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Government Chemist

Stakeholder Workshop

Report 2019

Government Chemist Stakeholder Workshop Report 2019

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Executive Summary

This report presents the findings of the stakeholder workshop carried out on 14 May 2019 at the Royal Society of Chemistry, Burlington House, London. Forty-three stakeholders from across the food and feed sector, including representatives from manufacturers, distributors, retailers, importers, regulators, legal and government, established the key divers influencing the food and feed sector to which the proposed Government Chemist Programme 2020-2023 should respond.

The workshop comprised of two components, an initial brainstorming followed by a prioritisation stage.

In excess of 250 ideas were gathered in the initial brainstorming phase. From this wealth of information, participants decided the following as priorities:

- the impact of alternative packaging materials,
- the use of point of use analysis technologies,
- persistent issues with allergen testing,
- increase in food fraud in a global market, and
- lack of trust in emerging technologies as well as the databases they use.

Other concerns highlighted related to austerity, in terms of depleted resources, skills, scientific capability and sampling. Technical challenges were recognised by attendees in the measurement of ethical claims of both existing and likely future products and on measurements of ingredients for which there is a 'zero tolerance' attitude.

> Note: Despite EU-Exit, and the potential changes in legislation that may or may not follow, being a consistent narrative in the drivers put forward, it was not prioritised by attendees directly in the top 10 issues (in terms of importance and certainty) that the Government Chemist should consider and build capability for. However, due to the potentially large impact that any changes could have, the Government Chemist will continue to monitor EU-exit related issues in its horizon scanning activities of the current programme until clarity on the UK's position is reached. The impact of EU-exit related changes will be fed into the future programme and the situation will be closely monitored.

Based on these identified priorities, the Office of the Government Chemist will now prepare a draft future work programme for further prioritisation by the Department for Business, Energy and Industrial Strategy (BEIS) appointed Programme Expert Group in November 2019, to allow contracting and start of the finally agreed programme in April 2020.

1. Introduction

The Government Chemist programme is funded by The Department for Business, Energy and Industrial Strategy (BEIS), with a current annual budget of approximately £1.1M.

The overarching aim of the Government Chemist function is to provide independent science-based opinion and advice, defined more fully as:

- *Referee Analyst*

    An independent and impartial statutory function, resolving disputes that occur in relation to relevant legislation which focuses on public protection, value for money and consumer choice, predominantly in the food and agriculture sectors;

- *Advisory*

    A source of advice for Government and the wider analytical community across measurement science to assist Government in its policy-making, standards-setting and regulation across the public sector.

The Government Chemist role is supported directly by a small specialist team comprising the Office of the Government Chemist (OGC), with the resources of the wider National Measurement Laboratory at LGC also being available to its functions.

The impact of the Government Chemist programme lies principally in preventing unwitting errors in measurement science that would have adverse impacts on consumers, businesses and the criminal justice system. In addition, it delivers scientific advances and advice to enable the analytical community to tackle measurement problems that are perceived as difficult and so help protect consumer health or choice and foster innovation.

The Government Chemist programme is renewed on a three yearly cycle, with the next programme starting in April 2020. To establish the focus of the next programme, a workshop was held with, a cross section of external stakeholders with an interest in the Government Chemist Programme, to share their opinions and establish a list of prioritised drivers.

The Government Chemist programme forms part of a wider portfolio of programmes comprising the National Measurement System. Together they align to the UK Measurement Strategy. The results of the workshop will also feed into the evidence base used to shape the next strategy.

2. Aim

To identify drivers which should shape the direction of the Government Chemist Programme 2020-2023 and to establish priorities based on the importance and certainty of the outcomes resulting from these drivers.

3. Methodology

The approach followed was PESTLE Driver Mapping, as detailed in the Government Office of Science Futures Toolkit[1]. This approach identifies the political, economic, societal, technological, legislative and environmental drivers (PESTLE) shaping the future for the sector.

Approach: Facilitated workshop with forty-three invited participants with an interest in the Government Chemist Programme.

Timing: Three hours in a workshop setting.

Output: A list of drivers to be included in the future strategy and scope of the Government Chemist Programme 2020-2023, which in turn will feed through to the next UK Measurement Strategy. It will also provide details of drivers that need to be tracked and those that are considered important for the programme, but have an uncertain outcome preventing their current prioritisation.

