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Healthy soil, Healthy food, Healthy people: an outline of the H3 project

Running title: An outline of the H3 project

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Abstract:

This paper provides an outline of a new project, funded through UKRI's 'Transforming UK food systems' programme. The H3 project (Healthy soil, Healthy food, Healthy people) aims to transform the UK food system 'from the ground up', through an integrated programme of research at lab, farm, landscape, local, regional and national scales. This article introduces the H3 project with a particular emphasis on those parts of our work that have most direct relevance in terms of improving human diet and nutrition. Specifically, we seek to make early interventions in the food system through biofortification and other measures that reduce the need for costly interventions at later stages. Focusing on low-income populations and using a 'health by stealth' approach, we also seek to increase fibre consumption among the UK population by reformulating foods that are already an established part of people's diet. The paper concludes by assessing the likely impact of these interventions and the significance we attach to working with stakeholders in business, government and civil society.

Keywords:

Food systems, soil health, biofortification, nutrient enhancement, fibre consumption, dietary change

Introduction

Food security and sustainability are among the greatest challenges of the C21st (Godfray et al. 2010). Conventional solutions, often cast in terms of 'sustainable intensification' – the idea that more food can be produced per unit area with fewer inputs through the use of technological innovation -- have been criticised as unachievable as evidenced by stagnating yield gains in many staple crops despite C21st innovation (Garnett et al. 2013). There are now growing calls for comprehensive system redesign (Pretty et al. 2018) and new metrics proposed for assessing food system change (Benton & Bailey 2019). While many of these issues are global in scale, they are also salient at the national level, given the environmental impact of the UK's intensive agricultural system, the nationwide prevalence of diet-related ill health and our heavy reliance on imported food (Bhunnoo & Poppy 2020). The vulnerabilities of the UK food system have been further highlighted by the Coronavirus pandemic and by the uncertainties associated with the UK's post-Brexit trade arrangements.

The H3 project (Healthy soil, Healthy food, Healthy people) addresses these issues through an ambitious interdisciplinary initiative, designed to transform the UK food system 'from the ground up', focusing on the connections between sustainable growing practices and the adoption of health-promoting diets. Funded by UKRI's Strategic Priorities Fund, the H3 project is one of four consortia that will address various aspects of the UK food system.[1]

The H3 project

Bringing together researchers from Sheffield, Leeds, Bristol, Cambridge, Newcastle and City Universities, the H3 Consortium will address the links between food production and

[1] With a total investment of £47.5m, the programme has funded four research consortia and a food systems Doctoral Training Centre. Details of the four consortia are available here: https://www.ukri.org/news/healthier-food-healthier-planet-transforming-food-systems/ and further information on the DTC is available here: https://www.ukri.org/news/5-million-investment-to-transform-the-uks-food-systems/. The programme funders include several research councils (BBSRC, ESRC, MRC, NERC and Innovate UK) and government departments (Defra, DHSC, PHE and FSA. Further projects will be funded as part of a second Call, currently in review: https://www.ukri.org/opportunity/transforming-uk-food-systems-for-health-and-environment/.

consumption, taking a 'whole systems' approach to identify workable paths towards a transformed UK food system. The H3 project will be delivered via a series of interventions: at lab, farm, landscape, local, regional and national scales. It will also seek to improve the food system's resilience to disruptions caused by economic, environmental and health-related challenges.

The proposed research responds to a range of UK government policy drivers from the urgent need to improve soil health, reduce greenhouse gas emissions, biodiversity loss and water pollution from farmland, through to addressing diet-related ill health. The project also seeks to rebuild trust in the food system, promoting clean growth and supporting the translation of scientific research and new technologies for the benefit of the UK environment, economy and society. Our approach is thoroughly interdisciplinary, combining soil and plant scientists, biologists and ecologists, health researchers, economists and social scientists. The H3 project is structured into six interconnected work-packages (WPs) and three cross-cutting themes (CCTs) (see Figure 1).

