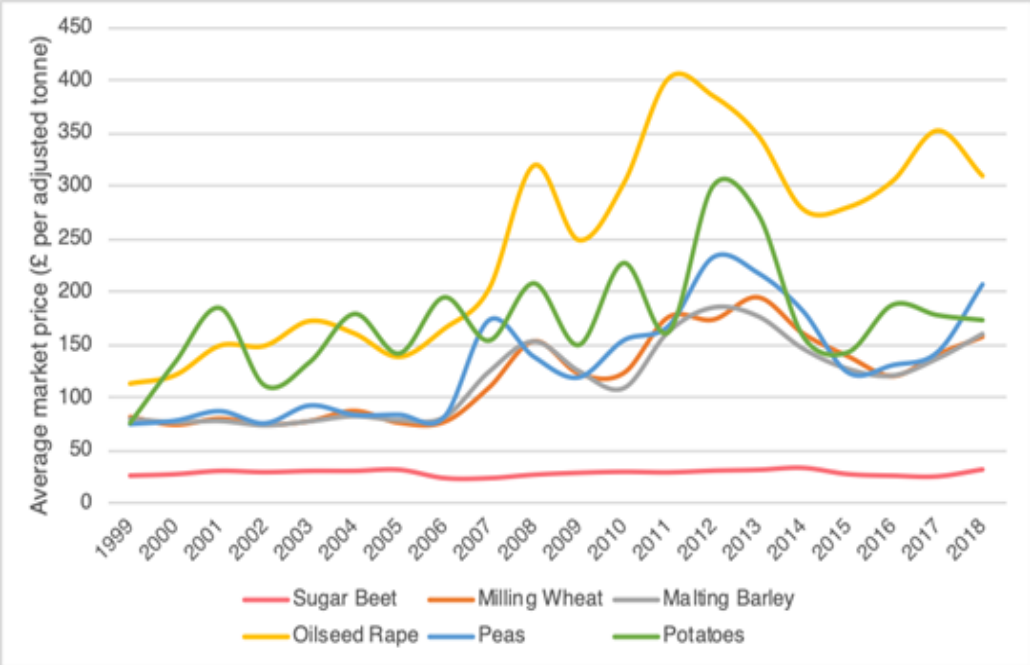


Figure 4: Annual average price per tonne (including bonuses) for UK sugar beet and alternative crops (Defra, 2019a)

However, from September 2017 onwards, the EU ended this quota system for EU sugar beet. The sugar beet quotas had been in place for nearly 50 years, and were the last crop to be subject to quotas – with the sugar sector given €5.4 billion to prepare for this transition (European Commission, 2017a). The European Commission represented this move away from protectionism as an opportunity for sugar beet producers to compete on the global market (European Commission, 2017a). Primarily as a result of the abolition of EU sugar quotas, coupled with favourable weather and high yields, UK sugar beet production experienced a 30% increase in cropped area and a 58% rise in production in 2017 (Defra, 2018a, p. 34). This led to a decline in EU sugar beet prices. Mainly as a result of this, British Sugar's parent company, ABF, predicted that profits from AB Sugar in 2018-19 would be roughly half what they were in 2017-18 (ABF, 2018, p. 24). This decline in prices also significantly offsets the effect of the Sugar Tax.

The effect of Brexit on this policy environment is currently uncertain. If the UK leaves the EU, the government has indicated that between 2021 and 2017 it wishes to phase out current Common Agricultural Policy subsidies and replace them with a new system of "public money for public goods", where subsidies are less tied to land area and more to environmental and health outcomes (Harvey, 2018). In this context, sugar beet subsidies may come under scrutiny due to sugar's negative health impacts (see Box 6 'Redefining productivity').

Future supply-side policies to reduce UK sugar consumption

Given the impact to date of agricultural policy on the supply of sugar, there are good reasons to believe that managed reduction in UK sugar production could assist efforts to reduce sugar consumption. Since an estimated 87% of sugar beet and cane sugar purchased in the UK is in manufactured food and drink (Richardson and Winkler, 2019, p. 5), and over half of the refined sugar consumed in the UK is sourced from UK sugar beet farms, restricting domestic sugar beet supply could affect sugar prices prices enough to incentivise manufacturers to reformulate their products with lower sugar content. At the very least, agricultural policy could avoid undermining public health policy by lowering sugar prices and reducing the impact of the Sugar Tax on manufacturer decisions.