Method: The method includes three steps:

• Step 1: Introduce the workshop and the PESTLE approach

• Step 2: Brainstorm the drivers

• Step 3: Map the drivers

Step 1: Workshop facilitator introduced the workshop and the PESTLE approach

The aim of the workshop was introduced as:

• To inform the direction of the next Government Chemist Programme (2020-2023)
• To feed key areas of interest into the next UK Measurement Strategy (2020-2025)

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[1] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/674209/futures-toolkit-edition-1.pdf

Participants were asked for their views on the political, economic, societal, technological, legislative and environmental drivers (PESTLE) when considering the question:

What factors do you think will impact the Government Chemist Programme over the next 10 years?

Step 2: Participants brainstormed these drivers for 45 minutes.

Participants were asked to identify factors driving change within the context of the question posed in the introduction. These drivers were captured onto Post-it® notes (one driver per Post-it® note) and placed on one of six boards containing the headings:

- Political
- Economic
- Social
- Technical
- Legal
- Environmental

The Post-it® notes were then collated into related themes, with duplicates being discarded. The summary set of Post-it® notes detailing the over-arching themes were presented back to the workshop participants for use in the driver mapping session that followed.

Step 3: Driver Mapping Axes of Uncertainty, 45 minutes, in groups of 10.

Each groups of participants was asked to map the drivers on a matrix according to their importance for the Government Chemist Programme and the certainty of the outcome of each one, considering a 10 year time frame (see Figure 1).
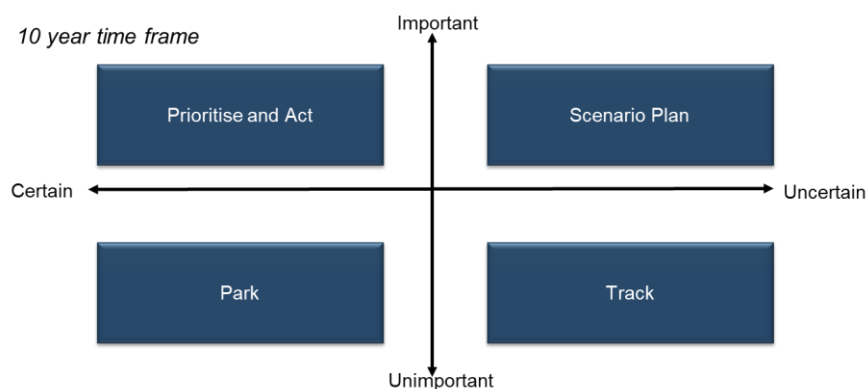

Figure 1- Axes of Uncertainty.

The groups were then asked to cluster the drivers by theme and, focussing on the top left quadrant, to identify the four priority drivers that they believed to be most important for the Government Chemist Programme.

A representative from each group presented their top four drivers and the justification for their choice to the rest of the participants. A discussion was then held with all participants to establish the narrative for each of the top drivers.

Data Analysis:

Each driver detailed on a Post-it® note was given a score based on its quadrant and whether it was identified as a priority driver:

Priority Driver	5
Important & Certain (Prioritise)	3
Important & Uncertain (Scenario plan)	2
Unimportant & Uncertain (Track)	1
Unimportant & Certain (Park)	0

For Post-it®s notes that had been positioned on the border, an average was taken, e.g. a driver on the line between Park-Track would be given a score of 0.5. Scores of the different groups were summed and averaged for each cluster. For the priority drivers and high scoring themes, additional narrative is presented in the results section.

4. Results

PESTLE Drivers Identified (not prioritised)

Step 2 produced in excess of 250 PESTLE drivers, although many had recurring topics and trends. Where topics overlapped the PESTLE groupings, they were grouped to the most prevalent occurrence, unless a specific additional point was being made.

Political

The main theme that emerged related to EU-exit.

EU-exit

Overall, EU–exit is seen to provide a potential cost increase and an increased security risk for ensuring the safety and quality of our food, as access to key resources. Lack of access to the European Food Safety Authority (EFSA) risk assessment data and food standards database, and the reduced ability of the UK to influence emerging EU standards were major considerations behind this concern.

