UK Plant Sciences Federation

Funding Working Group implementation plan

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This report was produced by an independent working group convened under the UK Plant Sciences Federation. All views, unless otherwise noted, are those expressed at the working group meetings, and are not necessarily those of the convening groups.

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External guests

Rob Bradburne	Defra
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Dean Cook	Innovate UK

Background to the group's activities

The UKPSF Funding Working Group was set up to review current constraints around UK plant science funding and to develop a future plan to implement the recommendations set out in the UKPSF's plant science status report. The group met on two occasions, 22nd July and 30th September 2014. On the 30th September 2014, Rob Bradburne (Defra) was invited to provide an overview of Agri-Tech investment, and Amanda Collis (BBSRC) and Dean Cook (Innovate UK) attended to discuss mechanisms for influencing top-level science funding decisions in UK.

Scope

Plant science currently receives less than 4% of UK public research funding. Total investment in UK plant science from Government, levy boards and charities is approximately £125m per year.

The withdrawal of Government funding from near-market research in the 1980s, followed by annual cuts to Defra's R&D budget since 2005, have led to a serious decline in applied plant science research and skills. BBSRC has been under pressure to fill the gap in applied research and resources are now spread more thinly.

Having one major public funding agency for plant science has potential merits in creating a coherent, overriding investment strategy. However, it has placed plant science at a disadvantage relative to other areas of biology that can obtain funding from multiple public sources. Non-strategic grant applications must compete for a very limited pot of BBSRC money (12–15% of BBSRC's responsive mode budget) and plant science research that does not fit easily within BBSRC's remit has few other opportunities to receive funding.

Without building and sustaining funding for fundamental plant science alongside financial support for applied and translational science, the research system risks fracture.

Key recommendations from UKPSF report:

- Increased investment in plant science is urgently needed:

Government and industry must work together to build capacity by doubling current funding across the spectrum of plant science. They must develop integrated fundamental and applied programmes of research to increase crop productivity and resilience while conserving natural ecosystems. Centres for Agricultural Innovation that focus on crop improvement and crop protection would deliver much-needed progress towards food security and sustainability.

- Stability of funding is essential in the long term:

Extreme swings in policy and research funding priorities on a 5–10 year cycle are destructive to skills, infrastructure and innovation. We must create a long-term, balanced portfolio of basic and applied plant science research to generate a more durable system that produces a constant flow of knowledge and research outputs. This will be crucial to reinforce the UK's position as a world leader in plant science, which in turn will attract greater international collaboration and commercial investment.

Working Group analysis of the current status of plant science funding

A major issue for UK plant science is that it only has a single major funding agency. A consequence is that plant scientists, unlike those for example in medical research, have effectively no opportunity to submit re-worked proposals elsewhere. This situation is made worse by the BBSRC policy not to encourage re-submissions. The result is a loss of many good scientific ideas, loss of morale within plant science academia and a reluctance to

submit already excellent grant proposals until they are absolutely “watertight”. This is unhelpful for the field, and in particular discouraging for early career PIs who would benefit from advice and support from constructive external peer review.

Although the UK Government has renewed its interest in applied and translational plant science, there are concerns in a number of areas. Public funding for translational science has a strong focus on near-market research but leaves a gap in the translational space for pre-commercial research which is too risky for industry to fund alone. This is illustrated by current Innovate UK funding streams, and in the loss of the LINK programme from Defra, where current funding, specifically SAF-IP and Agri-tech Catalysts do not adequately fill the gap and are not sufficiently academically driven. Outside of BBSRC, funding opportunities are frequently one-off, with insufficient emphasis on sustained support.

The possibility of approaching different kinds of funders should be considered. In particular, there are opportunities in traditionally medical funding agencies with regards to research focused on nutritional benefits. There are also overseas opportunities (e.g. USA and Canada) for bilateral collaborative efforts.

Overall, the Working Group agreed that a better, co-ordinated approach was needed, that incorporated a “bottom-up” push from academia to complement the “top-down” pull from industry which is currently being established. It was recognised that industry needs to be encouraged to advocate the value of supporting basic research for transformative ideas.

This is an important time to be having discussions with funding agencies and Government; funding reviews are taking place in a number of organisations (e.g. Innovate UK), and the next Comprehensive Spending Review is in Autumn 2015.