FIGURE 1 ABOUT HERE

The work packages

WP1 (novel growing technologies) involves fundamental research into agricultural practices that have the potential to transform the quality of food produced in the UK while minimising its environmental impact. Developing hydroponic technologies in WP1 will enable the upscaling of horticulture across the UK. WP1 will demonstrate the potential of novel growth substrates and the use of protective microbes that supress disease and concomitantly enhance secondary metabolite production. Secondary metabolite production not only plays an important role in plant responses to pathogens but is also vital to human health. For example, carotenoids such as α-carotene, β-carotene, lycopene, β-cryptoxanthin, lutein and

zeaxanthin, present in fruit and vegetables such as tomatoes, sweet potatoes and spinach, are the major carotenoids in the human diet. Higher dietary intake and blood concentrations of carotenoids have been shown to be inversely associated with coronary heart disease, stroke, cardiovascular disease, cancer and all-cause mortality in a recent systematic review and meta-analysis (Aune et al. 2018), demonstrating their beneficial health properties. They also have specific functions: β-carotene is a precursor of vitamin A whilst lutein and zeaxanthin are involved in eye health. Moreover, increasing the carotenoid content of fruit and vegetables also has the potential to enhance flavour. Beta-ionone and geranylacetone are two examples of carotenoid-derived volatiles that, in combination with others, contribute to the overall aroma and taste of tomatoes (Baldwin et al. 2000). Enhancing the secondary metabolite content of crops via the novel techniques proposed in WP1 has the potential to yield health benefits, to improve the flavour and increase the consumption of these healthy foods.

WP2 (peri-urban hydroponic horticulture) addresses the linked challenges of improving diets and increasing the environmental, economic and labour sustainability of UK production of healthy leafy greens which is currently concentrated in the rapidly degrading peat-rich soils in the East of England. These are hot-spots for greenhouse gas emissions, and production in these areas has been highly reliant on migrant labour from the EU. Leafy greens are a rich dietary source of folic acid, vitamins (C, K), essential elements including micronutrients, fibre and healthy carbohydrates which are commonly deficient in UK diets (Slavin & Lloyd 2012). Polytunnel-based hydroponics extend growing seasons, agricultural productivity and working conditions compared to open fields, and locating these close to urban areas has been suggested as a way to meet UK requirements more sustainably, with shorter supply chains. We will explore the introduction of new systems of hydroponic production into urban and peri-urban areas where horticulture is currently limited but where our published analyses have revealed significant potential (Edmondson et al. 2020). Microbial inoculants developed in WP1 will be deployed to supress diseases rather than relying on synthetic chemicals, the

use of which is increasingly restricted, and the effects on food nutrition and quality will be assessed. The approach includes assessing the feasibility of a 'hybrid farm' model where the new hydroponic production of healthy leafy greens and salads is integrated with existing farm businesses that have established efficient local supply chains to urban populations.

WP3 focuses on cereal crops grown across the landscape and the potential for more widespread adoption of regenerative agriculture. Current intensive cereal agriculture is highly reliant on exogenous fertilisers and pesticides to maintain present yields. This is not only expensive but also damaging to the agricultural ecosystem. New, more sustainable farming systems such as regenerative agriculture have been shown to enhance the ecological quality of the environment and allow better-quality, nutrient-rich, foods to be produced at lower cost and with fewer inputs, leading to increased farm profits (e.g. LaCanne & Lundgren 2018). In some farming contexts, but not all, regenerative agriculture approaches can deliver these benefits without any loss of yield, avoiding trade-offs with global food production, food security and land conversion elsewhere in the world (e.g. Shackelford et al. 2019, Mondal et al. 2021). Achieving a transition to more sustainable farming systems, so that in time they become the 'conventional' approach to agriculture, requires new systems to be evaluated in a wide range of commercial settings, in partnership with farming communities, as well as developing the policy framework and stakeholder engagement to support the rollout of new technologies and approaches. To facilitate this, we are deploying a suite of 'living laboratories' in UK arable landscapes, characterising and monitoring the transition to regenerative agriculture in at least two different arable and mixed farming contexts.

