High Value Biorenewables in personal care: challenges and solutions

11 July 2023

REPORT

Index

Introduction

The workshop's objective was to identify challenges and possible solutions towards developing sustainable, high value, biobased ingredients for use in the personal care industry. The workshop comprised a series of talks highlighting the need for solutions in this sector, followed by presentations on new innovations and finally highlights of services and facilities available. These talks were followed by focussed round table discussions to explore opportunities for research and innovation, infrastructure and support services (including regulation and policy) before finally asking delegates to consider the scope of a potential new working group.

The programme of talks started with a session on the need for more sustainable personal care solutions with talks from industry, a policy review, and an analysis of a defined regional landscape. Surinder Chahal described how Croda is addressing the increasing demand for sustainable products through using existing assets combined with collaboration and investment. Croda has acquired a number of specialist biotechnology companies in recent years, most recently Solus, a global leader in premium, biotechnology-derived active ingredients for beauty care and pharmaceuticals. This approach was also voiced by Fabien Deswarte from L'Oreal who urged the sector to work together through partnerships and collaborations. Policy fellow, Joanna Sparks, briefed delegates on how policy and regulation is needed to ensure novel products and feedstocks are sustainable as well as safe. Anna Alessi closed the session with an overview of the personal care ecosystem in Yorkshire as an exemplar of a broad and diverse set of stakeholders with potential to reduce the carbon footprint of personal care by working together, illustrated below (Figure 1).

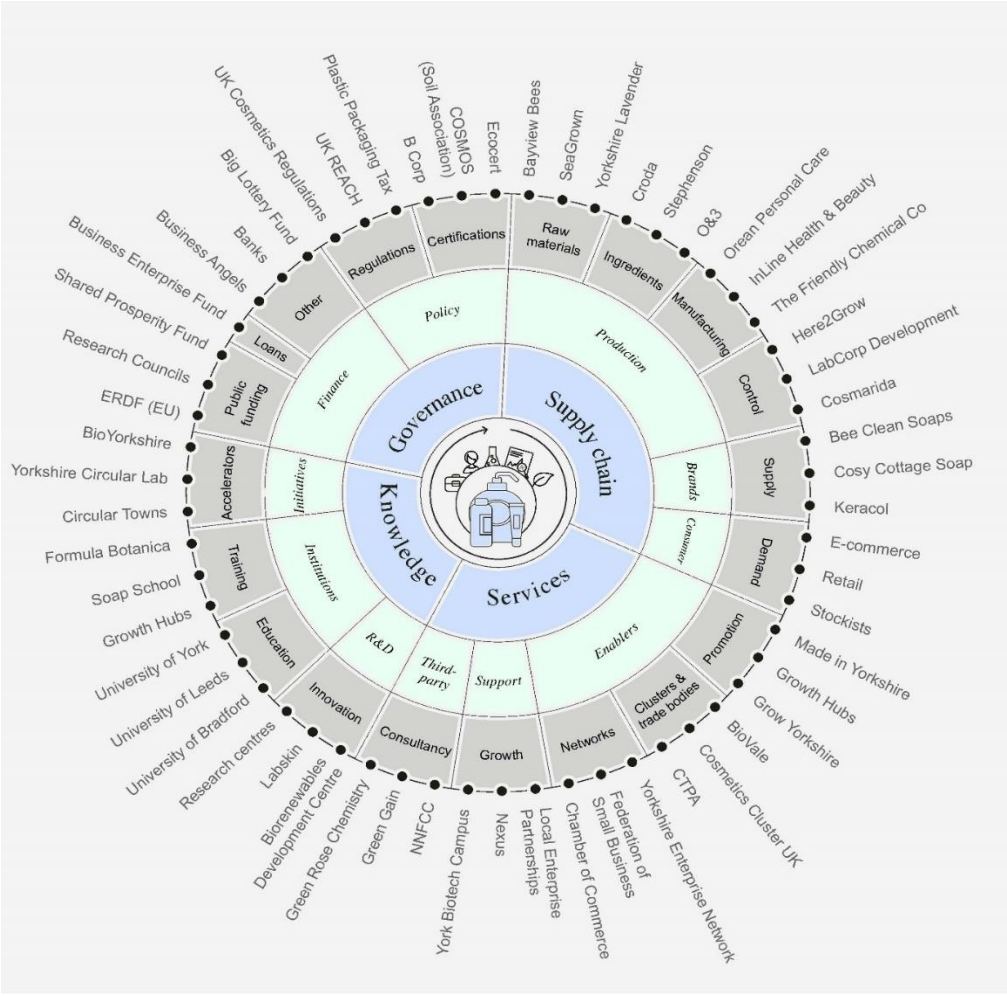


Figure 1. The circular personal care ecosystem for Yorkshire (Alessi, 2023)[1]

The next session focussed on personal care innovations, starting with Dale McLure from Brunel University who described how algae can be used to produce pigments, lipids and polysaccharides. Kyle Stewart followed with an update on the exciting progress being made to develop biobased skin care products at Watercress Research Ltd. Their watercress extracts have potential to reduce skin damage in incontinence products by inhibiting urease and scavenging the free ammonia from urine. Martin Challand then explained Zentraxa's process for producing and extracting high performance personal

[1] Source: The Circular Personal Care Ecosystem for Yorkshire, Jan 2023, Dr Anna Alessi, AHRC Design Ecosystem Future Observatory Fellow

care ingredients using synthetic biology. Their method for isolating products simplifies downstream processing, enabling lead candidates to be selected avoiding extraction issues at scale.

