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Interim Impact Evaluation of the Agri-Tech Catalyst

Phase 2: Final Report

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SQW

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Executive Summary

1. The Agri-Tech Catalyst (ATC) was introduced in 2013 as a key programme under the UK Strategy for Agricultural Technologies. The programme secured £60m from the Department for Business, Energy and Industrial Strategy (BEIS), Innovate UK and the Biotechnology and Biological Sciences Research Council (BBSRC) to support UK-based innovation projects in the agri-tech sector[1]. The ATC programme aimed to:

   "accelerate translation of research into practical solutions, best practices and applications of new technologies in agriculture – ultimately to contribute to improvements in agricultural output and productivity, whilst reducing the environmental impact of agricultural production".

2. Over five competition rounds, the ATC awarded funding to 103 UK-based projects, led by 80 separate organisations, and involving nearly 230 collaborators. Three grant types were available, reflecting different stages of the R&D process:

- early stage awards to test commercial potential of scientific ideas/feasibility of new technologies, with grants of £150k to £500k (37 projects)
- industrial research awards to develop innovative solutions through technology development, lab-based prototyping, pilots, trials market testing, with grants of up to £3m (54 projects)
- late stage awards, to test/trial innovations in real-life context ahead of larger-scale deployment, including commercial assessments for technologies that are closer to commercialisation, with grants of up to £1m (12 projects).

3. All projects had to be collaborative in nature – early stage grants could be led by a business or academic, but industrial and late stage grants had to be industry-led. Any sector or discipline could apply, and funders were keen to see spill-in of typically non-agricultural partners to encourage technology convergence.

4. SQW in partnership with Martin Collison and BMG Research, was commissioned by BEIS in December 2017 to undertake an interim impact evaluation of the ATC, in two phases: phase one reviewed early and late stage projects; phase two (this report) focuses on industrial stage awards.

5. The evaluation is theory-based, comparing evidence on what has actually happened as a result of ATC against the original Theory of Change of what was expected to happen, including a 'contribution analysis', considering the

[1] £10m was also provided by the Department for International Development for international projects. These projects are excluded from this evaluation. Throughout this report, 'the programme' refers to the UK-based aspects of ATC only. In total, the 103 projects, which excludes DFID projects, received £28.3m from IUK and £22.7m from BBSRC.

role and relative importance of ATC alongside other factors. Phase two has involved review of data and documents, stakeholder consultations, surveys with project leads and collaborators (covering 26 of the 54 industrial stage projects), surveys with unsuccessful applicants (mainly of projects that were 'fundable' but not funded), and in-depth case studies with seven projects.

Programme portfolio and rationale

6. The programme involved over 180 organisations in the delivery of industrial stage projects. The survey evidence suggests that most organisations involved in ATC projects – and those that led unsuccessful applications – were actively engaged in R&D in the period before their application to the programme, including collaborative R&D activity; this is not unexpected, but does provide important context for the potential nature and scale of effects of the programme on beneficiaries. However, the programme has encouraged some spill-ins of technologies that are new to agri-tech, reflecting potentially the convergence of underpinning technologies across a range of different market sectors.

7. The programme has also stimulated new collaborations for industrial projects, where some or all of the partners had not worked together previously. This said, project leads commonly seek to involve 'known' partners in their projects: of the 16 project leads surveyed, only two indicated they had not worked with any of their project partners previously. This may reflect the scale of industrial stage grants, with leads seeking to include some 'known/trusted' partners in the collaboration to manage/mitigate the risks of project delivery. Given the often novel and high-risk nature of the projects supported by ATC this is not unexpected.

8. Consistent with this risk-profile, there is strong alignment between the reasons that leads gave for why they had not taken forward their project prior to applying for a Catalyst award and the original rationale of the programme related to externalities, the uncertainty of benefits and co-ordination issues. However, it was commonly a mix of factors, rather than a single issue that prevented project progress. Further, the evidence suggests that at the industrial stage, the programme has often supported R&D that was regarded as qualitatively different in its risk profile than more 'standard' R&D activities undertaken in the past, with the role of the potential collaboration also an important factor for some in making the case for public support.

9. The case study evidence highlighted how this collaboration opportunity was important both for the lead applicant and collaborators, particularly in case studies that involved larger consortia. ATC provided the opportunity for collaborators to work with a range of other organisations for the first time, both academic and commercial.

10. 'Feeder' schemes were important in generating ideas for industrial projects, including longer-term investment in fundamental research; half of project leads surveyed had received other public funding that led to the ATC project.

This highlights the role of the programme in the wider innovation support landscape, and the importance of ensuring effective links and pathways between programmes.

Activities and technological progress

11. The evaluation indicates that there is a generally close fit between the activities anticipated in the programme logic model and that delivered by industrial stage projects. However, the TRL stage of ideas is mixed, and the programme does appear to have supported some projects at earlier stages of technology readiness than may be may be expected for industrial stage awards. This may have implications for the time-paths to commercial (and wider) impacts of these projects. However, TRL estimates should not be taken too far, given the iterative nature of innovation and product/process development, and the evidence from the evaluation that ATC projects can span multiple TRLs levels.

12. ATC industrial stage projects come in all shapes and sizes, with a very broad mix of activity types, and project delivery models in terms the size, shape and mix of project partners. ATC project delivery also quite commonly involves inputs from organisations outside of the formal partnership. The specific roles played by external support varies, but do not appear to be qualitatively different to the types of inputs provided by core partners, and accessing wider perspectives was a theme common to several of the projects surveyed where this was evident.

13. The programme has performed well in terms of encouraging technology progression though industrial stage projects and enabling this to be realised more quickly than might otherwise have been the case without ATC support. Notably, nearly all of the project leads surveyed (15 of the 16) indicated that the ATC project had progressed a technology towards market readiness by the point of the survey.

14. However, the evaluation's survey data and project close out reports also suggest that the objectives anticipated from projects are unlikely to be realised consistently across the portfolio, with implications for overall impacts. Further, there are differences between lead and collaborator views – across and within projects – in terms of whether objectives have been or will be met, highlighting the different experiences and expectations of partners involved in ATC projects.

Outcomes and impacts

15. There is strong evidence that the outputs and outcomes identified in the logic model associated with innovation behaviours, capacity and partnerships have been realised in practice at this interim evaluation stage. For example, 90% of beneficiaries surveyed reported they had experienced improved staff skills/knowledge, and 80% new or improved collaborations with the

academic/research base. The effects on these behaviour, capacity and partnership outcomes were consistently positive for both leads and collaborators.

16. There is also a high level of confidence amongst surveyed beneficiaries that new or improved products/services will be introduced to the market following ATC projects, although to this point this is principally anticipated rather than realised, with just 5 of the 41 beneficiaries reporting that a new product/service had been introduced at this interim evaluation stage. Many beneficiaries also expect to realise new or improved processes because of ATC, reflecting the varied ways in which the R&D projects are expected to bring about benefits for participants. However, further R&D activity and investment will be needed in most cases to realise the expected product/service and process benefits; this is consistent with the focus on industrial stage projects on progressing technologies towards, but not fully to, the commercialisation stage.

17. Reflecting the progress of products/services, the quantitative effects of the projects at this stage are modest. This said, employment effects have been realised for over half of projects where data is available; the case studies suggest this can include both R&D staff to deliver the project, and/or new commercial positions that will help to move projects towards commercialisation. Achieved turnover effects are very limited at this stage but projects are expected to lead to turnover benefits in the future in a high-majority of cases.

18. ATC has led to some changes in the behaviours and perspectives of those involved, which are crucial for further collaborative R&D activity in agri-tech in future: over half of beneficiaries surveyed indicated that the programme has made it more likely they will invest internal funds in R&D activity in the future, and/or bid for Government funding to support R&D activity.

19. The collaborative approach of ATC has added value to the delivery of industrial stage projects, and the flexibility offered through the programme has also been an important enabling factor reflecting the scale and length of the projects at this stage.

Additionality and contribution

20. The activities and outcomes described above are attributed to the ATC. However, the key question that follows is the extent to which they would have happened anyway in the absence of the programme i.e. the extent to which the activities and outcomes are *additional.*

21. In terms of activity, the evaluation does suggest that the ATC has catalysed new R&D activity at the industrial grants stage, delivering 'activity additionality'. The evidence from beneficiaries of projects that were supported, and those leads of unsuccessful projects that were not, indicates that much of the activity might not otherwise have occurred at all without the programme,

and even where it would have progressed, this would likely have been later and of a lower quality and scale. Further, two-thirds of collaborators surveyed indicated they would not have engaged in *similar* collaborative R&D without ATC; this demonstrates the role of the programme in helping to 'capture' and/or 'lock in' organisations to engage in collaborative R&D in the agri-tech sector, including academics. The case study evidence supported these findings, and provided further details on how the programme has brought about additional activities, including how ATC funding was critical to enable R&D at scale, which can be crucial in enabling robust data collection and analysis to validate new approaches.

22. In terms of outcomes, the additionality of industrial stage grants also appears to be high, reflecting the binary nature of R&D activity at this scale and stage in development. Overall, the evaluation evidence suggests that the programme has led to technology progression and the development of new products/services and processes that would not otherwise have been realised. There is strong evidence of the effects of the ATC in progressing technologies and new products/services and processes when comparing the two groups of leads: of 14 leads of unsuccessful applications to ATC, just two progressed their project's technology towards market readiness, compared to 15 of the 16 leads of successful applications.

23. For the outcomes that are additional, a related question is *the relative contribution* of ATC compared to other factors in realising these outcomes. The survey and case study evidence demonstrated that the way in which ATC projects interact with other changes and developments in participant organisations, and its relative level of influence in delivering outcomes is varied and highly context specific. However, there is consistent evidence that other factors alongside ATC are commonly also important. ATC does not in most cases stand alone in explaining the outcomes that have been realised, with other R&D activities and partnerships and wider business development playing an important and complementary role. Put simply, in most cases, the evaluation suggests that the ATC project is one of several reinforcing explanations for why outcomes have been realised.

24. This said, the evaluation also indicates that the R&D activity that was supported through ATC would not have been progressed in that scale, form, of timing without the ATC supporting in the first place. Therefore, although once underway other factors have been necessary for outcomes to be realised, these outcomes do derive ultimately from the initial investment made through the programme, and would not have been realised to the same extent without it.

25. This conclusion is not unexpected given the characteristics and pre-programme behaviours of organisations supported by ATC industrial stage awards: they are experienced in R&D and undertaking other innovation activities and partnerships in parallel to the delivery of ATC-funded activity, and implementing changes to influence behaviours and performance across their wider activity-sets. Further, it is important to recognise that it remains too early to assess definitively the contribution of the programme in realising outcomes given the interim nature of the evaluation, with commercialisation

and quantitative outcomes largely expected rather than realised. The relative role of other factors – including follow-on R&D and finance – in realising the full outcomes from industrial stage projects may change over time. This will be an important issue to consider at a final evaluation stage.

26. It is also noted that the programme also influences wider business strategies and plans and the establishment of other innovation partnerships or collaborations. This may lead to longer-term legacy effects of participation in the programme. Again, this will be an important issue to consider at a final evaluation stage.

Learning

27. Although the specific deliver, technology and market context varies across projects, the key lessons regarding what has enabled hindered progress and pathways to impact in relation to industrial stage ATC projects include:

- The collaborative approach of ATC has added value to delivery in terms of capacity/knowledge, providing connections and industry reach, and improving the prospects of commercialising benefits, including where partnerships have spanned the value chain.
- The ability to undertake multi-disciplinary projects at scale was a key enabler for projects, and was crucially important in unlocking potentially transformational opportunities.
- Related to the above, the academic input to projects was identified as a key theme from industrial partners in terms of what the key factors have been in enabling the success of project activity.
- The level of flexibility in delivery of project; this was seen to be particularly important at the industrial stage given the scale and length of activity, and where projects were required to ‘pivot’ to reflect findings as they emerged and/or to deal with the realities of delivering agri-tech research in the field.
- The breadth of projects – which in some cases include a high number of multiple partners – has encouraged spill-ins of technologies from other areas and sectors to agri-tech. However, the breadths of the partnerships can also cause management issues and challenges, and there is no ‘right’ size or project mix given the very specific technical requirements involved in each case.
- Reflecting the scale and length of projects, ‘process’ issues around effective project management, monitoring structures and routines, and regular meetings/catch-ups have been important in enabling effective progress to be made and outcomes generated.
- Looking forward, a key potential risk to realising intended outcomes is access to follow-on funding for later stage R&D. Most beneficiaries thought that further R&D would be required – but for many, ATC had not sufficiently de-

risked the project for solely internal investment, and sources of potential external funding were not yet clear.

- External challenges, including related to regulation and uncertainty around the policy landscape were identified as barriers, or potential barriers, to the full realisation of outcomes
- Some industry participants encountered capacity issues in managing such large-scale, multi-disciplinary teams.

Overall performance against objectives and rationale

28. The evidence suggests that through industrial stage projects, the programme is delivering successfully against its aim to "*accelerate translation of research into practical solutions, best practices …"* and encourage greater R&D in the sector. While most of the technologies supported remain in development rather than in the market and so the effects on the application of new technologies in wider agriculture remain at this stage limited, this is consistent with the expectations of industrial stage project and reflects in part the time paths to impact.

29. There is encouraging evidence of the potential effects of ATC projects if they are realised as anticipated, and dissemination and demonstrations activities to facilitate adoption are delivered effectively, alongside access to finance for projects to reach the commercialisation stage. Further, whilst not all project will meet their original objectives this reflects that the programme has supported projects at the appropriate level of risk and uncertainty, where some failure or change in expectations is expected as the R&D is delivered.

30. Positively, industrial grants are meeting the Agri-Tech Strategy's ambitions for the Catalyst in terms of: supporting collaborative relationships between academics and industry (both new and existing); securing significant co-investment from the private sector through match funding for the R&D projects; supporting SMEs to take part, with SMEs accounting for over half of industry participants and half of leads of projects; and supporting a wide range of project types, including both the nature of the activity delivered and in terms of the size and nature of the partnerships. The programme has also addressed many aspects of the original rationale, supporting R&D through the programme that is regarded by participants as qualitatively different, and therefore high-risk and uncertain in realising outcomes.

31. Looking forward, longer-term evaluation will be required to provide further evidence on the effects on supported organisations as the technologies supported by the programme are further developed and taken to market, and wider impacts on the agricultural sector. Given the programme design and context, the case remains for a theory-based approach, consistent with the original Evaluation Framework, with an evaluation in 2022; a further evaluation in 2025, could also be considered, including whether this is proportionate and of value in on-going policy development at this point.

1. Introduction

1.1 The Agri-Tech Catalyst (ATC) is a flagship programme under the UK Strategy for Agricultural Technologies published in 2013. With £60m sourced from the Department for Business, Energy and Industrial Strategy (BEIS)/Innovate UK, and the Biotechnology and Biological Sciences Research Council (BBSRC), the ATC awarded funding to 103 UK-based projects between 2013 and 2017[2]. The projects have involved over 80 lead organisations and nearly 230 organisations acting as collaborators.

1.2 The supported projects cover a wide range of R&D activity, ranging from the development of novel vaccines for livestock and anti-microbial technology to control disease in crops, through to optimising the use of big data in different agricultural contexts, testing innovative sensor technologies and building the UK's first aquaponics urban farm.

1.3 ATC offered three grant-types, reflecting different stages of the R&D process:

- **early stage awards** to test commercial potential of scientific ideas/feasibility of new technologies, with grants of £150k to £500k. This grant was designed to move ideas to Technology Readiness Level (TRL) 4
- **industrial research awards** to develop innovative solutions through technology development, lab-based prototyping, pilots, and trials market testing through to TRL 7, with grants of up to £3m
- **late stage awards**, to test/trial innovations in real-life context ahead of larger-scale deployment, including commercial assessments for technologies that are closer to commercialisation, with grants of up to £1m. This enabled projects to reach TRL 9.

Introducing the evaluation

1.4 SQW, in partnership with Martin Collison and BMG Research, was commissioned by BEIS in December 2017 to undertake an interim impact evaluation of the ATC over 2018 and 2019, and to develop an evaluation framework for longer-term impact evaluation of the Catalyst. This study follows (but is separate to) SQW's earlier work to develop a baseline and evaluation framework for the UK Agri-Tech Strategy in 2016[3] (that included the ATC), and more recently a process evaluation of the ATC (and Industrial

[2] £10m was also provided by the Department for International Development for international projects. These projects are excluded from this evaluation. Throughout this report, 'the programme' refers to the UK-based aspects of ATC only.
[3] http://www.sqw.co.uk/insights-and-publications/agri-tech-industrial-strategy-evaluation-scoping-study-and-baseline/

Biotechnology and Energy Catalysts) for Innovate UK that reported in mid-2018[4].

1.5 The Steering Group for this project includes representatives from BEIS, Innovate UK and BBSRC (now both part of UKRI), the Department for International Development (DFID), the Department for Environment, Food and Rural Affairs (Defra), and the Department for International Trade (DIT).

1.6 The overarching aim for the evaluation, as set out in the Brief, was to:

"gauge early impact and to assess the extent to which the programme is making or has made an impact taking into consideration its original aims, the market failures it seeks to address, and the key strategic goals of the Agri-Tech Strategy more widely".

1.7 During an initial scoping phase for the study, in discussion with the Steering Group and wider stakeholders and a review of programme documentation, a detailed set of research questions were identified for the evaluation. These are presented in Table 1-1.

Table 1-1: Key evaluation questions

Key question area	Key issues to consider
What has been delivered to date?	What is the spend-profile to date, compared to expectations, and how much private sector funding has been levered? What is the profile of activities and lead/collaborators supported? Are collaborations new? Are projects encouraging new actors/disciplines (including spill-ins) to engage in R&D in the agri-tech sector? Have the activities been delivered in partnership with other programmes (e.g. Agri-Tech Innovation Centres)? Are any other programmes acting as "feeders" for the Catalyst?
What outputs, outcomes and impacts have been achieved to date?	What is the nature, scale and reach of outputs, outcomes and impacts achieved by industry and academic partners, compared to expectations? How are outcomes distributed across portfolio/beneficiaries, including variation by type of grant (in a qualitative sense)? What are the wider indirect outcomes on innovation in the sector more widely, spillovers (e.g. knowledge transfer), unexpected and unintended effects, observed effects on the finance community (e.g. banks, VCs)? To what extent is the Catalyst portfolio being packaged and communicated to deliver more than the sum of its parts (e.g. in terms of spillovers, synergies between projects)? How sustainable are the outcomes achieved to date?

[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/791302/IUK_-_Catalyst_process_evaluation_-_FINAL_Report_24_May__edit_27_Sept__for_publication.pdf

What is the added value of the collaborative approach?	What is the added value arising from the collaborative approach across supply chains, with academia/industry, with other programmes (including the Agri-tech Innovation Centres)? How sustainable are collaborative relationships with research partners, the supply chain and other programmes (such as the Centres)? Is the programme changing attitudes towards collaborative R&D and/or propensity to collaborate in future?
To what extent are outcomes and impacts additional?	To what extent would outcomes/impacts have been achieved anyway without the Catalyst?
How are outcomes/impacts delivered?	What are the pathways from inputs/activities to outcomes/impact for direct beneficiaries (leads and collaborators)? How are outcomes expected to impact on the wider agri-tech/agricultural sector (and achieve the Catalyst's ultimate objectives)? Are mechanisms in place to enable this? How do routes to impact compare with the Theory of Change (and associated assumptions/risks)?
What is the contribution of the Catalyst relative to other internal/external factors identified?	To what extent can outcomes/impacts be attributed to the Catalyst? What has been the role of programme design and project-related factors, and influence and relative importance of other internal and external factors to achieving outcomes/impacts (e.g. role of the overarching Agri-Tech Strategy, wider policy, market, technological and people/skills drivers, consumer acceptability)?
What has supported or inhibited the progress, effectiveness/efficiency of the Catalyst?	What broader factors/processes have supported or inhibited performance? e.g. the context and system in which the programme operates, integration with other programmes (incl. Agri-tech Innovation Centres).
What are the anticipated outcomes/impacts of the Catalyst in future?	What is the nature and scale of outcomes expected in future (incl. environmental benefits)? How and when will these be achieved, and how do they compare with the logic chain(s) and Theory of Change? How these outcomes/impacts can be measured in future?
How is the Catalyst performing overall?	To what extent is the Catalyst on track to deliver against original aims/objectives (of the programme and wider Agri-Tech Strategy) and addressing the original rationale? Linked to this, to what extent have projects achieved their original objectives? What the remaining barriers to commercialisation?