Drawing together the learning from WPs 1 and 3, we will scale up the novel technologies and interventions and evaluate their performance through field trials with real food producers. Our network of hybrid farms will bring together new food production approaches and compare them to current farming practices, evaluating their viability and sustainability in both financial and environmental terms. The interventions have been co-designed with food

producers, addressing real needs for innovation across the sector, seeking to understand the barriers to technology adoption while testing out routes to application driven by user need. WPs 1-3 will use life-cycle assessment (LCA) and related methods (deployed in CCT1) to assess the health and sustainability benefits of our interventions while identifying potential trade-offs and avoiding unintended consequences.

WPs 4 and 5 then evaluate the impact of food produced using the novel approaches and technologies rolled out at scale in WP2 through nutrient enhancement and biofortification (in WP4) along with an industry partnership model, designed to reduce the adverse effects of refinement and increase dietary fibre intake in ways that are acceptable to consumers (in WP5). These interventions will include pragmatic dietary advice and practical cooking skills to maximise the potential health benefits of these fundamental changes to the food system for low-income communities for whom access to affordable fresh fruit and vegetables is increasingly difficult.

Specifically, WP4 builds on the outputs of WPs 1-3 to investigate the potential health benefits of crops grown in systems that are produced in environments conducive to enhanced secondary metabolite production. Sensory attributes will be characterised and physiological validation of the extent to which consumption of nutrient-enhanced foods translates into elevated bioavailability will also be explored. WP4 will assess the potential health benefits of biofortified foods at the level of the whole diet, understanding barriers to consumption including accessibility, cost and taste. WP5 draws on established dietary interventions to enhance the consumption of wholegrain in order to address the barriers to UK adoption of increased dietary fibre and its associated health benefits. Finally, WP6 investigates how supply chains respond to perturbations such as climate change, economic shocks and health emergencies (including COVID-19 and the effects of Britain's withdrawal from the EU).

The cross-cutting themes will use hybrid LCA, Delphi, meta-analysis of secondary datasets, panel data analysis, systems dynamic modelling and scenario analysis as integrative

methodologies (CCT1) to assess the environmental, social and economic impact of different interventions and policy options at multiple scales (micro to macro). Our research will also attend to key questions of consumer demand, accessibility and cultural appropriateness (CCT2) without which dietary change will not materialize. Finally, we will work closely with stakeholders from government, business and civil society (in CCT3 and across the programme) to ensure that our ideas have traction and that our pilot innovations and interventions can be scaled up and rolled out across the UK. Figure 2 illustrates the connectivity between the different elements in our work programme.

FIGURE 2 ABOUT HERE

Nutritional interventions

Our research seeks to demonstrate the benefits of early interventions in the supply chain, such as nutrient enhancement and biofortification, reducing the need for costly remedial measures further along the chain. Drawing on lessons learnt from previous behaviour change interventions, we also seek to improve the quality of commonly eaten foods rather than simply advocating dietary change, a goal that has proven to be highly elusive in previous individual-scale behaviour change initiatives. Lessons learnt from elsewhere, such as the Danish Wholegrain Partnership, will be applied to the UK, assessing the value of 'health by stealth' and other initiatives aimed at improving dietary quality and nutrient intake by those with the poorest diets.

The remainder of this paper provides further detail on two of our proposed interventions which best demonstrate the potential of our research to achieve significant nutritional change.

Biofortification through nutrient enhancement: UK food-based health inequalities have been exacerbated through prolonged austerity and the COVID-19 pandemic. Malnutrition in

both its forms (over- and under-nutrition) is of concern in the UK partially due to rising levels of food insecurity, increased accessibility to low nutrient, highly processed, cheap food and low intake of fruit and vegetables. A recent report by the Food Foundation, analysing the National Diet and Nutrition Survey data demonstrated that only 33% of UK adults and 12% of children aged 12-18 are consuming the recommended five a day: https://foodfoundation.org.uk/wp-content/uploads/2021/06/Peas-Please-Veg-Facts-2021.pdf. This suggests that much of the UK population are not consuming important nutrients that a diet rich in fruit and vegetables can offer. Further, the recent 'Broken Plate' report (https://foodfo undation.org.uk/wp-content/uploads/2021/07/FF-Broken-Plate-2021.pdf) revealed that by age five, UK children were on average shorter than other comparable income countries. The general environment, including the food environment, plays a key role in infant and child growth (Jelenkovic et al. 2016) and these findings likely reflect the current state of nutritional intake in the UK.