The final set of talks covered a diverse range of facilities and services available for the sector. Ray Marriott described the vast automated horticultural facilities and downstream extraction and processing technologies at Bridge Farm Bioscience that are available for collaborations to develop novel personal care molecules. Jude Huggan explained the services available at NCIMB, which houses a culture collection of over 10,000 microbial strains. Next, Olusola Idowu revealed how HexisLab is using AI to identify biobased molecules with desired functional properties for personal care products. Finally, Tarl Prow described some of the projects at the Skin Research Centre (HYMS, University of York) including microtechnology for topical drug delivery and skin sampling.

The talks were followed with focussed group discussion in which participants were asked to work in teams of 8 to consider targets for research and innovation, UK infrastructure, and regulatory and policy matters, and finally to suggest ideas to initiate a working group for biobased personal care solutions. The outcomes of the discussion are summarised below.

Research & Innovation

Participants were asked to focus on the main opportunities and drivers for industrial biotechnology research and innovation in the personal care sector.

Biotechnology provides an opportunity to develop sustainable replacements for common petrochemical-derived ingredients in the personal care industry, which the sector is eager to explore for solutions to reduce its carbon footprint. Drop-in chemicals can be made by fermentation and bioprocessing, as well as innovative biobased molecules with functionality to improve product performance. In short, biotechnology can resolve challenges that chemistry alone cannot. There is also a market pull from customers who are willing to pay a ‘green premium’ as long as the product function is not compromised. Using premium products for market entry, along with other areas of personal and home care to increase market volume, provides a robust business case for developing a biobased product.

It is important to establish what key compounds need to be replaced so that research efforts and funding can be focussed on addressing the biggest problems. Prior to the event, Croda listed these as: biosurfactants, fragrances, polymers and proteins. Delegates suggested that novel preservatives to prolong shelf life and reduce potential wastage are also needed to replace existing chemicals that no longer pass regulatory requirements or consumer acceptance. UV actives and rheology modifiers (that control how products flow) were also identified as ingredients requiring biobased alternatives.

Downstream processing and process intensification remain challenging. One possible solution could be modular manufacturing systems that may offer benefits in shorter supply chains and more responsive and flexible production that can be adapted according to demand. These smaller, local manufacturing units might also be able to upcycle waste streams from agriculture or food for added benefit.

Advanced technologies for personal care products include use of AI and machine learning to predict the function of novel ingredients for formulation and using microbial inclusion bodies to separate products within a mixture. Skin microbiome screening offers a novel approach to product development and understanding the net effect on the skin's microflora. Meanwhile, social research is needed to understand whether these innovations will be accepted by consumers and guide product development.

Knowledge exchange of research and innovation is essential to maximise its impact and benefit to society. Establishing collaborations via workshops and funding collaborations between academics and industry is key to solve industry challenges. This indicates the valuable role the Networks in Industrial Biotechnology and Bioenergy play in supporting the sector.

UK Infrastructure

Scale-up and pilot scale facilities are essential for innovations to reach the marketplace. It was acknowledged that the 'BioPilots' (CPI, BDC, BEACON and IBioIC) provide open-access facilities for developing products along the technology readiness level towards commercialisation. It would be useful to map the UK infrastructure and supply chain capabilities and establish a centralised database to help innovators know who they can approach for essential services and equipment as they scale up. There may be opportunities to repurpose existing/out of use facilities for the requirements of biobased production. University lab facilities should be included in the mapping exercise and routes to maximise their use explored. Universities have an important role to play in innovation and it was noted that there are variable levels of commercialisation support from different institutions.

Funding to access scale up facilities would enable SMEs to perform proof of concept studies which can then attract investment. Product data packages are essential in attracting both investors and customers as well as meeting regulatory demands, and this is another area where a funding scheme to support access to accredited labs would be beneficial.

Building and operating specialist pilot scale and manufacturing facilities requires a skilled workforce with training in biotechnology. There is a perceived skills gap in the UK in biochemical engineering, fermentation, and downstream processing. A further mapping exercise to identify places to train at or recruit from was suggested; for example, IBioIC deliver training on fermentation and the National Horizons Centre run courses including downstream processing. There is an opportunity to address skills gaps by working with industry, for example through Knowledge Transfer Partnerships and collaborations like the Prosperity Partnerships and Industrial Cooperative Awards in Science & Technology funded doctoral studentships. Cross-industry training is needed to enable multidisciplinary teams to work better together, and this starts with undergraduate courses that should include relevant cross discipline training.

At a very high level, delegates commented that the UK National Infrastructure Investment Bank could provide a means of mobilising private sector investment and addressing key challenges including climate change and sustainability. As well as ensuring fiscal sustainability, the government owned bank would be required to measure and minimise carbon emissions associated with the bank's investments and operations.

Regulation

Regulations and standards for developing new personal care ingredients and products exist to ensure items are safe for consumers to use as well as addressing wider requirements including the impact on the environment during production and at the end of life.