New trade deals allowing import and export of products with different legislation may require new tests and standards. Use of treatments and technologies not currently allowed in the EU e.g. GMO in imported products, may require testing. These potential changes in patterns of trade/foods imported post EU exit could mean a requirement for increased import controls (especially if from third countries), though it is not known at what level and whether there will be an impact on laboratory capacity.

Different tariffs will become a driver for origin fraud, compounded by the reduced accessibility of origin information and loss of EU protected designation for food produced in the UK (e.g. clotted cream) may cause an increase in adulterated or fraudulent products. In order to overcome this, greater international collaboration will be required.

Economic

Overlapping with political drivers were government budget cuts. Additional economic drivers included potential effects of an economic downturn, globalisation and the economic benefits resulting from more healthy ageing. Economic effects of environmental factors such as changes in energy sources and recycling practices were also highlighted.

Economic downturn:
Some participants feared further 'austerity' measures resulting from any economic downturn may impact enforcement further, through reduced funding for Port Health Authority, Trading Standards and Public Analysts (PA) roles. Then the question of "how will safety & quality be policed and what will 'referee' function mean then?" was posed.

Associated with any downturn was a predicted increase in the cost of foods and the added potential incentive to adulterate food. Any associated 'race to the bottom' on commodity pricing may generate a reliance on 'up-labelling' premium food products.

Public health
For healthy ageing (growing ageing population), nutritional considerations were considered to become increasingly important, as preventative measures to reduce the healthcare burden.

Globalisation
Local economics are seen to be influenced by the food culture of incoming nationalities.

Energy
As we change from fossil fuel to clean/new energy sources, how will this affect food prices?

Sustainable packaging
How will HM Treasury know that plastic is >30% recycled, if businesses are not going to pay plastic tax?

Social

This was by far the section with the largest number of drivers listed, with details on the latest food trends in terms of what and how food consumers are buying, as well as consumer concerns and expectations, and how many of these are driven by changes in how we access information.

Food trends

Consumers still want to try more different foods, such as exotic meats, novel foods and trendy spirits, but the question was asked "Do they always contain the ingredients/botanicals they claim?" The continued growth of online market places is also thought to be further expanding the sources and variety of food available to consumers. This is also perceived to extend to the children's food market, e.g. with gastro/hipster meals becoming available for infants. In addition, inward migration is leading to changes in food that is retailed and consumed.

Healthy living was observed as a significant trend with the decrease in fat-, sugar- and carbohydrate-based foods, as well as alcohol consumption. This, combined with both environment and welfare concerns, has resulted in growth in veganism and vegetarianism, which in turn has driven an increase in certain product types, e.g. vegan protein alternatives, so raising potential for vegan food integrity scares. This change in people's dietary preferences from less traditionally farmed meat, to more plant based foods & feeds, is also driving emerging initiatives such as alternative protein sources (fungi, insects, algae) and laboratory grown meat. It was also thought that there is a driver for an increase in fortified foods and food supplements, as diets change. However, there were concerns that emerging crops/products (e.g. cricket flour) may lead to novel mycotoxins being present.

Personalised nutrition was also seen as an emerging trend. Concerns were raised as to validation and data protection in such a case. An additional emerging trend that was noted related to fasting and targeted new supplements to kill senescent cells. Such new foods or new production methods may require new technologies for emerging pathogens and viruses, or residual food processing aids, cells or enzymes.

There was also a perceived issue with increased presence of plant-based foods on the market place and the issue of any associated psychoactive substances (so called legal highs).

Food purchase/delivery mechanisms

Increasing food security/sustainability concerns and associated legal responsibilities were raised, especially relating to increase in food fraud in a global market, heightened by the proliferation of online shopping, which makes traceability, international enforcement and monitoring difficult. One specific area of concern in this regard was the purchase of food supplements.

There were also concerns from participants that online delivery via robots (selecting products) meant there may not be a supermarket team checking product quality prior to it reaching the consumer. In addition, app-based restaurant intermediate delivery mechanisms are thought to potentially increase risk of allergic reactions, should customers not be able to enquire directly about ingredients.

Consumer concerns

Allergens are perceived to continue to be an issue as intolerances increase amongst UK consumers. Increased focus on allergens has resulted in a growth in 'free-from' foods.

