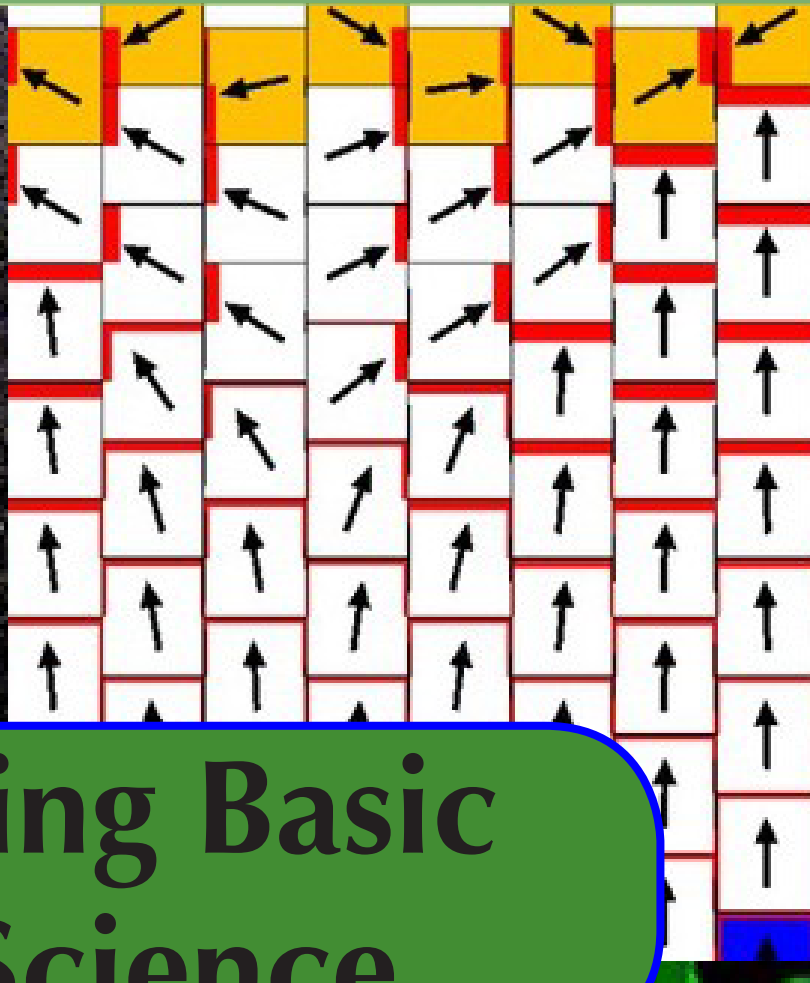
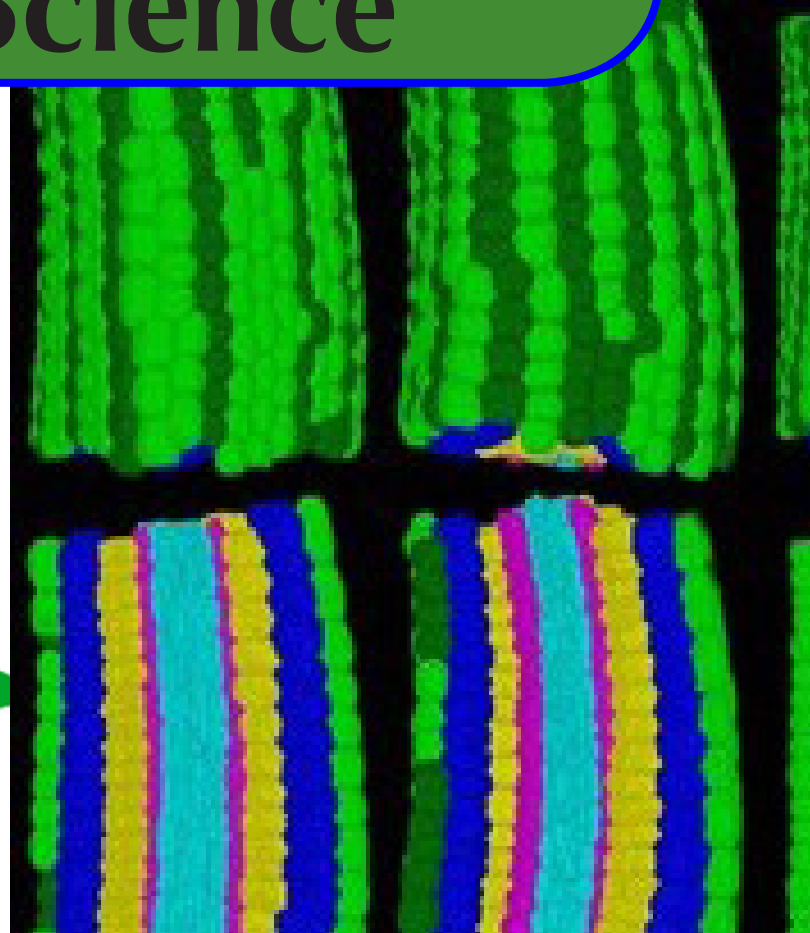