Macronutrient deficiencies are observed in over- and under-nutrition and the prevalence of various macronutrient deficiencies and associated non-communicable diseases are set to rise under the current food system. WP4 aims to address nutritional shortfalls by enhancing the nutrient content of habitual diets via nutrient enhancement of UK-produced vegetables (WPs 1 and 2) and biofortified vegetables and legumes, leading to a sustainable transformation of the food system with a concomitant positive impact on health.

UK topsoil contains low and variable concentrations of important micro nutrients, resulting in a lower and variable nutrient content in the yielded crops. Hence, there is a need to adopt novel technologies to support more stable nutrient concentration and enrichment in UK-produced crops. Adopting the novel technologies, growing innovations and nutrient-enhanced vegetable crops cultivated in WPs 1-2, WP4 will examine the inter-related issues of food quality, safety, bioavailability of nutrients and consumer acceptance.

WP4 will partner with crop growers (farmers and seed companies), companies with expertise in nutrient enhancement and biofortification, retailers, public health officials and consumers

to determine the economic, social, health-related and regulatory barriers to, and facilitators of, increased uptake of nutrient-enhanced and biofortified vegetables and legumes from production to consumption. Outputs will be used to inform strategies to encourage production, sales and consumption of nutrient-enhanced and biofortified crops at a UK population level.

Nutrient-enhanced and biofortified crops are generally well accepted (Birol et al. 2015), yet this has not been assessed in a UK context. Nutrient enhanced crops produced in WPs 1 and 2 will undergo rigorous checks to ensure that they are safe for human consumption prior to the bioavailability of nutrients being assessed. Changes in micronutrient and phytochemical composition can result in discernible changes to taste, appearance and cost (Wanyama et al. 2019). To explore potential impact at the consumer level, a series of consumer acceptance tests (including sensory, hedonic, willingness to pay and willingness to consume) will be implemented. Sensory characteristics (such as visual appearance, texture, odour, taste profile) will be determined by a trained sensory panel (working in conjunction with CCT2). This will provide an initial understanding of the taste profile of the nutrient-enhanced crops compared to the standard crop. Key attributes defined by the sensory testing will inform subsequent interventions. Sensory characteristics will be mapped on to the presence of health-promoting secondary metabolites (phytochemicals). Positive and negative descriptors will be entered into machine learning to establish whether secondary metabolites map on to taste and quality perception of the vegetables (Hopkins et al. 2017).

Working in partnership with our commercial partner HarvestPlus, a pilot study will also be carried out to examine consumer acceptance of biofortified crops compared to the commercially available equivalent in the home environment. Households will be provided with samples of biofortified products, such as beans fortified with iron, and standard versions to assess in their home. A sub-sample of participants will be invited to be interviewed to examine the consumer experience in more depth. The feasibility of the intervention will also

be explored to provide critical information to inform a larger study. Willingness to pay adds an important economic dimension to consumer acceptability and we will also recruit a sample of adults to take part in an online experiment using a contingent valuation approach to establish the extent to which consumers are willing to pay a premium for nutrient-enhanced/biofortified produce. This information will determine the extent to which health-related inequalities may be exacerbated due to cost, encouraging government support for a wider biofortification programme across the UK.