However, any policy change would need to factor in the impact of trade policy and imports. Merely introducing restrictive quotas on UK sugar beet production could increase prices for domestic sugar, increasing the likelihood that food producers would simply shift to EU or other imports. Modelling done on behalf of British Sugar has been used to show that removal of UK farming subsidies would decrease domestic output and raise consumer prices, although it would also increase imports (Flint, 2018). Sugar cane is not environmentally better than sugar beet, and in some respects is worse (see Box 8). Measures to reduce UK sugar beet consumption therefore need to ensure that they do not significantly drive up imports which would only serve to offshore the environmental impact. Measures such as sustaining or even increasing import tariffs on sugar could be considered.

Another consideration is that food manufacturers may not be able to reformulate products as easily as the soft drink industry, so there may be a risk that higher prices may be passed onto consumers. As a result, Hawkes and Watson note that "Since sugar is inherent to the functional properties of many manufactured foods, measures will be needed that encourage substitution of manufactured foods and drinks with fresh, non-manufactured foods with no added sugars" (Hawkes and Watson, 2017, p. vii). Where substitution is possible, they also recommend that careful consideration be given to the health impacts of the potential substitutes.

A complementary package of supply-side and demand-side policies are needed to bring down both UK sugar production and consumption. Other possible supply-side measures include phasing out subsidies to sugar production and introducing greater subsidies to vegetable production or taking measures to convert UK sugar beet production to organic. Renationalising British Sugar in order to manage a decline in its production and ensuring a just transition to alternative livelihoods should also be on the table.

BOX 8 - IS SUGAR CANE ENVIRONMENTALLY BETTER THAN SUGAR BEET?

The short answer is no, and therefore reductions in UK sugar beet consumption need to ensure that they do not significantly drive up imports which would only serve to offshore environmental impacts. Water use (5,200 m3 per hectare for sugar cane compared to 40m3 for sugar beet) and chemical inputs (particularly nitrogen) are both greater for sugar cane than for sugar beet (Renouf et al., 2008). Soil erosion is also significant for sugar cane as well as beet and the production of cane also involves turning over new land to the crop, whereas beet tends to be farmed on existing agricultural land (WWF, 2005, p. 5). In terms of overall carbon impact, sugar cane consumed in the EU has a higher impact than EU grown beet, driven by transportation, with 45-60% of the emissions of cane sugar in the EU from transport (Klenk, Landquist and de Imana, 2012).

9. CONCLUSION

This report has demonstrated the huge costs to our health and environment of growing sugar beet in the UK. Measures to cut our sugar consumption will be lopsided and ineffective unless we complement them with measures to also reduce sugar production. Indeed, supply-side policies present a huge opportunity. They have the potential to reinvigorate UK domestic vegetable production, improving our food security and reducing reliance on imports. They could improve the nation's health, reduce burdens to the NHS caused by excessive sugar consumption, and support the adoption of healthier alternatives to ultra-processed food full of empty calories. Vitally, they is an opportunity to preserve the UK's soils from the massive losses caused by sugar beet farming, to help preserve soil fertility, the viability of agriculture, and food security into the future.

This report has raised many questions in relation to the interaction between supply and demand for sugar, and the policy trade-offs to secure a healthy and sustainable future. These questions tap into much wider debates on agricultural and land use transitions, in the context of mitigating agriculture's contribution to Greenhouse Gas (GHG) emissions, addressing ecosystem degradation and restoring our soils, as well as growing enough healthy food for UK citizens.

The interactions between production and consumption of sugar are complex. Feedback is exploring how a transition away from high sugar production could be facilitated, without damaging farmer livelihoods in the process. We plan to investigate policy levers such as extending existing sugar taxes, quotas on sugar production, tariffs on imports, the renationalisation of British Sugar, shifting subsidies away from sugar and increasing them for vegetable production, and shifting to more organic sugar production.