GARNish

Support for Basic Plant Science



Supporting Basic Plant Science



Reversing the Decline in Plant Science Applications to the BBSRC Responsive Mode: analysis and recommendations from GARNet

GARNet Advisory Committee

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GARNet is a community-facing UK network funded by BBSRC through Responsive Mode that supports the delivery of outstanding plant science research^a. GARNet's primary focus is supporting researchers who work on fundamental areas of plant science, particularly around the adoption of new technologies and new ways of working. Recently members of the plant science community have expressed concerns about a perceived lack of opportunities to obtain funding for fundamental plant science.

The primary mechanism for obtaining funding of this type comes through BBSRC Responsive Mode funding predominantly via Research Committee B: Plants, microbes, food and sustainability^{b,c}. As a service to the community, GARNet asked the BBSRC to analyse their data regarding the number of plant science applications, which is not in the public domain. The BBSRC found that the number of total plant science applications is declining in line with the number of funded projects. However the number of applications to study aspects of fundamental plant science is declining at a faster rate (Figure 2). Our findings allowed us to make a series of recommendations that are outlined at the end of this article.

- In recent years funding for fundamental plant science research has declined

Since 2014 the success rate for grants submitted to Research Committee B has remained between 20-25%^d. However we found that across all successful grants the distribution of research topics has changed. We illustrated these changes in two ways. Firstly we divided the successful grants into four categories: Category 1- grants that use Arabidopsis in any part of the proposed work, Category 2- grants that propose to work with cereals, Category 3- grants that propose to work with any other plant species, such as potato or tomato, Category 4- grants that do not include any aspect of plant science (Figure 1A).

Secondly we interrogated the text descriptions of successful plant science grants and characterised them as being 'fundamental' or 'translational/applied' (Figure 1B). This analysis includes an important caveat that the classifications have been determined from written descriptions so the actual research program might include fundamental or translational/applied activities that are not immediately obvious and that sometimes the distinction between these categories is blurred.

Figure 1A shows that the split between plant and non-plant grants had remained consistent between 2014-2016 although over the past year support for non-plant grants has risen. Within the plant categories (1-3), the number of grants in category 1 has declined whereas category 3 grants have increased. Categories 2 and 3 grants predominantly, although not exclusively, included translational/ applied research, which explains why category 1 in Figure 1A is similar to the 'fundamental' portion of Figure 1B. Figure 1