Nano-technology is thought to be a consumer and government concern (currently big issue in France), with social issues on labelling and their measurement being very challenging.

Genetically modified organisms (GMOs) are still considered a consumer fear; however if there was a change in public perception and changed legislation, it could lead to the potential release of gene editing technologies for the development of novel foods.

There is still thought to be a strong anti-science movement which is fanning the increase in 'chemical free' products, with organic foods being a staple of this market place, but is authenticity testing possible?

Rising Consumer Expectations

Workshop participants reported increased consumer awareness and complaints, as consumers expect products to be '100% perfect', with greater awareness driven by social media.

In terms of food labelling, it is expected that consumers will want more information. Increasing consumer awareness of the Government Chemist programme could mean the programme potentially receives more complaints directly from the public about products people have purchased.

Consumer Information

Consumers are using social media as a tool for research, which is a change of behaviour; however this often can be a source of misinformation - public perception/myths versus facts.

Although social media is spreading news/info very quickly, it is still thought that there is a distrust of experts and a proliferation of fake news stories to gain readership. Public understanding of food authenticity and manufacturer claims has increased, as has their understanding of the use of chemicals in/on food. There is a perception that this in turn has driven visibility and openness expected by the public from food manufacturers. NGO pressure from public opinion/campaigns can drive consumer choices but it is not always based on scientific facts. Effective knowledge management across different platforms has also opened up new ways of communicating and sourcing data, e.g. calorie counting apps.

Technical

Participants expressed the general opinion that the development of, and access to, new technology and methods of analysis needs to be a feature in the future programme; one that is affordable for industry to duplicate and suitable for real day-to-day use and one able to provide a rapid response to emerging issues. Participants felt that there would be an increased demand for dispute resolution-capacity issues.

POT/Rapid/Non-targeted

Stakeholders expressed the need for rapid, non-targeted, point of test screening methods for officials and food business operators (FBOs), to improve testing and that this would help manage any changes in logistics that could impact on border checks. Specific requirements are required for easy, cost effective, multi-species authenticity and multi-allergen methods. There is also thought to be an increasing potential for these types of technologies to enable the consumer to act as the analyst, especially in light of the falling cost of electronics (image analysis), with some predicting that mobile DNA tester kits for foods may become a reality. However, this would require strong guidance and validation, as effective sampling, and reliability of test and sample size/suitability, as tests become miniaturised, could become a problem.

Emerging technologies

Another trend that emerged was a lack of trust by the food industry in data-rich emerging technologies e.g. digital polymerase chain reaction (dPCR), next generation sequencing (NGS) and nuclear magnetic resonance (NMR) applied to food authenticity, especially if these are seen solely as 'black box' technologies. This highlighted the increasing need for more validation, analyst training and continuing professional development skills, along with the maintenance of databases they access (in some cases). A growth in Proficiency Testing schemes for techniques such as NGS was seen as a route to overcome these concerns.

Improved Limits of Detection (LODs)

Improvement in sensitivity of instruments also means that there can be enhanced 'zero tolerance' on 'banned' substances, though defining what 'not present' means for LODs is considered an issue, especially when different LODs and limits of quantitation (LOQs) are established by different laboratories.

Manufacturer's requirements

Production facilities use in-line/at-line technologies to monitor critical components; a comparison of results generated in-line/at-line with those from laboratory-based instruments would be beneficial.

Data

Issues highlighted by participants can be broken down into two components, databases and artificial intelligence (AI), with concerns detailed below:

Databases:

- ownership
- management and curation
- inconsistency in current platforms
- access (open)
- introduction of block chain technology
- not enough authenticity data
- how to verify and validate the reference set
- how to challenge with an orthogonal technique
- provenance

AI (machine learning) will emerge for trade data analysis and will take a big data approach. This will require much broader multi-disciplinary working to solve global issues.

Specific Measurement Issues

Other specific technical concerns raised by workshop participants:

- cross reactivity issues with allergen testing
- guidance on reporting of allergen results
- origin determination
- Food and Veterinary Office (FVO) Audits-Animal feed testing
- residues over the maximum residue level (MRLs)
- genetic sequencing of fish.
- growth in sensory/texture claims to differentiate products but no methods to substantiate
- detection of increasing adulteration of plant products, especially extracts
- a growing need for analytical methodologies for contaminants as maximum levels are being set for some analytes with no defined methods laid down.

