FEEDING THE FUTURE, FOUR YEARS ON:

A review of innovation needs for British farming.

NFU

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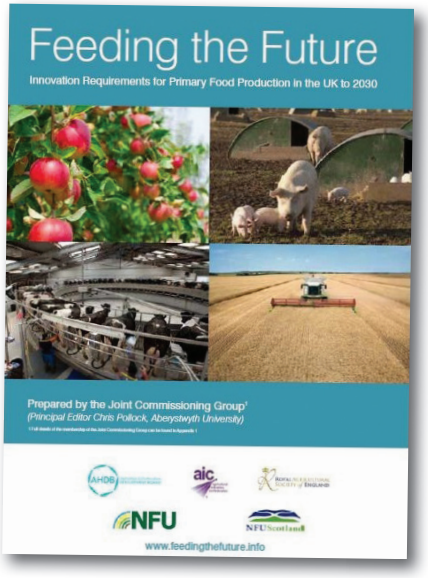
Introduction



In 2012, a group of industry organisations jointly commissioned a project to gather opinions about what the agricultural sector needed the scientific research community to prioritise over the next two decades. The project was funded by the Technology Strategy Board (now Innovate UK) and undertaken by: the National Farmers' Union; Agricultural Industries Confederation; Royal Agriculture Society of England; Agriculture and Horticulture Development Board and NFU Scotland. Prof Chris Pollock was commissioned to write the report. Research needs were discussed at a series of workshops and consultations with farmers, growers and the wider agriculture industry. The output was summarised under eight broad themes that were designed to stimulate the concerted direction of funding for research from funding bodies in the UK.

The final *Feeding the Future* report was published in June 2013 and just before the government's Agri-Tech Strategy was launched in July 2013. The research priorities identified in *Feeding the Future* formed part of the evidence base for development of the Agri-Tech Strategy. The Report has since been widely referred to and quoted by individuals and organisations seeking to understand and articulate those challenges that face UK agriculture and horticulture, for which investment in research may provide solutions.

While the widely-accepted challenges of food security persist, a great deal has changed since *Feeding the Future* was published, not least the agricultural research funding landscape, the decision to leave the EU and advances in new technology. While most of the priority issues identified remain relevant, there are areas where the science or the emphasis has moved on. In this context, the NFU decided to carry out a light-touch review of the research priorities element of the report to ensure continued relevance. The intention is to use this updated summary of industry priorities to re-engage with research funders, the academic community and other relevant decision makers.

Short workshop sessions were held with the NFU's six national commodity boards (Dairy, Livestock, Poultry, Combinable Crops, Horticulture, Sugar), its Environment Forum and the National Pig Association Producer Group. The Organic Forum and the organisation's regional boards were also given the opportunity to feed in their views. The original commissioning group and other contacts were invited to comment during the process.

Government Agri-Tech Strategy

On 22 July 2013, Department of Business, Innovation and Skills (BIS), Department of Environment, Food and Rural Affairs (Defra) and Department of International Development (DfID) ministers launched a new UK strategy for agricultural technologies, with £160 million government investment attached. The Agri-Tech Strategy addresses the UK's declining productivity growth and competitiveness, and the gap between research and commercialisation.

There are two funding mechanisms.

- The 'Agri-Tech Catalyst' is administered through Innovate UK and Biotechnology and Biological Sciences Research Council (BBSRC) for academic/ industry partnerships, including small and medium-sized enterprises (SMEs), with a rolling funding call for applicants since 2013. An interactive map is available with details and locations for all of the Catalyst projects funded so far

- Four new 'virtual' Centres for Agricultural Innovation were established by October 2016 as not-for-profit companies limited by guarantee. They received five years of funding (primarily for investment in new facilities) to enable farming and food businesses develop, adopt and exploit new technologies and practices. The intention is they will become national focal points and sources of expertise and training. They will be expected to work closely together to share facilities, data and expertise and thereby deliver more value than working separately or in competition

  - **Agrimetrics** is 'empowering the agri-food system to embrace big data and related technology', integrating and interpreting datasets, and devising metrics for sustainability

  - **Agri-EPI** (Engineering Precision Innovation) "delivers research, development, demonstration and training on precision agriculture and engineering across all farming sectors", including use of satellite farms to measure variance

  - The **Centre for Applied Crop Science** is "an international centre for innovation in crop protection, uniting industry, agriculture and academia to revolutionise the way global farming deals with crop threats"

  - **CIEL** (Centre for Innovation Excellence in Livestock) "delivers global leading livestock production and product quality research to deliver improved food quality and farming systems"

The Agri-Tech Strategy originally focused on primary production, but during 2016 it was decided to broaden the remit to encompass the whole food supply chain. An Agri-food Technology Leadership Council now oversees the strategy development and implementation. The council is co-chaired by Judith Batchelar (Sainsbury's) and Defra and Department of Business, Energy & Industrial Strategy (BEIS) ministers. It has 17 members who, alongside attendant government officials and funding body representatives, provide expertise across the breadth of the food supply chain from farming, waste management, agchem, food manufacture, retail, consumer affairs and scientific research.

Two analyses were published by the former Agri-Tech Leadership Council in July 2016. One provides statistics on the UK agri-tech sector and describes ways in which it may be possible to evaluate if the strategy has successfully delivered its objectives. The other provides quantitative summary data on the scale of UK public and private funding of agri-tech research and development from April 2012 to March 2013, using the *Feeding the Future* themes as a starting point.