Proposals for improving funding to UK plant science

Immediate and on-going activities:

- Encourage a broader re-submission policy for the top non-funded grants at BBSRC.
- Seek funding opportunities from agencies that have not traditionally supported plant science (e.g. Wellcome Trust and MRC) and encourage plant scientists to submit applications.
- Integrate the new Centres for Agri-Tech Innovation with a wide base of academic institutes, by making the case for specific Research Council calls for related basic and early stage applied research.
- Increase cross-sector science by encouraging more funding collaboration between Research Councils and other agencies, and breaking down funding area divides (e.g. MRC and BBSRC for medical and nutritional benefits of plant science).
- Attract international investment in UK plant science by increasing major international collaborations (e.g. BBSRC and NIH joint calls).
- Continue to make the case to Government and funders for the value of investment in UK plant science.

Medium to long term activities – within three years:

Develop a roadmap for UK plant sciences for the next 25 years. This should:

- Include the breadth of plant science.
- Focus on the Grand Challenges for plant science (Appendix 1).
- Include a Risk Register (draft outline in Appendix 2) and importantly, an Opportunities Register that focuses on the strategic high value of plant science.
- Receive input from academia, industry, funding agencies and NGOs. Amanda Collis (BBSRC) and Dean Cook (Innovate UK) have both indicated interest in contributing to this effort. The Knowledge Transfer Network (KTN) Plant Sector group could also be approached for help in identifying major stakeholders.

The Working Group recommends that UKPSF prioritises the roadmap development as a core activity and engages immediately with various stakeholders to establish their interest.

Points to consider for the roadmap are:

<u>Rationale for each Grand Challenge:</u>

- What is the economic value to the UK?
- What are the current drivers for this Grand Challenge?
- What additional drivers might there be in 10 years?
- What are the current trends in this Grand Challenge, and where do we expect trends to be in 5 and 10 years?
- Where are we currently in relation to technology development?

<u>Engagement:</u>

- What events might influence the prioritisation of this Grand Challenge?
- Where is public opinion at present? How should we look to inform the public about this Grand Challenge in the future?
- What is the current political position (national and international) on this Grand Challenge?
- How could political will be influenced to develop policy changes that will influence public funding direction?
- What is the extent of industry engagement in relation to this Grand Challenge?
- Is more industry participation in this area required, if so how can that be encouraged?

Scientific development:

- What technical innovations are required in the short and long terms?
- How does our basic science understanding in this area need to be strengthened?
- What additional capacity is needed?
- To what extent and where is cross-disciplinary research collaboration required?
- How ready is the field to respond to an unexpected emergency?

The Working Group is aware of other reports and initiatives that address areas relevant to the roadmap proposal. These include the "Feeding the Future – Innovation Requirements for Primary Food Production in the UK to 2030" report,[1] the conclusions of the Green Food Project,[2] the "New Innovative Approaches to Crop Protection" report from the Food Research Partnership,[3] a mapping exercise currently being completed by the Food Research Partnership[4] and the development of a UK Strategy for Animal and Plant Health (due to be published in 2015).

[1] http://feedingthefuture.info/
[2] https://www.gov.uk/government/publications/green-food-project-conclusions
[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/278446/13-892-innovative-approaches-crop-protection.pdf
[4] http://www.foodsecurity.ac.uk/assets/pdfs/gfs-strategic-plan.pdf

Appendix 1 – Grand Challenges

Food security

The population is expanding and there must be enough food for everyone.

- Improving yield
    - Higher yield varieties
    - Closing the yield gap
- Reducing food waste
    - Reducing postharvest loss
    - Innovative storage solutions and extended product freshness
- Tackling plant pests and disease
    - Improved resistance
    - Improved plant protection products
    - Integrated pest management systems
- Extending seasonality and quality of produce
- Improving year-round supply:
    - Modifying maturity
    - Improving stress tolerance
- Extending crops' geographical area
    - Improved germination and growth in UK conditions

Producing healthier foods

As well as enough food, it needs to be the right quality – calories are not enough.

- Developing food crops with higher nutritional values and novel health benefits
- Developing food crops with reduced levels of unhealthy compounds
- Improving digestibility for human or livestock consumption

Adapting to climate change and extreme weather

Our climate is changing and we must adapt our crops to be more resilient.