Legal

There is a general concern that, on the one hand, testing methods cannot keep up with legislative requirements and likewise there is a need to ensure regulation is informed by effective, reliable, reproducible and affordable test methods. On the other hand, legislation can lag behind developing technologies and it does not always set appropriate threshold levels.

EU-exit

As highlighted earlier, the unknown impact of post EU-exit legislation on UK law and how this relates to international trade deals was a concern for participants with respect to importing and

exporting foods. This was thought especially to be a challenge for managing 'borderline' product claims and health claims as the UK potentially diverges from EU framework law. However, there was a perceived opportunity for limits based on UK population risk assessments.

Supply chain integrity and scrutiny

Different / new types of food fraud identified through investigative activities of National Food Crime Unit (NFCU). Impact of changes made to the delivery of food law enforcement by FSA.

Proposition 65

There are broader consumer concerns about certain products following recent changes to the California Proposition 65 US, officially known as the Safe Drinking Water and Toxic Enforcement Act, which requires an increased number of ingredients to be listed with their full chemical name and a warning symbol if they are known by the state of California to cause cancer or reproductive toxicity. One example to be added to the amended list in 2018 as a carcinogen, is furfuryl alcohol; created naturally as a result of the process of heating sugar to create a caramel colour. It is often used in caramel, coffee, cola, root beer, and maple-flavoured drinks.

Environment

Sustainable and reduced packaging (also social and technological drivers)

As the amount of recycled materials used increases, this may in turn make food contact materials a bigger issue in establishing methods to determine the potential toxicity of recyclate used.

Growth in novel packaging materials and the potential for edible packaging e.g. seaweed spheres was raised as an issue, and whether these could become the next 'jelly cups' in terms of a choking hazard.

Packaging reduction also causes many hygiene and allergen management challenges, as well as increased food waste, as there is a difference between shelf life and open shelf life. Focus on plastics may lead to more on-pack claims, which need to be authenticated.

Recycling

How can recycling be used to minimise and control impact, e.g. lithium from batteries or hydrochlorofluorocarbons (HCFCs)? How do we establish waste-integrity?

Pollution

Many specific concerns were raised, these have been listed below:

> Air and water pollution:
> - small particles - plastic microspheres but what else? What is the by-product of bio-fragmentation and at what point are they safe? Also, what are the critical waste streams? how do they need regulating? micro plastics

- air quality in cities/towns: -what pollutants are important to monitor? How much/how safe? -fugitive emissions
- purity of bottled water
- environmental drift (pesticides)
- accidental spread of GM crops and impact on compliance with GM laws
- decline in insect populations.

Climate change

Changing climate or change of weather patterns will result in reduced crops and increase in food prices, leading to likely fraud increases. It may also drive the introduction of new ingredients/varieties, e.g. drought resistant crops, which, in turn, may lead to the occurrence of new mycotoxins and food allergies. In addition, the warming of the seas may lead to new/more marine toxins. Climate change could lead to the prevalence of new pests that may require new pesticides to be applied to crops, which will need to be tested.

Environmental targets will drive to shortened supply chains (fewer food miles) and pressure on producing home-grown ingredients, which could affect consumers' choice.

Ethical Claims

How do we establish if food sustainability ethical claims/organic claims/environmental claims are genuine?

Reduced Natural Resources

Participants thought that there will be increasing pressure on food production causing soil depletion, increased land use, intensive farming and water shortage. "Do we have a long term plan for water, land, food and feed especially considering population migration and increasing global population?"

A specific concern for carrying out testing is the global depletion of inert gases making sourcing of gases required for laboratories an issue, e.g. Argon and Helium.

PESTLE Driver Mapping

The 250+ PESTLE drivers produced in step 2 were collated into 94 drivers for prioritisation in Step 3. The details of these, presented as a ranked list, are included in Appendix 1. Appendix 2 lists the details of the top four priority drivers by group. The ten drivers that scored highest are listed below along with narrative from discussions captured at the workshop. Where drivers are similar, these have been grouped.