New research and KE initiatives since 2013

A new **Food Innovation Network** was launched in October 2016, driven by the Agri-Food Technology Council. It is designed to break down barriers to collaboration between businesses and scientists, and enable easier access to funding, technology experts and advisers. Funded by Defra, BBSRC and the York, North Yorkshire and East Riding Local Enterprise Partnership (LEP), it will be delivered by the Knowledge Transfer Network (KTN). The KTN has also developed an interactive landscape tool of the agri-food innovation infrastructure, currently available in BETA form.

The Sustainable Intensification Research Platform (SIP) started in 2014. This multi-partner programme is funded by Defra and the Welsh Government to explore the opportunities and risks of sustainable intensification (SI) from a range of perspectives and at different scales (field to landscape) across England and Wales. It aims to develop a community of researchers and practitioners, using study farms to host research and create a data platform. The programme runs until November 2017.

The **Global Food Security Programme** is a £14m research programme focused on resilience of the UK food system in a global context. This was launched in May 2015 and is funded for five years by Natural Environment Research Council (NERC), Economic and Social Research Council (ESRC), Food Standards Agency (FSA), with Defra and FSA also involved in its design.

Innovative Farmers (IF) is a network that provides farmers with research support and funds for trialling, testing and hands-on research as part of the Duchy Future Farming Programme.

Innovation for Agriculture (IfA) is a consortium of 15 English Agricultural Societies. Through the creation of technical centres around England, IfA delivers new science and innovation to farmers via its website, publications, conferences, seminars, workshops, on farm demonstrations and new media.

European Innovation Partnerships (EIPs) are part of the Countryside Productivity Scheme (part of the Rural Development Programme for England). Grants provide funding for collaborative groups consisting of farmers, researchers and others to look for solutions to real problems that farmers come up against. Defra were expected to announce the first successful EIP grants in summer 2016.

The **N8 AgriFood Programme** was launched in June 2016 and combines the expertise of more than 370 researchers and six farms at eight universities across the north of England with the support of more than 40 businesses. This represents the largest concentration of researchers in the agri-food sector in the UK, set against a backdrop of some of the country's most diverse and productive agricultural and rural economies.

SIRN (Sustainable Intensification Research Network) was launched in September 2016 and is a network of UK researchers in the agricultural, biological, environmental and social sciences working on sustainable intensification.

NIAB (National Institute of Agricultural Botany): Two recent changes to the research landscape involve this key agricultural research centre. After an announcement in December 2012 that the Potato Agronomy Unit at Cambridge University Farms (CUF) would become part of NIAB, February 2016 saw East Malling Research join the NIAB group, combining soft and top fruit research with NIAB arable, potatoes and ornamental expertise.

Funder developments

Innovate UK: The government's innovation agency, previously the Technology Strategy Board, is sponsored by the Department for Business Energy and Industrial Strategy. It will publish a new strategy for 2016 to 2020, coinciding with the publication of the government's National Innovation Plan, as part of the current Spending Review period. Innovate UK's 2016/17 delivery plan includes a restructure in four sector groups: Emerging and Enabling Technologies; Health and Life Sciences; Infrastructure Systems; Manufacturing and Materials. Food and agriculture fits into 'health and life sciences,' with a priority activity of improving agricultural productivity and enhancing food quality. Support for the four agri-tech centres will continue to flow through Innovate UK.

UK Research and Innovation: Government has committed to implementation of the recommendations of Sir Paul Nurse's review of the research councils, published in November 2015. This includes creating UK Research and Innovation (UKRI), a new body that will incorporate the seven research councils, Innovate UK and Higher Education Funding Council for England (HEFCE) with a combined budget of over £6 billion. In the 2016 Autumn Statement, an extra £2 billion of research and development (R&D) investment was announced as part of a new National Productivity Investment Fund."

REF 2014: The Research Excellence Framework was introduced for 2014 as the new system for assessing quality of research in UK higher education institutions. The process included, for the first time, an assessment of non-academic impact. This was defined by the Higher Education Funding Council for England as 'an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life, beyond academia'.

Agriculture and Horticulture Development Board (AHDB): AHDB is funded by a statutory levy on six sectors of the primary production industry (dairy, beef and lamb, pork, cereals and oilseeds, horticulture and potatoes). During 2015 and 2016, AHDB undertook a major strategy review alongside a significant internal reorganisation aimed at maximising the positive impact on the industry of AHDB work. AHDB's revised vision and strategy was published in November 2016.

It includes the overarching priorities to inspire British farming and growing to be more competitive and resilient, and to accelerate innovation and productivity growth in line with our main competitors through co-ordinated research and development and the associated knowledge exchange (KE). AHDB is the major funder of applied agriculture and horticultural research in the UK (around £12m per annum of direct project spend), and as a result of the strategic changes in AHDB, the research programme is being re-aligned to address specific industry priorities under six broad themes:

- Realising genetic potential
- Building sustainable plant and animal health
- Managing resources efficiently and sustainably
- Driving precision technology into practice
- Facilitating trusted food in the supply chain
- Honing business and technical skills

These broadly reflect the priorities in the original *Feeding the Future* report and indicate their continued relevance. At the same time, AHDB is completely re-modelling its knowledge exchange function to make sure that the right tools are put in place for maximum farmer engagement and uptake of best practice as well as ensuring that new and potentially game-changing innovative technologies are introduced into the industry as quickly as possible.

Changes at European Union level

Scientific advice to the EU Commission:

The post of Chief Scientific Adviser to the Commission ceased to exist when Jean-Claude Juncker became President in November 2014. It has been replaced by the Scientific Advice Mechanism, led by a High Level Group of seven scientists. The group's first meeting was in January 2016.