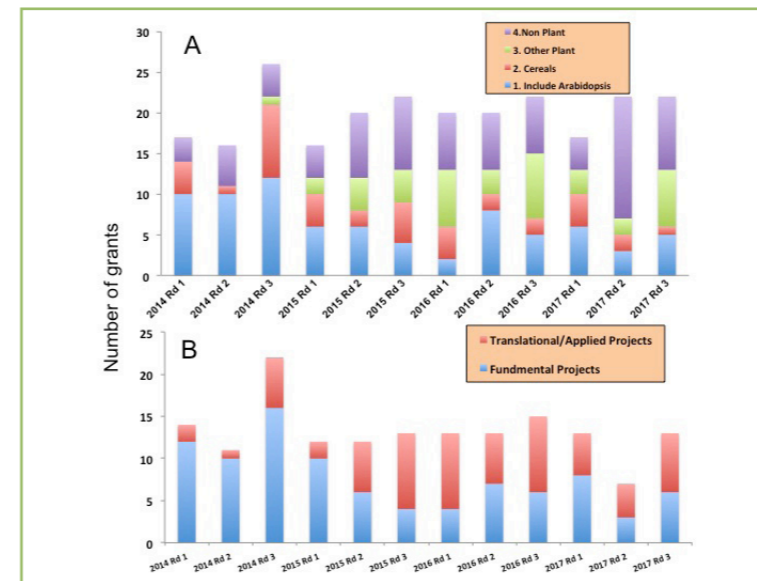


Figure 1: BBSRC responsive mode grants funded by Research Committee B between 2014-2017. A- Successful grants have been placed in four categories: 1. Grants featuring any Arabidopsis research 2. Grant focused on Cereals 3. Grants focused on research using another plant 4. Grants that focus on non-plants B- Successful plant science grants have been divided into those who propose to work on fundamental vs translational/applied areas of research. In this analysis multiple awards >£100K to work on the same great are treated as separate awards.

appears to support the perceived concerns within GARNet of a decline in support for fundamental plant science.

This decline should be of wider concern given that research in Arabidopsis and other model organisms underpins much of the work that is now supported in wheat and other cereals and drives the world-class basic research for which the UK plant science community is recognised. Without this fundamental work incentivizing new techniques and discoveries, it is highly likely translatable opportunities will diminish and result in reduced international competitiveness.

Because Responsive Mode is the primary support route for fundamental research, which is typically underrepresented in strategic priority calls (e.g. GCRF, ISCF^e), we approached BBSRC to inquire

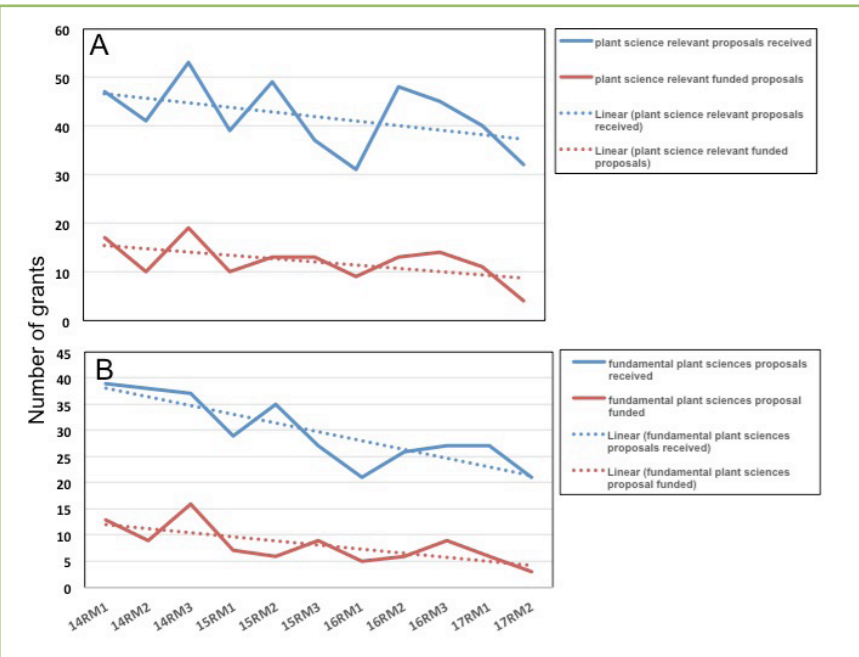
whether there has been a change in policy regarding the support for fundamental research grants. BBSRC responded clearly that the answer is no.

- BBSRC data highlight a worrying decline in plant science submissions

Information about the total applications made to Responsive Mode is in the public domain and the numbers submitted to Committee B have remained constant over the past 4 years. However information about the distribution of research topics within those unfunded submissions is not publically available. Upon GARNet's request the BBSRC examined their in-house information regarding plant science grants submitted to responsive mode, the categorisation of which were determined with the same caveats as above. Figure 2 shows that the number of successful grants has declined, both for plant sciences as a whole (Figure 2A) and for those that are characterised as fundamental research (Figure 2B). This information matches GARNet's findings from Figure 1.