What are the key lessons from the Catalyst?	At a programme level, what has worked well (or not) and why in delivering outcomes/impacts? Are there examples of transferable good practice from projects? What makes for a successful project? Which factors have been critical to success? Is the Catalyst a good model for encouraging greater public/private investment in R&D?

Source: SQW, drawing on original Specification for the study, SQW's proposal, discussions with the Steering Group, and feedback from the scoping consultations

1.8 The **overarching approach for the interim evaluation is theory-based,** which assesses and compares the evidence collected on what has actually happened as a result of an intervention, against its original Theory of Change of what was expected to happen (explained in more detail in Section 2).

1.9 The evaluation involves two phases:

- **Phase 1** covered projects in receipt of **early and late stage** grants, on the basis that these projects were most likely be completed and be able to demonstrate emerging outcomes at the time of the evaluation given their relatively short timeframes for delivery. The research for this phase took place over February-June 2018, with a final report following approval from BEIS' external expert peer review process in December 2018.
- **Phase 2** (the focus of this report) covers projects in receipt of **industrial research grants**, which are longer in duration. The research was undertaken over December 2018 to April 2019, by which stage most projects had formally 'closed' in terms of their participation in the ATC programme, though for many this was very recently, but some projects were still in delivery.

1.10 Each phase has adopted a similar **mixed-methods approach**, including a desk-based review of data and documentation (such as monitoring data and close-out reports), stakeholder consultations, surveys with project leads and collaborators and unsuccessful applicants, and a series of in-depth case studies of selected projects. Phase 2 has also included consultations with strategic, management and delivery staff, and the development of a framework to assess the longer-term impacts of the ATC programme overall.

1.11 A separate **extended Executive Summary** sets out the summary findings of this evaluation covering both Phase 1 and Phase 2 and considers the implications for the future. This extended Executive Summary can be read independently of the main, more detailed reports for Phases 1 and 2.

1.12 Note that this interim evaluation of the ATC for BEIS **excludes 24 DFID-funded projects** under the Agri-Tech Catalyst programme (not included in the 103 UK-based projects noted above), which are international by nature, and are subject to a separate evaluation commissioned by DFID. Throughout this report, 'the programme' refers to the non-DFID aspects of the Agri-Tech Catalyst.

Report structure

1.13 This report is structured as follows:

- Section 2 sets out the approach adopted for Phase 2 of the evaluation in more detail
- Section 3 summarises the logic model and Theory of Change that form the conceptual framework for the evaluation
- Section 4 summarises the industrial grants portfolio, and considers evidence on rationale and engagement
- Section 5 sets out the activities delivered to date
- Section 6 presents evidence on outputs, outcomes and impacts achieved to date, and expected in future
- Section 7 provides an assessment of additionality and the contribution of ATC
- Section 8 presents the conclusions, including the overall contribution story, performance against the programme's objectives to date, and key lessons learned.

1.14 The main report is supported by the following annexes: Annex A provides further details on the survey sample; Annex B presents the individual case study reports.

2. Approach

2.1 This section describes the approach adopted for this evaluation and details the research tasks undertaken to gather evidence, and its limitations. It also provides further detail on the survey response rates and profiles of respondents.

Key messages

This phase of the evaluation has focused on industrial stage grants. Early and late stage projects were the focus of Phase 1, completed in December 2018.

A theory-based approach has been adopted for the evaluation, drawing upon 'contribution analysis', reflecting the 'small-n' but complex programme, the diversity of projects supported, and multiple routes to impact across a diverse sector.

The evaluation has also sought to identify lessons to inform future policy, particularly in terms of what has supported or inhibited pathways to impact.

The methodology encompasses mixed methods, including a review of monitoring and application data and close-out reports, consultations with strategic and wider stakeholders, a survey of beneficiaries and unsuccessful applicants (with 41 and 14 respondents respectively), and seven in-depth project-level case studies.

Where possible and appropriate, the beneficiary survey results are compared to those of unsuccessful applicants to provide some insight and qualitative evidence into the potential counterfactual position.

The evaluation has involved an iterative process of evidence gathering and analysis to develop the 'contribution story'. A combined quantitative and qualitative assessment is provided, rather than a 'single figure' estimate which would be partial and omit changes and benefits brought about by the Catalyst.

Overarching approach

2.2 The overarching approach to this evaluation is **theory-based,** which has involved developing and then testing logic models and a Theory of Change for the programme, and drawing upon '**contribution analysis'.** The complexity of the programme in terms of three types of award, complex and multiple routes to impact and the very diverse nature of projects supported, combined with relatively small sample sizes (particularly when assessing outcomes for each type of award), meant that empirical impact evaluation was not appropriate for the ATC. The overarching approach aligns with the recommendations for the evaluation of the ATC set out in SQW's evaluation framework for the Agri-Tech Strategy in 2016.

2.3 Theory-based evaluation, and specifically contribution analysis, is an approach to evaluation that assesses and compares the evidence collected *on what has actually happened* as a result of an intervention, against the intervention's original Theory of Change of *what was expected to happen*. The approach is based on the development of logic models and underlying theory as to how intended outcomes and impacts were to be brought about[5]. Evidence is used to evaluate the intervention's contribution to the observed outcomes and impacts (e.g. new products developed, employment and turnover generated) by constructing a "contribution story" on the extent to which the intervention was important in generating these observed outcomes and impacts relative to other factors[6], such as external market, policy or environmental conditions, and other decisions-made or activities-delivered by participants.

2.4 Following the collation and analysis of the evidence, a plausible association can be made (or attribution is demonstrated beyond reasonable doubt) if the following are satisfied[7]:

- a reasoned Theory of Change for the Catalyst is set out
- the activities of the Catalyst have been implemented as set out in the Theory of Change
- the chain of expected results, e.g. on individual businesses, academics, and the wider sector can be shown to have occurred
- other influencing factors have been shown not to have made a difference, or the decisive difference.

2.5 Alongside the contribution analysis that responds to the research questions related to the interim impacts of the Catalyst, the evaluation also focuses on **learning**. This includes consideration of what has supported, or inhibited, progress informing the outcomes and impacts that are realised, the added value of the collaborative approach, and what has worked well (or not) for whom and why, in progressing towards the ATC's intended impacts.

Research tasks

2.6 A **mixed-methods approach** has been adopted within the theory-based framework. This includes a desk-based review of documents and data, consultations with strategic and wider stakeholders active in the agriculture/tech field, a survey of beneficiaries and unsuccessful applicants,

[5] Mayne, J. (2001) *Addressing Attribution Through Contribution Analysis: Using Performance Measures Sensibly*, The Canadian Journal of Program Evaluation, Vol. 16 No. 1, pp. 1-24.
[6] White and Phillips (2012) *Addressing Attribution of Cause and Effect in Small n Impact Evaluations*, International Initiative for Impact Evaluation Working Paper 3.
[7] White and Phillips (2012).

and in-depth case studies with seven industrial stage projects. In addition, SQW has met with the Steering Group to agree research questions, and present and discuss interim findings.

2.7 Given the nature of the programme, we have not included econometric techniques, but have employed basic statistical tests to supplement the analysis, including z-tests[8], to test the equality of distributions of characteristics and the outcomes between samples (e.g. successful and unsuccessful applicants or leads and collaborators, responding to the survey). Although this approach does not provide evidence of causation of the programme (as it does not control for any other factors), it highlights key differences that are statistically significant, e.g. where project leads are more likely to have experienced a particular outcome compared to collaborators.

2.8 In the paragraphs that follow, we outline in more detail the research tasks undertaken to inform this report, and, for the survey, present details on response rates and profiles.

Desk-review of documents and data

2.9 Programme documentation was reviewed to develop the logic models and Theory of Change for the programme[9], and for each grant stage. Subsequently, we have reviewed: **monitoring data** from Innovate UK (including application and project data); **baseline data** set out in application forms on type of organisation, turnover, employment and sub-sector of those applying; **funders panel data**[10] on the assessor scores of each application; and **close-out reports**[11] available at the time of the evaluation.

2.10 Baseline data from applications was available for application leads, but not collaborators, with the collaborator survey (see below) used to gather relevant baseline data. This provided some (partial) evidence on collaborators before their involvement in ATC, but the lack of comprehensive data means it was not possible to compare the profile of collaborator survey respondents with the population to check the representativeness of the sample.

[8] A two-sample z-test can be used to test the difference between two population proportions p1 and p2 when a
sample is randomly selected from each population. In this case, we can apply the two-sample z-test to test for any statistically significant differences between two samples.

[9] Documentation included the Agri-Tech Strategy and Evaluation Framework, ATC Business Case, Competition Guidance and Briefings.

[10] For each round of ATC competitions, applicant information and assessor scores and feedback were compiled and presented to the 'funders panel'. The 'funders panel' comprised Innovate UK, BBSRC, DFID and BEIS, and a selection of assessors.

[11] Once an ATC project has been completed, the project lead and collaborators complete a close-out report, which contains information on performance against project level objectives, outputs and outcomes, and wider spillovers, exploitation and dissemination plans, and lessons learned from the project.

Stakeholder consultations

2.11 A total of **10 consultations were held with strategic and wider stakeholders**, involving representatives from the organisations set out in Table 2-1 .

Table 2-1: Organisations involved in strategic consultations

BEIS	CIEL Agri Centre - Livestock
Innovate UK	KTN Plant and Crop Sector Advisory Board
BBSRC	Agri-Tech East
Department for International Development	Map of Agriculture
Department of International Trade	Science and Technology Facilities Council Food Network

Source: SQW

2.12 The consultations gathered stakeholders' views on the activities delivered by the Catalyst to date, the programme's fit with the wider innovation support landscape, emerging outcomes and overall performance, lessons learned about what works (or not) and why, and remaining barriers to commercialisation in the sector.

Surveys with beneficiaries and unsuccessful applicants

Approach

2.13 The purpose of the survey with **beneficiaries** – that is, project leads and collaborators of industrial projects – was to gather evidence on their experience with collaborative R&D in agri-tech before ATC, which provides important context for their engagement with the programme and potential effects; their rationale for engaging with ATC; activities funded through the programme (and the extent to which they were additional) and technological progression; outcomes achieved so far and expected in future; key enablers or barriers to progress; progress since the ATC project (where relevant); and the overall level of attribution, additionality and the contribution of ATC compared to other internal and external factors.

2.14 The sample frame for the survey included:

- all beneficiaries from projects supported in rounds 4 and 5 who had not previously been contacted for Phase 1 of the evaluation[12]
- project leads and collaborators from rounds 1-3[13] that opted-in for their contact data to be shared with the evaluators.

[12] 52 beneficiaries. Where a contact was involved in both early and/or late stage projects and industrial stage projects, the early and/or late stage project was prioritised. This was based on the larger population for the industrial stage projects.
[13] 18 beneficiaries

2.15 The survey of **non-beneficiaries** – that is, leads of unsuccessful applications for rounds 4 and 5 industrial stage projects – followed a similar structure to the beneficiary survey, but asked whether projects had proceeded without ATC funding, and if so, to what scale/timing/quality, how this has been achieved, the technological progress made anyway, and any outcomes/impacts observed from the activities undertaken.

2.16 The sample frame for the survey included all leads of unsuccessful applications in rounds 4 and 5, excluding those who were subsequently successful in later rounds for ATC funding. It was not possible to include leads from unsuccessful applications in rounds 1-3 owing to data protection issues[14]. The original research design was to survey only those leads of unsuccessful applications that scored at least 70 (out of 100) on the Innovate UK assessment, a level deemed 'fundable' but not funded (as it did not rank highly enough in the 'fundable' category in that funding round). However, in practice, given the reduced number of potential leads (with rounds 1-3 not available), a pragmatic decision was made to include leads of all unsuccessful applications in the sample frame in order to maximise the response rate.

2.17 The interview with each lead and collaborator focused on a single project in each case, and the effects of this project (where appropriate). This approach was adopted for two reasons: first, in some cases, organisations have been involved in multiple projects (and in different capacities, as lead and/or collaborator) and it would not have been possible to seek to cover all of these projects in a single survey; and second, seeking to attribute changes in overall organisational performance (for example, on turnover, employment of R&D expenditure) to the Catalyst alone was not likely to be possible, particularly for medium-sized and large businesses and for academic participants. A series of rules were applied, in agreement with the Steering Group, to identify the project to be the focus of the survey for each individual beneficiary. In summary, this meant that we prioritised an organisation's involvement as lead (rather than collaborator), and the earliest completed project where a lead or collaborator was involved in multiple projects enabling outcomes to have been realised as far as possible[15],[16]. For the survey with the leads of unsuccessful applications, a similar approach was adopted, whereby we focused on the

[14] It was necessary for Innovate UK to ask unsuccessful applicants from Rounds 1-3 to opt into the survey, but none did. There were two related issues which impacted on the timing and scope of the survey work for Phase 2 of this evaluation. The Data Sharing Agreement (DSA) between SQW and Innovate UK was put in place prior to the introduction of the General Data Protection Regulations (GDPR) coming into force in the UK. The DSA needed amending to make it compliant with GDPR. The terms and conditions (T&Cs) of the Agri-Tech Catalyst programme itself were amended in competition Rounds 4 and 5 from those in Rounds 1-3. This meant that the contact information for non-beneficiaries of Rounds 4 and 5 was readily available for evaluation purposes. This was not the case for unsuccessful applicants under Rounds 1-3

[15] Given the timing of the projects – with the earliest project starting in 2014 – the risk of memory decay (which if evident would suggest the focus is on the later projects) is not considered to be a major issue, particularly given the potential long time-paths to impacts, meaning that the earlier the project was completed the greater potential for outcomes and impacts to have been generated. Indeed, the evaluation was split into two phases to balance memory decay and allowing sufficient time to pass to observe (at least) intermediary outcomes.

[16] Note that we contacted all collaborators, including where there were multiple collaborators on an individual project.

most recent application if the organisation had applied multiple times for ATC funding.

Survey response rates

2.18 The surveys were undertaken by BMG Research over December 2018-February 2019. Each interview lasted up to 30 minutes for beneficiaries and 15 minutes for unsuccessful applicants.

2.19 For the **beneficiary survey, 41 completions were secured**, out of 70 viable contacts provided[17], a response rate of 59%. The 41 completions included:

- 16 leads and 25 collaborators
- leads/partners from 26 separate ATC projects (out of the 54 projects);
- responses from two or more completions for a single project in 17 cases, in these cases, the survey sample enables analysis to provide a richer story for projects where we have multiple perspectives on the nature and routes to outcomes of these individual projects.

2.20 For the **non-beneficiary survey, 14 completions were secured**, out of 33 viable contacts provided, a response rate of 42%.

Response bias

2.21 With the theory-based evaluation approach, drawing principally on evidence and feedback from participants in the programme via the surveys and case studies, there is a risk of response bias, where those individuals that have had a more positive experience with the programme are more likely to engage in the research (e.g. by responding to the survey).

2.22 Quantifying the exact level of response bias is not possible: we do not know the equivalent experiences and perspectives of those participants (and their projects) that did not participate in the evaluation, and there are gaps in the coverage of close-out reports and monitoring data. However, we have sought to test for response bias and, given the following**, we are reasonably confident that the survey cohort is representative of the wider beneficiary population:**

- the composition of the beneficiary sample was statistically equal to the programme population in terms of industry/academic representation, business size and sectors (see Annex A for further details)
- the beneficiary sample is representative of the population in terms of the average assessor scores on applications, i.e. the difference between the mean scores for the two samples is not statistically significant
- the majority of survey refusals from beneficiaries (that is, those beneficiaries that explicitly said they would not participate, excluding those where it was not possible to make contact) were due to key personnel moving on or time

[17] i.e. correct phone number etc.

constraints, rather than issues with project failure, suggesting that a higher response rate from successful projects is not causing response bias

- a comparison of self-reported performance against project objectives in close-out reports between beneficiaries who did/did not take part in the survey (to see whether those responding to the survey appear to have performed better) identified no difference between the groups – most believed they had achieved their objectives, very few did not[18].

2.23 This said, we recognise that there remains some risk of response bias. For example, there are 10 projects (of the 54 projects covered by this phase of the evaluation) where we have no evidence on project progress and outcomes, with no survey responses and no close-out report[19]. Further, there may be other factors/variables that have influenced project success that are not captured fully by the analysis above on characteristics, application scores and close out reports that may still mean there is some response bias in the survey sample. This should be taken into account when reviewing the findings and conclusion of the evaluation at this stage.

2.24 In terms of the non-beneficiary data, the composition of the unsuccessful applicant sample was statistically equal to the population of unsuccessful applicants in terms of business size and sectors (see Annex A for further details).

2.25 Comparing the lead beneficiary and unsuccessful applicant survey samples suggests that the two groups are broadly similar in terms of size and maturity of business, as summarised in Table 2-2 below. It is notable that the beneficiary survey included five leads from very large businesses, with over 1,000 employees.

[18] The sample size here is small; 24 close-out reports were provided, of which five had participants that were included in the survey.
[19] Monitoring data does not provide information on outcomes.

Table 2-2: Comparisons between beneficiary lead and unsuccessful applicant survey samples

		Beneficiary leads (n=16)	Unsuccessful applicants (n=14)
Business size	0-9	2	2
	10-249	5	6
	250-999	3	3
	Over 1000	5	3
	No answer	1	0
Business established	Pre-1950	5	4
	1950-1975	2	0
	1976-2000	6	6
	Post-2000	2	4
	No answer	1	0

Source: Survey responses

2.26 Four further points are noted regarding the survey evidence, each of which needs to be recognised in the analysis and interpretation of the results.

- First, the fieldwork was undertaken at a point when many projects remained in delivery, with many projects planned to close towards the end of the 2018/19 fiscal year. Specifically, at the launch of the fieldwork in December 2018, 24 of the 54 projects had been completed; by April 2019, 45 of the projects had been completed (with nine in delivery). The implication is that the survey evidence contains a low number of responses (just 4 of the 41) from beneficiaries of projects that had been completed by that point.
- Second and linked to this, the data on the number of projects completed in the months alongside the evaluation research highlights the interim nature of the evaluation. With issues around data protection limiting the number of contacts from earlier rounds of the programme, the beneficiary survey is weighed towards participants of projects supported in rounds 4 and 5 (30 of the 41) in 2014/15 and 2015/16. With industrial stage grants lasting up to

three years, it remains therefore early for the majority of the beneficiaries covered by the survey to have realised benefits.

- Third, the timing of the applications between the successful leads and unsuccessful leads varies: the former includes leads from all rounds except round 3, whereas all of the latter were from rounds 4 and 5, meaning they may reasonably be expected to be less well progressed, given the time-paths involved in R&D activities.
- Fourth, given the modest sample sizes, the diversity of projects covered and the small number of respondents observing quantifiable impacts (such as employment and turnover) to date and able to quantify these, it has not been considered appropriate to 'gross-up' the quantitative results of the surveys to the project population.