To support the SAM, a new project, led by a network of European science academies, has been established, with an initial four years of funding through Horizon 2020. The Science Advice for Policy by the European Academies (SAPEA) platform is expected to start work in October 2016.

In addition, a European Innovation Council has been proposed by DG Research and Innovation Commissioner Carlos Moedas. A 'high level group of Europe's top innovators' is expected to start work on its design by end of 2016. The EIC could simplify access to and fill the gaps in innovation support, and provide advice on improving the innovation environment.

Horizon 2020 replaced FP7 in 2014 and is the biggest ever EU research and innovation programme. The budget is nearly €80bn, with €4.1bn for food, agricultural and the bioeconomy. The UK is a net recipient of EU research fund, ranking second behind Germany both in number of participants and budget share. The EU Referendum decision is likely to have an impact on the agricultural research community. It has already brought considerable uncertainty and concern given the flows of funding, collaboration and recruitment within the EU. Work has started to explore opportunities to improve, strengthen and build on the UK's agricultural research base once the UK leaves the EU.

FEEDING THE FUTURE REVIEW:
Cross sector research priorities, by theme

NFU members from across all sectors of agriculture and horticulture specifically highlighted the following needs relevant to the science, research, technology, advisory and policy communities. They demonstrate a particular feature of farming: The need for not only innovative products but also innovative management practices, policies and knowledge exchange. This distinction, but also the interdependence between the two, necessitates investment in both.

The Sustainable Agriculture and Food Innovation Platform and the Agri-Tech Catalyst mechanisms through Innovate UK have presented significant opportunities where industry co-funding is relevant and available. For those priorities related to farming practices and policies, it is vital that future investment by other funders including Defra, AHDB and the Research Councils is sufficient and targeted to enable sustained gains in the industry's performance and competitiveness.

What's changed four years on?

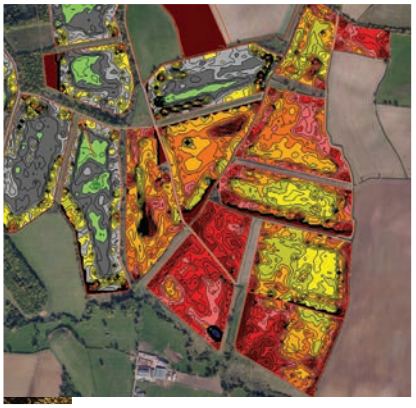
NFU members from all sectors identified the following research priorities as having particular emphasis and greater importance compared to the original report:

- Harnessing the power of recent developments in data and digital technologies, including precision farming
- Improving and balancing environmental protection and agricultural productivity in commercial farming systems
- Understanding how farm businesses can build resilience to contend with changes in policy and trade in the coming decades
- Developing labour-saving technologies
- Understanding farming's contribution to the health and wellbeing agenda

Digital, data-driven and engineering technologies

- Explore and realise the potential of digital, automated, robotic and other innovative engineering technologies to:
  - ease labour and skills shortages;
  - enable remote and real-time system monitoring by collection and interpretation of data across farming systems and landscapes (including in areas of poor connectivity);
  - improve weather forecasts and facilitate appropriate responses through development of specific decision-support tools;
  - predict livestock performance;
  - enable pre-emptive responses to pest and disease threats;
  - improve product storage, quality and safety;
  - provide an understanding of sources of system variability and thereby enable optimised inputs and efficient use of resources including: fuel, fertilisers, water, crop protection products, and veterinary medicines; and
  - demonstrate effective delivery of environmental goods and services.

- Collect, integrate, curate and analyse bio-physical and business-related data from farming and other land-based activities to enable the development and implementation of intuitive and reliable decision support tools.



- Understand and remove barriers to the adoption of precision management approaches across all sectors and scales of business including:
  - challenges of interoperability between machinery and other devices and between databases throughout supply chains;
  - recognition and transparent return on the value being derived from farmer-generated data; and
  - delivery of new capabilities for existing ubiquitous devices such as smart phones.

- Link increasing understanding of animal behaviour to improved design of housing and systems of livestock management.

Crop and livestock genetics and breeding technologies

- Promote the development and uptake of New Breeding Techniques (NBTs) such as gene-editing and accelerate their application to agriculture;

- Apply to precision breeding of plants and animals the increasing ability to manage and analyse very large datasets;

- Increase emphasis on composite livestock breeding to achieve genetic gains and reduce priority accorded to specific breeds;

- Apply all available genetic technologies to address high priority challenges facing British crop and livestock producers including:
  - increasing yield and feed conversion efficiency;
  - resistance to pathogens, parasites and pests;
  - adaptation to climate change (flood, drought, heat-waves, extended growing season etc.)
  - delivery of enhanced nutritional quality (food or feed);
  - ease of crop harvesting;
  - reduction of greenhouse gas emissions and diffuse pollution;
  - greater resource use efficiency;
  - improved fertility;
  - positive behavioural traits;
  - genetic determinants of meat eating quality and product uniformity (a vital component of competitiveness and meeting market demand).