There are a number of regulations that can intersect with the personal care sector, including (but not limited to) cosmetics, biocides, medical devices, waste, labelling, pharmaceuticals, REACH, Nagoya. This illustrates the potential complexity of bringing a new ingredient or product to market. Depending on which regulation is being addressed, new ingredients or products could be assessed for efficacy, chemical composition, toxicology and allergenicity, and stability. It is a very complex area and depending on the claims being made about how a product works, different regulations would need to be addressed, along with the associated costs.

For the cosmetics sector, there is a particular overlap between the medical and cosmetics regulations which can be confusing. Similarly, the framework of regulations governing 'waste' needs to evolve as technologies that derive products from waste feedstocks provide opportunities for more sustainable practices. It was also suggested by delegates that UK-REACH regulations could be more responsive to technological developments in a post-Brexit era, as has already been seen with the passing of the Genetic Technology (Precision Breeding) Act 2023 that will provide a route for products from gene edited crops to be authorised.

In suggesting any revisions to the regulatory process, it is important to work with policyholders and regulators to ensure regulations are fit for purpose and, importantly, remain relevant as technological advances are made. Equally, regulators need to keep abreast of technological advances and ensure regulations are updated to safely realise opportunities for more sustainable products. During the COVID pandemic we saw how regulators worked together with the pharmaceutical industry to expedite the urgent approval of the COVID vaccine. Addressing climate change by reducing our reliance on fossil fuel is an equally urgent mission and a similarly cooperative approach is needed. It would be encouraging for regulators to engage with the sector by attending network events or inviting industry experts to offer advice on novel technologies.

When setting regulations, it is important that terms by which products are described, and claims are made are understood by both technical experts and the public. Designating products as 'biobased' and clearly agreeing what that means would enable an incentive scheme such as the US 'biopreferred' initiative, which could incentivise the use of renewable resources and foster innovation in biobased product development. Carbon accounting may provide a method for evaluating sustainability credentials, but transparency is needed and the evaluation should cover all aspects of the product life cycle. Connecting consumer tax with a robust life cycle assessment (LCA) would be ideal but LCA is complex, costly and the standards and protocols must be developed and agreed upon.

Summary

Delegates were asked to prioritise their ideas for a final workshop summary slide - the main themes were related to infrastructure and regulatory matters (see Figure 2).

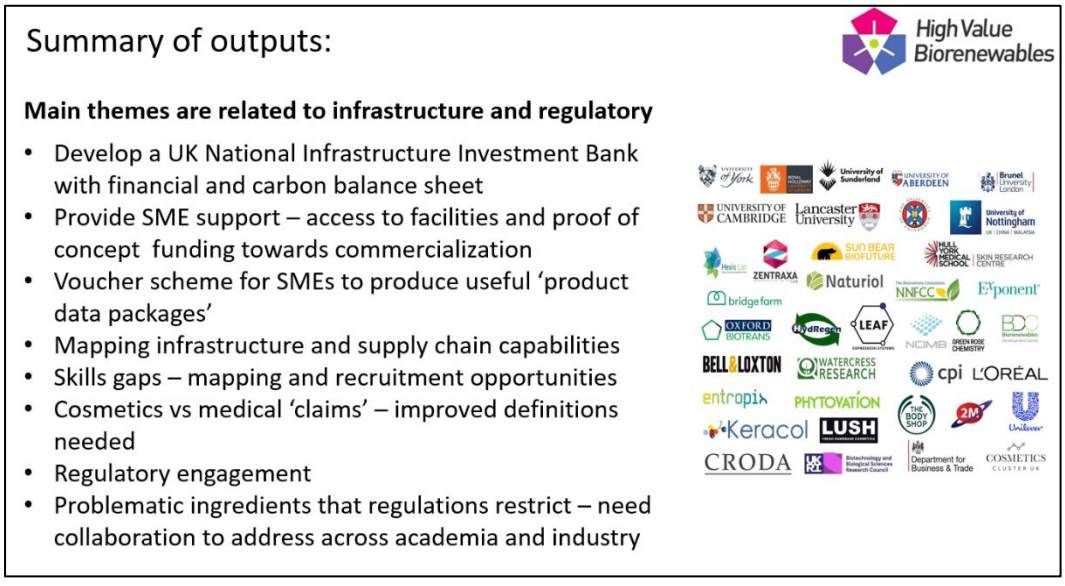


Figure 2 - key outputs from the workshop discussion groups

Future Working Group

Delegates were asked to consider a potential working group in the area of biotechnology and personal care as suggested by the Croda report - *Biotechnology: personal care market report*[2]. Discussions were focussed on terms of reference for such a group, including membership and scope.

In terms of group membership, our discussions identified the following stakeholders as potential participants in a working group:

- Industrial Biotechnology Leaders Forum (IBLF)
- UK Research and Innovation (UKRI)
- Scale up facility providers
- Environmental/ consumer groups
- Investors
- Primary producers
- Regulatory specialists

Existing networks, and their members could also participate in the group:

- Cosmetics Cluster UK (CCUK)
- Personal Care Products Council (PCPC)
- Industrial Biotechnology Innovation Centre (IBioIC)
- The Cosmetic, Toiletry and Perfumery Association (CTPA)
- High Value Biorenewables (HVB)

In order to engage with regulators and policymakers, the following governance bodies were suggested:

- Medicines and Healthcare products Regulatory Agency (MHRA)
- The Health and Safety Executive - Chemical Regulations Division (who are the body responsible for many of the regulations applicable to this sector)
- Defra - Nagoya
- BSI - standards/ metrics/ labelling

Due consideration should be given to making the working group unique - so it is not replicating the work of other groups. For example, the working group could be a valuable mechanism to increase the exposure of SMEs and innovators to key players in the sector.