The underlying driver of the trends in Figure 2 is the drop in total number of plant science applications over that time-period, which is proportional to the decline in funded grants (Figure 2A). However the number of grants submitted that propose to work on fundamental plant science has **declined at a faster rate** than the decline in funded grants of this type (Figure 2B).

A BBSRC member of staff familiar with the plant science funding landscape attended the GARNet advisory committee meeting in December 2017 to discuss these findings. The minutes from the meeting can be downloaded from the GARNet website^f and the topics discussed are documented below.



Activity: Figure 3 shows that the seed stock orders from the Nottingham Arabidopsis Stock Centre (NASC) by UK institutions has largely remained steady over the past four years^g. Given that stock orders most likely represents the initiation of a new research project this data suggests that in the UK the amount of Arabidopsis research is increasing or at the very least continuing at a similar level.

Outputs: When the NCBI PubMed database is searched for “Arabidopsis” and “UK” it shows that the number of original research papers has risen since 2014 (Figure 4). GARNet categorically recognises that ‘fundamental’ research does not exclusively represent that conducted using Arabidopsis but feel it is a reasonable comparison for our purposes.

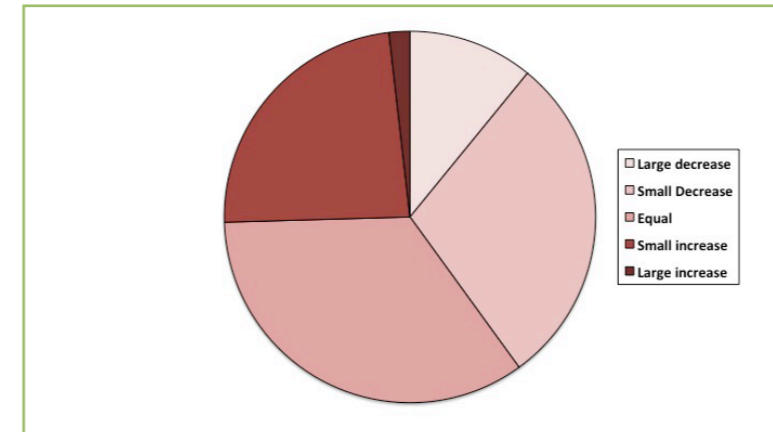


Figure 3: Change in number of Arabidopsis seed stocks ordered from NASC between 2014 and 2017. Between 2014-2017 each UK academic institution was ranked by the number of Arabidopsis seed stocks they ordered from the Nottingham Arabidopsis Stock Centre (NASC). Rank 1= No orders; rank 2= 1-99 orders; rank 3= 100-999 orders; rank 4= 1000+ orders. For each institution the 2017 rank number was subtracted from the 2014 rank number to give a final value that is included in this figure. For this figure a value of -2= large decrease in seed stock orders, -1= small decrease in seed stock orders 0= no change in seed stock orders 1= small increase in seed stock orders 2= large increase in seed stock orders. For example The University of York ordered 1000 seed stocks in 2014 (rank 4) and between 100-999 in 2017 (rank 3) and therefore receives a value of -1 (small decrease). Data kindly provided by NASC.

has provided unprecedented opportunities for translational and applied plant scientists who are working on topics relevant to ODA countries and to a lesser extent, translational opportunities to exploit outputs from fundamental plant science. This spread of opportunities appropriate for more translational/applied plant scientists might therefore reduce the total number of plant science applications made to Research Committee B.