NIAB – NATIONAL INSTITUTE OF AGRICULTURAL BOTANY

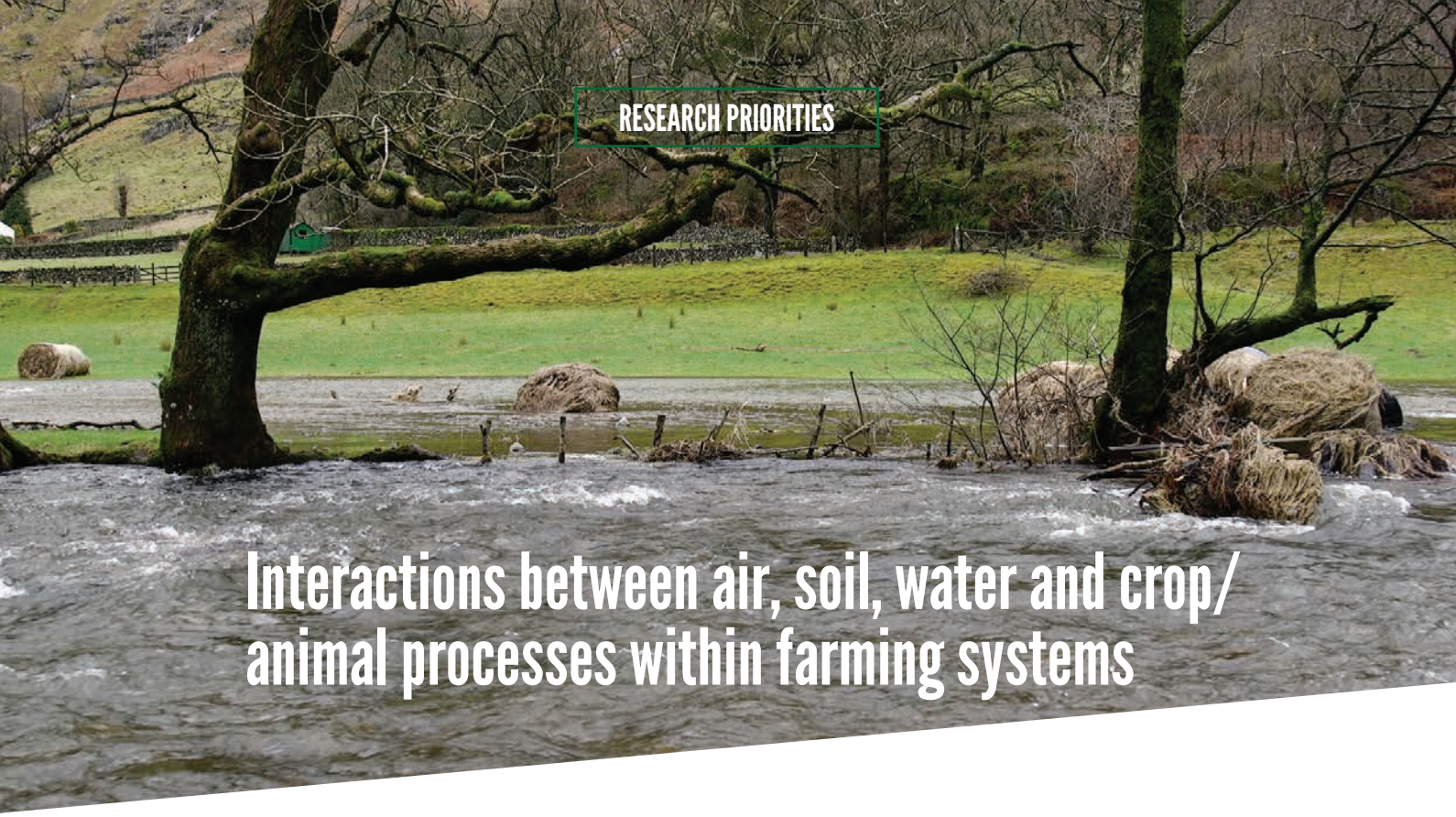
Step 1 **Step 2**

Step 1: Wild Goat Grass + Durum Wheat = Synthetic Wheat

Step 2: Synthetic Wheat + Elite Wheat = Superwheat

- Find genetics-based solutions to the declining availability of crop protection products and increasing challenge of antimicrobial resistance in pathogens of crops, livestock and poultry.

- Advance knowledge of pathogen, pests and weed genetics (including interaction with crops, livestock, and the wider farming environment) to enable design and implementation of integrated approaches to the sustainable management of these threats.



Interactions between air, soil, water and crop/ animal processes within farming systems

- Undertake research that will enable UK agriculture to mitigate and adapt to the predicted impacts of climate change including:
  - assessment of the future impacts of climate change (temperature, sea level, flooding etc.) on UK food production and how it will influence where and what will be produced;
  - improved predictions and management responses to extreme weather events with a particular emphasis on water (e.g. land use, drainage, capture and storage);
  - understanding and quantification of the trade-offs in commercially viable farming systems inherent in seeking to balance productivity with emissions of greenhouse gases and other diffuse pollutants; and
  - development of novel crops particularly to reduce import dependency and meet human and livestock nutritional requirements.

- Provide an ability to map and understand the source of spatial variation in soil nutrients and biophysical properties contributing to soil health (including use of break crops) as a prelude to better fertiliser targeting and achievement of both environmental and productivity gains;

- Deliver technology to sample and manage air and water quality in housed livestock production systems including early detection of diseases;

- Provide a mechanistic and predictive understanding of the influence of agronomic practices on the nutritional status of crops for food and feed;

- Devise and implement systems at a range of scales for the management and utilisation of manures and farm wastes that enable both environmental benefits and gains in productivity to be achieved;

- Provide simple and standard test systems for nutrients in soil and crops as an aid to diagnosis of deficiencies

Integrated approaches to management of crop weeds, pests and diseases

- Undertake research to enable durable integrated management of crop pests, diseases and weeds in the face of continuing regulatory restrictions on the availability of crop protection chemicals, the lack of new chemical solutions and resulting resistance problems. This portfolio of work to include:
  - provision of a strong evidence base for a future chemical regulatory system that is both fit for purpose and enabling by comparison with the EU's existing hazard-based approach;
  - develop biopesticides and introduce biological control system commercially as part of integrated management in all crop sectors.