1. **Alternative packaging materials** (Environmental & Social): Moving away from traditional plastics, as well as an increase in recycled materials, may in turn make food contact materials a bigger issue, especially as more recyclate is used. Plastic tax is out for consultation and the plastic waste debate doesn't take into account the constraints on food packaging/storage/distribution. There is a lot of social pressure on this issue, could this lead to decreased shelf life/more food waste? There is a perception among public/media that there are many solutions out there, which are almost ready for the market. Concern that this enthusiasm could undermine regulatory stringency. Unlikely to have a solution in the next 5-10 years. Businesses will want to innovate, therefore, there needs to be a 'go-to' place for innovators in this field to check regulations etc.

2. **Consumer as the analyst.** Food scares have driven the introduction of home testing (analysis using smart phones), which in the future could be uploaded onto public cloud databases. However, this requires proper validation and guidance. Point of test (POT)/Rapid/Non-targeted testing is also on the increase. There is particular concern about allergens testing and the use of such technologies especially on two main issues:

   • verification of the test

   • how do you sample effectively?

   How can we help people make good decisions? We need to demonstrate what constitutes good technology and help people understand the accuracy of the test they are performing. Just because the device gives you a certain result doesn't mean that it's correct. (Social & Technological)

3. Cross reactivity issues with **allergen testing** (Technological).

4. Food security and sustainability **increase in food fraud in a global market.** Increasing online shopping, which makes traceability and international enforcement and monitoring difficult due to potential impact on where responsibility lies. An economic downturn and increase in cost of food would also be an increased incentive to adulterate food. There will also potentially be a race to bottom on 'commodity' pricing, generating a reliance on 'up-labelling' premium food products. (Economic)

5. **Lack of trust in emerging technologies** e.g. NMR, dPCR and NGS, especially if these are seen as 'black box' technologies. This also highlighted the increasing need for more complex/expensive analyses and sustainability/funding to include the cost of validation, analyst training & continued professional development skills as well as the maintenance of database they access (in some cases). It was a concern that there is a move to NGS testing for everything. It was suggested that there could be PT schemes for NGS to assess the performance of laboratories. (Technological)

6. **Lack of skills in government regulators**. (Political, Economic & Technical) Depleted resource and skills in official control laboratories. Analyst training and Continuous Professional Development (CPD) needs to be improved. Participants observed that graduates tend to struggle with:

   - translating what they have done at university into day-to-day applications
   - problem solving
   - routine tasks – pipetting, how to set up instruments for themselves etc.

   Good analysts tend to move on, they don't stay in a laboratory based role forever. Plymouth University is an example of good practice in applying skills to practical scenarios.

7. **Databases (Technological):** A big issue with trust in the current database content, with inconsistency in current platforms. Effectively there is a provenance and traceability issue because the database is your reference point. However, curation is not always rigorous enough in terms of how to verify and validate the reference set and how to challenge with an orthogonal technique. Questions were raised over the boundaries on ownership, management, curation and use of databases, which were thought in general, should be open access. However, on the whole, private companies won't want to share their data. Difficult to determine what government's role is in establishing databases should be. In addition, the explicability of algorithmic decisions/machine learning/AI implications is something for the Government Chemist to consider, as it is emerging for trade data analysis, taking a big data approach (also potentially accessing databases). This will require much broader multi-disciplinary working to solve global issues. However, if taken solely as a 'black box' approach there will be an inability to explain findings.

8. **Economy shrinking**: If there is an economic downturn, **further 'austerity'** may impact on enforcement. The concern is that there will be no/reduced funding for Port Health Authority, Trading Standards and Public Analyst roles and therefore, participants asked "how is safety and quality policed and what will 'reference' function mean then?". There is already a continuing decrease in the number of samples taken by local authorities (LAs)

as their funding has been reduced, which in turn is diminishing capability of the PA service available across the UK to Local Authorities and capability to keep pace with scientific development. (Economic & Political).

9. Improvement in sensitivity of instruments also means that there can be enhanced '**zero tolerance' measurements made for 'banned' substances**. Defining what 'not present' means for LODs is still considered an issue, especially in establishing differences in LODs and LOQ between laboratories. (Technological).

10. **Ethical Claims** Food sustainability-ethic claims/organic claims/environmental claims, how do we establish if they are genuine?