Increasing fibre consumption: WP5 seeks to transform human health through dietary change, focusing on the UK's inadequate dietary fibre intake. Although the health benefits of increased fibre consumption are well established (SACN 2015), UK consumers have not responded eagerly to recommendations to increase dietary fibre due, in part, to the poor organoleptic properties associated with high fibre products. Consequently, average adult intakes of 17.2g/day are well below the recommended intake of 30g/day. Our work builds on the success of the Danish Wholegrain Partnership (DWP), which achieved significant transformations in dietary behaviour. However, the DWP was least successful among low socio-economic status (SES) groups whose fibre intake is the lowest in both the Danish and UK populations (Bates et al. 2014, PHE 2018) and we will target this demographic. WP5 will co-design transformative interventions across the supply chain to increase fibre intake among low SES groups in the UK.

WP5 will engage with key players in the cereal supply chain to identify strategies to incorporate higher levels of fibre into the food system (via reduced refining and fortification), addressing issues of consumer preference, palatability and cost. Lower SES groups typically purchase more refined grains and processed staples (e.g. white bread) than wholegrain or high fibre alternatives which are often more expensive and considered less palatable. Building on our established relationships with food manufacturers and retailers,

WP5 will identify products from the UK diet in which dietary fibre can be most effectively retained or substituted in a 'health-by-stealth' approach.

Using a combination of food processing expertise and sensory/nutritional assessment, we will adapt well-established formulations preferred by low SES consumers to develop products that are fibre-rich, affordable, and appealing. Many of the beneficial effects of fibre are associated with the ability to lower the rate of sugar and fat absorption from foods and to decrease appetite. We will use our expertise in food science to demonstrate improved functionality (slower, more sustained energy release) and to address any potentially detrimental effects on the availability of bioactives caused by the decreased digestion kinetics. Working with CCT2 and WP4, we will use sensory panels and in-home field studies to assess the palatability of new/reformulated products including their impact on appetite. Other specific interventions will include:

1) *Augmenting fibre intake in children from low SES backgrounds.* WP5 will work in partnership with our commercial partner Bagel Nash to reformulate their existing products (breakfast bagels) to increase fibre and wholegrain content. Their Magic Bagel is a special-recipe bagel for school food provision specially made with 50:50 wholemeal/white flour fortified with vitamin D. The new formulations will be piloted within the National School Breakfast Programme (NSBP) to which Bagel Nash is a supplier. The NSBP aims to improve the dietary intake of school children, operating in over 2500 schools in socio-economically deprived areas across England by improving access to healthy breakfasts. Taste and repeated exposure are key to acceptance of the reformulated bagel and continued uptake of these new foods and we will assess these effects on fibre intake in children in a longitudinal study in local schools. Our approach also aligns with the National Food Strategy (NFS) recommendation to increase fibre intake across the population and a health-by-stealth approach seems the best way to do this, starting with children where we

can 'educate' their palates by exposure and encourage consumption of increased fibre foods via school food provision.[2]

We will also work with our retail partners to explore options for wider commercialization. This work is important because, as is now widely recognised, 'Children with empty stomachs struggle at school: they find it hard to concentrate, their behaviour deteriorates, and they are more likely to be disruptive in class' (NFS 2021, p.151). Most of the core school curriculum is taught before lunch. Therefore, breakfast is essential for effective learning and habitual breakfast consumption is associated with better academic outcomes and in-class behaviour (Adolphus et al. 2013, 2015, 2019). The quality of the breakfast is, of course, important for overall dietary quality and health.

2) *Improving fibre intake in food-insecure and vulnerable adults.* We will collaborate with an established social enterprise, using cooking skills-development sessions and coupled educational materials, to demonstrate how higher fibre may be incorporated into palatable, affordable and achievable meals. The social enterprise will co-develop these sessions, delivered as bespoke on-site training workshops. We will use foods and ingredients donated by our commercial partners alongside biofortified high-iron beans and the biofortified crops (such as tomatoes and lettuce) produced in WP2 and WP4 with recipes and advice appropriately tailored to the financial constraints of low SES consumers. The success of these interventions will be evaluated via food choice questionnaires and dietary recall with participants before and after the intervention.