- As a basis for delivery of durable control strategies, provide an improved understanding of the biology of pathogens and pests of crops and particularly conditions necessary for development of epidemics.

Integrated approaches to management of animal disease within farming systems

- Develop and implement a robust strategy to counter the occurrence of antimicrobial resistance in pathogens of livestock.
- Design and adoption of effective, practical, tailored and sustainable farm biosecurity measures;
- Early warning systems and ability to detect and respond to pre-clinical symptoms such as pen-side technologies for diagnosis linked to decision-support tools for treatment.
- Studies to define and measure well-being and stress in farmed animals including tools to translate this into management 'best-practices' alongside accepted evidence-based supply chain requirements and consistent messaging to consumers.
- Increased focus on widespread, long-standing and intractable endemic health and welfare problems such as: red mite in poultry; and mastitis, lameness, digital dermatitis, scab and fluke in livestock.
- Development of innovative commercial-scale humane control of rodents.
- Provision of information on linkages between mineral content of soils, trace element requirements of livestock, the need for supplements in feed and potential for build-up in carcasses.

RESEARCH PRIORITIES

Evidence-based management and valuation of ecosystem service provision from farming systems

- Undertake work that develops and implements locally adaptable decision support tools to aid delivery of positive environmental outcomes from productive and commercially viable farming systems while avoiding simplistic reliance on single indicators for environmental performance or health of the farmed landscape.

- With the objective of enabling debate, informing policy and driving appropriate regulation, conduct studies to provide accurate baseline measurements from which can be determined changes in informative indicators of environmental impact (positive or negative) and interactions among potentially contributing factors including the contribution of farming.

- Quantify the contribution that farming practices make to the value of tourism, rural landscapes, human health and well-being and other aspects of the UK rural economy.

- To enable informed regional policy development and optimised land use strategies, provide detailed understanding and models of the route through which a range of different commercial farming systems can deliver ecosystem services within the diversity of UK landscapes and farm businesses.

- Explore innovative ways to use waste products at a meaningful scale in farming systems including full analyses of and solutions for possible negative impacts on such things as disease dissemination or soil and water quality.

Skills, training and KE

- Drive widespread adoption of proven innovative management practices by obtaining a deeper understanding of barriers to uptake and providing support to enhance sharing of best practice between farm businesses.

- Ensure training in agribusiness management skills, structures and resources can reflect the growing size and complexity of farm businesses such as:
  - combined use of training and technologies to increase efficiency of labour and address labour and skills shortages;
  - enhanced and scaled-up availability of training in new digital decision tools and technologies, including use of demonstration and farmer-to-farmer learning and support;
  - adoption of reliable, flexible and commercially-relevant benchmarking tools, capable of integrating technical decisions with economic and environmental outcomes.

- Provide the tools and technologies that will enable farmers to measure and monitor key environmental indicators with sufficient scientific robustness to provide evidence for achievement of sought-after outcomes.

- Establish effective long-term relationships between public and private sector scientists, advisory sectors and practitioners to address personnel and skills gaps in key areas such as soils, agronomy,

physiology, pathology and entomology.

- To achieve more rapid impact on industry-wide productivity, extend mechanisms to enable learning from and replication of existing innovation and cutting edge practices and technologies already in use in the UK and internationally.

- Impress on research funders and providers recognition of the value and impact of practical knowledge exchange and translation activities by seeking the following actions:
  - Embedding mechanisms that encourage recruitment and reward of those who demonstrating these skills;
  - Ensuring knowledge exchange and potential for practical impact is built in as a fully funded element of applications for research grants with implementation from the outset, continual review and refinement throughout the lifetime of the project.

Use of social and economic sciences

- In the context of policy development and implementation the following areas require consideration:
  - to determine where policy interventions may be needed, conduct economic analyses of political, geopolitical and other impacts on trade in primary products, including barriers to trade and new markets
  - development of a deeper understanding of market drivers as well as current and future consumer demands, acceptance, perceptions and behaviours surrounding areas with a history of challenge such as: crop and animal biotechnology, large livestock units, housing, and pesticides.
  - exploration of the short, long and medium-term impact of policy decisions and regulatory changes, including assessing risk of unintended consequences and tipping points;
  - understanding and finding solutions to the requirement for more younger people to enter farming;
  - considering and defining the routes by which research and KE influence and enhance future domestic agriculture and rural development policy.

- Design methods to measure the value of scientific research, technology adoption and innovative practices to individual business, wider farming sectors, the economy, environment and society at large.

- Develop innovative approaches to engage and involve farmers and growers in research, through better understanding of the variation in their needs and preferences as well as targeted utilisation of advances in communications technology.

- Explore financial, social, skills-related, structural and regulatory constraints on farmers' uptake of new practices and technologies, and understand the trade-offs, taking into account cost and benefit in their widest sense.

- Learn from what works in other sectors and other countries in terms of funding models, KE mechanisms and supply chain relationships that encourage adoption of new technologies, tools and practices.

- Explore and quantify the value and impact of farming on the human health and wellbeing agenda, including functional food R&D and supply chains; identify any opportunities to deliver greater benefit at individual and population scales.