Case studies

2.27 **Seven case studies** have been undertaken with industrial projects. The case study projects were selected from those completing the survey and agreeing to follow-up research through a case study, in addition to one recommended by Innovate UK. The case studies are illustrative rather than representative and have sought to cover a range of policy interests, varying scales/types of collaboration, and types of technologies, applications and markets, and varying degrees of success; this reflects the importance of understanding context in theory-based evaluation approaches. Details of six case studies are presented in Table 2-3, with case study reports are available in Annex B. The findings of the seventh case study were considered commercially sensitive and therefore confidential by project partners meaning the identification of the project was not possible; findings and lessons from this case study have been included in the analysis, and set out in the narrative anonymously where appropriate.

Table 2-3: Overview of six (of seven) case studies

Case Study	Funding round	Lead organisation	Lead location (region)	No. collaborators involved in project	No. partners consulted/surveyed for the case study	Collaboration type
Third Generation Polyethylene Greenhouse Cladding Materials	4	British Polythene Industries	Scotland	6	2	Academic and Industry
MUST: Miscanthus Upscaling Technology	4	Terravesta Assured Energy Crops Ltd	East Midlands	4	1	Academic and Industry
Developing Bacteriophage Technology to Optimise Potato Production	1	APS Biocontrol Limited	Scotland	5	3	Industry
Precision Breeding: Broilers from Sequence to Consequence	3	Aviagen Ltd	Scotland	1	1	Academic and Industry
Tools and technology for predicting tomato glasshouse production	5	Thanet Earth	South East	2	2	Industry
Integrating control strategies against soil-borne Rhizoctonia Solani in oil seed rape (ICAROS)	5	Syngenta Ltd	East of England	1	1	Academic and Industry

Source: SQW based on case studies

2.28 The case studies have provided in-depth evidence on the context before ATC (and spill-ins to agri-tech), the nature of outcomes observed to date (and whether these vary across the consortium), pathways to impact and factors enabling/hindering progress at each stage of the process, additionality and the contribution of internal/external factors in achieving these outcomes/impacts (and whether this varies across partners). The case studies have also provided an opportunity to focus on organisations that have been involved in multiple projects (ATC funded or not), to allow the evaluation to test interdependencies between projects, and the potential benefits and impact of this e.g. where there may be outcomes that are greater than the sum of their parts.

2.29 Each case study has involved a review of the project documentation and development of a project-specific Theory of Change, consultations with the lead (in most cases face-to-face) and follow-up consultations with collaborators. The findings have been summarised in a short stand-alone report (which has been reviewed by consultees before sharing more widely[20]), presented at Annex B.

Implementing the contribution analysis

2.30 We have adopted an iterative process of evidence gathering and analysis to develop the 'contribution story' for the evaluation. This has involved developing a Theory of Change and risks to it[21], gathering evidence against this through the mixed methods approach described above, and assessing the contribution story (and challenges to it). This was then followed by further evidence gathering and testing (including via a steering group workshop), and finally the revised and strengthened contribution story (based on the quantitative and qualitative evidence available) is presented in this report.

2.31 For each of the outcomes assessed, we have sought to triangulate evidence from a range of different sources to corroborate the findings (or where appropriate, demonstrate the diversity in opinion). The additionality of activities undertaken and outcomes achieved has been assessed through self-reported evidence from beneficiaries (and what would have happened in the absence of ATC), compared to the experiences of unsuccessful applicants.

2.32 The combined quantitative and qualitative assessment adopted here, rather than a 'single figure' estimate, is important. Any single estimate of impact will be partial and focussed on the results of the most direct routes to impact that can be most easily measured. This approach would understate the impact of the Catalyst, and omit key aspects of how it may be bringing about change and benefits – including through changes in behaviours and attitudes, and

[20] If the case study consultees provided feedback that they wished to be anonymous, this has been used to inform the overall analysis for the study (rather than included in the case study report).
[21] Which was discussed with the Steering Group and then signed off by the Group in a scoping report on 21 February 2018.

indirect effects on the wider sector and across the industrial and academic base.

2.33 The contribution analysis presented in the remainder of this report is structured around the four key lines of enquiry set out in paragraph 2.4:

- whether a reasoned Theory of Change for the Catalyst was established (Section 3)
- whether the activities of the Catalyst have been implemented as set out in the Theory of Change (Sections 4 and 5)
- the outcomes observed and expected in future, how these have been/will be achieved (i.e. factors enabling or hindering pathways to impact), and the extent to which they align with the Theory of Change (Section 6)
- the extent to which outcomes are additional and whether other influencing factors have made a difference (Section 7).

2.34 The overall contribution story is then presented in Section 8. This also includes a summary of the key lessons in response to the evaluation questions focused on learning, at this interim evaluation stage.

3. Programme logic model and theory of change

3.1 In this section, we summarise the programme 'logic model' and theory of change that have been tested through the evaluation, with an emphasis on industrial stage awards.

Key messages

The Catalyst was a core part of HM Government's 2013 UK Strategy for Agricultural Technologies, it responded to a series of market and other failures facing those wishing to pursue R&D in the agri-tech sector including information failures, risk, and co-ordination failures. The Catalyst also sought to enable the UK to respond to global opportunities for growth in the agri-tech sector.

The aim of the Catalyst was to accelerate translation of research into new technologies in agriculture, leading to improved agricultural output and productivity, and reduced environmental impact. It also sought to provide an economic boost to UK agri-tech industry, encourage greater investment in R&D, increase turnover, employment, productivity within the sector, and improve the UK's competitive position internationally.

The programme budget was £60m, which comprised £30m investment by BEIS/Innovate UK and £30m from BBSRC.

Industrial stage grants were awarded through five competition rounds. All projects had to be collaborative in nature and industry-led. Any sector or discipline could apply, and funders were keen to see spill-in of typically non-agricultural partners to encourage technology convergence. Intervention rates[22] were tailored according to type of award and business size.

Programme design and delivery

3.2 The 2013 UK Strategy for Agricultural Technologies included the proposal for an Agri-Tech Catalyst to improve the translation of research into practice which would:

- "support collaborative partnerships between academics and industry that contribute to the challenge of sustainable intensification
- be designed to attract co-investment from the private sector
- support business, and particularly SMEs, to take part

[22] i.e. the proportion of project costs funded by the public sector grant

- cater for a range of project types from quite large collaborative programmes of three-to-five years, to shorter feasibility studies and proof of concept
- develop, monitor and evaluate a portfolio of projects with clear outcomes"[23].

3.3 The specific aim for the Catalyst, as articulated in the Brief for this evaluation, was to "*accelerate translation of research into practical solutions, best practices and applications of new technologies in agriculture24 – ultimately to contribute to improvements in agricultural output and productivity, whilst reducing the environmental impact of agricultural production"*. The intervention should provide an economic boost to UK agri-tech industry, through greater investment in R&D in the sector, increased turnover (including exports), employment, productivity and an improved competitive position internationally.

3.4 The Phase 1 report contains a detailed overview of the programme as a whole[25]. For this Phase 2 report on Industrial Stage grants specifically, the following points are highlighted:

- The programme is designed to address **market and other failures**, including co-ordination/network failures where there are challenges in finding collaborators for R&D activity particularly in a diverse and fragmented sector such as agri-tech. The relative risk, long lead times, and (particularly for industrial research) high costs of R&D can lead to underinvestment in innovation and result in problems in accessing external finance at reasonable costs[26]. Firms are also likely to under-invest in R&D from a societal perspective because they are unable to capture full returns on investment – with technologies becoming become part of global knowledge stock, leading to socially and environmentally desirable objectives – and there are opportunities for positive externalities through spill-ins from other sectors and technology areas into agri-tech.
- The **programme budget was £60m**, which comprised £30m investment by BEIS/Innovate UK and £30m from BBSRC. Of the £60m total, industrial stage grants accounted for £39.7m of the grant allocations, approximately two-thirds of the total[27] In addition, the programme expected to secure £30m of industry match, which was exceeded with a total of £35.8m secured, of which most (£28.4m) came from the industrial stage projects that are the focus of this phase of the evaluation[28].
- Grants were offered through **five funding competitions between late-2013 and early-2017** for UK projects; each competition set out broadly defined

[23] HM Government (2013) UK Strategy for Agricultural Technologies.
[24] Other documentation also refers to application in related sectors.
[25] SQW (2018) Interim Impact Evaluation of the Agri-Tech Catalyst: Phase 1 final report. 3.6-3.10
[26] Compared to more established technologies
[27] Comprised of £20.9 Innovate UK funding and £18.8m BBSRC funding
[28] The proportion of match funding varied by type of grant and organisation type, and the scale of match funding also reflected the size of projects (as noted above, industrial stage projects were much larger). For early stage projects the intervention rate was 55% for SMEs and 45% for large businesses; for industrial stage it was 45% for SMEs and 35% for large businesses; and for late stage projects it was 35% for SMEs and 25% for large firms.

sector challenges, rather than having narrow or prescriptive thematic focus for each competition or proposing solutions, and asked for applications in the following areas:

- primary crop and livestock production, including aquaculture
- non-food uses of arable crops (for example, for biomass)
- food security and nutrition challenges in international development
- challenges in downstream food processing, provided the solution lies in primary production.
- All projects had to be **collaborative in nature** and industrial stage grants had to be industry-led; any sector or discipline could apply, and funders were keen to see spill-in of typically non-agricultural partners to encourage technology convergence.
- All sizes of business were eligible for the programme, but the **intervention rates varied** for SMEs and large firms; and from Round 3 for industrial stage projects, the rate was 45% for SMEs and 35% for large firms[29].

Logic model and Theory of Change

3.5 Figure 3-1 presents a **logic model for the Catalyst as a whole**. It sets out the rationale and strategic context, aims and objectives, inputs and intended outputs, outcomes and impacts for the Catalyst.[30] The specific emphasis in relation to the industrial stage grants are also highlighted for this Phase 2 report. For example, given the level of investment required at this stage of the R&D process, there may be particular issues around risk and access to finance for SMEs that the programme will address.

3.6 In Figure 3-2 we then present SQW's interpretation of the **Theory of Change (ToC) for the programme.** This attempts to show how and why the Catalyst might be expected to bring about outcomes and impacts, by setting out causal links between activities, outputs, outcomes and impacts, and associated assumptions and risks or reasons why the logic model might break down. Consistent with the theory-based approach to the evaluation, we have tested the extent to which the Catalyst is delivering against the intended outputs, outcomes and impacts set out below (and whether these vary by type of award), and the routes to impact, noting any differences in enablers or barriers at each stage of the process compared to expectations.

[29] There were some changes to the intervention rate during the programme. In Round 3, funders believed that greater leverage could be achieved for industrial (and early-stage) awards, partly given the higher-than-expected demand, so the intervention rate for SMEs changed from 60% to 45% for industrial grants. For large companies, the rate changed from 50% to 35% for industrial grants. In Round 5, intervention rates for SME were divided into two different rates, one for Micro/Small companies, and another for Medium-size companies.

[30] Note the logic model excludes any reference to DFID projects, as the DFID-funded Catalyst projects are not within the scope of this evaluation.

3.7 In doing so, it has been important to recognise that the **Catalyst is a complex intervention:**

- project topics are diverse, reflecting the nature of the agri-tech sector.
- both the time at which each project starts (i.e. not all projects started at the same date) and the stage of technology vary, even within grant types, with implications for when outputs and outcomes are expected to be generated, and routes to impact are variable, iterative and, in many cases, long.
- project outcomes are heterogeneous, with some being more/less relevant and important for different projects and different participants within projects; the outcomes cover both ‘market’ effects, and those related to behaviours and capacities, reflecting the focus on collaborative R&D activity, and also cover both ‘direct’ effects on those involved with the programme, and the ‘indirect’ effects on the wider agricultural sector and research base.
- attribution is a challenge for some beneficiaries (especially where they are involved in more than one project, and/or the scale of intervention is relatively small).

3.8 Given the timing of this interim impact evaluation for industrial stage projects, SQW and the Steering Group thought it reasonable to expect that the Catalyst would be delivering against intermediate outcomes set out in the Theory of Change – and potentially also final outcomes/impacts for industrial projects who have progressed technologies without moving on to late stage Catalyst grants who were funded during the earlier rounds of the programme.

Figure 3-1: Programme-level logic model and emphasis on Industrial stage grants

Strategy & design		Delivery		Benefits	
Context & rationale	**Aims & Objectives**	**Inputs**	**Activities**	**Outputs**	**Outcomes/impacts**
Co-ordination failures/network externalities. Lack of infrastructure for collaboration. Public/private sector lacks opportunity to engage with/build on research, large number of actors involved, diversity of sector. Collaboration will enable industry "pull" for innovative ideas and transform into commercial products **Information failures**: Absence of information about benefits of new technologies leads industry/farmers to perceive them as high risk investments; Uncertainty of research payoffs in agri-tech R&D – "valley of death" where government funding for basic research ends **Other challenges**: Farmers, the majority being small businesses with limited financial capacity themselves, are unable to invest in R&D/take tech from lab to market; Long lead times for research payback, leading to under investment from private sector **Wider externalities and spillovers**: Private firms likely to underinvest in R&D from a societal perspective because they are unable to capture full returns on investment – knowledge/technologies become part of global knowledge stock, leading to socially desirable objectives ("Innovation failures"). Agri-tech is an enabling sector supporting growth in other key sectors incl. healthcare, bioenergy and chemical industries, and plays important role in addressing societal challenges, climate change, environmental sustainability, food security. Knowledge exchange/spillovers and academic/industry people exchange. **UK Agri-tech Strategy 2013**: Vision: *That the UK becomes a world leader in agricultural technology, innovation and sustainability; exploits opportunities to develop and adopt new and existing technologies, products and services to increase productivity; and thereby contributes to global food security and international development.*	Overarching Agri-Tech Strategy aim: • support economic growth, employment and productivity by facilitating the development and uptake of world class UK based agri-science and associated technologies. For the Catalyst specifically: • accelerate translation of research into practical solutions, best practices and applications of new technologies in agriculture [and related sectors] • contribute to improvements in agricultural output and productivity, whilst improving animal welfare and reducing the environmental impact of agricultural production • providing an economic boost to UK agri-tech industry	£70m fund comprising: £30m BEIS £30m BBSRC [Plus £10m DFID] Plus £30m match Operational management, delivery and monitoring by IUK (incl. inputs from KTN, monitoring officers and panel assessors) Management and delivery inputs from BEIS, BBRSC,[and DFID] AT Leadership Council strategic oversight role	Competitive fund process, single point of access, resulting in 100+ new / additional applied/translational research projects: • early stage projects to test commercial potential of scientific ideas/feasibility of new technologies (taking ideas up to TRL 4) • industrial research awards to develop innovative solutions through technology development, lab-based prototyping, pilots, trials market testing (to TRL 7) • late stage awards, to test/trial innovations in real-life context ahead of larger-scale deployment, incl. commercial assessments for technologies that are closer to commercialisation (to TRL 9). All projects involve collaboration between industry and research base. All business sizes eligible, with ATS emphasis on SMEs Focus on pre-farm gate (excl. food processing)	• Additional private sector investment in R&D (match funding) • New patents filed • Number/New collaborations between industry and research • Research outputs • Skills acquisition • Commercial applications (including 'spill ins' of technology from other sectors and translating into agricultural applications) and technological progress/reduced risk of failure • New data available to industry	<u>Intermediate outcomes</u> • **Leverage of further investment**, where appropriate/required *after* ATC project • New products/processes successfully **incorporating R&D results, and then taken to market** (in UK/exports) • Business growth (**sales/market share) and/or productivity** • More businesses engaged with research base and/or extent of **engagement** increases (sustainable collaboration) • Greater **understanding/access** to innovative practices/techs across sector • Changes university **attitudes, behaviour, knowledge** of commercialisation process, better understanding of business needs/expectations and propensity to collaborate, improved ability to lever R&D funding (e.g. H2020) • **Take-up** of new techs/products/processes in market (UK/overseas) • **Turnover** (incl. exports) and **employment** generated for UK agri-tech firms <u>Final outcomes/impacts</u> • **GVA** of agri-tech firms engaged • Increased **GVA, turnover, no of firms, employment** in UK agri-tech sector, and increased exports (incl. to developing countries) • Improve **competitive position of UK** agri-tech, leading to anchoring investment/additional **inward investment** (the UK becomes the 'go to' destination for international agri-tech investment) • Improved attitudes/behaviours of banks/VCs towards investing in agri-tech R&D • Innovations/research rapidly adopted in **supply chains**, and application in other sectors (spillovers) • **Productivity gains** in agriculture sector UK: total factor productivity, labour productivity, yields • Improved animal welfare and more **environmentally sustainable** agriculture in UK, e.g. energy use, GHG emissions, nitrogen inputs, nutrient balance
	Timescales:	2014-17		2015-2020	2016-2025

Context/rationale: broad rationale applies, with emphasis on coordination failures (especially if new partners needed to progress concept, and ensure industry "pull"), information failures, uncertainty, risk, and lead time. Financial capacity of SMEs particular issue given scale

Aims/objectives: focus on acceleration of translation of research to practical solutions; and potentially agricultural output, productivity, environmental impact

Inputs: input per project up to £3m with varied intervention rates

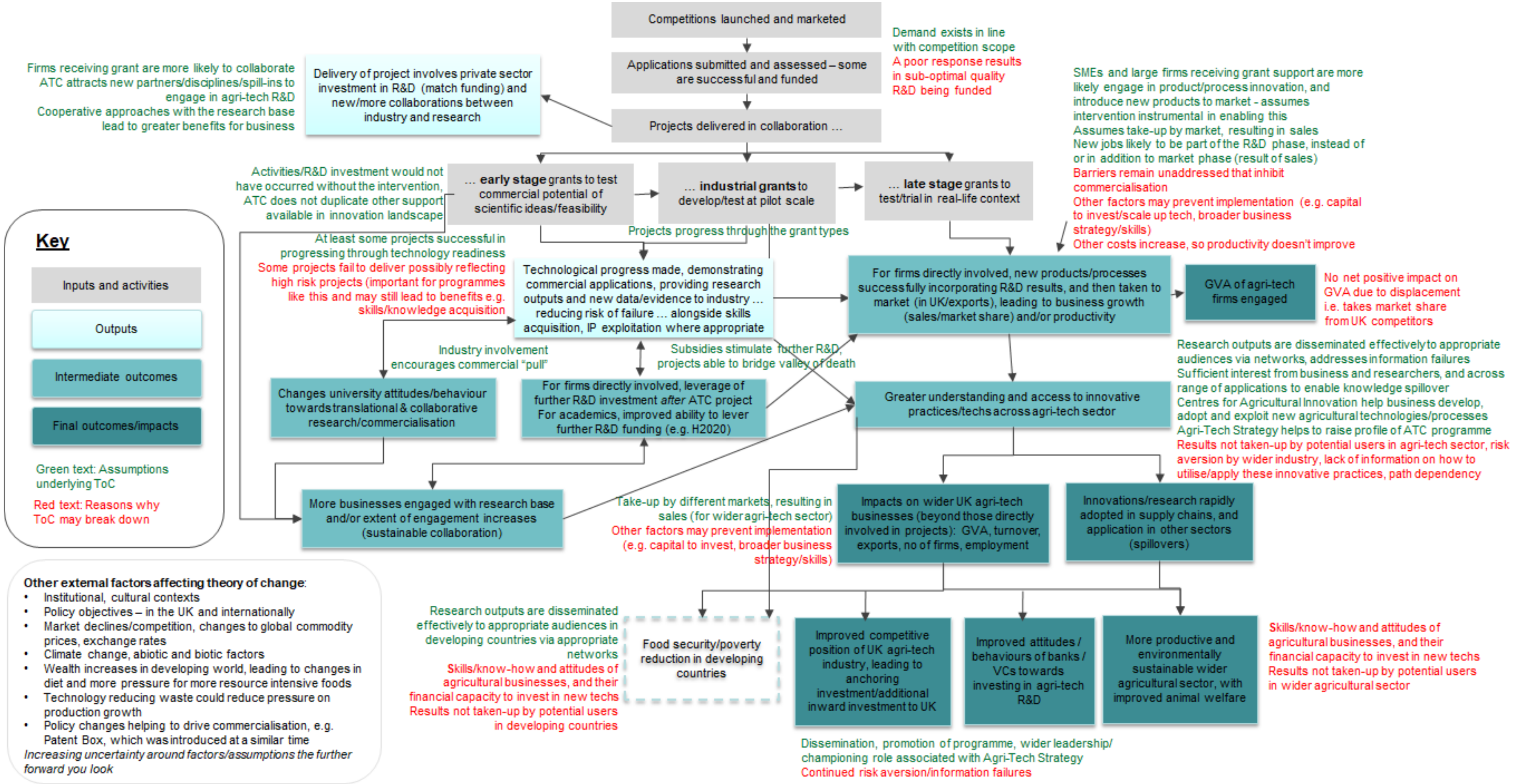
Activities: focus on developing innovative solutions to TRL 7, with projects up to 3 years which must be collaborative and led by UK business

Outputs: all outputs relevant, but emphasis expected on additional (private sector) investment in R&D, new patents filed, new collaborations, research outputs, skills acquisition, new data available to industry, commercial applications, and technological progress/reduced risk.