Since 2013 the BBSRC has provided over £12M supporting 27 grants funded through the ERA-CAPS program^k. Given that these are large consortia grants, making a distinction between fundamental and translational/applied research is more challenging but there seems to be an

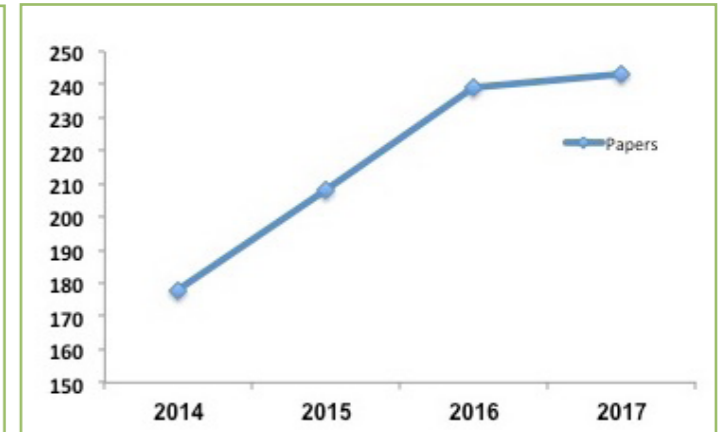


Figure 4: Numbers of original journal articles published between 2014-2017 that include research on Arabidopsis by UK plant scientists. NCBI PubMed was searched with the following parameters: Arabidopsis[Title/Abstract] AND UK AND "journal article"[Publication Type] AND YEAR[DP] NOT "review"[Publication Type].

even split between projects of either type. These projects usually support 3 years of postdoctoral research so it is possible that a successful ERA-CAPS applicant will be less motivated to submit a Responsive Mode proposal over this period. This could in part contribute to a small decline in Responsive Mode applications to research committee B.

An additional concern involves the fallout from Brexit and the future availability of ERC grants^l to UK plant scientists. Since 2014 thirteen UK-based plant scientists have received Starting, Consolidator or Advanced ERC grants amounting to approximately €35M and each of these proposes to undertake a significant proportion of research using Arabidopsis. If the UK does not participate in the next FP9 and other EU funding mechanisms then this clearly jeopardises a significant amount of support for fundamental plant science. The uncertainty around the post-Brexit role of UKRI prevents the BBSRC making any predictions regarding possible

What are the reasons that explain the decline in submitted plant science applications and especially those that propose to work on fundamental topics?

- Are there less UK plant scientists engaging in fundamental research?

There is no available data that directly documents whether there is less research activity in either plant science in general or specifically in fundamental areas of plant science. In an attempt to assess whether the number of researchers working on fundamental plant science has changed over the past few years we investigated two proxy measures.

Therefore Figures 3 and 4 indicate that fundamental plant science research activities using Arabidopsis have not decreased in recent years across the UK. This mirrors the global situation that continue to see a rise in the number of publications in which Arabidopsis is the primary research organism, demonstrating that other countries retain an emphasis in fundamental plant science research^h.

- Are UK Plant Scientists applying for funding elsewhere?

Agriculture and Food Security is a BBSRC strategic research priorityⁱ and the past years have seen more funding opportunities for researchers who work in translational or applied aspects of plant science. The recent implementation of the Global Challenges Research Fund^j (GCRF)

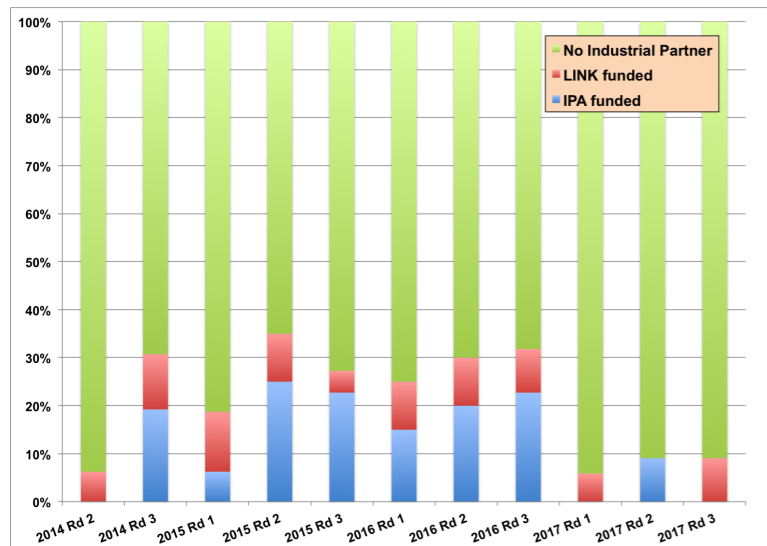


Figure 5: Number of successful LINK or IPA grants as a percentage of the total number of grants funded by Research Committee B in each grant round between 2014-2017. A description of IPA and LINK grants can be found at <https://www.bbsrc.ac.uk/funding>

supplementation of the funding pool if the opportunities to apply for EU funding disappear^m. We all continue to watch the slowly developing Brexit situation with some trepidation.