But one thing is certain – we cannot continue as we have been. UK sugar production is largely profiting a single corporation at the expense of our health and environment. With the huge food security and sustainability challenges posed by climate change, we cannot afford to waste valuable land, soils, and resources growing sugar. Nor can we afford to pay for both subsidies to grow sugar and NHS bills to treat the negative health effects of this destructive industry. Prioritising a transition to food production which provides maximum nutritional value for minimum environmental degradation, or even environmental enhancement, is an essential means to transitioning to healthier diets on a healthier planet.

APPENDIX

This appendix sets out the methodology used to calculate key statistical findings in this report.

1. Volumes of Soil Loss due to Crop Harvesting (SLCH) for UK sugar beet:

In order to calculate the degree of soil loss due to crop harvesting for sugar beet, Feedback took crop area and yield data for UK sugar beet production derived from (Defra, 2019, p. 47 Table 7.7) this data is shown in the top 2 rows of the table below:

Estimated soil loss from harvesting sugar beet

UK SUGAR BEET	2014	2015	2016	2017	2018	5 YR. AVG.	SOURCE
Area (thousands ha)	117	84	80	107	110	99	Defra 2019
Yield (tonnes per ha)	80	74	71	83	69	76	Defra 2019
Soil loss from harvest – yield x 6.5% soil tare (tonnes per ha)	5.2	4.8	4.6	5.4	4.5	4.9	Authors' calculation
Soil loss from harvest (thousands tonnes)	605	404	370	580	495	489	Authors' calculation

Soil moisture content will affect how much soil will cling to the crop and machinery during harvest – this is known as 'soil tare'. We assumed 15% soil moisture content (derived from Renwick and Revoredo-Giha, 2005, p. 10), and in these conditions, 6.5% soil tare (derived from Renwick and Revoredo-Giha, 2005, p. 10; Quine et al., 2006, p. 9).

To reach our soil loss figures, we used sugar beet yield figures provided by Defra (tonnes per hectare) and multiplied this by 6.5% soil tare, to calculate the Soil Loss due to Crop Harvesting (SLCH) for sugar beet in tonnes per. The SLCH per hectare was then multiplied by the area of land used for sugar beet cultivation each year between 2014 and 2018 to arrive at estimates for the total SLCH across the whole UK sugar beet harvest. We then calculated a five-year average.

A 2019 study estimated that SLCH for the whole UK sugar beet harvest was around 562,800 tonnes per year in 2000-2016, (Panagos, Borrelli and Poesen, 2019, p. 495). This study finds an average soil loss per hectare of 4.2 tonnes, slightly lower than the average of 4.9 tonnes per hectare 5-year average estimated in the table above[1]. However, because this study estimates

1. If 4.2 tonnes per hectare were the SLCH for the 2014-18 period where yield per hectare is 76 tonne per hectare, this would represent a slightly lower soil tare of 5.5%. However, these figures are not really comparable, because the 4.2 tonnes per hectare SLCH figures from (Panagos, Borrelli and Poesen, 2019) are based on the 2000-2016 period, in the earlier years of which sugar beet yields per hectare would have been lower, affecting the volume of SLCH per hectare. Therefore, the rate of soil tare in (Panagos, Borrelli and Poesen, 2019) is likely to be closer to the 6.5% assumed in this report – but with lower per hectare SLCH spread over a wider area of production, i.e. 135,200 hectares.

135,200 hectares of UK land is used to grow sugar beet per year across 2000-16, the overall estimate for SLCH in the UK is 562,800 tonnes per year – at the upper end of our estimates of 400,000 to 600,000 tonnes soil lost per year. The difference is likely because the yields for sugar beet have significantly increased between 2000-16, so the volume of sugar beet harvested and SLCH per hectare would increase in more recent years but be spread across a smaller land area.