Outcomes/impacts: emphasis on intermediate outcomes incl. leverage of further investment (bridging valley of death), new products/processes incorporating R&D results and potentially taken to market, leading to final outcomes/impact, more businesses engaged with research base/higher engagement, and changes in research base attitudes to tech transfer

Source: SQW

Figure 3-2: Theory of Change, assumptions and risks



Source: SQW

4. An overview of the project portfolio, rationale and engagement

4.1 This section provides an overview of the industrial grants project portfolio, and the evidence on the rationale for engagement with the programme and the characteristics of those applying for support.

Key messages

54 industrial stage projects were supported, involving 184 unique beneficiaries. Around half of the projects were led by micro/small/medium sized firms (mainly micro and small), and half by large firms.

Survey evidence indicates that a majority of applicants to ATC industrial grants were actively engaged in R&D in the period before their application to the programme.

There is strong alignment between the reasons that leads gave for why they had not taken forward their project prior to applying for a Catalyst award and the original rationale of the programme set out in the logic model related to externalities, the uncertainty of benefits and co-ordination issues. It was commonly a mix of factors, rather than a single issue that prevented project progress.

The programme has supported R&D that was regarded as qualitatively different in its risk profile than more 'standard' R&D activities undertaken in the past, with the role of the potential collaboration also an important factor for some in making the case for public support.

'Feeder' schemes were important in generating ideas for industrial projects, including longer-term investment in fundamental research, reflecting the role of the programme in the wider innovation support landscape, and the importance of ensuring effective links and pathways between programmes.

The Catalyst has encouraged some spill-in of non-agricultural disciplines and companies who are new to agri-tech, although the scale of this appears to be modest with spill-ins focused principally in terms of technologies not participants, reflecting potentially the convergence of underpinning technologies across a range of different market sectors.

The programme has stimulated new collaborations, where some or all of the partners had not worked together previously, although project leads of industrial projects do commonly seek to involve 'known' partners in their projects.

Industrial Stage portfolio

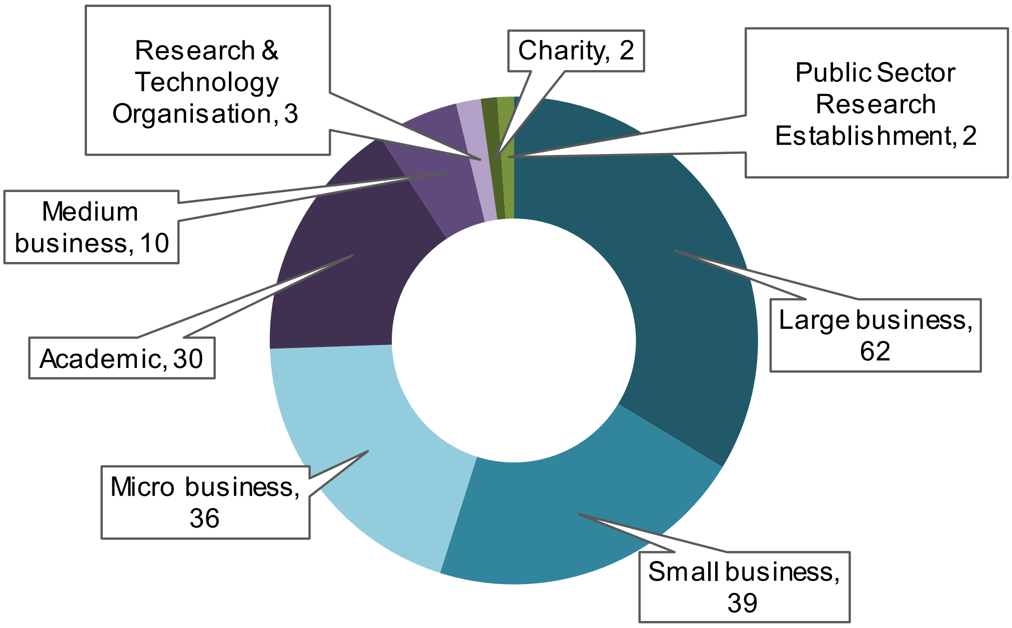
4.2 The Phase 1 report provides a detailed overview of the ATC programme portfolio across the three grant types[31]. In the context of this Phase 2 report on Industrial Stage grants specifically, the following points are highlighted for context:

- 146 applications were received, of which 84% scored at least 70/100 in the IUK assessment, reflecting the high quality of applications received overall
- 54 projects were supported, split across the five rounds of the programme: 14 projects in Round 1; 13 projects in Round 2; 9 projects in Round 3; 8 projects in Round 4l; and 10 projects in Round 5
- there were 184 unique beneficiaries[32] involved across the 54 projects. Of these, 37 were leads only, 136 were collaborators only, and 11 acted as both a lead and collaborator on different projects
- the 184 unique beneficiaries played 262 separate roles across the 54 projects (i.e. 54 lead 'roles' and 208 collaborator 'roles' across the separate projects)
- around half of the projects were led by micro/small/medium sized firms (mainly micro and small), and half by large firms
- the majority of collaborators were firms, but around a third were academics/RTOs; the split of the organisations involved in industrial project is set out below, this highlights the high level of engagement in the programme at the industrial stage by large businesses (accounting for around a third of all participants) but also micro and small businesses, which together accounted for 75 of the 184 beneficiaries.

[31] SQW (2018) Interim Impact Evaluation of the Agri-Tech Catalyst: Phase 1 final report. 4.3-4.6/Annex B

[32] There were 188 unique names in the data provided to the evaluators. However, four duplicates were identified

Figure 4-1: Type of organisations involved in industrial stage projects



Source: IUK monitoring data

4.3 The spatial distribution of project leads and collaborators for industrial stage awards is set out in Table 4-1. The data indicates that leads are located in all of the UK's regions/Devolved Administrations. There were concentrations of project participants in the East of England, South East and Scotland; this reflects the spatial focus of much of the UK's agricultural sector, and where key research centres and assets are located.

4.4 Two other points are noted for context:

- given participation in multiple projects, Scotland-based organisations accounted for 14% of the unique organisations involved in industrial stage projects, but 19% of the total number of 'roles' played by beneficiaries, equal first with the East of England.
- three organisations were involved as collaborators in more than five projects: the National Institute of Agricultural Botany (NIAB) was involved in ten projects, Scotland's Rural College was involved in six projects, and The James Hutton Institute was involved in five projects[33]

[33] This does not include projects in which the James Hutton Limited was involved, which is a wholly-owned subsidiary of the James Hutton Institute; James Hutton Limited was involved in five projects, including one as a lead

Figure 4-2: Geographical spread of industrial leads and collaborators

Geography	No. participants
East of England	32
South East	32
Scotland	25
London	15
East Midlands	16
West Midlands	14
South West	13
Yorkshire and the Humber	13
Wales	8
North West	8
North East	4
Northern Ireland	4

Source: IUK monitoring data. Note, UKRI assumes the postcodes provided are for the office of the participating organisation

4.5 As noted in Section 2, by the end of April 2019 (the point at which the analysis was completed), 45 of the projects had been completed, with nine still in delivery.

Pre-programme R&D behaviours

4.6 The surveys of beneficiaries and unsuccessful applicants suggest that **a very high proportion of applicants to ATC industrial grants were actively engaged in R&D in the period before their application to the programme.**

4.7 Specifically, in the three-year period before their application, 40 of 41 beneficiaries (including all 16 lead beneficiaries), and all 14 leads of unsuccessful applicants had invested in some form of R&D. This was most commonly 'Internal R&D' activity across both groups (for 34 of 41 beneficiaries and 14 of 14 leads of unsuccessful applicants), with 'Training for innovative activities', and 'Acquisition of advanced machinery, equipment and software for innovation' also evident for at least two thirds of beneficiaries and leads of unsuccessful applications.

4.8 As suggested by this data, applicants to ATC industrial grants (both successful and unsuccessful) invested in a mix of R&D activities. For example, 36 of the 41 beneficiaries invested in more than one type of R&D over this period.

4.9 The most common source of funding for this R&D investment was the organisation's own funds (identified by over 90% of both beneficiaries and leads of unsuccessful applications), with UK public sector grants the second most common source of funding, identified by over half of both groups (with no statistical variation between the samples). Other sources of public funding were also quite common (e.g. Research Councils and EU funding), compared to loans/overdrafts and equity finance; this is not unexpected and reflects the challenges associated with raising loan or equity finance for R&D activity across sectors and disciplines, given the level of risk and uncertainty to the funder/investor at this stage, and the relatively nascent position of agri-tech in this context (for example, compared to health and life sciences).

4.10 As a competitive R&D support programme, and one that is open to firms of all sizes, it is perhaps to be expected that the majority of applicants were already investing in some form of R&D activity, providing the capability, capacity and experience to deliver (and de-risk) further R&D.

4.11 The programme also sought explicitly to support collaborative R&D, and it is notable that the surveys suggest applicants to ATC industrial grants were also generally experienced in co-operation on innovation activities with other organisations. Of the 41 beneficiaries, 39 had co-operated on innovation activities with other organisations in the three-year period prior to their application to ATC (including all 16 leads), as had all 14 leads of unsuccessful applications surveyed. The range of organisations involved in this innovation across both beneficiaries and unsuccessful leads was broad including suppliers, clients, other businesses in the relevant industry, and universities/other higher education institutions.

4.12 However, in the context of the anticipated role of the programme in supporting more or enhanced engagement between industry and the research base, it is noted that 10 of the 16 beneficiary leads (63%) – all of whom were businesses – had co-operated with universities or other higher education institutions prior to their application, compared to 13 of the 14 (93%) leads of unsuccessful applications, which is a weakly significant difference.[34] The explanation for this is not clear from the data, however, it does indicate that the programme has led to new engagements with the research base by industry (covered in more detail below).

[34] A significant difference at 10% level (z-test)

Rationale for engaging in ATC

Leads

4.13 There is **strong alignment between the reasons that leads gave for why they had not taken forward their project prior to applying for a Catalyst award and the original rationale of the programme set out in the logic model related to externalities, the uncertainty of benefits and co-ordination issues**.

4.14 The reasons most commonly cited by leads of both successful and unsuccessful applications were a lack of finance absolutely and/or relative to other uses for finance, and the uncertainty and risk associated with the R&D activity. The inability to secure external finance for the projects was also identified as a factor by two-thirds of the beneficiary leads and half of the leads of unsuccessful applications. Reflecting the importance of the collaborative nature of ATC projects, 7 of the 16 beneficiary leads (and 8 of the 14 leads of unsuccessful applications) indicated that a lack of internal skills/knowledge prevented the project progressing prior to applying for a Catalyst award, with this issue in all cases evident alongside finance barriers.

4.15 The evidence from the leads also indicates:

- it was a combination of factors – both related to finance and more widely – that prevented project progress. The data is set out in detail for the beneficiary leads in Figure 4-3; all 16 respondents identified at least two (and in many cases five or more) factors that prevented the project progressing prior to applying for a Catalyst award. This is consistent with the evidence from the case studies, where a range of mutually re-enforcing factors were identified in a number of the case studies that prevented project progress (and led to the application to the programme). Put simply, the survey and case studies suggest that it is the mix of factors, rather than a single issue, that prevents project progress, particularly given the scale of industrial stage projects (as discussed in more detail below).

Figure 4-3: Factors preventing beneficiary leads from taking forward the project prior to applying for a Catalyst award

	Lack of internal finance	Unable to secure external finance	R&D costs too high relative to other uses for finance	Uncertainty in relation to the outcome and/or commercial return	Lack of internal skills/knowledge	Availability of Catalyst funding stimulated development of project idea	Lack of suitable collaborators
Lead 1			✓	✓			
Lead 2	✓		✓	✓	✓		
Lead 3	✓	✓	✓				
Lead 4	✓	✓	✓	✓			
Lead 5	✓		✓	✓	✓		✓
Lead 6	✓	✓	✓	✓	✓		✓
Lead 7	✓	✓	✓	✓	✓	✓	✓
Lead 8	✓	✓	✓	✓			
Lead 9	✓	✓		✓	✓	✓	
Lead 10	✓	✓	✓	✓		✓	
Lead 11	✓	✓	✓	✓		✓	
Lead 12	✓	✓					
Lead 13	✓			✓			
Lead 14	✓	✓	✓	✓			
Lead 15			✓		✓		
Lead 16	✓	✓	✓	✓	✓		✓

Source: Industrial stage grants beneficiary survey, 2019

- the **role of the ATC programme in stimulating the development of the project idea** was more common for leads of unsuccessful applications than beneficiary leads. Specifically, four of the 16 beneficiary leads indicated this (25%), compared to 9 of the 14 leads of unsuccessful applications (64%); despite the small sample size, this is a statistically significant difference (at 5% significance). This may reflect that projects that were funded (with on average higher scores than unsuccessful applicants) were further developed/drew on earlier R&D, rather than they were stimulated by the availability of the funding and therefore more 'speculative'.
- beneficiary leads and leads of unsuccessful applications surveyed were equally likely to have **considered other sources of finance** to progress the project for which they secured/sought ATC funding, with half of the leads in each group indicating they had considered other sources of finance (8 of 16 and 7 of 14 respectively). In all cases this included the businesses' own funds, with public sector grants also identified by around two-thirds of both groups, with mixed reasons for what this finance was not used including unsuccessful application and obtaining in part only the finance.

4.16 As noted above, all 16 leads of industrial stage projects surveyed had previously invested in R&D, and all 16 also stated that finance issues (a lack of internal or external finance absolutely, and/or relative to other uses) prevented the progress of this specific project without ATC. This raises the question of why they were they not prepared to invest in the case of the project for which they secured ATC funding, but had been previously? This issue was probed in the survey and case studies. Four main themes emerged:

- First, and most commonly the **level of risk associated with the project** was highlighted, which **alongside the uncertainty of outcome and the scale of**

the investment required at the industrial stage meant that public support was necessary to de-risk sufficiently the project. For example, one lead noted simply that '*It was (a) bigger and (b) higher risk than before*", and another that "*This project is high risk, almost slightly speculative, which we couldn't afford to invest money on a relatively high-risk project with very uncertain outcome."*

- Second, the **potential to stimulate and enable collaboration** was identified in a number of cases as an explanation for why public funding was required, particularly in terms of collaboration with the academic base. The need for public funding to cover the academic inputs, and the limited other sources of funding for applied R&D within the academic funding landscape was identified in the case study research.
- Third, and linked to the point above, it encouraged projects to be **more ambitious and tackle challenges through larger scale R&D** than would otherwise have been the case, and this is seen as critical in unlocking "transformational opportunities" and positioning the UK as an agri-tech lead internationally.
- Fourth, several leads indicated that the project was **focused on a new area** for the business (be this a new sector or market application), which increased the need for match funding to justify the investment in the context of the 'mainstream' business activity.

4.17 The survey data and case study evidence therefore suggest that **the programme was seen to be supporting R&D that was regarded as qualitatively different in its risk profile than more 'standard'[35] R&D activities previously undertaken within the business,** with the role of the potential collaboration also an important factor for some in making the case for public support. These issues are particularly relevant at the industrial stage (relative to the early and late stage ATC grants) given the scale of the investment required, as illustrated by several of the case studies (see below), which also highlight the varied delivery context.

Third Generation Polyethylene Greenhouse Cladding Materials:

This project aimed to develop novel plastic material for use in horticulture which could reduce pests, increase yields and reduce water demands. The project was led by a large UK-based plastics manufacturer, and involved six collaborators (growers, a manufacturer, a research institute and academics), including partners that had worked together on previous publicly funded collaborative R&D projects and other activities. It was argued that the project could not have gone ahead without external funding – this reflected not only its scale and complexity, but also the relatively high risk associated with bringing together activities ranging from novel academic research through to product development in one project.

[35] By which we mean R&D activities that had been typically undertaken by participant organisations, often using their own funds, and which was substantially different in nature/focus/risk profile to R&D activity supported by the ATC grant.

Miscanthus Upscaling Technology (MUST)

The project was business led, and involved three other business partners and a University, and sought to improve technology used to establish a bioenergy crop, enabling more rapid expansion of the crop area to meet proven market demand. The most important driver for ATC support was the ability to bring together a multi-actor, commercial and academic partnership, who would not have come together without support. The scale of work needed and its breadth - which were critical to unlocking what was seen as a transformational opportunity for the sector and positioning the UK as a lead in this field internationally – was beyond the capacity of any of the partners on their own.

Precision Breeding:

This project was led by Aviagen, a major livestock breeding company, in collaboration with a University-based research institute. It aimed to develop a novel approach to predicting/controlling of economic gains arising from genetic improvement, which relied on testing whole genome sequencing data on an unprecedented scale. The two partners had prior experience of R&D activities in the agri-tech space, and a longstanding collaborative relationship, but the ATC project was significantly larger in scale and higher risk than prior R&D activities. This would not have been funded internally by the lead business given the level of risk/uncertainty combined with scale of activity that was necessary to validate the novel approach (a smaller project would have limited value in this context). Moreover, collaboration was a key driver for the project: the business lead brought historical data that the research institute would not have otherwise had access to, and the research institute provided expertise in innovative sequencing techniques and computational capability that the business did not have in-house. The research institute had also secured funding for other R&D projects (including another ATC project), which enabled knowledge sharing, pooling of resources to purchase a larger/more powerful computer, and the employment of a larger team of specialists who could be deployed on each project as required.