Although other funding opportunities for plant science researchers are available, these do not appear significant enough to explain the decline in Responsive Mode applications to Research committee B.

- Is there a problem with perception of BBSRC funding for fundamental plant science?

The majority of fundamental plant science research has used *Arabidopsis* as a model organism. However, GARNet identified a perception within the UK plant science community that the BBSRC prioritise funding other plant research ahead of *Arabidopsis* proposals. The GARNet Advisory Committee was assured by the BBSRC that this is not true and that they fund world-class bioscience of any type irrespective of the experimental organism.

The above perception may in part be due to a lack of understanding within the plant science community and by extension Committee B, of what IMPACT means for grant proposals. 'Impact' is an important aspect of any grant proposal as well as being a key component of the UK Research Excellence Framework (REF)ⁿ. However the BBSRC makes the case that all 'Impact' is not equal. Whereas REF-able 'Impact' usually refers to real-world applications of research outputs, the BBSRC Responsive Mode impact statement is assessed differently. Here 'Impact' can also refer to a longer-term fundamental contribution to a particular research area^o. If the proposal elucidates key questions that change the way we think about a biological problem then its long-term impact on a research area can be considerable and perfectly appropriate for the BBSRC impact statement.

GARNet Advisory Committee members were unsure whether this message is being strongly conveyed. In GARNet's experience many proposals include unnecessary portions of translational or applied research within grants that are clearly focused on a fundamental topic in order to accommodate a strategic component. **The BBSRC are clear that inclusion of a translational or applied component is not a necessary requirement for its support of world-class proposals on fundamental plant science but does encourage the addition of an applied component if it is appropriate for the suggested research.**

Related topics relevant to an assessment on the level of support for plant science applications for responsive mode funding.

- What is the current status of Research Committee Panel membership?

In recent years the research expertise present on Research Committee B may have been disproportionately distributed between fundamental versus translational/applied plant scientists. So how can a better balance of research expertise on the committee be achieved? In 2010 GARNet had similar discussions with the BBSRC about levels of grant funding. Alf Game, the then Deputy Director of Research for Innovation and Skills, prepared a comment piece for the GARNish newsletter that urged members of the GARNet community to apply to serve on grant panels^p.

Over the following 7 years it appears that this situation has not greatly changed. BBSRC emphasised the importance of participating in the evaluation process, first by agreeing to review grants and also by becoming members of Research Committees. The GARNet Advisory Committee suspects that the reduced involvement of fundamental researchers with Research Committee B might be due to a vicious cycle wherein the decline in funding levels decreases the willingness of fundamental researchers to engage with the review and selection process.

Encouraging more fundamental plant science researchers to become involved with committee membership could potentially arrest this cycle. The annual application process to join the BBSRC Pool of Experts usually occurs in the spring and is currently open for applications^q.

- Do the successes of LINK and IPA grants reduce the available pool of funding for fundamental plant science?

The numbers of successful proposals that support fundamental plant science is connected to the level of success of BBSRC IPA and LINK grants^r. Given their industrial links these grants almost exclusively fund translational or applied research. Since 2014, the average success rate for these grants is 50% (IPA, average number of submissions per round is 5.6) or 70% (LINK, average number of submissions is 2.8), which is significantly above the overall success rate across Responsive Mode^s. Figure 5 shows that from 2014 to 2017 between 9- 35% of total grants funded in each round via BBSRC Research Committee B are either IPAs or LINKs. This demonstrates that in many Responsive Mode rounds these more translational or applied awards remove a significant pool of funding that might otherwise be available to support fundamental plant science proposals.

- Can plant-science proposals be submitted to other research committees?