The group could identify and support champions who bring together researchers and businesses working on similar methodologies or ingredients for a collaborative effort to achieve regulatory approval. This will help SMEs understand and navigate the complex process, while drawing strengths from across the consortium. For example, exploring a mechanism to clearly differentiate between a medical product and cosmetic would require a group of interested parties to provide the evidence and rationale to build a case for the governance bodies to consider and review.

In terms of scope, a key question that needs to be addressed in the development of sustainable personal care products is what are the problematic ingredients that need replacing? Suggestions include:

[2] https://www.croda.com/mediaassets/files/corporate/biotechnology-personal-care-market-report.pdf?la=en-GB

- biosurfactants
- fragrances
- polymers
- proteins
- preservatives
- UV actives
- rheology modifiers

The group should also consider skills gaps and advocate for training in specific areas such as microbiology, fermentation, biochemical engineering, and downstream processing. Further ideas included lobbying for funding for access to lab and scale-up facilities, organising events to pitch or promote ideas to larger companies, and coordinating efforts to map UK infrastructure pertinent to biotechnology supply chains.

This feedback is available for the personal care sector to establish a working group for sustainable personal care solutions. The HVB network continues to support the community with events and funding opportunities, including a business interaction voucher funding call focussed on personal care projects, launched as a follow up to the workshop.