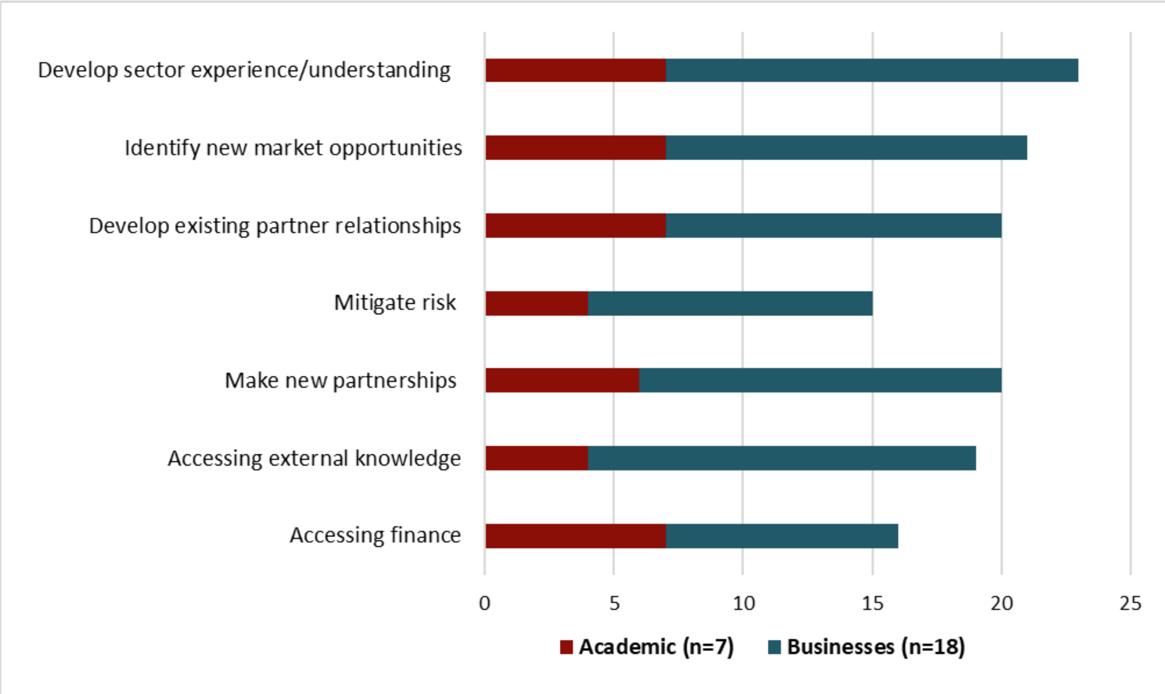
Integrating control strategies in oil seed rape:

This project developed targeted seed treatments and associated guidelines to improve disease management and protection in crop breeding. It was led by a large multinational company (Syngenta) in collaboration with a University (building on an existing collaborative relationship) and an agricultural levy/research body (ADHB). Reflecting the mixed nature of activity – with considerable research, analysis and modelling capabilities required, alongside access to field trial team and facilities – the need for collaboration between industry and academia was core to the rationale for applying to ATC. The financial support was equally important, with high costs and uncertain outcomes given the novel nature of the research, and the low level of awareness in the market of the potential for addressing the effects of the pathogen.

Collaborators

4.18 The beneficiary survey also gathered data on collaborator motivations for involvement in the ATC project. Consistent with the evidence from the leads, **for collaborators, in most cases a combination of drivers explained participation in the ATC project:** of the 25 respondents, 24 identified three or more reason for involvement on the ATC project. As set out below in Figure 4-4, 23 of the 25 collaborators (including all seven academic collaborators surveyed) identified developing sector experience/understanding as a motivation for participation in the ATC project, with identifying new market opportunities, making new partnerships and accessing external knowledge also common.

Figure 4-4: Collaborator responses to 'Why did you want to get involved in the Agri-Tech Catalyst project'



Source: Industrial stage grants beneficiary survey, 2019

4.19 The case study evidence provided some further perspectives on the motivations for collaborators to participate. One theme that emerged which is consistent with, but provides further insight to the survey data, is related to the **development of new partnerships and relationships**, and how this was important both with the lead applicant but also more broadly across the consortia that have been developed. The opportunity for collaborators to work with a range of other organisations – both academic and commercial – was highlighted in some of the case studies that involved larger consortia.

Tools and technology for predicting tomato glasshouse production:

This project developed tools and technology to predict glasshouse vegetable production and was led by a large-scale producer in collaboration with a research organisation and imaging company. All project partners had prior experience of R&D. The lead and research organisation had worked together previously, and the latter had extensive research experience and interest in the field already – but was keen to become involved in a project with potential for commercial gain for their organisation. The lead and research organisation had not worked with the imaging company prior to this project. The imaging company's main motivation for getting involved was the opportunity to expand further their experience in the agri-tech sector, which they had been diversifying into for the past 5-6 years – including through a previous Innovate UK project focused on using imaging sensors to detect disease in plants – and to develop imaging tools for use in specific conditions.

Developing Bacteriophage Technology to Optimise Potato Production:

This project involved five collaborators, and alongside the lead (APS) spanned the full value chain in a major horticultural sector. The partnership involved a mix of existing and new collaborations and emerged from an earlier proof of concept stage Innovate UK funded collaborative R&D project led by APS and involving two of the partners on the ATC project. Alongside opportunities to work with the lead (an SME), collaborators consulted for the case study highlighted the benefits of working with other collaborators for the first time or developing further existing relationships, including organisations operating in different part of the sector providing the mechanism through which to explore other potential R&D and commercial activities, and to share knowledge and insights on the development of the sector more broadly. The opportunity to engage with major industrial partners in the project was an attraction for a number of project partners.

Feeder schemes

4.20 **'Feeder' schemes were also important in generating ideas for industrial projects, reflecting the role of the programme in the wider innovation support landscape, and the importance of ensuring effective links and pathways between programmes.**

4.21 Specifically, from the survey groups:

- half of lead beneficiaries (8 of 16) had received other public funding that led to the ATC application; this included other UKRI programmes, specifically through Innovate UK and BBSRC funding (e.g. The Sustainable Agriculture and Food Innovation Platform and Knowledge Transfer Partnerships), and EU programmes (e.g. H2020)
- over half (8 of 14) leads of unsuccessful applications had received other public funding that led to the ATC application; this focused particularly on Innovate UK schemes.

4.22 The case studies also demonstrate the importance of feeder schemes, both in the 'innovation' landscape and the earlier stage 'research' landscape. For example, in one of the case studies, the industrial stage ATC project emerged from earlier university-led research on a related issue as summarised below.

Integrating control strategies in oil seed rape:

The aim of the project was to identify novel resistance traits/loci to Rhizoctonia solani anastomosis group (an aggressive pathogen that reduces yields) in oilseed rape (OSR) to inform the development of guidelines, targeted seed treatments and varietal resistance for use in crop breeding, to provide improved disease management and protection. The idea for the ATC project emerged from research undertaken by the academic partner in 2011-12 on a crop that is often used in rotation with OSR (wheat). Through an existing collaboration between the academic partner and industrial lead, an opportunity was identified to undertake a collaborative R&D project to test whether it was possible to identify a genetic component in the crop that is the focus of the work drawing on the findings of this earlier research. This followed an earlier unsuccessful application for BBRSC funding for the project, meaning that the ATC was regarded as the only possible source of funding for the project that required both academic and industrial inputs and expertise.

Encouraging spill-ins and new collaborations

Spill-ins

4.23 **The Catalyst has encouraged some spill-in of non-agricultural disciplines and companies who are new to agri-tech, although the scale of this appears to be modest with spill-ins focused principally in terms of technologies not participants, reflecting potentially the convergence of underpinning technologies across a range of different market sectors.**

4.24 From the baseline application data, we can see that just over two thirds (69%) of leads providing sectoral codes (n=40)[36] were in agricultural sectors (such as crop production, livestock and plant propagation, or the manufacture of agricultural and forestry machinery or agrochemical products). This demonstrates that the programme has supported innovation activity for existing sector actors, which is important given the founding rationale and objectives of the programme. However, it has also encouraged some businesses from non-agricultural sectors such as transport and engineering to lead large-scale ATC projects.

4.25 A similar picture emerges from our beneficiary survey with collaborators, where approaching three-quarters (15 of the 18) business collaborators were operating in typically agriculture-related activities (reflecting the focus of many industrial stage projects on pilots and field trials, which necessitates agricultural partner involvement), with the remainder in marketing, robotics

[36] 40 of the 54 industrial stage projects provided Standard Industrial Classification (SIC) codes as part of their application.

technology and analytic instrument manufacture. As noted above (see Figure -4), the survey also found that the need for greater agri-tech experience and understanding prompted many collaborators to apply for ATC funding.

4.26 However, care is needed in interpretation based on SIC code data, as firms that may appear to be in non-agri-tech sectors are operating in this space. On more detailed analysis[37], it appears that 45 of the 54 project leads (including 34 of the 40 cited above where SIC codes were available) are in fact involved in the agricultural sector. For example, businesses coded under the “wholesale of solid, liquid and gaseous fuels and related products” SIC code focus on energy crops, and “air transport” businesses grow and distribute flowers. The case study evidence also provided limited evidence of spill-ins to agri-tech in terms of participants in projects; in one case the project involved a partner that traditionally worked in other engineering sectors, however, they had been involved in agri-tech for over five years, including participation in an earlier agri-tech innovation project funded by Innovate UK.

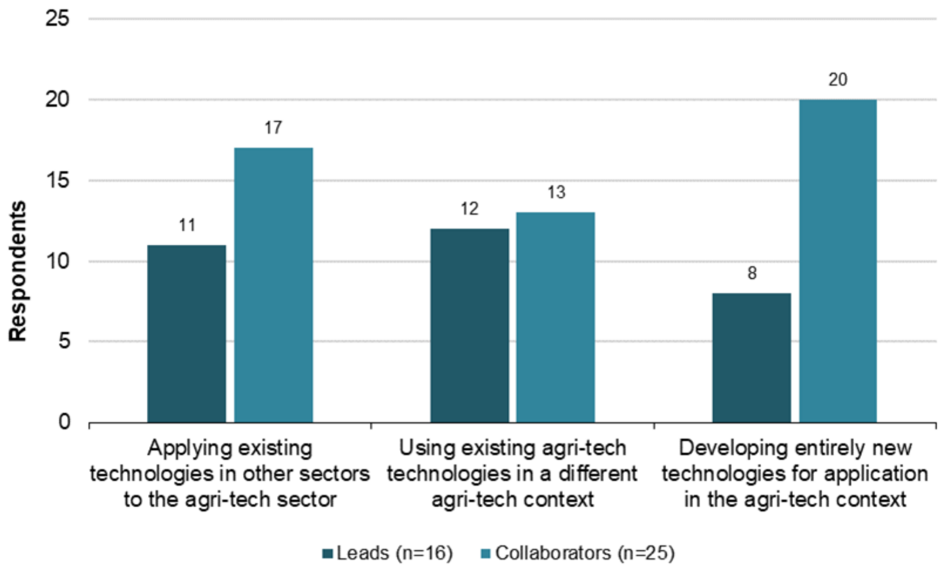
4.27 Of the 7 academic respondents to the beneficiary survey, nearly all indicated they focused on ‘core’ agri-tech disciplines, including agricultural and food sciences, crop physiology and organic chemistry. Few specialised in non-agricultural disciplines (examples included professional services). This is not unsurprising, with academic partners often playing a key role in undertaking the lab-based research activity as part of ATC projects, where the focus is likely to be on ‘core’ agri-tech issues. There was some evidence from the case studies of wider disciplines supporting projects (not as formal partners), including statistics and genetics, but this was evident in one case only.

4.28 This data suggests that for industrial projects, ATC projects generally involve participants that are part of the existing agri-tech landscape, with modest levels of spill-in from outside. However, a further perspective on spill-ins was gathered through the beneficiary survey on the nature of the technology involved in the project, rather than the sectoral or discipline background of the participants.

4.29 As shown below, 11 of the 16 leads of industrial stage projects surveyed and 17 of the 25 collaborators (taken together, 28 of the 41 participants, or 68%) indicated that their project included the application of technologies from other sectors to the agri-tech sector. This does suggest a higher level of spill-ins to agri-tech through the programme than the background of the participants would suggest. An example of the spill-in of technologies identified in the case study is set out below. The mix of technologies suggested by the survey responses (where multiple responses were allowed) also highlights the complex and multi-faceted nature of ATC funded projects, with a mix of technologies developed both existing and new to the sector.

[37] SQW undertook a desk-based analysis on websites of the 54 lead companies.

Figure 4-5: The nature of spill-ins across ATC projects



Source: Industrial stage grants beneficiary survey, 2019

Tools and technology for predicting tomato glasshouse production:

In this project, the business collaborator had previously undertaken a collaborative R&D project using imaging sensors to detect disease in plants. This technology had previously been used in the rail sector, but the ATC project was the first-time imaging sensors had been used to determine ripeness of the vegetable by colour.

Collaborations

4.30 **The programme has stimulated new collaborations, where some or all of the partners had not worked together previously, although project leads of industrial projects do commonly seek to involve 'known' partners in their projects.**

4.31 According to the beneficiary survey, over a third (15 of 41) of all respondents (both leads and collaborators) had not worked with any of their ATC partners before, meaning that the project involved working with all new partners. Further, approaching three-quarters (29 of 41) worked with at least one new partner through the ATC project i.e. the project involved working with some or all new partners. The data is set out in Table 4-1.

Table 4-1: For beneficiaries (n=41), Catalyst project activity involved working with …

Response	Number of beneficiaries	% beneficiaries
No new partners	12	29%
Some new partners	14	34%
All new partners	15	37%

Source: Industrial stage grants beneficiary survey, 2019.

4.32 However, this headline data masks a significant variation between project leads and collaborators. Of the 16 leads surveyed, only two (13%) indicated they had not worked with any of their project partners (i.e. it was a completely new partnership), compared to 13 of the 25 collaborators (52%); despite the modest sample size, this is a statistically significant variation. This may reflect the scale of industrial stage grants, with leads seeking to include some 'known/trusted' partners in the collaboration to manage/mitigate the risks of project delivery. Given the often novel and high-risk nature of the projects supported by ATC (as perceived by leads, discussed above) this is not unexpected.

4.33 The data highlights, however, the benefits of the programme in supporting new relationships within partnerships between collaborators. The importance of the opportunity to work with new partners was highlighted above as a key driver for participation in the programme by collaborators, and the survey evidence provided positive evidence that this is being realised.

4.34 This said, it is also important to recognise the potential benefits – both in terms of de-risking project activity, and in embedding and deepening relationships – in ATC projects supporting the continuation of existing collaborations, either in full or part. The case studies provided examples where the ATC project had helped both to develop further existing bilateral relationships and to bring some new partners together to deliver collaborative R&D activity, providing a mix of new and existing relationships.

Third Generation Polyethylene Greenhouse Cladding Materials:

The project involved a mix of new and existing collaborations between consortium members. For example, the project lead and a university partner had worked together on previous R&D projects but not to the same scale as the ATC project, and the lead had not worked with some of the industrial partners previously. The lead indicated that the project has formed closer relationships with commercial partners. Further, one of the industrial partners consulted indicated they had become more aware of the potential benefits of academic collaborations and more open to such relationships as a result of its participation in the ATC project.

Tools and technology for predicting tomato glasshouse production:

In this project, the long-term prior working relationship between two of the three partners has meant they "speak the same language" and felt able to be open and honest about any difficulties or challenges. Their relationship has continued to develop and improve as a result, and the partners plan to work together in future. A new partnership has been established with the third private sector partner, who brought advanced image analysis and automated technology expertise to the project. This relationship would not have happened at all without the ATC project.

4.34 In summary, the evidence above suggests the industrial grants have led to some new actors engaging in the agri-tech sector and to new collaborations. However, at the industrial stage, the spill-ins appear to be more focused on technology than participants, and for lead partners the involvement of known and therefore potentially trusted partners appears to be particularly important. This is consistent with the scale of investment involved, and the risks associated with the R&D activity supported by the programme, which the evidence suggests is regarded in many cases as qualitatively different to other more 'standard' R&D activities delivered by participants. In Sections 5 and 6, we discuss the implications of this for the delivery progress and outputs and outcomes that have been realised by projects.

5. Activities and delivery progress

5.1 This section sets out the evidence on the activities undertaken, and delivery progress at this interim evaluation stage, drawing on the surveys, consultations and case studies.

Key messages

There is generally a close fit between the activities anticipated and delivered by industrial stage projects, although the TRL stage of ideas is more mixed than may be expected.

ATC industrial stage projects come in all shapes and sizes. However, within this diversity there are consistencies in the roles played by collaborators, with nearly all collaborators surveyed indicating they provided technical expertise/knowledge to the project.

There is evidence that ATC project delivery involves inputs from organisations outside of the formal partnership. The specific roles played by external support varies, but do not appear to be qualitatively different to the types of inputs provided by core partners, and accessing wider perspectives was a theme common to several of the projects surveyed where this was evident.

ATC has performed well in terms of encouraging technology progression though industrial stage projects and enabling this to be realised more quickly than might otherwise have been the case without ATC support.

Survey data and close out reports suggest that the objectives anticipated from projects are unlikely to be realised consistently across the portfolio, with implications for overall impacts. Further, there are differences between lead and collaborator views – across and within projects – highlighting the different experiences and expectations of partners involved in ATC projects.

Given the progress of projects, the evidence on dissemination for this Phase 2 interim evaluation on industrial grants is limited. However, case studies illustrate both the challenges with dissemination, and where dissemination activities have been identified as important to potential impact and plans are in place to raise awareness and demand across industry.

Activities delivered

Nature of project activity

5.2 A key question in the theory-based approach to the evaluation is whether the activities of the Catalyst have been implemented as set out in the Theory of Change, and specifically whether the projects funded are undertaking activities aligned with the scope of their industrial stage award. Drawing primarily on survey evidence, the evaluation indicates that there is **generally a close fit between the activities anticipated and delivered by industrial stage projects, although the TRL stage of ideas is more mixed than may be expected.**

5.3 For each of the projects where the lead was surveyed, Figure 5-1 summarises the self-reported technology stage[38] at the start of the project and the range of activities that the projects have delivered (using broad categories given the significant technical variation between individual projects). For context, the expectation as set out in the Logic Model is that early stage grants will support projects at TRLs 1-4, industrial stage grant take projects to TRL 7, and late stage grants would support projects up to TRL 9.

5.4 Three points are noted from the data:

- the number of projects at the 'experimental research' stage and the TRL stages aligned with this (where identified) is higher than we might expect given the underpinning Logic Model, accounting for over half of the surveyed leads (nine of 16)
- the nature of activities undertaken is closely aligned with the Logic Model, including lab-based prototyping, market testing, product development planning, and particularly extending proof-of-concept (which was identified by 11 of the 16 leads)
- there is no clear relationship between technology types and activity types, with activity types spanning technology stages.

5.5 The data on technology levels should not be taken too far, owing to the challenges in accurately identifying TRL stages given the iterative nature of innovation and product/process development. Further, reflecting the varied and multi-faceted nature of ATC projects (as discussed above in relation to technology), they can span multiple TRLs levels. The case study evidence provided examples of this, as summarised below.

5.6 However, if the projects are in some cases 'earlier' in terms of technology progression at project start than may be expected, this may have implications for the time-paths to commercial (and wider) impacts of these projects, and the ATC programme, including at this interim evaluation stage. We return to this issue in Section 6 when we consider the outcomes realised at this interim evaluation stage and anticipated for the future.

Case study example: Miscanthus Upscaling Technology (MUST).

As noted previously, the overarching aim of this project was to develop new production systems, using seed propagation, to increase the potential to grow the miscanthus sector through enabling faster propagation than offered by traditional rhizome division. The project involved a number of activities,

[38] Note: descriptions of each stage and level were used to ascertain levels with respondents, rather than TRL numbers.

including trialling varieties of miscanthus, specifying and designing machinery for planting, developing agronomy protocols for plug plant produced crops, followed by field trials and further refinement. During this process, the technological progression of each aspect of the project has varied:

Seed propagation methodology has moved from TRL 3 to TRL 9,

The mechanisation for miscanthus planting/husbandry has moved from TRL 4-5 to TRL 8/9,

Plant production processes for miscanthus have moved from TRL 4-5 to TRL 8/9,

Root inoculation processes have progressed from TRL 3 to TRL 6,

By the end of the project (in June 2019) the aim is to have a fully developed business model in market, which will then be scaled up rapidly.