Our objectives align with the National Food Strategy recommendation of trialling a 'Community Eatwell' programme to provide targeted healthy eating support for people on low

[2] The National Food Strategy, published in July 2021, makes several recommendations related to fibre consumption. They include: mandatory reporting of sales of major nutrients by large food companies (including retailers, restaurants and fast food outlets, contract caterers, wholesalers, manufacturers and online ordering platforms); targets to increase fibre intake and reduce consumption of sugar, salt and saturated fat; increasing the availability of healthier products while using taxation to encourage the reformulation of existing products; introducing a new 'Eat and Learn' initiative for schools; extending eligibility for free school meals; and strengthening government procurement rules to ensure that taxpayers' money is spent on healthy and sustainable food.

incomes and cooking lessons in community kitchens as a key route of delivery for the NFS. These workshops aim to empower adults to develop some of the skills that the NFS seeks to bring back for school pupils via the reintroduction of food into the curriculum because successful dietary change needs less 'preaching about diet' and more efforts to 'impart… kitchen skills and expand… palates' (NFS 2021, p.47).

Taken together, these interventions exemplify a multi-scale approach to improving fibre consumption among low SES groups, via reformulations, increased access and changes to processing, knowledge and attitudes. We will also produce a roadmap to up-scale implementation, targeting policy-makers, industry and charities, modelling the health benefits achievable through adoption of our interventions.

Prospective impact of our proposed interventions

The H3 Consortium will deliver a series of measurable impacts within the five-year funding period (2021-25), with a longer-term legacy in terms of food system transformation. The proposed innovations and interventions will be conducted in close collaboration with our stakeholders to maximize potential uptake and impact. Specifically, WPs 1 and 2 will seek to increase the production, quality and sustainability of health-promoting vegetables while reducing reliance on harmful agricultural inputs and imported food. The integration of hydroponic production systems within conventional soil-based farming will have a significant impact on public health and sustainability, stimulating the consumption of locally-produced vegetables and reconnecting urban populations with food production though our outreach programme, as well as diversifying UK farming systems and increasing the resilience of the supply chain. The exploitation of microbiomes in hydroponic growth systems (in WP1) also has strong potential to increase nutrient efficiency and reduce pesticide reliance, contributing to reduced agrochemical residues in crop products and waste streams. WP2 will contribute to dietary health and sustainability by creating a linked network of hybrid demonstrator farms, increasing local vegetable production while decreasing the land footprint and

supporting soil regeneration. WP3 will contribute to a step change in the uptake of regenerative agriculture innovations that improve the farmed environment and food quality, helping to promulgate successful combinations of practices nationally. Training and monitoring activities in our demonstrator farms will be shared on social media and with the farming press and industry stakeholders. The benefits for soil health, bird and invertebrate numbers, and the extent of yield or profit changes are hard to estimate in advance for the systems we are working in, as these effects are context dependent. By working in partnership with farmers, our research develops a whole farm system approach that is responsive to local conditions and builds on farmer knowledge to deliver the best possible outcomes in each landscape.

WP4 addresses the key public health challenges of micronutrient deficiency and, as discussed above, will develop and apply state of the art methods of nutrient enhancement for UK vegetable consumption. Public health benefits will also arise through increasing access to safe, nutritious food. Sustainability benefits include reduced inputs at later stages in the supply chain (from post-harvest fortification of food and the use of industrial supplements). WP5 will benefit public health by increasing dietary fibre intake, learning from the Danish Wholegrain Partnership which led to a significant rise in wholegrain consumption, especially among younger consumers, with associated health and sustainability benefits. WP6 will transform the consumer-retailer relationship to build a more resilient and responsible food system, resistant to disruptions in the supply chain. This will be piloted with retailers and other stakeholders before launching on industry-wide platforms once its feasibility has been tested. Based on previous work with Asda (Young et al.2017) which led to substantial savings in terms of food waste and CO_2 equivalent, the cross-sector agreed standard (developed with WRAP and championed by Asda), aims to reduce food waste and increase healthy diets for 6 million households while protecting sustainability supply chain standards.