- Increasing genetic diversity used for breeding
- Exploring new crops or those from other environments that will suit our future climatic conditions
- Identifying novel stress tolerance characters
- Development of small molecules to mitigate stress

Environmental sustainability

Both food and other crops must not drain the resources that we have.

- Using resources more efficiently

    - Improving resource uptake by plants
    - Improving resource (e.g. nitrogen, phosphorus and water) use efficiency
    - Reducing wastage of resources (e.g. by leaching)
    - Engineering nitrogen fixation
- Protecting biodiversity
    - Monitoring biodiversity
    - Identification of emergent pests, diseases and invasive species
    - Improving resistance to emergent pests and diseases

<u>A green bioeconomy</u>

We must ensure sustainable production of plant based non-food products for the future, as our finite resources are depleted.

- Producing bioenergy
    - Identifying new alternative bioenergy sources
    - Developing more efficient bioenergy feedstocks
        - Increased biomass
        - Improved digestibility/quality attributes
- Making bioproducts
    - New crops for specialist markets
    - Plant natural products for the food, drink, agriculture and pharmaceutical industries
    - Industrial applications e.g. novel biodegradable polymers
    - Pharmaceutical end-use properties e.g. protein-based drugs, vaccines and antibodies
    - Fibre

Specific roles for plant science

- Understanding plant genetics/genomics, biochemistry/metabolism, physiology and evolution, and how these underpin phenotypes and environmental response.
- Identifying, understanding and exploiting genetic variation.
- Understanding and exploiting plant chemistry.
- Plant phylogeny and taxonomy.
- Understanding interactions between organisms.
- Translation of basic knowledge into crops.
- Incorporation of traits into breeding programmes.
- Modelling to predict traits e.g. for climate change scenarios, and testing under (artificial) conditions.
- Improving scale-up and extraction of plant bioproducts.
- Understanding ecosystems and ecosystems services.
- Integrating and analysing big data.

Appendix 2 – Draft Risk Register outline

Risk 1: Outbreaks of plant pests and diseases

- **Causes:**
    - Insufficient research on pest/disease resistance and prevention of disease spread.
    - Insufficient research into plant protection methods.
    - Regulatory barriers with respect to plant protection products.
    - Insufficient surveillance of new and existing disease threats.
    - Inadequate monitoring/quarantining/regulation of plant imports.
    - Reliance on monoculture.
    - Training and skills gaps in pest/pathogen identification and management.
- **Likelihood:**
- **Severity of impact:**

From UKPSF Report:
- Crop protection currently saves UK consumers an estimated £70bn in annual food costs.
- Leaf blotch: capacity to reduce wheat yields by 30–40% and can cause UK crop losses of up to £35.5m a year.

- **Overall risk score:**
- **Preventative measures:**
    - Increased/coordinated fundamental, translational and applied research into disease resistance and plant protection.
    - Increased UK workforce training in plant pathology.
    - Implementation of a risk-based regulatory system for plant protection products.
    - Improved surveillance of pests/diseases.
    - Improved border controls on imported plant products.
    - Improved integrated pest management protocols and transfer of this knowledge to growers and land owners/managers.
    - Coordinated strategies to access funding across the breadth of fundamental, translational and applied research.
    - Raise the issue of stricter border controls for non-native plant species with UK Government.
    - Work with researchers, growers, levy boards and industry to coordinate and communicate improved integrated pest management strategies.
- **Contingency/proposed action:**
    - Ring-fenced funding to access in the event of an outbreak.
    - Fast training in pathogen identification and management practices.
    - Fast establishment of panel of experts, international if necessary.