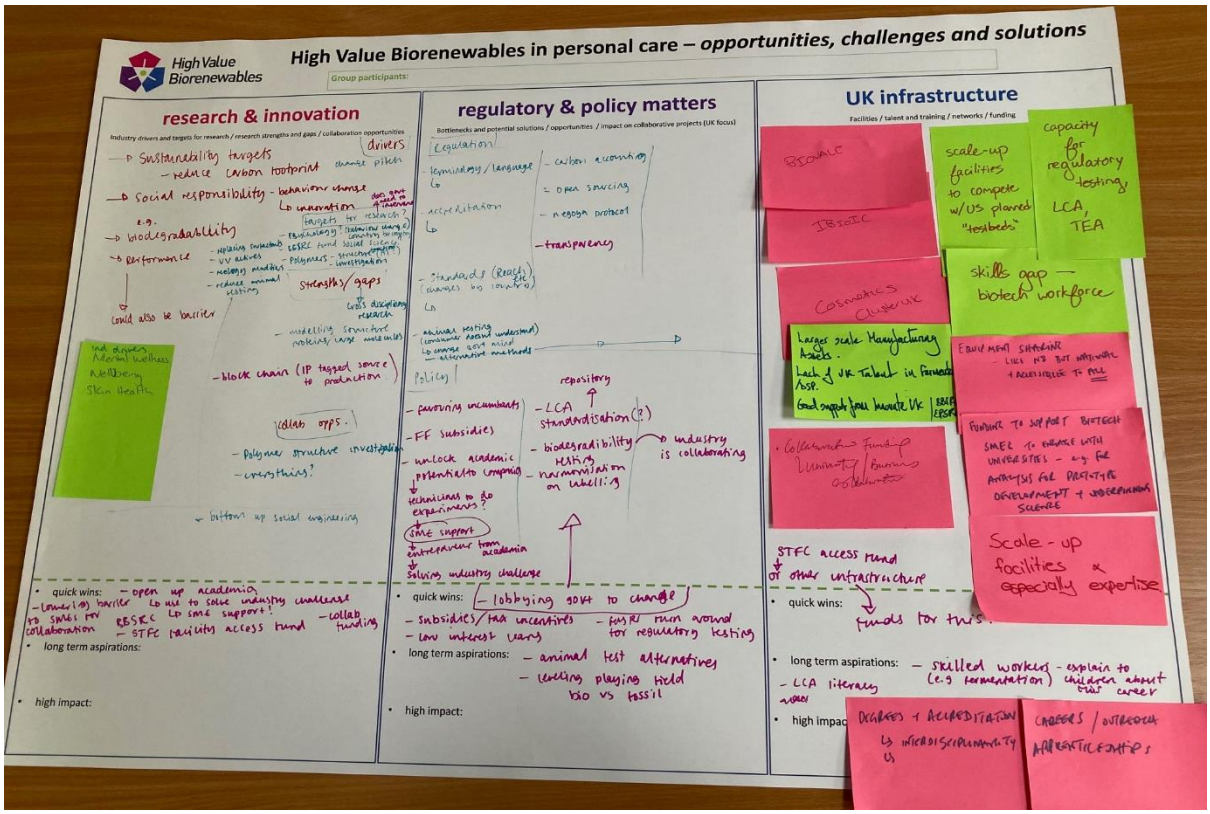
Appendices

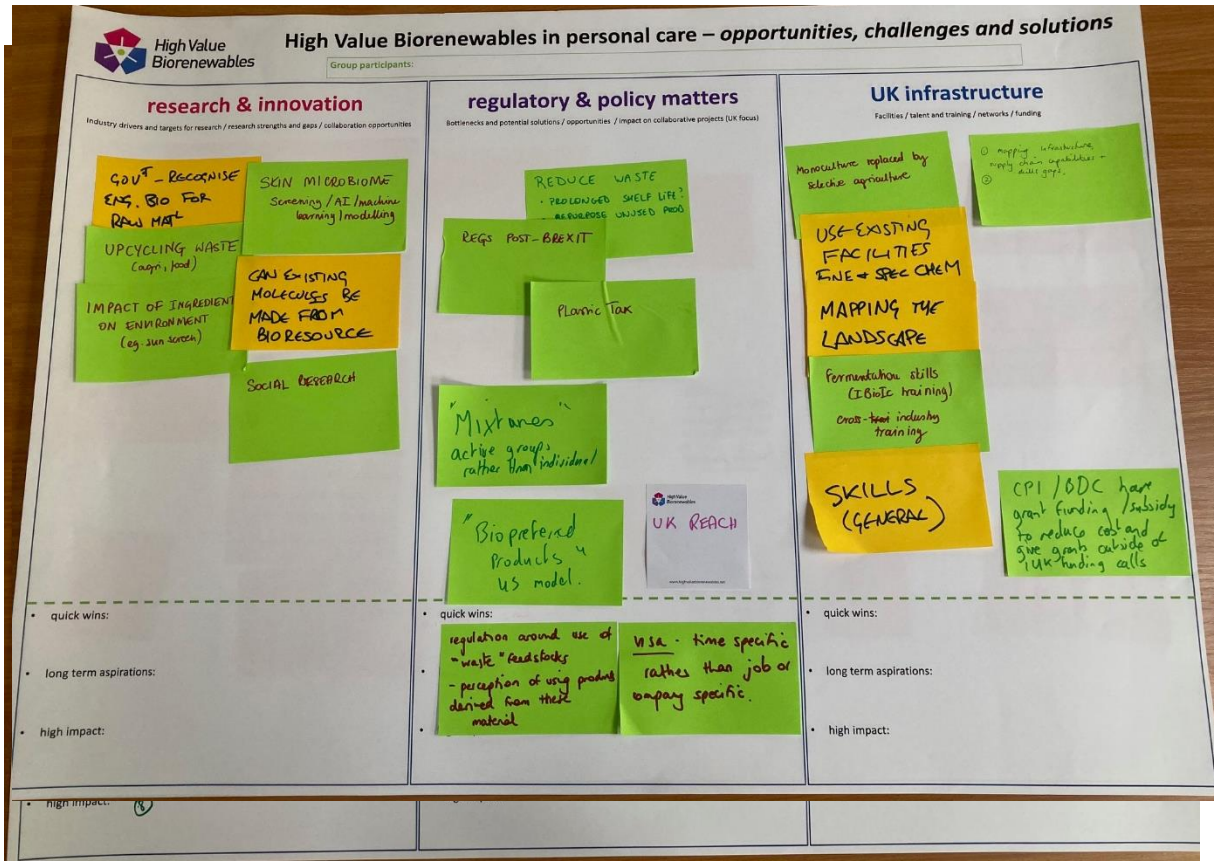
Appendix A: Participant List

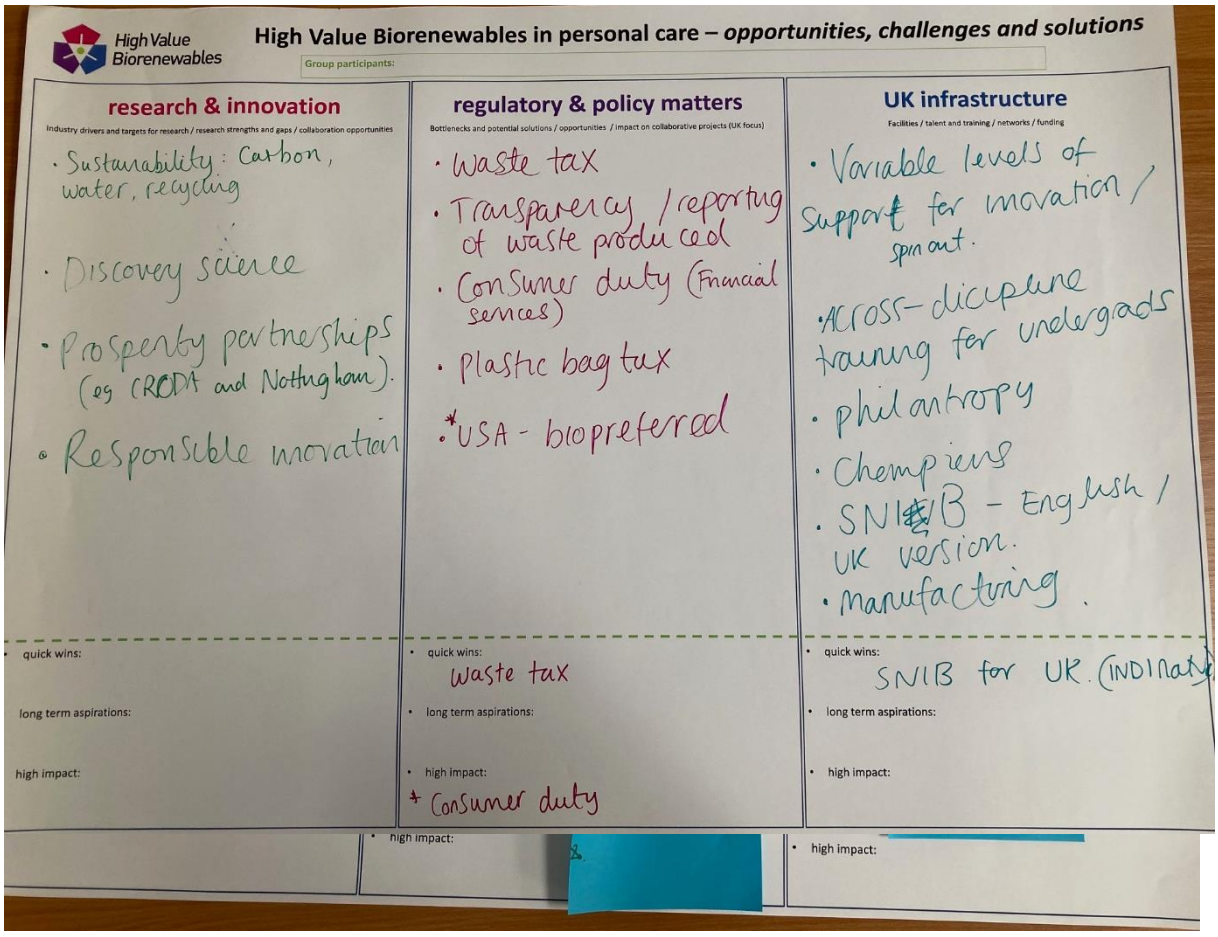
Many thanks to all the participants of the workshop who shared their expertise and contributed to the discussions.

Name	Affiliation
Anna Alessi	Biorenewables Development Centre
Andrew Beggin	Phytovation Ltd
Joe Bennett	Biorenewables Development Centre
Harriet Berry	Royal Holloway University of London
Sheila Batchelor	NCIMB
Dominic Campopiano	University of Edinburgh
Mark Carlile	University of Sunderland
Surinder Chahal	Croda
Martin Challand	Zentraxa
Yolande Cordeaux	University of Cambridge (Dept. Chemistry)
Tomasz Czechowski	University of York
Claire Fordyce	Exponent International
Alastair Gardner	Department for Business & Trade
Ian Graham	University of York
John Hardy	Lancaster University
Adrian Higson	NNFCC The Bioeconomy Consultants
Pendle Hill	Lush Fresh Hand Made Cosmetics
Matthew Hodges	Oxford Biotrans / HydRegen
Jude Huggan	NCIMB