In terms of our cross-cutting work, CCT1 will provide an integrating methodology including a series of new metrics for assessing multi-scale vulnerabilities in UK food systems. We will also assess the environmental, social and economic impact of different interventions for UK production systems and agri-food trade as proposed in WPs1-6 and related policy options. CCT2 will explore the context (understanding of consumer behaviour and mechanisms of dietary change) into which our innovations and interventions are launched. This will help to ensure that they are steered effectively, increasing the chances that they will take hold and that the effects of any changes will be maximised. Finally, working closely with stakeholder organizations, CCT3 will seek to maximise the impact of our research on policy and practice.

Conclusion

The H3 programme began in January 2021 and will conclude in December 2025. While it is premature to predict the full implications of our proposed research, we hope to achieve a transformative impact on the UK food system by providing a road map through which our interventions can be scaled and integrated with existing practices, addressing the twin aims of increased environmental sustainability (through reduced pesticide and fertiliser use and more efficient agricultural production) and improved public health (through changes to the UK diet). We will measure and monitor the impact of our interventions, working closely with our academic and stakeholder advisory boards to ensure that our objectives are met. We welcome inquiries about the progress of our research via the contact details on the project website: https://www.h3.ac.uk.

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aspects of the project from Caton, Dye, Adoplhus and Boyle. The other authors were responsible for the separate work-packages and cross-cutting themes, details of which are available on the project website.

Conflicts of interest:

No conflicts of interest were reported in connection with this paper.

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Figure captions:

Fig 1: Structure of the H3 programme showing policy drivers, work packages and cross-cutting themes, sectoral integration and stakeholder engagement.

Fig 2: Diagrammatic work-plan showing multi-directional flows of resources and knowledge between the work-packages (WPs), facilitated by the cross-cutting themes (CCTs).

Figure 1

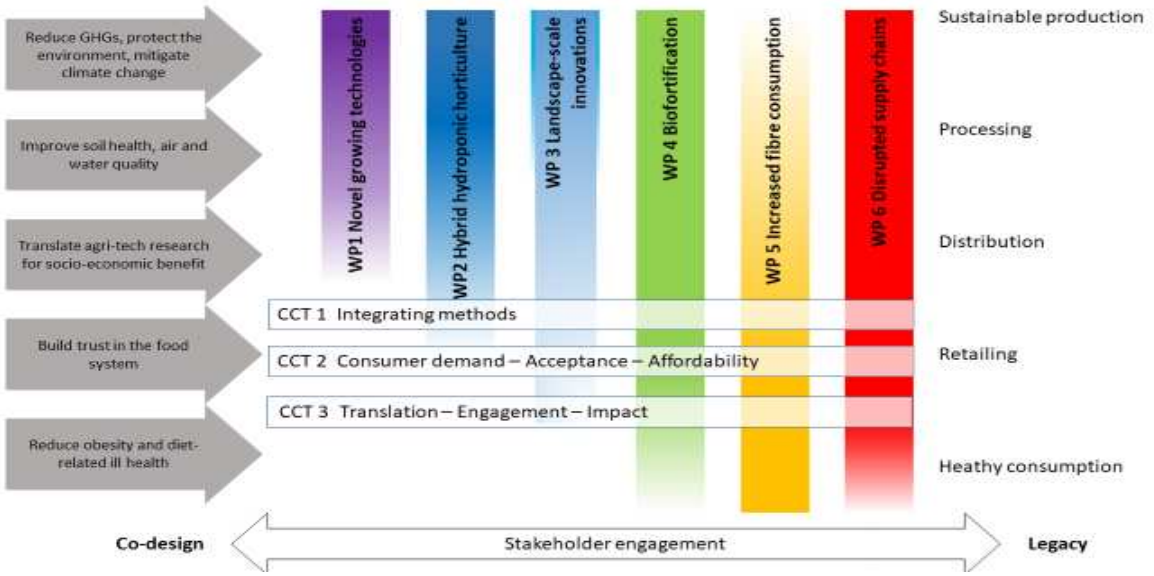

Figure 2