COMMODITY PRIORITIES

LIVESTOCK AND DAIRY

Link animal
BEHAVIOUR
to housing design and livestock
MANAGEMENT SYSTEMS

Link analysis of
LARGE DATASETS
to precision breeding of animals

Develop robust strategy to
COUNTER ANTIMICROBIAL RESISTANCE

Sample and manage
AIR AND WATER QUALITY
in housed livestock
for early diagnosis

Intractable challenges

MASTITIS | **LAMENESS**

DERMATITIS | **SCAB AND FLUKE**

GENETICS TO ADDRESS:

Greenhouse gas **EMISSIONS**

FERTILITY

BEHAVIOURAL TRAITS

Genetic determinates of **MEAT** eating quality/ uniformity

BIOSECURITY

Emphasise composite
LIVESTOCK BREEDING
to achieve genetic gains

Provision of information about
TRACE ELEMENT
build-up in carcasses

Manage and utilise manures and farm wastes for
ENVIRONMENTAL BENEFIT AND PRODUCTIVITY

COMMODITY PRIORITIES

ARABLE

Realise potential of
ROBOTIC, DIGITAL, AUTOMATED
and innovative engineering technology

REAL-TIME SYSTEM MONITORING

WEATHER FORECAST
improvement and response

DATA

COLLECTION

INTERPRETATION

and return on the value of
FARMER-GENERATED DATA

INTEROPERABILITY
between machinery and other devices and databases

GENETIC SOLUTIONS
to decline in crop protection products

REMOVE BARRIERS
to the adoption of new approaches and practices

ADDRESS POOR CONNECTIVITY

EFFICIENT RESOURCE USE
such as fuel, fertilisers, water, crop protection

SIMPLE STANDARDISED TEST SYSTEMS
for
NUTRIENTS
in soil and crops to aid diagnosis

Promote the development of
NEW BREEDING TECHNIQUES (NBT)

MAP AND UNDERSTAND
the source of variation in soil properties

TRAINING IN AGRIBUSINESS
management skills & new digital decision tools

Use training and technology to
INCREASE LABOUR EFFICIENCY
and address shortages

Deeper understanding of
MARKET DRIVERS

Enable
DURABLE INTEGRATED PEST MANAGEMENT

COMMODITY PRIORITIES

HORTICULTURE

Use of innovative technologies to

EASE LABOUR AND SKILLS SHORTAGE

Explore and quantify value and impact of farming on the human

HEALTH AND WELLBEING

agenda

APPLY GENETIC TECHNOLOGIES

to high priority challenges facing crop producers

- Yield
- Resistance
- Climate Change
- Enhanced nutritional quality
- Ease of harvest

Enable

DURABLE INTEGRATED MANAGEMENT OF CROP PESTS, DISEASES AND WEEDS

in the face of regulatory restrictions and limited availability of crop protection

- Chemical regulatory systems fit for purpose
- Commercial biological control systems as part of integrated management

DEVELOP NBTS

such as gene editing and accelerate application to agriculture

COMMODITY PRIORITIES

POULTRY

GENETIC SOLUTIONS
to antimicrobial resistance in pathogens

Define and measure
WELL-BEING AND STRESS
in farmed animals leading to 'best practice' tools

Technology to sample and manage
AIR AND WATER QUALITY
in housed systems

Focus on widespread health and welfare problems such as
RED MITE

Innovative use of
WASTE PRODUCTS

TRAINING
in agribusiness management skills, structures, resources

Explore financial, social, skills-related, structural and regulatory
CONSTRAINTS ON FARMER UPTAKE
of new practices and technologies

Commercial scale
RODENT CONTROL

Quantify value of farming on human
HEALTH AND WELLBEING

Deeper understanding of
MARKET DRIVERS

NAME: David Speller – East Midlands
SECTOR: Poultry – broiler chickens

Example of innovative farming:

In addition to owning a poultry farm in the East Midlands, I also run the management company Applied Poultry, which helps manage broiler farms across the UK. On average, we manage three million chickens per day. With most farms processing eight cycles of chicks every year, this equates to 20 million chickens per annum. On the farm I have increased biosecurity measures using a range of different techniques. For instance, grain lorries no longer come anywhere near the sheds. Instead the grain is deposited at a different site then sent through underground feed shoots to the poultry sheds. We have also introduced fob systems to get in and out of each area, preventing unnecessary access and heightened disease risk. In some cases these systems are connected to hand dryers to encourage hygienic practice. If the hand dryers haven't been used for at least 10 seconds then the fob will not work.

Investment in a new poultry shed can take 15 years to pay off. At a time when margins are down it is more important than ever to have effective management in the sheds to increase both productivity and welfare.

The industry needs:

- An improved use of data to forecast and manage each farm
- To embrace sensor technologies as they develop
- To understand how to cope with a reduction in the use of medicine as a welfare tool

I believe remote optimisation is the way forward. We need a global, web-based platform in different languages that can be used on every farm. Not only should this system tell you what is wrong, for example if the chickens haven't eaten their usual quantity of food on a certain day, but also why this has happened and what the farm manager can do to help – such as adjusting the temperature in the sheds, changing the height of the feeders or changing the type of feed.

Future goals:

- Immersive technology – to be able to see, hear and smell the birds from your desk, allowing for more intuitive management
- Mobile sensors on robots – to test how disease spreads through a shed, look out for signs of lameness etc
- Biometric sensors
- Predictive software to analyse data

> *To improve innovation in agriculture it is useful to look at how issues such as biosecurity have been dealt with in other industries, for instance in the medical industry, and how we can adapt these methods for use on the farm*

NAME: Chris Wray – East Midlands
SECTOR: Arable – South Lincolnshire.

Example of innovative farming:

I believe simplicity is vital for new technology in agriculture. One of my key concerns is the movement of data and data flow between different software on my farm. If we can integrate different systems it would save farmers a lot of time and help them to produce more efficiently. For instance, on my farm in Lincolnshire I use the same system to control the lights in my home, the solar panels used to heat our hot water, the roller doors outside in the barns and to control the temperature within my grain stores. If I could do this with all my farm software it would simplify and quicken the process significantly.