APPENDIX 1

Rank	Driver	TOTAL SCORE
1	*Alternative packaging materials – away from plastics (S)	20
2	Consumer as the analyst. POU/Rapid/Non-targeted testing. Point of test. (T)	17
3	Cross reactivity issues with allergen testing (T)	16
4	Food security/sustainability- increase in food fraud in a global market (S)	16
5	Lack of trust in emerging technologies e.g. NMR, dPCR. NGS testing for everything. (T)	16
6	*Will food contact materials become a bigger issue as more recyclate is used? (En)	15.5
7	**Analyst training & CPD – skills(T)	15
8	Databases: -ownership –inconsistency –management -access (open) -curation-block chain tech -harmonisation (T)	15
9	***Further 'austerity' impacts on enforcement. No Public Analyst Roles-how is safety quality maintained. Funding for enforcement- Port Health, Trading Standards, Public Analysts. (Ec)	14.5
10	**Lack of skills in government regulators. Depleted resource and skills in official control labs. (P)	14.5
11	Improvement in sensitivity of instruments- zero tolerance on 'banned' substances. What does 'not present' mean for LODs (T)	13
12	*Waste reduction – packaging/recycling Contaminant reduction (also socially driven)(Ec/S)	13
13	***Financial resource- govt cutbacks (P)	12.5
14	Food sustainability-ethic claims/organic claims/environmental claims. Are they genuine? (En)	12.5
15	Point of use tests:-validation &-guidance (T)	12.5
16	Data: -authenticity/validation, quality, provenance, AI (machine learning), trade data analysis (T)	12
17	Nano-technology: -Consumer concerns, - Govt concerns (currently big issue in France), - social issues on labelling (S)	12
18	EFSA risk assessment may be lost (P)	11.5
19	NGS-testing: good practice in sampling & analysis (T)	11
20	Allergens: Continue to be an issue as intolerances increase (S)	10.5
21	Exotic meat (S)	10.5
22	Looking at genetic sequencing of fish (T)	10.5
23	Organic foods – authenticity? Is testing possible? (T)	10.5
24	As 'edible packaging' (e.g. seaweed spheres) are developed, will they become the next 'jelly cups' ? (Env)	10
25	Change in consumer habits- increase in Veganism and Vegetarianism driving initiatives such as lab meat. (S)	10
26	Development of and access to new tech (T)	10
27	Effective sampling – wherever! (T)	10

28	Emerging crops (cricket flour) may lead to novel mycotoxins (T)	10
29	Food waste, shelf life and open shelf life (En)	10
30	Global population increasing. Depleted feedstocks. (Ec)	10
31	Lack of protein globally. Insect derived protein. Meat substitutes (cell grown food). (T)	10
32	Online shopping: international enforcement and monitoring (e.g. supplements) (S)	10
33	Free-from foods (S)	9.5
34	Air pollution: -Small particles -plastic microspheres but what else?-what is the by-product of bio fragmentation & at what point is something safe? (En)	9
35	Climate change: Environmental drift (pesticides) (En)	9
36	Impact of post Brexit legislation on UK law and how this relates to international trade deals with respect to importing and exporting foods (L)	9
37	Increase cost of foods with EU exit – incentive to adulterate (Ec)	9
38	Increasing pressure on food production: -soil depletion -pressure on land -intensive farming -water shortage (En)	9
39	Population growth (Ec)	9
40	Developments in analysis methodology – affordable for industry to duplicate and make 'real' day-to-day (T)	8.5
41	Food processing aids - enzymes (T)	8.5
42	Air quality in cities/towns: -what pollutants? How much/how safe? -fugitive emissions	8
43	Antibiotics and added water in imported products post-EU exit (T)	8
44	Artificial Intelligence. Big data. Multi-disciplinary working to solve global issues. (T)	8
45	Change in public perception in that GMO becomes acceptable-legislation changes, which in turn leads to the release of gene editing technologies for the development of novel foods (S)	8
46	Changing climate- food prices increase, fraud increases. Climate change-effect on mycotoxin occurrence. (En)	8
47	Climate change – methodology issues e.g. measure car emissions, drivers based on emissions rather than car age. How to create planetary stewardship (En)	8
48	Food retail economics: Race to bottom on 'commodity' pricing- reliance on 'up-labelling' premium products (Ec)	8
49	Social driver of 'No Chemicals' (S)	8
50	Transport/agri emissions (En)	8
51	Emergence of new allergens of importance to UK consumers (S)	7.5
52	Continuing economic downturn-less testing so adulteration increases (Ec)	7
53	Global connectivity EU exit (S)	7
54	Managing 'Borderline' product claims. Health claims reviewed-UK specific law? Diverges from EU framework law? (L)	7
55	Natural chemical –precursors -stacking of levels (En)	7
56	New food purchasing mechanisms e.g. Deliveroo increase risk of allergic reactions (S)	7
57	Online delivery via robots – no supermarket quality team (Ec)	7