Figure 5-1: Overview of surveyed lead project TRL stage and activities

	Summary stage	TRL stage (at start of project)	Intended project activity						
			Technology development	Lab-based prototyping	Product Development planning	Extending proof-of-concept	Exploration of production mechanisms	Market testing	Other
Lead A	Experimental research	Basic principles observed and reported (TRL 1)	✓	✓	✓	✓		✓	
Lead B	Experimental research	Basic principles observed and reported (TRL 1)			✓	✓		✓	
Lead C	Experimental research	Basic principles observed and reported (TRL 1)	✓		✓				✓
Lead D	Experimental research	Basic principles observed and reported (TRL 1)	✓		✓				✓
Lead E	Experimental research	Proof of concept (TRL 3)	✓	✓				✓	
Lead F	Experimental research	Proof of concept (TRL 3)	✓	✓		✓	✓		✓
Lead G	Experimental research	Proof of concept (TRL 3)	✓	✓	✓		✓		
Lead H	Experimental research	Basic technological components integrated to establish that they will work together (TRL 4)			✓	✓		✓	✓
Lead I	Applied R&D	Basic technological components integrated to establish that they will work together (TRL 4)	✓		✓	✓			
Lead J	Applied R&D	Basic technological components integrated to establish that they will work together (TRL 4)	✓	✓		✓	✓		
Lead K	Applied R&D	Testing prototype in a simulated operational environment (TRT 5)	✓						
Lead L	Tech. implementation	Prototype demonstration in an operational environment (TRL 7)	✓	✓		✓		✓	
Lead M	Experimental research	-	✓			✓			✓
Lead N	-	-	✓		✓	✓	✓	✓	✓
Lead O	-	-	✓			✓	✓		
Lead P	Applied R&D	-	✓		✓	✓			

Source: Industrial stage grants beneficiary survey, 2019

Partnership structures and roles

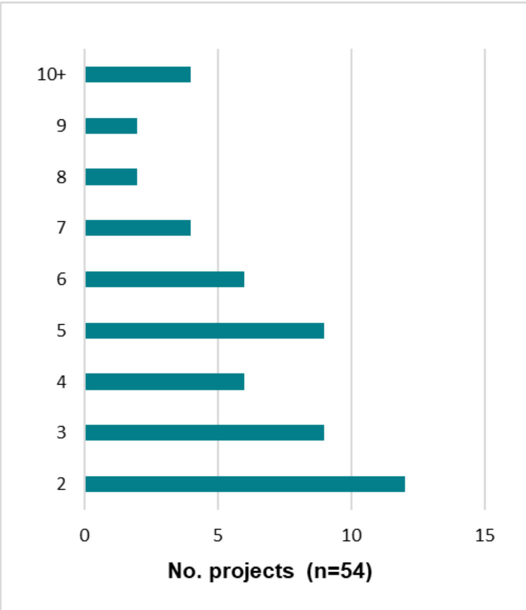
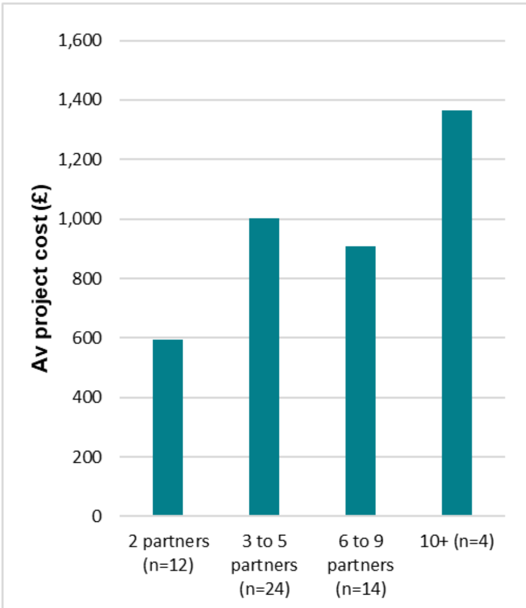
5.7 Reflecting the varied nature of activity, ATC industrial stage projects also have very varied and bespoke structures; put simply, **ATC industrial stage projects come in all shapes and sizes**. However, the survey evidence suggests that within this diversity there are consistencies in the roles played by leads and collaborators.

Structures

5.8 The partnerships structures involved in the delivery of industrial stage projects varies substantially, both in scale and nature. In terms of scale:

- the majority of the projects (42 of 54) involved three or more partners (including the lead), with 12 involving a single collaborator alongside the lead
- the average (mean) size of partnerships (including both leads and collaborators) was 4.9 partners, but this varied with four of the 54 projects involving ten or more partners compared to 12 with only one partner
- there was a general relationship between the number of partners involved in projects and the total cost of the project as may be expected, particularly between the smallest and largest partnerships; however, this relationship was not straightforward, as shown below, the average total cost for projects with 3-5 partners (including the lead) was higher than those with 6-9 partners.

Figure 5-2: Number of partners and average size of project by partnership size

Number of partners	Average project cost by number of partners (public sector funding)
	

Source: IUK monitoring data. Note: project cost taken from Innovate UK data (total project cost, which we understand includes Innovate UK and BBSRC funding)

5.9 Further to the differences in the scale of project partnerships, there was also a very wide variation in the nature of the partnerships, and the mix of industrial and academic partners; the latter were not evident in all cases with six projects being business only collaborations. The variation is summarised in Figure 5-3 below:

- the x-axis sets out the number of industrial partners (including the lead) involved in each project
- the y-axis sets out the number of academic partners involved in each project (if any)
- the size of the bubble and label indicates the number of projects where this partnership structure is evident e.g. 11 projects involved one industrial partner and one academic, and six projects involved four industry partners and one academic partner,

Figure 5-3: Size of collaboration for industrial stage projects (n=54)

Source: IUK monitoring data

5.10 The figure highlights the diversity of project structures, although some general points emerge:

- the most common structure is a single industrial partner (i.e. the lead) and one academic
- in most cases the number of industry partners (excluding the lead) involved in the project was higher than the number of academic partners, and a single academic partner involved in a project was by far the most common approach (in 34 of 54 cases)

- this said, most project did involve a mix of both industrial and academic partners, only 6 of the 54 projects involved no academic partners[39]
- the volume of industrial partners on projects is notable: over a quarter (16 of 54) involved at least five industrial partners (meaning the lead plus at least four other industrial partners).

5.11 The case studies that further highlight the very different scale and nature of partnerships delivering ATC projects, and the varied content within which activity is progressed and benefits may emerge. For example, the Third Generation Polyethylene Greenhouse Cladding Materials project and Developing Bacteriophage Technology to Optimise Potato Production project were large multi-disciplinary consortia, including both academic and industrial partners of varying scales and operating across relevant supply/value chains. This contrasted with the Precision Breeding and ICAROS projects that involved a single industrial partner (as lead) and a single university.

Roles

5.12 The beneficiary survey highlighted the roles played by collaborators in the industrial stage projects. The summary data across all 25 collaborators surveyed are set out below, with nearly all indicating they provided technical expertise/knowledge. However, 24 of the 25 collaborations identified they played more than one of these roles in the project, and in some cases that they delivered all five specific activities set out below.

Table 5-1: For project collaborator: What was your role on the project? (N=25, multiple response)

	Business (n=18)	Academic (n=7)	Total	%
Technical expertise/knowledge	16	6	22	88
Testing in laboratory or demonstrators (facilities or equipment)	10	10	14	56
Testing in operational environment	12	12	17	68
Analysis or evaluation	11	11	17	68
Market expertise/knowledge	11	0	11	44
Other	2	3	5	20

5.13 The roles played by academic and business collaborators was generally consistent, for example, 10 of the 18 (56%) business collaborators indicated they undertook testing in laboratory or demonstrators, as did 4 of the 7 academics (57%). The one exception, as may be expected, was in providing

39 We are unable to compare this to unsuccessful applicants, as data only available for leads.

market expertise/knowledge, with businesses accounting for all 11 relevant respondents.

5.14 The picture was similar for the case studies. In four of the seven, the project lead provided access to operational data or production/trial environments, whereas the collaborators (businesses and academics) provided analytical, computational and technical expertise to address the challenges often raised by the lead business. Two of the seven case studies involved larger consortia where the leads were product suppliers, and collaborators included manufacturers, growers who trialled new technologies, and businesses/academics providing technical and analytical expertise. Across the board, the relationships appear to be genuinely collaborative (rather than more transactional/sub-contracted relationships).

Engagement with the wider innovation landscape

5.15 An interesting finding from the interim evaluation of the early and late stage projects was that a sizeable minority (8 of 20)[40] of the project leads surveyed indicated that they had received other forms of support to develop the idea during delivery of the ATC project; that is, further to the formal project partners, support had also been provided by other organisation including HEIs, consultants, commercial labs or private sector R&D institutes, and RTOs.

5.16 This trend also appears to be evident for industrial stage projects. In the survey of 16 leads, five indicated they had received support to develop the idea during delivery of the ATC project from organisations outside of the formal partnership (11 had not). The five projects varied in size, from one collaborator to ten, but all involved academics. The specific roles played by external support varied in these cases, although across the five projects the inputs do not appear to be qualitatively different to the types of inputs provided by core partners. For example, one lead noted that the additional support was for field research and data analysis, modelling and data visualisation, and another to develop further the 'thinking behind the idea' which involved engagement with a number of different organisations in the research and innovation base, and the public sector.

5.17 In this context, the rationale for seeking support from outside the consortium was dependent on the specific circumstances. However, accessing wider perspectives was a theme common to several of the projects. For example, one lead (that had engaged with other universities, RTOs and commercial R&D assets) noted the size of their consortium influenced the need to secure wider perspectives 'to see what is out there, the consortium is only two partners, so it is quite small', and a second (that engaged with other universities) reported that this wider engagement 'adds another dimension and allows us to get more academic integration in other areas.'. In one case, external support was secured (via sub-contracting) owing to challenges in recruiting a researcher within the project partnership, illustrating the practical

[40] SQW (2018) Interim Impact Evaluation of the Agri-Tech Catalyst: Phase 1 final report. 5.8

issues influencing project activity and engagement with the wider research and innovation base.

5.18 The case studies provide examples of where this has occurred, including where particular expertise, data, equipment or materials has been identified amongst external organisations.

Integrating control strategies in oil seed rape:

The project partnership involved an industrial lead and a university that had an existing and long-standing collaboration. As part of the delivery of the project, the lead at the university drew on their network to access additional specialist materials and samples from a separate university. This enabled the project to undertake a more comprehensive analysis to inform the development of new products and services.

Precision Breeding: Broilers from Sequence to Consequence:

The project partnership involved an industrial lead and a research organisation, who managed the project on a day-to-day basis and provided expertise in innovative genomic sequencing methods. The project also involved subcontracted inputs from an external organisation (Edinburgh Genomics), who provided analytical sequencing support.

5.19 For long-term (up to three years) and large-scale (over £3m) projects, it is not unexpected that expertise/capabilities that were not expected at the outset may be identified and necessary. Indeed, several of the case studies identified that one of the strengths of the ATC programme was its flexibility, which enabled projects to evolve as they progressed. For example, in the MUST case study, the decision taken by the project team in conjunction with Innovate UK to add six months to the end of the project will enable more substantive results to be delivered for a crop which takes 2-3 years to reach maturity and where the field trials were adversely affected by poor weather conditions in spring 2018. The flexibility of Innovate UK was appreciated by the project team, as it ensured that the project was able to respond flexibly to factors beyond their control. Similarly, the flexibility to suspend direct drilling trials when these proved unsuccessful and to focus entirely on plug plants was very important. The monitoring officer assigned to the project was very accommodating in responding positively to learning in the early stages of the project to focus later stages on the most promising areas.

5.20 However, the use of wider support outside of the formal partnerships developed for project delivery, reinforces the point that a range of factors, including external support, may influence outcomes from Catalyst funding. This is discussed further in Section 7 as part of the contribution analysis.

Project progress

5.21 At this interim evaluation stage, nine of the 54 Industrial stage projects supported by the ATC remain in delivery (with project lasting up to three years), and many had completed in recent months (see 2.26). Therefore, it is too early to provide a comprehensive and definitive assessment of whether the projects have delivered as anticipated against their objectives across the full portfolio.

5.22 However, three perspectives are available on delivery progress, that taken together provide an indication of project progress at this interim evaluation stage:

- survey evidence on the extent to which the projects have, at this stage, led to the progression of technologies
- survey evidence on actual/expected delivery against objectives
- close-out report evidence on actual/expected delivery against objectives (covering 20 projects, completed by project leads).

Technology progression

5.23 The survey suggests that **the ATC has performed well in terms of encouraging technology progression though industrial stage projects** and enabling this to be realised more quickly than might otherwise have been the case without ATC support.

5.24 Over half (26 of the 41) of the beneficiaries reported that the ATC project had progressed a technology towards market readiness at the point of the survey; the majority of which said this had been accelerated faster than would have been the case without the Catalyst support “to a significant extent” (n=19). In most other cases (13 of the 41), beneficiaries indicated they expect that the project will progress a technology towards market readiness in the future. Just one of the 41 beneficiaries (an academic collaborator) indicated that technology progression had not and would not happen.

5.25 However, this summary data may underestimate the contribution of the programme as it includes the perspectives of project collaborators who may have a less detailed understanding of the progress of the project as a whole (given they can be focused on a specific element). Considering leads only, **15 of the 16 indicated that the ATC project had progressed a technology towards market readiness at the point of the survey,** (with one indicating this would happen in the future). Of the 15 leads that indicated technology progression had been realised, a high majority (12) said the technology progression had been accelerated faster than would have been the case without the Catalyst support “to a significant extent”.

5.26 This is a positive finding, indicating that in nearly all cases, those leading ATC industrial stage projects believe that the funding has progressed a technology towards market readiness at this interim evaluation stage.[41]

Evidence on delivery against objectives

5.27 The **beneficiary survey suggests mixed views on the performance of the project against their original objectives**. As set out in Table 5-2, under half (18 of the 41) beneficiaries indicated their project had met or would meet its objectives in full, with a similar number reporting that the objectives would be met in part. Again, reflecting potentially varied levels of knowledge of the project, leads were more likely to report that the objectives had been or would be met in full (10 of the 16, or 63%), compared to collaborators (8 of the 25, or 32%); this is a (weakly) statistically significant difference (at 10%).

5.28 Given the small sample sizes, it is not possible to compare the perspectives between completed and live projects statistically. However, it is noted that the four leads of completed projects, two indicated the project had met its objectives in full, and two in part.

Table 5-2: Did the project achieve its original objectives? OR Do you believe the project will achieve its original objectives?

	Total (n=41)	Leads (n=16)	Collaborators (n=25)
Yes - in full	18	10	8
Yes - in part	19	5	14
No	2	1	1
Don't know	2	-	2

Source: Industrial stage grants beneficiary survey, 2019

5.29 Consistent with the difference between lead and collaborator perspectives, where multiple participants in a project were surveyed, different views from different partners regarding progress against objectives were identified. The beneficiary survey gathered data from two or more partners for nine of the 25 projects covered; this was a mix of leads and collaborators (n=4) and multiple collaborators (n=5):

- in six of the nine projects (including all four where leads and collaborators were surveyed), different views on delivery against project were identified; leads were generally more positive than collaborators as we may have expected from the data set out above

[41] Owing to the modest sample sizes, the data has not been cut by Round or by project status (live/closed)

- in three of the nine projects (all where multiple collaborators were surveyed) there was consistency on the view of project progress; in these cases, all collaborators agreed that objectives had or will be met partially.

5.30 This is likely to reflect different levels of awareness of project progress but may also be owing to different expectations amongst project partners in terms of what they are seeking to achieve from the project, which is likely to vary between partnerships, and/or different approaches to relationship management.

5.31 The evidence from the close out reports was consistent broadly with the overall survey evidence. Of the 20 close out reports (all completed by leads), 16 (80%) indicated that the objectives had been achieved fully, with 4 (20%) partially achieved.

5.32 Material from the case studies provides further insight as to why some of the projects have partially delivered against their original objectives. For example:

- in the Precision Breeding case study, whilst the project successfully delivered against its analytical milestones, the results found a smaller gain in accuracy than expected, and so further R&D activity will need to take place before the lead business can fully integrate the novel approach into routine breeding
- in the case study focused on tools to predict tomato production, following a delayed start, a chemical producer in the consortium withdrew from the project, which meant the team were restricted to testing existing chemical coatings on the new plastic film being developed rather than creating new coatings as originally intended. The delayed start also meant the project missed the first growing season, and therefore further grower trials will be needed to test the product further.

5.33 The implications of these findings related to project progress across the different sources of evidence are not straightforward. To some extent, the level of realism amongst project beneficiaries through the survey is encouraging, reflecting the challenges of R&D activity, and the high-risk nature of the projects supported, which is likely to involve cases where expectations are not met in full; zero or no failures would imply that the programme was insufficiently risk averse – or supporting only low-risk projects. By targeting higher-risk projects, the programme has arguably delivered against the original rationale (around risk) and increased the level of additionality (i.e. projects were too risky to be taken forward anyway in the absence of ATC).

5.34 This said, **the survey data and close out reports also suggest that the objectives anticipated from the projects are unlikely to be realised consistently across the project portfolio, with implications for overall impacts of the ATC programme.** Further, the survey data indicating the difference between lead and collaborator views – both across and within projects – highlights the different experiences and expectations of partners involved in ATC projects.

Dissemination

5.35 One of the critical assumptions in the Theory of Change was that the learning and results of the ATC projects would be disseminated effectively, both by the projects themselves and Innovate UK (and other funding partners), to ensure that wider knock-on impacts are delivered, such as knowledge spillovers and uptake of new technologies across the wider agri-tech/agricultural sector.

5.36 As reported in the Phase 1 report[42], the evaluation has identified some frustration amongst stakeholders consulted with the lack of dissemination from projects themselves and Innovate UK to date (particularly post award), even from stakeholders who are very active in the agri-tech R&D space. Barriers to dissemination included concerns over retaining IP and the commercial value of knowledge gained to those involved, an unwillingness to share project-related issues or failures, the use of limited or very niche dissemination routes, and the fact that dissemination take place after Catalyst funding has ended (so there is no incentive, funding to deliver it, or assessment to check it occurs). In academia, whilst the evidence from case studies and close out reports suggests ATC findings are being published in journals, paywalls for academic journals can mean learning does not reach all stakeholders. Whilst this was recognised as a problem with R&D support programmes more generally, it was identified as a particular challenge for ATC given the need for dissemination to generate demand and knowledge of the technologies developed in the wider agri-tech sector in order for impacts to be realised fully.

5.37 Given the progress of projects, the evidence on dissemination for this Phase 2 interim evaluation on industrial grants is limited. Just four of the projects surveyed were completed at the time of the beneficiary survey, of which three indicated they had disseminated the findings/learning from the project beyond those directly involved in the project. The dissemination activities undertaken included producing journal articles for academic publications, and the delivery of training session to primary users (or potential users) of the technology developed through the project to raise awareness and understanding. The completed project where dissemination had not been undertaken illustrates how project challenges can impact on dissemination, with issues over IP between project partners and the tensions this caused within the partnership limiting dissemination activities.

5.38 The case studies reflected some of the challenges with dissemination discussed above. However, they also provide examples of where dissemination activities are recognised as crucial to achieving impact, and where plans are in place to raise awareness and demand across industry.

