Working Group

Update on Working Group 6 Net zero carbon (NZC) and food safety in primary production

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1. Summary

1.1 This paper outlines progress of the Working Group 6 review on Food Safety and Net Zero Carbon (NZC).

1.2 The Science Council is asked:

- to review the information in this paper on the workshop and discuss the preliminary outputs that will be presented in the verbal update.
- To discuss next steps in Phase 3 to review the workshop prioritised outputs and establish current understanding of them.
- To advise about options for considering the rest of the food chain and what approaches might best be used.

2. Introduction

2.1 The UK set a legal target in June 2019 to achieve NZC emissions by 2050. The government recently set a new legally binding target to cut the country's greenhouse gas emissions by 78% by 2035 compared to 1990 levels.

2.2 This means any carbon emissions are balanced by schemes to offset an equivalent amount of greenhouse gases from the atmosphere, such as planting trees or using technology like carbon capture and storage. It does not include the carbon footprint of imported products. These are important qualifiers as

it doesn’t mean an end to UK carbon emissions, or the carbon footprint driven by UK’s consumption of imported products.

2.3 At the 9th Science Council open meeting, the Council agreed in its closed session an initial work plan to deliver a review of the food safety implications of moving to net zero carbon; the Terms of reference were finalised on 27 October 2021.

3. Discussion

3.1 The early scoping Phase 1 (interviews and survey) is complete and sought expert input on activities over the next decade to achieve net zero carbon which are being made to, or affect, the whole food system. For example, possible changes to animal feed, changes/innovations in soil management for carbon capture, changes to crop growing practices, and restoration of wetlands.

3.2 We initially approached five key experts to interview them about the broad landscape of carbon emissions reduction for the food system in July and August this year. These experts were:

1. **Tim Benton** (Chatham House): Tim has extensive experience in food and climate change, is an IPCC and CCRA author and is very well connected.
2. **Jonathan Scurlock** (NFU): Jonathan has over 30 years’ experience as a specialist in environmental science and energy policy, with particular expertise in bioenergy and other renewable energy technologies, climate change and the global carbon cycle.
3. **Emma Piercy** (FDF): Head of Climate Change and Energy Policy at the FDF, which recently announced their roadmap to net zero by 2040.
4. **Bob Doherty** (University of York): Professor of Marketing and Chair in Agrifood at the University of York Management School.
5. **Pete Smith** (University of Aberdeen): Science Director of Scotland’s Climate Change Centre of Expertise

3.3 The WG6 chair (Claire Nicholson) and deputy chair (Jonathan Wastling) interviewed these experts with assistance from the Science Council Chair (Sandy Thomas) and a Science Council Member with expertise in Soil Health Peter Gregory. These interviews helped frame the questions used in the follow-up survey.

3.4 A **targeted survey to a diverse range of experts** across a range of disciplines relevant to sustainability, carbon reduction and the food system asked them to identify specific NZC changes that will be happening to (or affecting) the food system over the next decade. The survey was sent to nearly 90 individuals and was also forwarded to other experts by respondents. We received nearly 31 responses and summary of the activities raised by the survey is in **Annex 1**.

3.5 Phase 2 was a workshop that took place on 18 November and focused on primary production and processing: mapping out the food safety implications of activities over the next decade to help achieve net zero carbon.

3.6 The structure of the workshop is described in **Annex 2.** The outputs of the workshop will be provided as a verbal update at the 10th Science Council meeting.

Council members are asked to consider in light of the information presented what approaches might be taken (workshops or otherwise) to cover processing, distribution and manufacture.

3.7 Phase 3 will involve further investigation (possibly involving a review of literature and/or further expert input) to create a list of priority activities which are most likely to have significant implications for food safety. This will give a clearer picture of actual impact of these activity and possible ways to address them.

3.8 The exact approach taken for phase 3 will depend on the final outputs from the workshop. Phase 3 planning will begin on delivery of the final report (to be completed by 10 January).