58	Government Review/Implementation e.g. Sampling at Local Authority level. (P)	6.5
59	Change in consumer habits of fasting and new supplements to kill senescent cells (S)	6
60	Changes in global supply chains - harder to do traceability (Ec)	6
61	Focus on plastics leads to more on-pack claims – need to authenticate (En)	6
62	Food and Veterinary Office (FVO) Audits-Animal feed testing. (T)	6
63	Growth in sensory/texture claims to differentiate products – but no methods to substantiate (T)	6
64	Migration leading to changes in common food retailed and consumed (S)	6
65	Personalised nutrition: Validation of approach & data protection (S)	6
66	Detection of increasing adulteration of plant products, especially extracts (T)	5.5
67	Accidental spread of GM crops and impact on compliance with GM laws (En)	5
68	Changing production methods (En)	5
69	Commercialisation of tests (T)	5
70	Distributed foods – direct to door sales (Ec)	5
71	Environmental targets shorten supply chains (fewer food miles) so pressure on home-grown ingredients (En)	5
72	Impact of changes made to the delivery of food law enforcement by FSA (L)	5
73	Impact of eating more plant-based foods (En)	5
74	Heath of the nation: drive on healthy foods, tax on unhealthy (P)	4
75	How will HM Treasury know that plastic is >30% recycled if businesses are not going to pay plastic tax? (Ec)	4
76	Prop 65 – US (California) chemicals regs. (T) Proposition 65, officially known as the Safe Drinking Water and Toxic Enforcement Act of 1986, was enacted as a ballot initiative in November 1986. The proposition protects the state's drinking water sources from being contaminated with chemicals known to cause cancer, birth defects or other reproductive harm	3.5
77	Argon, lack of He etc.- Inert gases required in lab (En)	3
78	Health drivers being dictated by Government to reduce health cost burden (P)	3
79	National vs local regulation/control (P)	3
80	Nationalism/ nationalist agendas (P)	3
81	Infant food: Trend to 'gastro' and hipster meals for infants (S)	2.5
82	Consumer awareness of LGC – potentially more complaints from public about products people have purchased. (S)	2
83	Consumer expectation: 100% perfect (S)	2
84	Food labelling: consumers will want and expect more info (S)	2
85	For healthy ageing (growing ageing population), nutritional considerations as preventative measures become increasingly important (Ec)	2
86	Increase in fortified foods (S)	2
87	legal highs (S)	2
88	Noise pollution: How to regulate/measure What's the noise equivalent of a breathalyser? (S)	2
89	Social media as a tool for research, change of behaviours and misinformation. (S)	2

90	Trendy spirits – do they contain the botanicals they claim ? (T)	1.5
91	Public perception & education on facts (not myths!) (S)	1
92	Public understanding of food authenticity & manufacturer claims (S)	1
93	Purity of bottled water (En)	1
94	Anti-vaccination movement (S)	0

Table 1. Drivers ranked by score in the prioritisation exercise () indicating if political (P), economic (Ec), societal (S), technological (T), legislative (L) and environmental (En).

APPENDIX 2

The Top 4 Priority drivers by Group

Group 1 (Yellow)

- *Packaging/contact materials*
- *Food security/sustainability*
- *Skills*
- *Consumer as analyst/POU.*

Group 2 (Red)

- *Skills/lack of resources*
- *Authenticity*
- *POU*
- *packaging/contact materials.*

Group 3 (Green)

- *Databases*
- *Food security/sustainability*
- *packaging/contact materials/waste reduction.*

Group 4 (Blue)

- *Consumer as analyst/POU*
- *Protein: insect-derived, meat substitutes, etc.*
- *Climate change – price increases & more fraud*
- *Databases/AI/Big Data.*