Conductivity records, field samples and yield results recorded by the combine are all used to produce precision application maps. I use these, not only to aid the traceability of my grain (I should be able to pinpoint exactly where a tonne of grain has come from), but also to variably apply seed and fertiliser based on the requirements of each part of the field. For instance, if I know a particular area is prone to blackgrass I will set my sprayer to turn off when passing over this area. In doing this we're aiming to maximise output, not waste or dose areas unnecessarily and protect the environment.

My licence to fly a drone for commercial use allows me to get a birds-eye view of the crops as we progress through the year, identify potential problems and decide what to do better next year. However, drones are only useful to farmers in terms of data flow. Any technology that takes too long to set up, or that relies on broadband in areas where access is not guaranteed, will always be limited.

Do you have any interaction with researchers or technologists?

On 23 November I was one of a group of eight NFU farmers who spoke at a seminar hosted by Tech UK. The event provided the opportunity for digital innovators and farmers to come together to develop innovative solutions to real-world problems.

> ***Farmers are naturally innovative. They build on and adapt equipment every day until it is fit for purpose. Future research needs to make use of this and provide farmers with the opportunity to test and trial new technology, giving them a channel through which to feedback. This will ensure technology is produced in line with the needs and asks of its target audience.***

"We are stuck with technology when what we really want is stuff that works" – Douglas Adams

CASE STUDY

NAME: Adam Quinney – West Midlands
SECTOR: Livestock – mixed farm in Warwickshire

Example of innovative farming:

In addition to working with AHDB, primarily in the cattle and sheep sector, I run a livestock farm in Warwickshire with my wife. We use various technology systems to manage the farm more efficiently, from the feeder wagon to the cattle crush. Many farmers already have farm recording software, primarily to comply with regulatory record keeping. Persuading a farmer to change to a system that delivers management assistance in addition to meeting recording needs and being understood can be a challenge. Another barrier to upgrading is the need for any new system to also be able to migrate across years' worth of data. Our software, at every stage, needs to be able to 'talk' with one another on farm and between farms. For instance, we have software on our feed wagon detailing ration ingredients and quantities, separate recording software telling me which cattle are in which pens, as well as hardware recording the weight of the cattle. Recently we have combined all three so that I receive amalgamated information directly to my phone. This provides me with live performance and financial data reports for the pens and individual cattle.

Databases also need to talk to each other. There are many different ones just in the livestock sector, such as animal movement, assurance, breeding values and animal health. If we could combine all the information it would lead to a more competitive industry. The experimental LIDEH (Livestock ID Exchange Hub) is a demonstration of this. It could mean that when buying cattle in the ring you would see whether the farm is TB-free, farm-assured and what medicine has been used on the livestock, allowing you to bid accordingly. This would help reward the previous owner for genetic selection and animal health status. We do, however, need to be wary about data ownership. To share data effectively there needs to be stringent measures in place to assure and protect the individual.

Improving farm efficiency is not just about new kit but is largely to do with stockmanship. Good fencing linked to mob grazing, for example, can lead to 20-30% higher output. We have started introducing experimental virtual fencing to keep cattle in certain areas of the field for a set period before being allowed to roam onto new pasture every few hours. This is accomplished using ringing noises and low voltage electric shocks from collars around the necks of the animal – these also monitor animal health and behaviour. However, there are still issues with this technology as we need to develop a longer lasting battery. Robust and practical technology is the way forward.

New technology will also help us to classify carcasses based on retail value not meat yield. Soon we expect to see 3D cameras estimating the retail value of each carcass based on where the meat yield is on the animal. Producing cattle where a higher percentage meet the needs of the consumer will be vital in giving UK cattle farmers the edge and helping to reduce volatility.

> *"We need more money invested into the industry to ensure technology and software databases in British agriculture are cutting edge and competitive. In Ireland, they are spending 250 million euros over four years looking at beef genomics; comparatively in the UK we are spending £160 million as part of the Agri-Tech strategy. The next generation of livestock farmers want systems that can gather data easily, provide good quality information to enable sound management decisions, and maintain consumer confidence in production standards without burying farmers in paperwork."*

CASE STUDY

NAME: Phil Jarvis – East Midlands
SECTOR: Mixed farm – Leicestershire

Example of innovative farming:

I manage the GWCT Allerton Project on the Loddington Estate. The project researches farm ecosystems and the effects of different farming methods on wildlife and the environment. It has been managed in collaboration with a neighbouring farm since 2001, when we moved to minimum tillage. Due to widespread interest in the Allerton Project we have constructed a visitor centre, built from sustainable materials, where we provide education and training courses. We are interested in trialling different farming methods and technology which work to increase productivity whilst also protecting and preserving the surrounding environment.

I believe we have lost touch with what is good for our soil and that soil health has been neglected for too long. At Allerton we are trying to make our soils more resilient. We're also exploring our crop nutrition with regard to the soil and plant relationships and questioning where, when and how we can get smarter in our use of a range of fertilisers. We are looking to increase our efficiency leading to higher financial crop margins, whilst looking after the ecosystems that exist in our rural landscape.

We have successfully widened our rotations, introduced cover crops as 'soil armour' and we are now making the transition, wherever possible, towards direct drilling. The low-intervention drilling approach allows our soils to remain largely undisturbed by leaving crop residues on the surface from harvest until sowing. Seeds are placed into narrow slots created by purpose built drills. We have developed a two pass operation. A low disturbance sub-soiler is used to remove compaction. We then drill into retained moisture using a Dale Eco-drill. To complement this we have reduced the size of our machinery and replaced the tyres on our combine with tracks.