4. Conclusions

4.1 Science Council members are invited to:

- **To review the information in this paper on the workshop and discuss the preliminary outputs that will be presented in the verbal update.**
- **To discuss next steps in Phase 3 to review the workshop prioritised outputs and establish current understanding of them.**
- **To advise about options for considering the rest of the food chain and what approaches might best be used.**

Annex 1

Summary of responses from September/October survey of experts on changes to (or affecting) the food system to help achieve net zero carbon over the next decade.

(Note this was used as an input to the Phase 2 November workshop).

Crop Production

- Crop production inputs
    - Move away from synthetic nitrogen-based fertiliser to more organic based
    - Field carbon sequestration.
    - Increased environmental hygiene risk (particularly Listeria mono) in non- competitive growing environments and post-harvest environments where less biocide use
    - Increased product contamination risks (e.g., toxic weeds) due to lack of herbicide options
    - Removal of food safety steps (e.g., product washing)
    - Development of circular economy principles to utilise waste streams
- Crop production
    - Leguminous plants co cropped with wheat to replace nitrogen fertiliser
    - Nitrogen without CO2
    - Mixed rotations
    - Less use of manufactured fertilisers
    - Perennial energy crops (miscanthus, willow)
    - Reduced inputs and increased sequestration
    - Reduced reliance on ammonium nitrate fertiliser-circular economy development
    - Crop breeding - Low energy rice and grain processing, potential for 90% energy reduction.
- Alterations to fertiliser practises
    - Move from inorganic to organic fertilisers
    - Abated fertiliser due to supply in the UK
    - Reduced reliance on ammonium nitrate fertiliser
- Targeted pesticide and agrochemical use

    - Integrated pest management (IPM)
    - The advent of biopesticides

Soil Management

- Soil Management
    - Improving nutrients
    - Increase carbon sequestration
    - Offsetting carbon pollution through NPP
- Environmental Land Management (ELM) - Trials associated with soil carbon

Regenerative Farming and Land Use Changes

- Regenerative farming techniques
    - No/minimal till
    - Cover crops and nitrogen fixing crops
    - Mixed rotations which include livestock
    - Nutrient management
    - Hedgerow and woodland management
    - Reduced inputs
    - Investments in Anaerobic Digestor plants
    - Soil
    - Afforestation
    - Nature-based solutions
        - Increased increments in hedges
        - New woodlands
        - Soil carbon management
        - Agroforestry
- Land use change
    - Planting woody biomass
    - Balance between for agriculture and for carbon storage

Livestock Farming Changes

- Livestock diet changes
    - Alternative feed
    - Biotechnology in feed ingredients, including generation of enzymes and supplements
    - Reduce enteric fermentation's emission of methane - including archaeal suppressant commercial use

    - Feed rations that deliver lowest carbon footprint per product (not just feed input)
    - Home grown feed replacement of soya
    - Use of novel feedstuffs
    - Supplements in cattle to reduce methane production
    - Insect protein (including for aquaculture)
    - Improvements to feed utilisation
    - Alternatives to soya in feed formulation
- Animal breeding
    - More efficient and resilient animals
    - Lower carbon footprint
- Animal husbandry
    - Improving utilisation of feed
    - Improve fertility
    - Improve genetics
    - Greater integration of livestock and arable farming in some areas

Aquaculture

- Aquaculture
    - Multi-stream culture systems (e.g., fish plus water plants such as watercress)
    - Ocean farming and harvesting of seaweed

Packaging

- Packaging materials
    - Net impact is negative as packaging protects and preserves products through the supply chain and the product loss that it prevents has a greater Greenhouse Gas (GHG) footprint than packaging itself.
    - Media and Corporate Social Responsibility (CSR) driven reduction of packaging (particularly substitution of plastics packaging by alternative materials) will increase GHG impact and must "follow the science" not rhetoric.
    - Including recycled content into primary food packaging.
    - Shift to recyclable petroleum based or biobased packaging materials

Waste Reuse/Management

- Conversion or reduction of food waste

    - Into 'fertiliser' at scale
    - Valorisation of side streams
    - Reducing food waste
- Waste valorisation
    - Abstraction of slurry
    - Reduced food waste in home as a result of increased prices
    - Waste reduction and management - Zero waste to landfill