A final discussion topic involved community experiences in which plant science-focused proposals submitted to Research Committees A, C or D have been moved to Committee B. Anecdotal evidence indicates that in some cases this appeared to have happened without the knowledge of the submitting PI. While the BBSRC indicated they retain the right to transfer proposals between committees to match remit, they agree such decisions should be communicated to the PI before transfer takes place. The BBSRC will investigate why in some cases this has not occurred and in future strives

to contact all affected PIs. The BBSRC also insists that plant-based proposals are welcome to be submitted to any Committee that is the best fit for the proposed program of research.

Recommendations

1. GARNet and other UK plant science stakeholders to spread the message that the BBSRC is 'open-for-business' to fund world-class grants based on fundamental plant science, including Arabidopsis-only research.

2. GARNet and other UK plant science stakeholders to encourage the academic community to review Responsive Mode grants and to apply to join Research Committees. Currently, this is a particularly important action point for fundamental plant scientists.

3. GARNet uncovered considerable confusion over what can be considered 'Impact' within Responsive Mode proposals. We recommend that BBSRC circulates updated information to potential applicants and Research Committee panel members to clarify what exactly can be considered as 'Impact'. The BBSRC is providing a piece on this topic for GARNish issue 29, published in Summer 2018.

4. Plant scientists are encouraged to submit their proposal to Research Committee B, but where more appropriate for the proposed research program they are also invited to submit to any of the other Research Committees. Should BBSRC deem it necessary to transfer proposals between committees, they will provide applicants the choice to withdraw their proposal.

5. BBSRC to advise potential applicants that world-class fundamental research is appropriate to be included in relevant GCRF applications, provided that it includes a clear long-term path toward a demonstrable benefit in an ODA country.

6. Given the success of IPAs, we recommend BBSRC reassesses the criteria for evaluating these grants. BBSRC could look into the possibility of capping the number of successful LINK/IPA proposals to a reasonable proportion of funded applications within a single grant round. Grants of sufficient quality would be encouraged to reapply in subsequent funding rounds if they do not fit under the cap in any one round.

7. Plant scientists are encouraged to engage with BBSRC to suggest areas that are relevant for special grant calls. The BBSRC has some flexibility to use Newton Fund and GCRF calls to respond to novel areas of research interest if there is a demonstrable relevance to the aims of these funds.

References and notes

a- The GARNet grant has been continuous supported since 2000 through BBSRC Responsive Mode funding. It has had an emphasis on supporting technologies that enable advances in fundamental research with an historic focus on the use of Arabidopsis thaliana. The current GARNet PI is Professor Jim Murray at Cardiff University and the activities of the full time GARNet Coordinator are advised by academics elected from the UK plant science community. Over the lifetime of the grant the large majority of academics on the GARNet advisory committee undertake fundamental rather than applied research, most using Arabidopsis as their primary research organism.

b- <https://www.bbsrc.ac.uk/about/governance-structure/committees/committee-b/>

c- GARNet recognizes that the Leverhulme Trust plays an important role in funding high risk, "blue sky" plant science projects and has been an increasingly key provider of last resort for many fundamental plant science projects deemed unfundable at Committee B.

d- <https://www.bbsrc.ac.uk/funding/post-application/awarded-grants/>

e- Outside of responsive mode there is a current opportunity to apply for a sLOLA award that is focussed on Frontier Bioscience and would be extremely applicable for plant scientists who work on fundamental topics. <https://bbsrc.ukri.org/funding/filter/lola/>

f- <https://www.garnetcommunity.org.uk/reports>

g- Data provided by Professor Sean May, director of the Nottingham Arabidopsis Stock Centre and a member of the GARNet advisory committee.

h- arabidopsisresearch.org/images/publications/mascreports/2017_MASC_Report.pdf

i- <https://bbsrc.ukri.org/about/governance-structure/committees/committee-pool-membership/join-our-pool-of-experts-research-committee-e-follow-on-fund-committee/>

j- <http://www.rcuk.ac.uk/funding/gcrf/>

k- <http://www.era-caps.org/joint-calls/era-caps-funded-projects>

l- <https://erc.europa.eu/>

m- <https://www.ukro.ac.uk/Pages/brexit.aspx>

n- <http://www.ref.ac.uk/>

o- <https://bbsrc.ukri.org/funding/apply/application-guidance/pathways-impact/>

p- https://www.garnetcommunity.org.uk/sites/default/files/newsltr/garnish_jun10.pdf

q- <https://bbsrc.ukri.org/about/governance-structure/committees/committee-pool-membership/join-our-pool-of-experts-research-committee-e-follow-on-fund-committee/>

r- Grants of this type require an industrial partner who agrees to fund either 10% (IPA) or 50% (LINK) of the total cost.

s- On the four occasions that more than four LINK grants have been submitted during a single grant round only 50% of the grants were funded.