Defra estimates that the UK loses 2.9 million tonnes of soil per year, excluding SLCH. We therefore calculate that the UK sugar beet harvest increases the UK's total soil loss by between 370,000 tonnes and 605,000 tonnes between 2014 and 2018 (depending on harvesting conditions, yield and area of land under cultivation for sugar beet), or between 13-21% per year. In addition, the harvesting of other root crops will further increase the UK's total soil loss per year.

2. UK sugar production relative to Recommended Daily Allowance (RDA):

Feedback calculated that the UK's average refined sugar production from domestically produced sugar beet between 2014-18 was 1.15 million tonnes annually (Defra, 2019, p. 47 Table 7.7).

Based on UK population data from ONS (2017) and Public Health England's estimates of different gender/age groups' current average daily free sugar consumption (Public Health England, 2015, p. 22 Table 2), we calculated the total tonnes of sugar consumed by the UK population is currently 1.35 million tonnes per year:

AGE GROUP	UK POPULATION	CURRENT INTAKE FREE SUGARS (G PER DAY)	TOTAL FREE SUGARS	TOTAL SUGAR CONSUMPTION (TONNES PER YEAR)
Women aged 65+	6,454,090	46.2	298,178,958	108,835
Women aged 19-64	19,672,574	49.2	967,890,641	353,280
Girls aged 11-18	2,842,593	63.9	181,641,693	66,299
Girls aged 4-10	2,754,754	58.5	161,153,109	58,821
Men aged 65+	5,359,995	58.5	313,559,708	114,449
Men aged 19-64	19,509,213	68.4	1,334,430,169	487,067
Boys aged 11-18	2,991,389	84	251,276,676	91,716
Boys aged 4-10	2,889,287	63	182,025,081	66,439
Total	62,473,895		3,690,156,034	1,346,907

NOTE: This excludes children under the age of 4, because Public Health England (2015) does not give current sugar consumption data for children of this age. There are 4,014,314 children under the age of 4, with recommended RDA of 19g/day – if their sugar consumption was factored in, the UK's total sugar consumption might be slightly higher.

Using UK population data from ONS (2017) and the Recommended Daily Allowance (RDA) for people of different ages provided by the NHS (2018) and (Public Health England, 2015, p. 22 Table 2), Feedback calculated that if the UK population reduced its sugar consumption in line with these RDAs, the UK would consume a total of 688,000 tonnes annually. RDAs are based on the Scientific Advisory Committee on Nutrition and World Health Organisation's recommendations that consumption of free sugars should not exceed 5% of total dietary energy intake (Public Health England, 2015):

AGE	EST POPULATION 2016	SUGAR RDA (G/DAY)	G PER YEAR	TONNES PER TOTAL POPULATION
0-4	4,014,314	19	6,935	27,839
5-9	4,037,456	24	8,760	35,368
10-14	3,625,062	30	10,950	39,694
15-19	3,778,927	30	10,950	41,379
20-24	4,253,751	30	10,950	46,579
25-29	4,510,648	30	10,950	49,392
30-34	4,408,163	30	10,950	48,269
35-39	4,179,537	30	10,950	45,766
40-44	4,174,065	30	10,950	45,706
45-49	4,619,147	30	10,950	50,580
50-54	4,094,448	30	10,950	44,834
55-59	4,066,685	30	10,950	44,530
60-64	3,534,233	30	10,950	38,700
65-69	3,636,517	30	10,950	39,820
70-74	2,852,065	30	10,950	31,230
75-79	2,154,524	30	10,950	23,592
80-84	1,606,746	30	10,950	17,594
85-89	992,988	30	10,950	10,873
90+	571,245	30	10,950	6,255
Total	**65,110,521**			**688,000**
Total (excluding 0-4 yr olds)				**671,729**

A national consumption of 688,000 million tonnes of sugar annually would be a 49% reduction in the UK's current annual sugar consumption of 1.35 million tonnes (excluding 0-4 year olds, because data was not available for their current consumption on grams).

To produce 688,000 million tonnes of refined sugar would require a 40% reduction in UK's current average annual sugar production of 1.15 million tonnes. This assumes that all sugar consumed in the UK is produced domestically as sugar beet, which is not currently the case, and includes 0-4 year olds in calculations.