Consumer Demand

- Consumer diet change
    - Eat less red meat and shift to plant-based foods
    - Non-animal-based protein sources
    - Meat and dairy substitutes
    - Reduced meat and dairy consumption
    - Insect protein
    - More dairy and meat substitutes
        - Novel proteins
        - Cultured meat
        - Minimally processed foods
        - Eating less meat but higher quality
    - Consumer being part of solution –
        - Novel foods
        - Alternative protein production

Greener Energy

- Green energy
    - Closer connectivity between heating and cooling systems
    - Changing energy grid
    - Enhanced efficiency in existing systems through energy conservation, monitoring and utilisation
    - Removal of coal and fossil fuels
    - Renewable sources
    - Solar panels
    - Energy efficiency
    - Solar powered thermally efficient systems working at the 50-95 degree Celsius range
    - Light Emitting Diodes (LED) lighting
    - Hydrogen fuel for supply chain transport and factory

    - Vehicle and machinery electrification
    - Gas to grid
    - Tractor biogas fuelling
    - Land-based renewables and energy storage, for on-farm and export
    - Bioenergy with carbon capture and storage - not in the food system, but uses land so will affect the food system
    - Replace water heated, jacketed pipework with lower energy electrical systems
    - Governmental support for the development of new sustainable energy technologies to replace hydrocarbon use
    - Hydrogen economy investment by government
    - Clean hydrogen instead of methane as a gas supply
    - Decarbonisation of crop systems grown in poly tunnels
    - Carbon credits for soil sequestration
    - Improved air pollution and changes to transport
    - Away from fossil based: solar, wind, earth, tides etc.
    - Solar Photovoltaic technology, coupled to (mainly) battery energy storage
    - Higher costs - Short term Opex increases
    - Higher costs - In electricity
- Zero fossil fuel use
    - Electrification
    - Hydrogen generation plants
    - Zero fossil fuel use-Bio-hydrogen
- Reduced emissions methods
    - Scrubbers and catalyst systems
    - Anaerobic digestion to generate "negative emissions"
    - Refrigeration
        - Improving efficiency
        - Onsite energy generation
- Renewable energy
    - Electricity generation
        - Wind and solar are variable
        - Tides are predictable

Technological Solutions/Developments

- Innovation and new technologies
    - Increased use of high-tech production systems (glasshouses, Controlled Environment Agriculture (CEA), hydroponics)

    - Vertical Farms
    - Less process steps and eyes on crop to identify and remove physical contaminants
    - New technologies
        - Genetic
        - Feed additives
        - Feed proteins
        - Robotics
        - Drones
        - Electric agricultural machinery
- Precision crop and livestock agriculture
    - Improved reproductive performance
    - Gene editing precision
- Animal and plant health Sustainable intensification-Lower carbon agronomy
- Lower carbon emissions - Net zero at production, but not guaranteed in food storage or consumption (energy usage, waste)
- Manure management - Anaerobic digestion
- Gene editing
    - For crop and livestock resilience
    - Livestock and rumen microbes as part of the pangenome approach
- Improved manufacturing efficiency
    - Reduce rejection and reduce rework and achieve zero waste
    - Deforestation policies among manufacturers

Others

- Protein self sufficiency
    - Use of alternatives to imported protein sources
- Benchmarking
    - Industry data collection and performance tracking, Climate Change Agreements (CCA) sector etc.
    - Better traceability
    - Improved measurements of emissions
- Productivity improvements
    - Basic knowledge exchange
    - Improved genetics
    - Energy efficiency
    - Precision farming
    - Nutrition
    - Reproduction

        - Production efficiency on farm
            - Whole carcass utilisation in processing
            - Improve the genetic potential of farmed crops and animals to include sustainability traits in new varieties and breeds.
- Financial incentives - Faster shift of investment away from unsustainable fossil fuel economy towards a sustainable bio-based and natural-resource-based economy to meet human needs for food, fibre and fuel while safeguarding natural capital

Annex 2: Net Zero Carbon Workshop summary

Introduction

The Food Safety and Net Zero Carbon Workshop forms part of the FSA Science Council's review of the implications for food safety of changes to (or affecting) the food system to deliver UK Net Zero Carbon.