Olusola Idowu	Hexis Lab
Mary Jenkinson-Finch	BBSRC
Adrian Jervis	Unilever
Andrew Jones	Fibra
Edward Jones	Naturiol Bangor Ltd
Gary Loake	University of Edinburgh
Peter Luebcke	Bell & Loxton Innovations Ltd
Ray Marriott	Bridge Farm Bioscience Ltd
Kirsty Mawhinney	Cosmetics Cluster UK
Dale McClure	Brunel University London
Timothy Miller	Croda Europe
Ross Overman	Leaf Expression Systems
Darren Phillips	Biorenewables Development Centre
Tarl Prow	Skin Research Centre, HYMS
Rob Rule	Entropix Ltd
Andrew Shearer	Bell and Loxton Innovations Limited
Parimala Shivaprasad	University of Nottingham
Richard Smith	2M Group Ltd
Katerina Steventon	Skin Research Centre, HYMS
Kyle Stewart	Watercress Research Ltd
Katrien Van Bocxlaer	University of York
Ben Williams	Sun Bear Bioworks
Anna Zhenova	Green Rose Chemistry
HVB Team and Facilitators	
Joyce Bennett	University of York
Caroline Calvert	University of York
Gail Shuttleworth	University of York
Stephanie Simpson	University of York
Joanna Sparks	Aston University