Only 13% of adults are already achieving the 5% dietary energy level for free sugars intake (Public Health England, 2015, p. 22).

3. What volume of other crops could be grown on land liberated by reducing UK sugar beet production in line with RDAs?

As calculated in the previous section, to produce 688,000 million tonnes of refined sugar (in line with UK citizens consuming their RDA of sugar) would require a 40% reduction in UK's current average annual sugar production – meaning the unprocessed sugar beet harvest would reduce from an average of 7.6 million tonnes to 4.5 million tonnes. This assumes that all sugar consumed in the UK is produced domestically as sugar beet, which is not currently the case.

We also assume that along with a 40% reduction in production, there would be a 40% reduction in land area used to produce sugar beet. Between 2014-18, an average of 99,456 hectares was dedicated to growing sugar beet, so in this scenario 60% (59,510 hectares) of this land would still be used to grow sugar beet, and around 40% (39,946 hectares) is freed for other purposes. Using yield data for peas and potatoes from (Defra, 2019) and separate yield data for carrots (Great British Carrots, 2019), Feedback calculated the volumes of these crops that could be produced annually on the liberated land:

	PEAS (MODELLED)	POTATOES (MODELLED)	CARROTS (MODELLED)
Area (hectares)	39,946	39,946	39,946
Yield, 5-year average (tonnes per hectare)	3.7	46.4	77.8
Volume of harvested production (tonnes)	147,800	1,853,494	3,107,799
Portions (80g) per person per year	28.5	356 (or 154 potatoes, 150g each)	596

4. What is the current average sugar consumption per person in UK?

Feedback took 2016 UK population data from ONS (2017) broken down by gender and age, and combined this with Public Health England's estimates for UK average sugar consumption broken down by gender and age (Public Health England, 2015, p. 22 Table 2) to create a total figure of 3,690,156,034g/day sugar consumed by the total UK population.

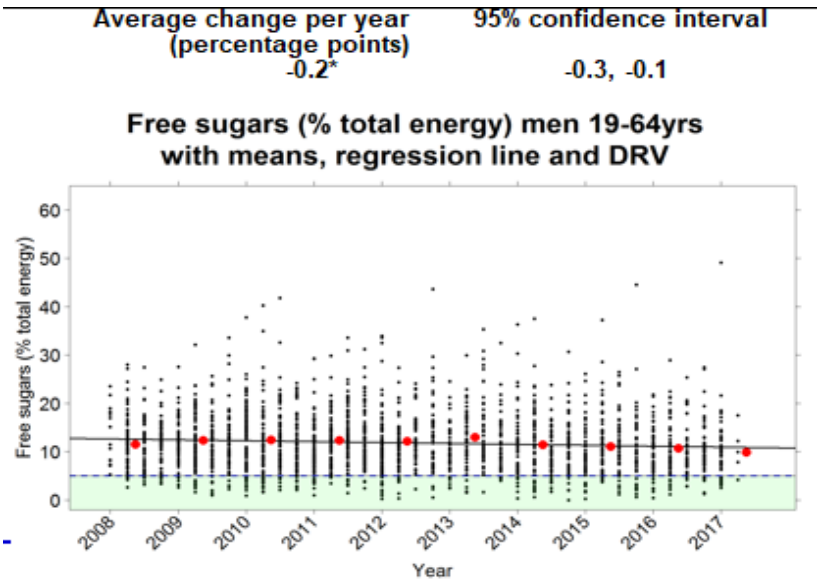
An example of how sugar consumption was calculated for each age/gender is given below for 25 year olds males and females. The same calculation was completed for all ages/genders (not shown here for brevity), and then totalled in the bottom row:

AGE	GENDER	UK POPULATION OF THIS AGE/GENDER	AVERAGE FREE SUGARS CONSUMPTION (G/PERSON/DAY)	TOTAL POPULATION SUGAR CONSUMPTION (G/DAY)
25	Female	450772	49.2	22,177,982
25	Male	468437	68.4	32,041,091
Total (all ages):		65,648,054	56.2	3,690,156,034
Total (18+ years)		51,767,543	57.4	2,971,333,134

We then divided this total figure for daily sugar consumption by the UK population (3,690,156,034g/day) by the 65,648,054 people in the UK in 2016 (ONS, 2017) to gain an average of 56.2g sugar consumed per person per day in the UK. This figure rises slightly to 57.4g per day when children under the age of 18 are excluded.