Interaction with researchers and technologists:

We belong to a group of 'Kelloggs Origins' farmers who are like-minded in their approach to wholesome profitable food production and environmental protection. Our meetings have allowed us to visit, discuss and collaborate with Rothamsted, NIAB and numerous other academic institutions. It is also becoming evident from our discussions at the NFU Environment Forum that productivity and greater environmental performance are very much integrated and can be delivered by similar science and technology on farms.

> ***"By providing training courses we are not only helping to raise awareness of the challenges facing farmers but also how they can overcome those challenges. Knowledge exchange and continued conversation between farmers and researchers is important in maintaining the balance between food production and the environment. Translating academic research and teasing out the key practical elements for farmers and growers is imperative to get the best value from our science and technology research. The rural landscape will benefit from such a joined-up approach and we need to make sure our policy makers show clear leadership to make this happen."***

Barriers and enablers to adopting new farm practices and technologies

Jim Godfrey
Lincolnshire farmer; Chairman of NIAB, Commercial Farmers Group and the International Rice Research Institute (IRRI); Member of the Agri-Food Technology Council and the Farming Futures steering group.

Feeding the Future was the opportunity for primary producers to set out their priorities for research over the next two decades. While the original report still stands, it was always intended to be reviewed and updated and I commend the NFU for revisiting its priorities with their members. Alongside the 2013 report, this new document reaffirms the importance of science to British farming and highlights some areas of increased importance. Having provided the foreword to the original report, here I give my personal perspective on some of the factors affecting the speed of uptake of innovations, with illustrations from my experience as a farmer and from my involvement in research centres in the UK and internationally.

The time lag between discoveries, further research, development and uptake can be many years. The reason for this is often attributed to slow adoption by the farmer but the reality is more complex. An example is the discovery in 1934 of ethylene as a naturally occurring plant hormone. In the 1960s Professor John Hillman researched the effect of ethylene on controlling sprouting in stored potatoes. In 2001 Greenvale AP were the first to use ethylene in commercial potato storage, patenting and marketing an application technique, Restrain, in 2003. Those 70 years between discovery and commercial use can be partly attributed to lack of effective means of application and to cheaper alternatives such as CIPC and tecnazene and the rate of development of high quality temperature controlled storage. Concerns over sprout suppressant residues facilitated the development and eventual adoption of the ethylene application technology. Today it is widely used to control sprouting in potato stores.

As well as these market and commercial factors, government regulation does affect the rate of development and uptake of technologies, sometimes in unexpected ways:

Slowing adoption: In the intensive pig sector the Integrated Pollution Prevention Control (IPPC) regulations only apply to indoor pig farms above a certain size. In the case of growing pigs this is set at 2,000 pig places on the farm. Most new pig growing buildings and farms are therefore below this threshold. They cannot achieve efficiencies of scale and are usually not incorporating the best available technology. Ultimately this also limits opportunities to reduce environmental footprint and damages the competitiveness of the UK pig sector.

Speeding up adoption: The introduction of the National Living Wage and possible reduction in the availability of non-UK labour following the UK exit from the EU, is prompting greater interest in labour saving technologies such as mechanical harvesting of field vegetables, greater automation in post-harvest handling, driverless tractors and robot technology.

Another important factor in innovation adoption is financial incentive. For example, many farm businesses are now collecting roof water for washing buildings and using private boreholes for drinking water for livestock and crop spraying. This is cheaper and more sustainable than buying potable water from water companies.

If the government genuinely wants to encourage innovation, it should conduct a cost benefit analysis to help decide whether the financial incentives and regulatory system are facilitating or hindering adoption. For farmers and growers it is in their interests to be early adopters of new tools and practices, to enable them to be more competitive and meet the needs of their customers. This review of *Feeding the Future* will help decision-makers, funders and providers to have a better understanding of the science and research required to meet the challenges facing agriculture in the decades ahead.

LINKS

Feeding the future – www.nfuonline.com/feedingthefuture/

UK Strategy for Agricultural Technologies – http://bit.ly/1hwcb2t

Agri-Tech Catalyst – http://bit.ly/1DUpd4S

Agri-Tech Catalyst Map – http://bit.ly/2iAsXUa

The Centre for Applied Crop Science – www.cropscience.uk

Agri-food Technology Leadership Council – http://bit.ly/2iAB2Z8

UK Agri-Tech Sector – http://bit.ly/2aIzepz

Agri-Tech Research and Development Funding – http://bit.ly/2j9qHUZ

KTN Interactive Landscape Tool – http://aflandscape.ktn–uk.org

Global food Security Funding Programme – www.foodsecurity.ac.uk

Innovative Farmers – www.innovativefarmers.org

Innovative for Agriculture – http://bit.ly/2iAv9uX

European Innovation Partnership – http://bit.ly/2hQCMsY

N8 Agri-food Programme – http://n8agrifood.ac.uk/

SIRN – http://sirn.org.uk/

NIAB/EMR – http://www.emr.ac.uk/

REF Impact – http://bit.ly/2j4HKn0

Nurse's Review of the Research Councils – http://bit.ly/1l7gl4A

Science Advice Mechanism – http://bit.ly/2iDKVTz

SAM High Level Group – http://bit.ly/1WPsLdi

SAPEA – http://bit.ly/2iIm9Ep

The European Innovation Council – http://bit.ly/1Q9F7J6

www.nfuonline.com/feedingthefuture

FEEDING THE FUTURE, FOUR YEARS ON:

A review of innovation needs for British farming.

This report was produced by Helen Ferrier, Verity Richards and Sam Durham, with input from NFU members.

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