What is IMPACT according to the BBSRC

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BBSRC as part of UKRI is committed to supporting excellent science and to realising the maximum impact of the research it funds. This benefits not only the taxpayer but also the research base, since it helps BBSRC make the case for continued government investment in research.

So what is Impact?

Impact is the effect that your research has beyond your lab. Impact can materialise in many different ways, and it is specific to each project, so it will be as varied and wide as your own research. Impact is not the same as applied research; both applied and fundamental research have impact and researchers should identify the best routes to achieve it. Impact can involve academic, economic or societal drivers which will vary depending on the nature of the research being undertaken (Figure 1).

Some ways that excellent research can have an impact include:

- **Knowledge:** research contributes to the understanding of basic questions in biosciences and scientific advances, and the wider body of scientific knowledge available to researchers.
- **People:** research contributes to long-term training of the research base that will contribute in future scientific developments.

- **Society:** research contributes to improvements in health, quality of life, and international development.
- **Economy:** research contributes to wealth creation, encourage investments, new companies and/or new products and procedures.
- **Policy:** research contributes to development of new policies or guidelines, by providing an evidence base and answering key policy questions.

How do I write a good Pathways to Impact statement?

It is important not to confuse the 'Pathways to Impact' statement with long term implications of research. 'Pathways to Impact' need to be project-specific and outcome-driven, you should pay special attention to identify all interested parties and to plan how you can engage with all of them. The most common issues are failure to comprehensively consider different types of impact route, failure to identify specific goals and outcomes, and failure to have a clear plan of how impact activities will be delivered, by who and when. Activities identified need to be project-specific rather than generic activities.

How is impact factored into peer review decision making?

Pathways to Impact are an important part of any Research Council application for funding and can make the difference between two equally scientifically excellent grant proposals, so is it not trivial to get it right. No matter where down the translation line your research is you should explore and consider the general impact that your research could have in the future when applying for funding.

Impact can be varied.....

.....is about more than just IP, products and spin outs



Figure 1: Examples of the variety of ways that excellent research impact can materialise

What is the relationship between impact and BBSRC's strategy?

BBSRC highly values the contribution that excellent fundamental research makes in advancing a research field. It is important not to confuse research impact with aligning with BBSRC strategic priorities! While all researchers need to consider the potential impact of their research and the best way to explore it, not all fundamental research needs to have short-term outcomes directly linked to strategic priority areas, such as crop improvement. Academics are encouraged to design their research in the most appropriate way in order to achieve their objectives. BBSRC will continue delivering funding, focussing on research excellence across its diverse remit.

Cover images:

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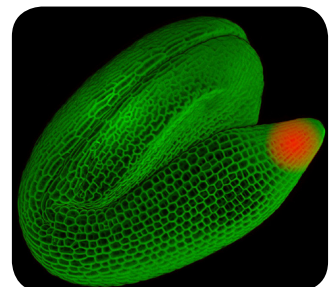
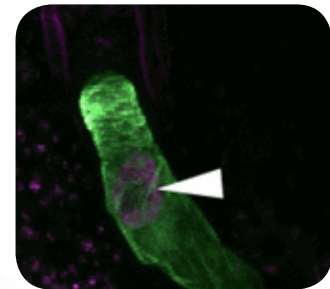
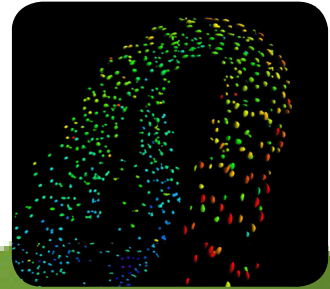
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 - > *10 talks from abstracts*
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