This **workshop** was an all-day event on 18 November 2021. Attendees were drawn from experts across academia and industry as well as the FSA to look at the results of the FSA Science Council survey which identified key activities up to 2030 to reduce carbon emissions to (or affecting) food system. The ask on the day was that they highlight activities affecting primary food production/processing which may have implications for food safety. It also reviewed the food-water-power nexus more widely to identify any second or third order potential effects on food safety.

The workshop

The **workshop** was held online with 19 external experts (listed in document **SC 10C-6a**) and people from the FSA and Science Council who were given a short-list of 40 activities created from the full list of activities provided by respondents to the prior survey.

Robin May (the FSA CSA) welcomed everyone and this was followed by presentations from Tim Benton (Chatham House) on Food Safety and Net Zero Carbon and Julie Hill (ACSS DC) on their Climate Change and Consumer Behaviour review.

A short brief was given to the attendees that provided a quick explanation of eight **food safety themes** (see **Appendix 1**). These gave them some insight into types of food safety concern to aide discussion of links between activities to achieve net zero carbon and possible implications for food safety.

The workshop then used a mix of facilitated group and breakout sessions where the attendees reviewed activities to achieve net zero within primary production and processing and identified those they considered have possible food safety impacts (good or bad).

The attendees then scored activities they had said would have food safety implications on three criteria: Speed to Market, Likelihood of food safety effects and impact of food safety effects.

Appendix: Eight Food Safety Themes

1. **Zoonoses** are infectious diseases caused by a pathogen (an infectious agent, such as a bacterium, virus or parasite) that can pass from animals to humans. Zoonoses can be transmitted directly from animals to humans through media such as air (influenza) or through bites and saliva (bluetongue, Ebola). Transmission can also occur via an intermediate species, which carry the disease pathogen without getting sick.
2. **Foodborne diseases** are caused by the consumption of pathogens (such as E. coli, Listeria, Campylobacter, Salmonella, Clostridium etc) which have contaminated food. Contamination of food can occur at any stage of the food production, delivery and consumption chain. They can result from several forms of environmental contamination including pollution in water, soil or air, as well as unsafe food storage and cross-contamination during processing or food preparation.
3. **Radiation** is radiological contamination of food with radionuclides (isotopes of elements that emit ionizing radiation) that emit radiation types and at levels that are harmful to humans. Examples include sheep from North

Wales and Cumbrian, where caesium-137 from the cloud emitted by the Chernobyl accident accumulated in the environment and affected their grazing land.

4. **Chemical contamination** is contamination of food with chemicals that can cause harm if ingested. These include heavy metals (such as mercury or lead), naturally occurring chemicals (such as mycotoxins that can be produced by some types of moulds), organic pollutants (like dioxins and PCBs, from burning hydrocarbons and old transformers respectively) and from processing food (such as acrylamide from burning carbohydrates).
5. **Food contact materials** include anything food touches as it passes through the food chain (e.g. packaging, processing equipment, pipes etc). Some materials can transfer harmful chemicals into food they are in contact with at levels which are considered unsafe. The amount transferred depends on: the material (e.g. moving from biodegradable packaging which contains allergenic chemicals), contact duration, temperature, acid/base food etc.
6. **Food Allergy (to peanuts, soya, egg etc)**, food intolerance (sulphites and lactose) and coeliac disease (gluten) is collectively called food hypersensitivity. This is when a person's body suffers an adverse reaction to even small amounts of certain foodstuffs. Changes to formulations of food to include allergenic ingredients, introductions of new vectors for existing allergens (such as bioplastics), new allergens and increasing use of allergenic raw materials for products like biodegradable packaging are all possible concerns.
7. **Nutrition** changes in the macro (fat, sugar, protein) and micronutrients (minerals and vitamins) are a potential outcome of changes to farming and production methods. New processing methods, changing species, breeding or GE modification of crops or animals for one characteristic may affect others, like nutrition. Whilst not an immediate food safety issue this does affect the health of consumers long term.
8. **Labelling** is important as accurate labelling and product information allows informed consumer choice, e.g. organic food, GM or GE modified. Where labelling is vague to allow exchange of ingredients depending on availability/cost, this restricts consumers' self-determination.