[42] SQW (2018) Interim Impact Evaluation of the Agri-Tech Catalyst: Phase 1 final report. 5.16

Case study example: Integrating control strategies in oil seed rape:

One of the core intended outputs of the project, and core to its overall potential success, is the development of guidelines for industry which will be developed and disseminated widely by the partnership. A focus from the outset on dissemination and awareness raising through the development of the guidelines has been important. The ultimate effects of this on levels of adoption is not yet know, however, the project appears to be in a strong position to generate demand and promote adoption and take-up through the dissemination of the guidelines. The project has also undertaken wider dissemination activities, including articles in trade journals and magazines to raise awareness and generate interest/demand for the project outputs.

Case study example: Precision Breeding:

In this case study, dissemination has (and will) focus primarily on sharing methodological learning across academia, e.g. via academic papers on the novel approach to genetic sequencing, Due to the proprietary value of the lead business' data used in the project and commercial sensitivities around the findings, dissemination will be restricted to the business' customers and internally across the holding company. Dissemination plans or responsibilities beyond this were not clear at the project's inception.

6. Outputs, outcomes and impacts

6.1 This section presents findings on the outputs, outcomes and impacts achieved to date and expected in future for those engaged in the programme, and key factors that have enabled or hindered pathways to impact. It draws on evidence from the survey with beneficiaries, case studies and consultations with stakeholders. It is important to note that whilst the outcomes and impacts discussed below have been attributed to ATC by those consulted, they are gross results, and do not take into account additionality (i.e. what would have happened without the programme) nor the contribution of other factors that might have influenced performance – these issues are covered in Section 7.

Key messages

There is strong evidence that the outputs and outcomes identified in the logic model associated with innovation behaviours, capacity and partnerships have been realised in practice at this interim evaluation stage.

There is a high level of confidence amongst surveyed beneficiaries that new or significantly improved products or services will be introduced to the market following ATC projects, although to this point this is principally anticipated rather than realised.

Many beneficiaries identified achieved/expected effects for both new/improved products and processes as a result of the ATC project.

Reflecting the progress of products/services, the quantitative effects of the project at this stage are modest, although employment effects have been realised for over half of projects where data is available. Achieved turnover effects are limited at this stage but projects are expected to lead to turnover benefits in the future in a high-majority of cases.

ATC has led to some changes in the behaviours and perspectives of those involved, which are crucial for further collaborative R&D activity in agri-tech in future.

The collaborative approach of ATC has added value to the delivery of industrial stage projects, and the flexibility offered through the programme has also been an important enabling factor reflecting the scale and length of the projects at this stage.

Coverage

6.2 The sub-sections below review the evidence on the outputs and outcomes (as described in the logic model) drawing on the evidence from the survey and case-studies. The following outcome-types are discussed in turn:

- innovation behaviours, capacity and partnerships
- new products and services, and processes
- employment and turnover
- other legacy effects
- wider agricultural sector outcomes.

6.3 At this interim evaluation stage, there was very limited evidence regarding follow-on investment, which has not been covered in detail; issues related to follow-on finance are drawn out from the case study evidence where relevant.

Innovation behaviours, capacity and partnerships

6.4 There is **strong evidence that the outputs and outcomes identified in the logic model associated with innovation behaviours, capacity and partnerships have been realised in practice at this interim evaluation stage.**

6.5 As shown in Table 6-1, there is widespread evidence of positive effects on beneficiaries in terms of improved staff skills and knowledge, improved understanding of R&D and commercialisation processes, and new and/or strengthened collaborations with the research base, and with industry. The survey evidence also indicates that the programme can have an effect on the (self-reported and perceived) profile, reputation and credibility of an organisation. This was corroborated through the case studies (as illustrated in Table 6-2).

6.6 It is also worth noting that around one in five (9 of 41) beneficiaries reported that the ATC project had led them to apply for/secure IP or patents, and a quarter (10) expect this to occur in the future. This indicates the programme is supporting the filing of new patents (as anticipated in the logic model), and if projects progress as expected, approaching half of surveyed participants consider that the ATC project will have led to a patent or other forms of IP; given that patents may not be appropriate, relevant, or timely in all cases given their stage of development and/or technology and business model, this is a positive finding.

Table 6-1: Effects of the project on beneficiary leads & collaborators (n=41)

	Experienced already	Expect to experience in future	Have not and will not experience	Don't know/not applicable
Improved staff skills/knowledge	37 (90%)	3 (7%)	0 (0%)	0 (0%)
Improved understanding of R&D and commercialisation processes	27 (66%)	6 (15%)	7 (17%)	0 (0%)
Improved profile, reputation, credibility	31 (76%)	6 (15%)	0 (0%)	3 (7%)
Improved understanding of market position and opportunities	25 (61%)	10 (24%)	6 (15%)	0 (0%)
New or improved collaborations established with industry	27 (66%)	7 (17%)	6 (15%)	0 (0%)
New or improved collaborations established with academia/research base	33 (80%)	5 (12%)	2 (5%)	0 (0%)
Patents or IP applied for and/or secured	9 (22%)	10 (24%)	15 (37%)	4 (10%)
Improved understanding of private sector investor opportunities and expectations	16 (39%)	7 (17%)	15 (37%)	2 (5%)

Source: Industrial stage grants beneficiary survey, 2019

6.7 The effects observed were generally consistent between leads and collaborators, with limited statistical differences evident. However, three differences were found, albeit all at the 10% level of significance, and therefore 'weakly significant' (although this is likely owing to the modest sample sizes):

- leads were more likely to report 'Improved staff skills/knowledge' had been experienced already (100% of leads, compared to 84% of collaborators)
- leads were more likely to report 'Improved profile, reputation, credibility' had been experienced already or was expected in the future (100% of leads, compared to 84% of collaborators)

- collaborators were more likely to report 'New or improved collaborations established with industry' had been experienced already or was expected in the future (69% of leads, compared to 92% of collaborators); this included all seven academic collaborators.

6.8 Whilst the effects observed by those who had worked with partners previously, and those who had formed new partnerships for the project were also consistent, one strongly significant difference was identified. Beneficiaries with existing partnerships were more likely to report 'Improved profile, reputation, credibility' (100%), compared to those who had formed new partnerships for the project (73%).

6.9 We have also analysed survey results in more detail where two or more partners were interviewed (eight of the 26 early and late stage projects) to see if there are any patterns in which type of actor has observed each type of outcome. However, there is no clear pattern – for some projects, both leads, and collaborators have observed the same types of outcomes; for others, the lead has observed more outcomes than collaborators, and vice-versa; and for others, one partner appears to have observed outcomes to date, but another expects outcomes in future. This likely reflects the varied benefits of ATC projects and how these are realised for and experienced by participants.

6.10 The case studies provide illustrations of many of the outcomes noted above, and how they have been realised practically (or are expected for the future).

Table 6-2: Case study evidence on outcomes

Outcomes	Case study examples
R&D and commercial-isation capacity	Precision Breeding: the project has improved knowledge and R&D capacity at the lead business, which has boosted the lead's confidence in genomics R&D. The project's success has also helped to "make the case" internally to expand the in-house genomics programme and increase R&D investment. MUST: working together on the ATC project has allowed the partners to identify new areas of applied R&D on which they can work. The scale of the project and its innovative approach has also meant that some of the partners are now active in larger projects across Europe, which will facilitate future new market development in high value products (e.g. through bio-refining). The partners are committed to continuing to invest in R&D given the impact the ATC project has had on their operations and customer base. Also, through two of the collaborators developing new relationships, they are exploring the potential to apply their technology to other existing crops.
Improved staff skills and knowledge	Integrating control strategies in oil seed rape: the project has enhanced the team's understanding of the underpinning science and evidence base on the project topic, and has led to a wide range of discoveries including on the complex relationship between the pathogen and the external growing environment, and the effects of the pathogen on crops' flowering rates and synchrony.

	Tools for predicting tomato production: project partners have improved their skills and knowledge as a result of the project. For example, the research partner had not previously used big datasets, but the project has upskilled their data teams and made their overall data systems more efficient; and the business collaborator has benefited from improving their knowledge of miniaturisation of technology and use of technologies in glasshouse conditions (this included practical knowledge they would not have gained any other way).
Profile, credibility and reputation,	Precision Breeding: the project has led to reputational benefits for both partners: for the business, it has helped to strengthen customer relationships and trust, and more generally strengthen their reputation as a global leader in genetic sequencing innovation; and for the research partner, the project has contributed towards building their reputation as a world centre of excellence in animal and plant breeding, which is seen as important in terms of attracting the best quality researchers to the institute (and the UK as a whole). Developing Bacteriophage Technology to Optimise Potato Production: the project has led to the development of networks and relationships in the UK and internationally for the lead partner, including through the access to international sector actors from the commercial partners involved in the project, and engagement in Innovate UK events where connections were made with firms and individuals in related sectors that would not otherwise have been realised.
Improved understandi ng of market position and opportunities	MUST: the project has successfully developed new production processes, alongside the production of plug plants with improved growth rates and new machinery and agronomy, which means that all four companies involved have developed their market and are part of a new scaleable commercial sector. The recruitment of an additional commercial manager at the lead company has allowed them to explore new markets for the product, which are mainly international. Tools for predicting tomato production: the project offers the potential for the technology to be adapted to predict the production of other crops, such as cucumbers and peppers, which are grown in glasshouses. In future, there may also be opportunities to develop the tool to other agricultural industries, such as vineyards or orchards, although due to different growing conditions this would need to be explored further. In addition, the technology could also be adapted for use in other sectors, such as health sciences.
New and/or strengthene d collaboration s with industry and academia	Integrating control strategies in oil seed rape: the project has improved relationships between the lead business and collaborating university. Whilst the partners were existing collaborators, the project has led to further embedding the relationships and sharing knowledge and understanding across the partnership. There has been significant added-value from the collaborative approach, providing access to the mix of technical expertise, specialist equipment, and capacity that was required for the project to be delivered across its workstreams. Greenhouse cladding materials: one of the manufacturers collaborating on this project has become more aware of the potential benefits of academic collaborations and more open to such relationships as a result of its participation in the ATC project.

	Developing Bacteriophage Technology to Optimise Potato Production: the project has enhanced the existing partnerships and relationships between collaborators, and provided the platform for developing wider partnerships, both within the ATC project and the follow-on project that this informed. Engagement between the research base and industry was regarded as a benefit for collaborators, providing an opportunity for the research base to understand more fully industry need and expectations, and informing wider research agendas.

Source: Case study evidence

New products and services, and processes

6.11 The survey evidence indicates a **high level of confidence that new or significantly improved products or services will be introduced to the market following ATC projects, although to this point this is principally anticipated rather than realised.** The programme is also expected to deliver process improvements, often alongside new products/services.

6.12 Considering new or significantly improved *products or services,* at the time of the survey:

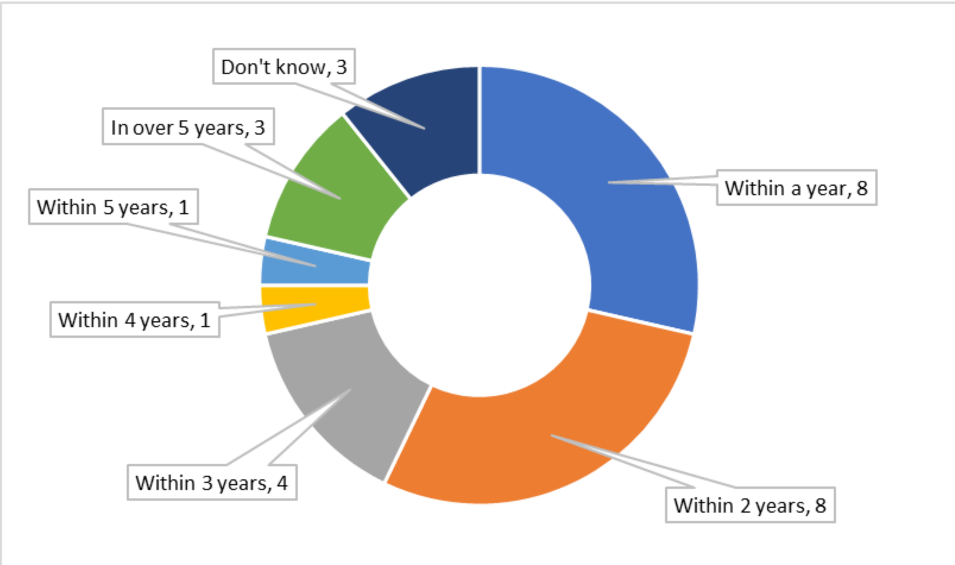
- 5 of the 41 beneficiaries reported that a new or significantly improved product or service had been introduced to the market as a result of the project; the beneficiaries were from five separate projects
- 28 of the 41 beneficiaries expected that a new or significantly improved product or service will be introduced to the market as a result of the project in the future.

6.13 There was no significant variation between leads and collaborators on this data. It is also notable that there was no consistent trend related to the Round of support. We may expect that new or significantly improved product or services would have been realised by projects supported in earlier rounds, however this was not the case: four of the five projects where a survey respondent indicated that a new or significantly improved product or service had been introduced to the market were from the later Rounds 4 and 5, and 10 of the 28 beneficiaries that expect this in the future were from the earlier Rounds 1 and 2. This highlights the very different time-paths to impact for ATC projects.

6.14 For the beneficiaries that indicated they expect that a new or significantly improved product or service will be introduced to the market as a result of the project in the future, the survey sought to gather data on the timing of this, to provide an indication of when the economic impacts of the project may start to work through, at least initially. Consistent with the point above regarding the varied routes and timing to impact, the data highlight the variation evident across the portfolio.

6.15 Most of the relevant respondents (20 of the 26) expect that this will occur within the next three years (with no statistical variation between leads and collaborators, or by Round). However, looking at the data in more detail highlights the variation in expected time-path to the market introduction (and in some cases the uncertainty), as set out in Figure 6-1. The two respondents who were involved in the shortest projects (12-18 months) did not expect to introduce a product or service to market, whereas the six respondents involved in the longest projects (48-60 months) all expected to introduce a product or service to market (five of whom expected this within two years).

Figure 6-1: Timescales to market (n= 28)



Source: Industrial stage grants beneficiary survey, 2019

6.16 Turning to new or significantly improved *processes*, at the time of the survey:

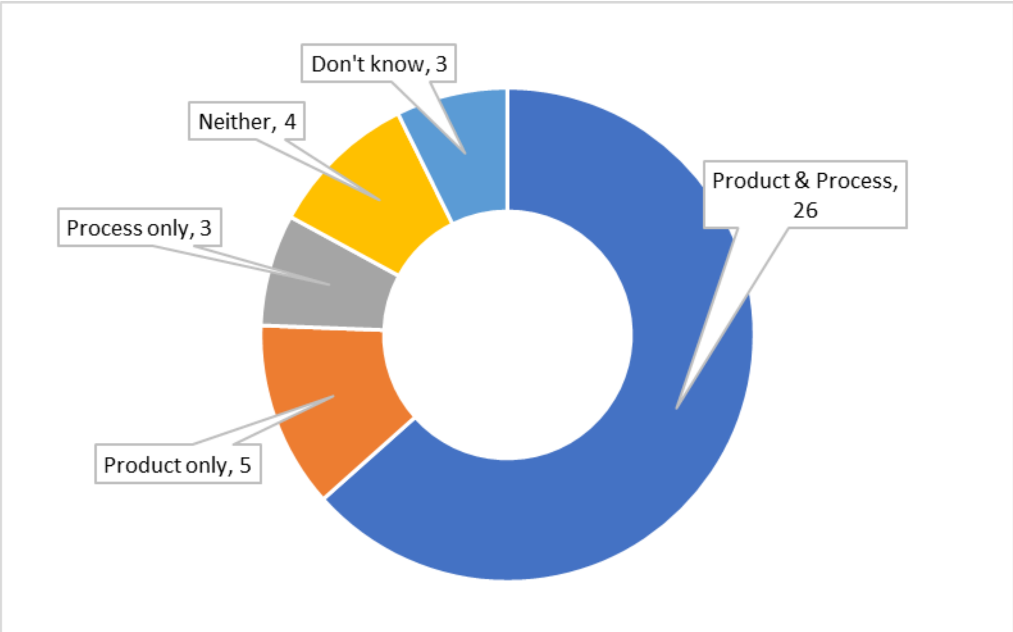
- 9 of the 41 beneficiaries reported they had introduced a new or significantly improved process; the beneficiaries were from eight separate projects (with two beneficiaries from one project – both collaborators)
- 20 of the 41 beneficiaries expected that they will introduce a new or significantly improved process

6.17 Consistent to the data on products/services, there was no significant variation between leads and collaborators or Round of support on the introduction of new/improved processes. For those expecting to introduce new processes in future, the expected timing of this was similar to that for new products/services above, with three-quarters anticipating the introduction of the process within the next three-years, but some variation across projects within this.

6.18 Two further points are important in relation to product/service and process development, First, **many beneficiaries identified achieved/expected effects for both new/improved products and processes as a result of the ATC project.** As shown in Figure 6-2, approaching two-thirds of beneficiary survey respondents (26 of 41) reported they had experienced or expected to experience both types of effect. This trend is consistent when looking at leads only, where 9 of the 16 reported both types of effect.

6.19 Interestingly, product only or process only effects respectively were limited (identified by 8 of 41 in total), highlighting the integrated nature of outcomes realised or expected from the R&D supported by the programme. This relationship indicates that the effects of the programme are likely to be realised through both new product introductions in the market and process improvements, which may lead to performance and productivity benefits over the longer-term.

Figure 6-2: Nature of effects experienced / expect to experience across new/significantly improved products/services and new/ significantly improved processes (n=41)



Source: Industrial stage grants beneficiary survey, 2019

6.20 Evidence from the case study research is presented in the box below, where new products and/or processes are expected to reach the market quickly. In many of the case studies, ATC has helped to develop new technological products that will realise significant improvements to farming processes.

Case study example: Miscanthus Upscaling Technology (MUST):

This project has successfully developed a new product (miscanthus plug plants), alongside new processes that are required to make the new product a success on the ground, including new seed production processes and adapted machinery to establish plug plants in poor quality soils. The lead is already commercialising the new product, before the project is completed, by using the results to develop new markets in the UK and Europe.

Case study example: Tools and technology for predicting tomato glasshouse production:

This project has developed a new automated imaging tool which the collaborator leading on its development intends to commercialise within six months. It is currently being used to predict production in the lead business, and will subsequently lead to process improvements across businesses that adopt the new technology once commercialised.

6.21 Second, **further R&D activity will be needed in most cases to realise the expected product/service and process introductions.** Specifically, of the 30 beneficiaries that indicated they expect to introduce new or significantly improved products/services and/or processes in the future, 24 (80%) indicated this will be dependent on further R&D activity; this proportion was consistent between leads and collaborators. In most cases (22 of the 24), the respondents were involved in live ATC projects, and this R&D activity may therefore be covered in full or part by the existing funding.

6.22 Similarly, some of the case studies will require further R&D investment to reach the market. This is unsurprising, given these are industrial projects that were designed to move a project forward to TRL 7. The case study evidence suggests that whilst ATC has enabled projects to move technologies forward, this has not de-risked the proposition sufficiently to secure (solely) private investment. In most cases, public sector funding will also be required; in some cases, this has been secured, but in others the specific source is yet to be identified. There is a risk that uncertainty at this stage on the realisation of product/service and process effects could have implications for the overall impacts of the programme.