Risk 2: Food insecurity in the UK

- **Causes:**
  - Insufficient year-round supply of home-produced foods to meet the UK population's needs, requiring increased reliance on overseas imports.
  - Inability to control crop pests and diseases.
  - Inability to close the theoretical–actual yield gap.
  - Loss of agricultural land for food and feed crops.
  - Rising costs in the supply chain leading to imports being cheaper than home-grown foods.
  - Excessive waste due to pests, disease, poor post-harvest storage etc.
- **Likelihood:**
- **Severity of impact:**
- **Overall risk score:**
- **Preventative measures:**
  - Increased/coordinated fundamental, translational and applied research into disease resistance and plant protection.
  - Increased/coordinated fundamental, translational and applied research into crop optimisation e.g. reducing oilseed rape pod shatter.
  - Increased research into effective post-harvest storage methods.
  - Incentives/marketing to encourage consumers to buy locally produced foods.
  - Incentives for retailers to buy/sell UK produce at a fair price.
  - Protection and/or reallocation of agricultural land for the growth of food or feed crops.
  - Incentives for growers to continue growing food rather than diverting land use.
  - Increased transfer of knowledge from research into practice to help growers farm more efficiently (reducing costs).
  - Coordinated strategies to access funding across the breadth of fundamental, translational and applied research.
  - Discuss issues surrounding food security with relevant stakeholders (retail, industry, processors, growers etc).
  - Improved forecasting.
  - Discuss strategies to protect/reallocate agricultural land with UK government.
- **Contingency/proposed action:**
  - Ring-fenced funds to access in an emergency to import food from abroad.

Risk 3: Public health crisis

- **Causes:**
  - Loss of nutritional traits from food and feed through inefficient plant breeding techniques.
  - Increased undesirable compounds in food and feed crops.
  - Loss of digestibility traits in food or feed crops.
  - Intolerance of crops to unpredictable, unseasonal weather and climate change leading to low grade produce.
  - Unaffordable nutritionally rich foods.
- **Likelihood:**

- **Severity of impact:**
- **Overall risk score:**
- **Preventative measures:**
    - Increased/coordinated fundamental, translational and applied research into breeding tolerant, resistant crop varieties.
    - Increased/coordinated fundamental, translational and applied research into breeding more nutritious food and feed.
    - Increased/coordinated fundamental, translational and applied research into the development of plant factories for beneficial nutrients.
    - Increased transfer of knowledge from research to practice to ensure growers farm more efficiently and effectively.
    - Protection and/or reallocation of agricultural land for the growth of food or feed crops.
    - Increased resource use efficiency.
    - Education and outreach campaigns.
    - Coordinated strategies to access funding across the breadth of fundamental, translational and applied research.
    - Coordinated strategies to effectively transfer knowledge from the lab/field to practice.
- **Contingency/proposed action:**

Risk 4: Loss of biodiversity and collapse of ecosystems

- **Causes:**
    - Pressure to increase crop yields and quality at the expense of the environment/native species.
    - Poor control of invasive species.
    - Insufficient protection for vulnerable/threatened native species.
    - Loss of habitat for native species.
    - Inadequate surveillance/monitoring of emerging threats to biodiversity.
- **Likelihood:**
- **Severity of impact:**
- **Overall risk score:**
- **Preventative measures:**
    - Increased transfer of knowledge from research to practice to ensure growers understand the importance of conserving biodiversity.
    - Improved management practices to reduce environmental impact of food production.
    - Increased research into breeding crop varieties with optimal resource use efficiency.
    - Increased use of crop wild relatives to increase genetic biodiversity.
    - Increased research and development into methods to identify and monitor invasive species/emerging diseases.
- **Contingency/proposed action:**
    - Coordinated strategies to access funding across the breadth of fundamental, translational and applied research.
    - Coordinated strategies to effectively transfer knowledge from the lab/field into

practice.
    - Discuss strategies to protect/conserve biodiversity with UK government.

Risk 5: Inadequate supply of 'green' energy when fossil fuels are depleted

- **Causes:**
    - Resistance to renewable/alternative energy sources (e.g. wind farms considered "eyesores", solar panels "inefficient").
    - Lack of investment into the development of efficient biofuels.
- **Likelihood:**
- **Severity of impact:**
- **Overall risk score:**
- **Preventative measures:**
    - Increased research into the development of efficient biofuels and alternative energy sources.
    - Improved regulatory landscape for developing genetically modified plants for biofuels.
    - Marketing/communication to highlight the benefits of and build support for alternative energy sources.
- **Contingency/proposed action:**
    - Coordinated strategies to access funding across the breadth of fundamental, translational and applied research.
    - Coordinated strategies to transfer knowledge effectively from the lab/field to commercial application.
    - Coordinated marketing campaigns to improve communication of the benefits of biofuels.
    - Work with energy industries, car manufacturers etc to increase accessibility to renewable energy.