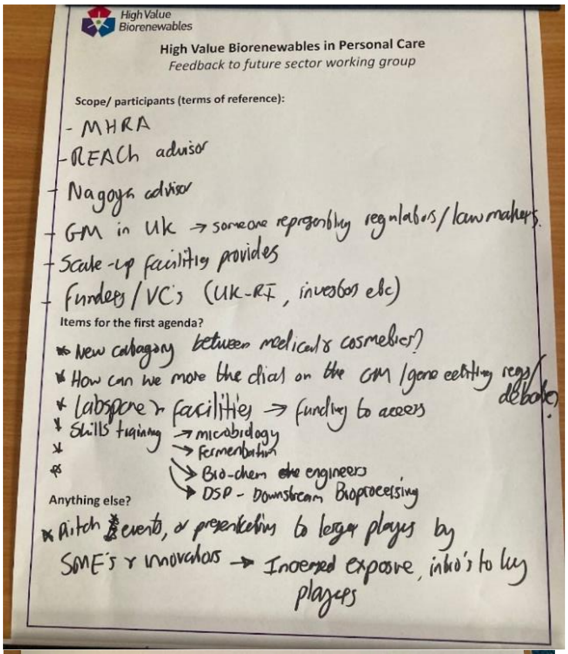
Appendix B: Discussion Posters




High Value Biorenewables
High Value Biorenewables in personal care – opportunities, challenges and solutions
Group participants:
research & innovation
Industry drivers and targets for research / research strengths and gaps / collaboration opportunities
GOVT - RECOGNISE ENG. BIO FOR RAW MAT
SKIN MICROBIOME Screening / AI / Machine learning / modelling
UPCYCLING WASTE (agri, food)
CAN EXISTING MOLECULES BE MADE FROM BIORESOURCE
IMPACT OF INGREDIENT ON ENVIRONMENT (eg. sun screen)
SOCIAL RESEARCH
regulatory & policy matters
Bottlenecks and potential solutions / opportunities / impact on collaborative projects (UK focus)
REDUCE WASTE
• PROLONGED SHELF LIFE?
• REPURPOSE UNUSED PROD
REGS POST-BREXIT
Plastic Tax
"Mixtures" active groups rather than individual
"Biopreferred Products" US model.
UK REACH
UK infrastructure
Facilities / talent and training / networks / funding
Monoculture replaced by selective agriculture
① mapping infrastructure, supply chain capabilities - ② skill gaps.
USE EXISTING FACILITIES FINE + SPEC CHEM
MAPPING THE LANDSCAPE
Fermentation skills (IBioIC training) Cross-tract industry training
SKILLS (GENERAL)
CPI / BDC have grant funding / subsidy to reduce cost and give grants outside of UK funding calls
• quick wins:
• long term aspirations:
• high impact:
regulation around use of "waste" feedstocks
- perception of using products derived from these material
USA - time specific rather than job or company specific.


High Value Biorenewables
High Value Biorenewables in personal care – opportunities, challenges and solutions
Group participants:
research & innovation
Industry drivers and targets for research / research strengths and gaps / collaboration opportunities
• Sustainability: Carbon, water, recycling
• Discovery science
• Prosperity partnerships (eg CRODA and Nottingham).
• Responsible innovation
regulatory & policy matters
Bottlenecks and potential solutions / opportunities / impact on collaborative projects (UK focus)
• Waste tax
• Transparency / reporting of waste produced
• Consumer duty (Financial services)
• Plastic bag tax
• USA - biopreferred
UK infrastructure
Facilities / talent and training / networks / funding
• Variable levels of support for innovation / spin out.
• Across-discipline training for undergrads
• philantropy
• Champions
• SNIB - English / UK version.
• manufacturing.
• quick wins:
• long term aspirations:
• high impact:
• quick wins: Waste tax
• long term aspirations:
• high impact: * Consumer duty
• quick wins: SNIB for UK (INDIrect)
• long term aspirations:
• high impact:
• high impact:

Appendix C: Feedback for Working Group



High Value Biorenewables

High Value Biorenewables in Personal Care
Feedback to future sector working group

Scope/ participants (terms of reference):

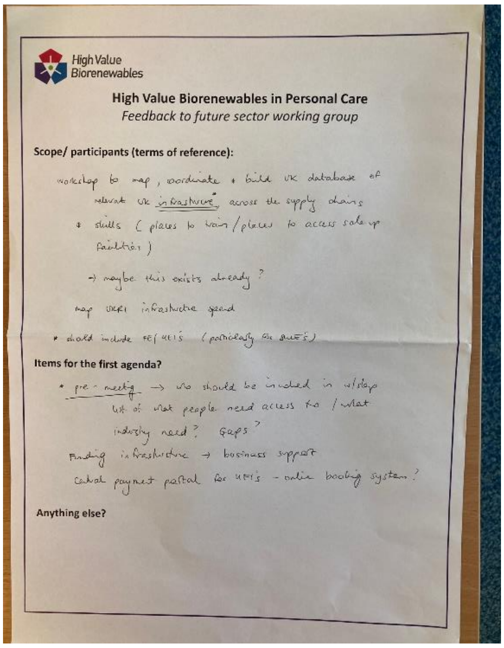
- MHRA
- REACh advisor
- Nagoya advisor
- GM in UK → someone representing regulators/law makers
- Scale-up facility providers
- Funders/VC's (UK-RI, investors etc)

Items for the first agenda?

- New category between medicals & cosmetics?
- How can we move the dial on the GM/gene editing regs/debate
- labspace & facilities → funding to access
- Skills training → microbiology → fermentation → Bio-chem engineers → DSP - Downstream Bioprocessing

Anything else?