5. How quickly will existing policies lead to reductions in public sugar consumption?

Data tables for (Public Health England, 2019 Time trend analysis Food and Nutrients, 3.26: Free Sugars) show a number of time trend graphs for different ages and genders – an example of these is below:



Using the same ONS population data as for our other calculations and the average annual rate of decline in free sugars consumption from Public Health England (Public Health England, 2019 Time trend analysis Food and Nutrients, 3.26: Free Sugars), the final calculation of the overall average decline in consumption between 2008/9 and 2016/17 is arrived at through a weighted average of the rate of decline for each of age/gender group:

GENDER	AGE	UK POPULATION IN 2016	TOTAL FREE SUGARS CONSUMPTION IN 2016 (G/DAY)	AVERAGE ANNUAL RATE OF DECLINE IN FREE SUGAR CONSUMPTION BETWEEN 2008/9 TO 2016/7 PROJECTED TOTAL FREE SUGARS CONSUMPTION IN 2017 (G/DAY)	PROJECTED TOTAL FREE SUGARS CONSUMPTION IN 2017 (G/DAY)
Female	4-10	2,754,754	160,153,109	0.3	160,669,650
	11-18	2,842,593	181,641,693	0.3	181,096,768
	19-64	19,672,574	967,890,641	0.1	966,922,750
	65+	6,454,090	298,178,958	0.2	297,582,600
Male	4-10	2,889,287	182,025,081	0.3	181,479,006
	11-18	2,991,389	251,276,676	0.4	250,271,569
	19-64	19,509,213	1,334,430,169	0.2	1,331,761,309
	65+	5,359,995	313,559,708	0	313,559,708
Total:		**62,473,895**	**3,690,156,034**		**3,683,343,359**

Using the average decline in consumption for each population group The projected **3,683,343,359g/day for 2017 is only 0.2% less than 3,690,156,034g/day in 2016, making an average of 0.2% decline in UK free sugars consumption between 2008/9 to 2016/7.**

At this rate of decline, the UK would not reach its target of a 50.1% reduction in public sugar consumption (i.e. 1,840,352,604g/day) for 422 years. However, it is important to note that as the Sugar Levy was only introduced in April 2018, there is not yet accurate data on the impact of this policy on current public sugar consumption, and therefore on a different pace towards meeting the target.

6. What is UK refined sugar production as a percentage of total UK sugar supply?

Between 2014-18, if all UK sugar beet production had been consumed domestically, it would have accounted for between 55-65% of total UK sugar supply. Between 15-33% was exported annually in this period. Feedback derived this data from the following Defra data:

Table 7.7 Sugar

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Thousand tonnes (unless specified otherwise)					Calendar year
	2014	2015	2016	2017	2018 (provisional)
Sugar Beet					
Area (thousand hectares)	117	84	80	107	110
Yield (tonnes per hectare)	80	74	71	83	69
Volume of harvested production	9 310	6 218	5 687	8 919	7 620
Value of production (£ million)	315	173	150	229	246
Sugar content (%)	17.2	17.3	17.3	17.8	17.9
Prices (average market price (£ per adjusted tonne)) (a)	33.9	27.8	26.3	25.7	32.3
All Sugar (refined basis)					
Production (b)	1 446	978	897	1364	1 080
Imports from : the EU	476	586	402	530	526
the rest of the world	699	546	601	458	422
Exports to : the EU	232	258	224	157	236
the rest of the world	94	75	46	46	125
Total new supply	2 296	1 776	1 632	2 147	1 666
Production as % of total new supply for use in the UK	63%	55%	55%	64%	65%

(a) Average price for all sugar, including transport allowance and bonus

(b) Sugar coming out of the factory in the early part of the new year is regarded as being part of production in the previous calendar year.

(Defra, 2019, p. 47)

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