- Pitch events, or presentations to larger players by SME's & innovators → Increased exposure, intro's to key players



High Value Biorenewables

High Value Biorenewables in Personal Care
Feedback to future sector working group

Scope/ participants (terms of reference):

workshop to map, coordinate + build UK database of relevant UK infrastructure* across the supply chains
* skills (places to train/places to access scale up facilities)

→ maybe this exists already?

map UKRI infrastructure spend

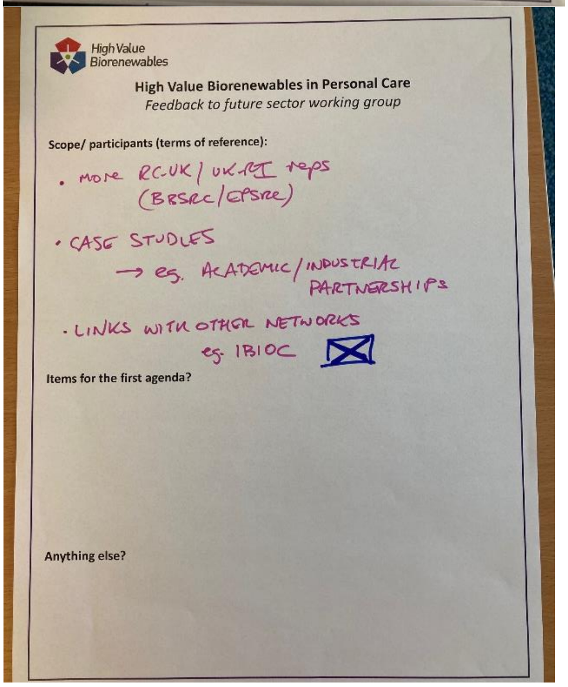
* should include FE/HEI's (particularly for SME's)

Items for the first agenda?

* pre-meeting → who should be included in w/shop
list of what people need access to / what industry need? Gaps?

Funding infrastructure → business support
Central payment portal for HEI's - online booking system?

Anything else?



High Value Biorenewables

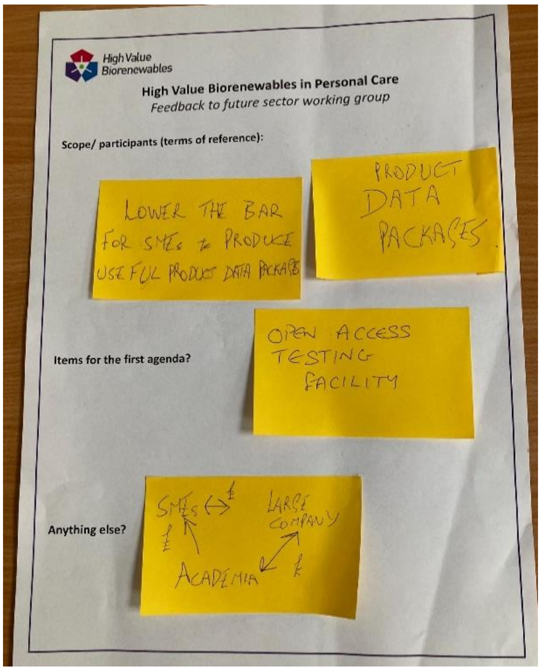
High Value Biorenewables in Personal Care
Feedback to future sector working group

Scope/ participants (terms of reference):

- More RC-UK/UK-RI reps (BBSRC/EPSRC)
- CASE STUDIES → eg. ACADEMIC/INDUSTRIAL PARTNERSHIPS
- LINKS WITH OTHER NETWORKS eg. IBIOC

Items for the first agenda?

Anything else?



High Value Biorenewables

High Value Biorenewables in Personal Care
Feedback to future sector working group

Scope/ participants (terms of reference):

LOWER THE BAR FOR SMEs TO PRODUCE USEFUL PRODUCT DATA PACKAGES

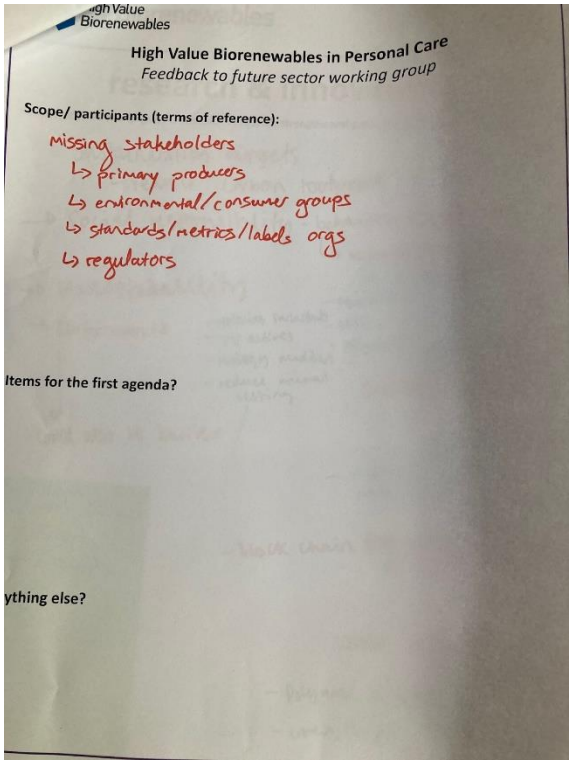
PRODUCT DATA PACKAGES

Items for the first agenda?

OPEN ACCESS TESTING FACILITY

Anything else?

SMEs ↔ £ LARGE COMPANY
£ ACADEMIA £



gh Value
Biorenewables

High Value Biorenewables in Personal Care

Feedback to future sector working group

Scope/ participants (terms of reference):

Missing stakeholders
- ↳ primary producers
- ↳ environmental/consumer groups
- ↳ standards/metrics/labels orgs
- ↳ regulators

Items for the first agenda?

ything else?