Developing Bacteriophage Technology to Optimise Potato Production:

The project was successful in developing the technology for the proposed product: the lead's close out report indicates that the innovation progressed from TRL 3 (proof of concept) through to TRL 5 (technology validated in relevant environment). Following the completion of the Catalyst project, partners successfully secured follow-on funding from IUK's open competition to take forward the commercial potential of the innovation. The follow-on project is being delivered over December 2018 to November 2020 and will seek to develop the innovation to the point at which regulatory approval can be sought.

Case study example: Precision Breeding:

Further R&D work is required on the new genetic sequencing approach before it will generate commercial returns. However, public and private investment will be needed to do this – whilst the project has made considerable progress, the ATC project did not sufficiently eliminate uncertainties/risk around the effectiveness of the new approach for the lead business to invest solely internal funds on the next stage of R&D. However, external/public sector funding sources had not yet been explored.

Quantitative effects: employment and turnover outcomes

6.23 Three sources of evidence can be used to provide an interim assessment of the effects of the industrial stage projects on employment and turnover: the beneficiary survey, the close-out reports from completed projects (for employment only), and the case studies. Each of these sources provide a partial perspective, however, taken together, they provide evidence on effects realised at this interim evaluation stage for 43 of the 54 projects. The evidence from each source presented individually and then the three sources are combined (where possible) to provide as rounded an assessment as possible at this stage.

Survey evidence

6.24 The beneficiary survey suggests that ATC industrial projects have led to **modest impacts on employment and/or turnover of those involved at this stage.** This is not unexpected given that most of the projects were on-going at the point of the survey, the modest introductions of new products/services or processes that may be required to realise these effects, and the wider time-lags to impact for new technologies and R&D activities. The key data from the survey are set out in Table 6-3 below.

Table 6-3: Employment and turnover effects of ATC industrial stage projects (gross) (n=41)

Achieved to date	Expected for the future
Employment effects	
15 reported achieved effects … of which 11 quantified an effect, providing an aggregate of 26 FTE jobs … an average per beneficiary that reported an effect of 2.4 FTEs jobs	17 reported expected effects … of which 12 quantified an effect, providing an aggregate of 51 FTE jobs (by 2021) … an average per beneficiary that reported an effect of 4.3 FTEs jobs
Turnover effects	
4 reported achieved effects … of which 3 quantified an effect, which in all cases was an estimate of up to £100k	22 reported expected effects … of which 13 quantified an effect, which ranged from £20k to £10m

Source: Industrial stage grants beneficiary survey, 2019

6.25 The data on expected future turnover effects highlights the potentially very skewed effects of R&D support schemes, with two respondents (one lead and one collaborator, from two separate projects) indicating they expect turnover effects of £10m by 2021 as a result of the ATC project, although in both cases they had yet to introduce a new or improved product/service to the market, so this effect is highly uncertain at this stage. By contrast, for the other 10 beneficiaries that indicated expected future turnover effects, the range was from £20,000 to £500,000, with an average (mean) of around 180k.

6.26 It is also notable that the survey indicates that a quarter of the leads surveyed (4 of the 16) have not and do not expect to generate either employment or turnover benefits from their ATC project. The explanations for this varied, including where it was project collaborator that expected to realise direct benefits, and where the project remained in delivery meaning these outcomes were uncertain at this stage. One lead indicated that the project had been halted at the proof of concept stage; whilst this may not initially appear as a positive outcome (and there may be a range of reasons why projects were not progressed unrelated to ATC), this may lead to efficiency effects if this is preventing the lead from investing additional resources in an idea or concept that does not have commercial potential.

Close out reports

6.27 There were 24 close out reports available for the evaluation which included information from 74 partners: 20 project leads, and 54 collaborators. There were two types of closeout reports completed by projects. The first type of closeout report (type A) was completed by four projects, and the second type of closeout report (type B) was completed by 20 projects.

6.28 Closeout reports show greater increases in turnover and employment than the survey results. This is not unexpected, as many projects were on-going when surveyed, whereas closeout reports are issued when projects are completed.

6.29 Whilst attributable changes in turnover cannot be ascertained for four projects (who completed the type A report), 27 project partners from across 15 projects (who completed type B reports) who expected to introduce products, services or processes as a result of the Catalyst funding quantified what they expected the future average annual financial impact to be.

- 24 partners across 15 projects quantified an increase in sales revenue, ranging from £10k to £5m
- five partners across four projects quantified an increase in licencing revenue, ranging from £20k to £1.5m
- eight partners across six projects quantified the impact of cost reductions, ranging from £5k to £4.3m.

6.30 Leads expected a higher increase in sales revenue than collaborators. Leads reported an average increase in sales revenue of £1.2m (across 10 leads), compared to £209k across 14 collaborators. For all projects where a lead and at least one collaborator could quantify an increase in sales revenue, the lead notes a greater increase. However, it is important to note that for some projects, leads did not quantify an increase where a collaborator did.

6.31 Across the 24 closeout reports, 40 partners from 21 projects reported that as a result of the project, they had retained or created jobs. This ranged from 1 to 12 jobs across 16 leads, and 0.2 to 20 jobs across 26 collaborators. However, whilst a greater range was reported by collaborators, leads had retained or created slightly more jobs on average than collaborators (3.3 jobs compared to 2.7 jobs).

Case study evidence

6.32 As above, the scale of job creation in the case studies is limited to date. However, our case studies provide further evidence on the *types* of jobs created and suggests these tend to focus on:

- R&D staff to deliver the project (e.g. in the Precision Breeding case study, the research collaborator employed a post-doctorate to work on the project, who has since been retained, and the project has “made the case” internally to expand the R&D team at the lead business involved in the project), and/or
- new commercial positions that will help to move the project towards commercialisation (e.g. in the MUST case study, where an additional commercial manager at the lead business has allowed the company to explore new international markets).

Synthesis of the evidence on quantitative effects

6.33 Evidence from the three sources have been combined to provide a high-level synthesis on the quantitative effects of ATC at this stage. Drawing on the data from leads and collaborators, Figure 6-3 sets out the evidence for 43 of 54 projects; in 11 cases, no evidence was available from the survey, close-out reports or case studies. This identifies:

- whether the project has introduced a new or improved product/service and/or process according to any of its partners (note: this was covered in the survey and case studies and not the close-out reports, so is provide for context only)
- whether the project has led to *achieved* effects in terms of employment and/or turnover for at least one of the partners – it is important to note that the close out reports included jobs safeguarded as a result of the project, which was not included in the survey, so the data set out here represents both jobs created and safeguarded to date
- whether the project has led to *anticipated* effects in terms of employment and/or turnover for at least one of the partners

6.34 The Figure should be regarded as indicative only: we do not have comprehensive data for all project leads and collaborators within each of these 43 projects. The Figure represents the best current indication of whether effects have been realised/expected drawing on the inputs from the leads and collaborators involved in the surveys, case-studies and completing close-out reports. However, it may underestimate the effects of the ATC projects at this stage, for example where the inputs from engaged leads/collaborators indicated that an outcome had not been realised, but this had been realised for other partners that did not contribute to the survey/case-studies/close-out reports. Moreover, some projects could have downstream impacts on employment - including by stimulating increased activity among growers and processors downstream of the businesses directly involved in the ATC project - that cannot be quantified at present.

6.35 This noted, a number of points do emerge from the synthesis of the sources of evidence:

- **the employment effect of ATC projects at this stage is more common** than the survey alone suggests, when including the evidence from the close out reports (including safeguarded jobs); of the 43 projects where evidence was available, 25 indicated some effect on employment to date achieved turnover effects are limited at this stage from ATC projects;
- although there are more gaps in the data (with the close-out reports not providing consistent data), where the evidence is available in most cases turnover effects do not appear to have been realised; this is not unexpected given the time-paths to impact and the 'mid-stage' nature of industrial stage projects

6.36 ATC projects are expected to lead to turnover benefits in a high-majority of cases, with 33 of the projects expecting to realise these benefits in the future (over 80% where evidence was available, n=40 on that issue); this highlights both the potential effects of the ATC projects in the future, and the caveat that these effects are principally anticipated for the future and therefore uncertain at this stage.

Figure 6-3: Synthesis of evidence on effects of ATC projects

Lead evidence	Rnd	Introduced product/ service	Introduced process	Achieved employment effects	Achieved T/O effects	Expect employment effects	Expect T/O effects
Yes	1			Y		Y	Y
No	1	N	N	Y	N	Y	Y
Yes	1			Y		Y	Y
Yes	1			Y		Y	
Yes	1	N	Y	Y	N	Y	Y
Yes	1	Y		N			Y
Yes	1	N	N	Y	N	N	Y
Yes	1	Y		Y			Y
Yes	1	Y		N	N		Y
Yes	2	N	N	N	N	N	N
Yes	2			Y		Y	Y
Yes	2	Y	Y	Y	Y	Y	Y
Yes	2			Y		Y	Y
Yes	2	N	N	N	N	Y	Y
Yes	2	N	N	N	N	N	N
Yes	2	N	N	N	N	N	N
Yes	2			Y		Y	Y
No	2			Y		N	
Yes	2	N	N	N	Y	N	N
Yes	2	N	N	Y	N	Y	Y
Yes	3			N		N	Y
Yes	3			Y		Y	Y
Yes	3			N		N	
Yes	3			Y		Y	Y
Yes	3			Y		Y	Y
No	3			Y		Y	Y
Yes	3			Y		Y	Y
No	4	N	N	N	N	N	Y
No	4	N	N	N	Y	Y	Y
Yes	4	N	N	N	N	N	Y
No	4	N	N	N	N	Y	Y
No	4	Y	Y	N	N	Y	N
Yes	4	N	Y	Y	N	Y	Y
Yes	4	N	Y	Y	N	Y	Y
Yes	4	Y	Y	Y	Y		Y
Yes	5	N	N	N	N	Y	Y
No	5	N	N	N	N	N	N
No	5	Y	Y	Y	N	Y	N
No	5	N	Y	Y	N	Y	Y
Yes	5	N	N	N	N	N	Y
Yes	5	N	N	Y	N	Y	Y
No	5	N	N	N	N	Y	Y
Yes	5	N	N	Y	N	Y	Y

Key
Green (Y) = Yes
Red (N) = No
Blank = Not known (not included in close-out report and/or no answer in the survey)

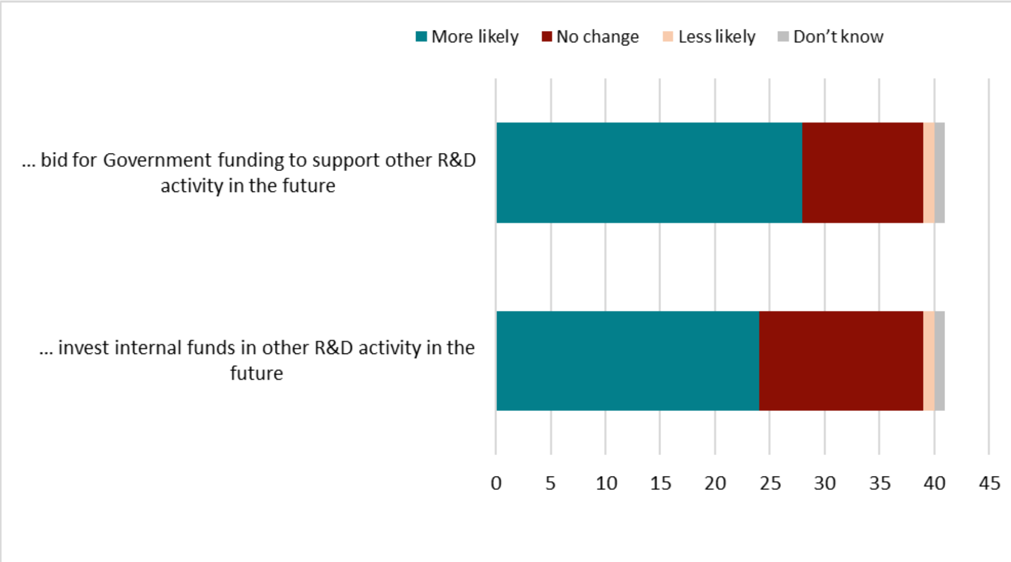
Source: Close-out reports, beneficiary survey and case studies

Other effects on participating organisations

6.37 In addition to the outcomes described above, the evaluation suggests that **ATC has led to some changes in the behaviours and perspectives of those involved,** which are crucial for further collaborative R&D activity in agri-tech in future.

6.38 As shown below, the beneficiary survey indicates that participation in the programme may lead to further internal investment in other R&D activity in the future, and increase the likelihood of participants engaging with Government funding to support other R&D activity in the future. There was no variation between leads and collaborators on these factors.

Figure 6-4: Response to 'Thinking generally about R&D, would you say your engagement with the Catalyst has made you more or less likely to … (n=41)



Source: Industrial stage grants beneficiary survey, 2019

6.39 Specifically, for academics, participation in ATC is leading to legacy effects, as they become more willing and able to engage in collaboration with industry and use the knowledge gained to inform their wider research activity, more committed to continued research in agri-tech, and are able to lever further R&D funding. A total of seven academic collaborators responded to survey (out of 25 collaborators). Of these:

- all 7 agreed/strongly agreed that ATC had improved their knowledge which would be of value to wider research activity
- 5 agreed/strongly agreed that ATC had improved their ability to engage in collaborations with industry
- 5 agreed/strongly agreed that ATC had changed their attitude towards commercialisation of research, so they are more likely to engage in future
- 3 agreed/strongly agreed that ATC had changed their attitude, so they were more likely to collaborate with industry in R&D activity in future
- 4 reported that ATC had enabled them to lever further research funding.

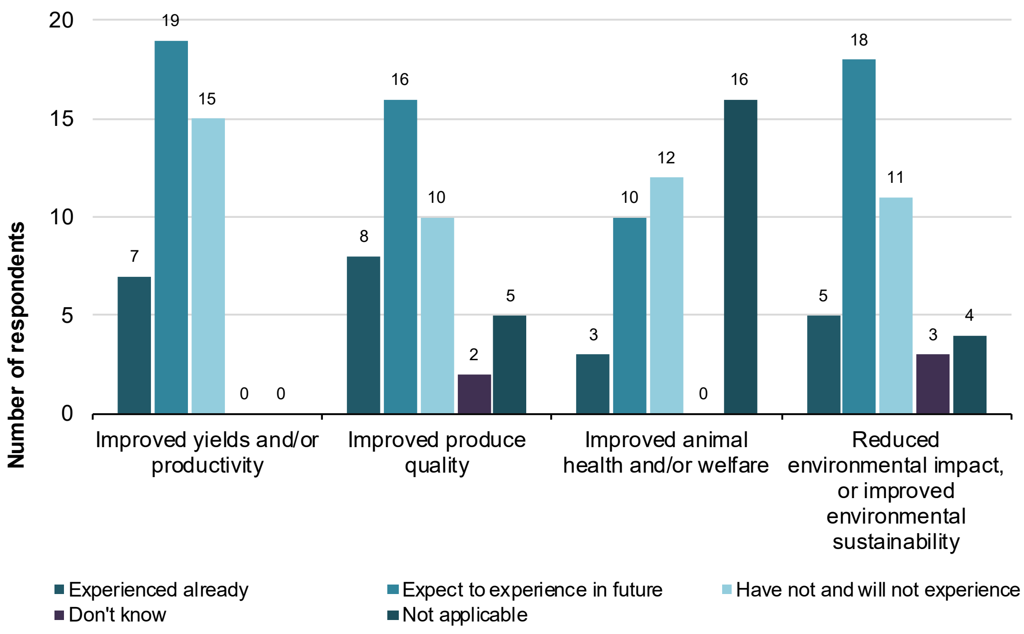
6.40 The sample size from the survey is small, however the case studies provided further evidence of the observed benefits for academics from engagement with the programme. For example, in the MUST case study, the project provided an opportunity for the university to develop partnerships to commercialise its Miscanthus research and IP, and are now exploring further R&D with the project lead to develop another generation of miscanthus crops suited to alternative, higher value markets, primarily in bio-refining.

Wider agricultural sector outcomes

Effects on participants

6.41 For the organisations involved in ATC projects, the survey results suggest that wider impacts have focused on **improved yields/productivity and improved produce quality and reducing environmental impacts or improving environmental sustainability.** Improved animal health/welfare is also evident in some cases, although this is not relevant for a third of respondents to the survey (reflecting the nature of projects covered by the survey). The data are set out in the figure below. There was no significant variation in responses between leads and collaborators on these issues.

Figure 6-5: Wider effects of the project on organisations involved (n=41)



Source: Industrial stage grants beneficiary survey, 2019

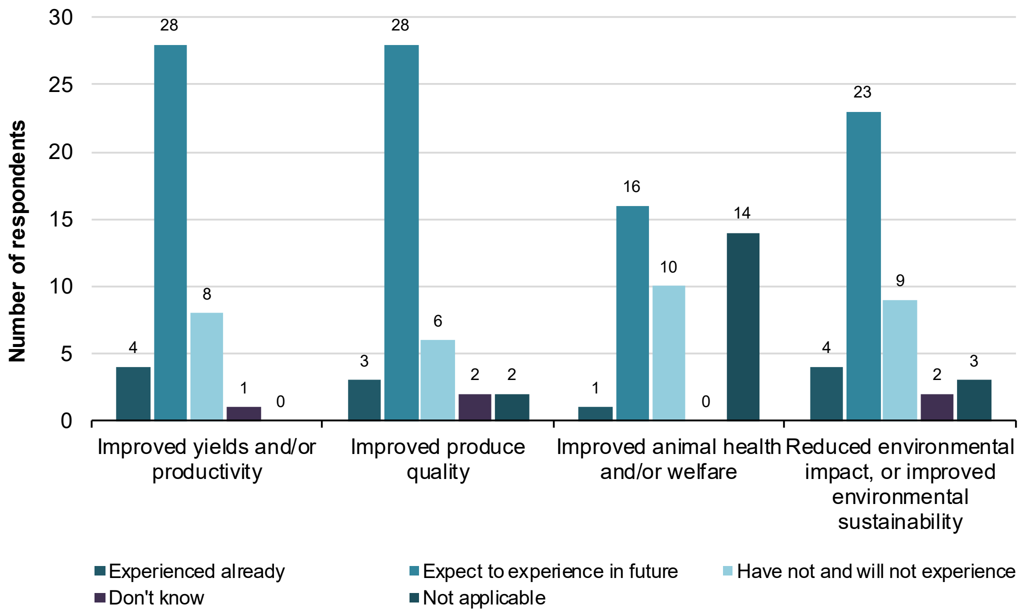
6.42 Beneficiaries have also observed some wider unexpected or unintended outcomes from their ATC experience. Four themes are noted, drawing on the case studies and survey evidence:

- several beneficiaries surveyed reported **the potential benefits of the findings and technology outputs from the project for their wider activities and market opportunities**; for example, one respondent noted that the *'scope of markets where the technology might be applicable is much wider than expected' and another that the project has 'opened the door to diversification'*
- there are reported **effects on wider research priorities and investments** particularly in academia, with one academic collaborator reporting in the survey that the work on the ATC project informed directly the creation of a new research centre and case study examples where the project has informed the development of follow-on funding applications as a result of the findings that have emerged; in this respect, there is some evidence of the Catalyst playing a role in informing activity in the research base at earlier technology readiness levels
- the potential for the project to **influence exporting behaviours**, and through this wider international supply chains, was identified in both the survey and case studies. For example, the 'Developing Bacteriophage Technology to Optimise Potato Production' case study found that the ATC project had enabled the development of a new product with significant export potential to Europe, including the Netherlands which is the world's major supplier of certified seed potatoes.
- in a number of the case studies, the ATC project has (or is expected to) lead to **spin-off research opportunities in other sectors**. For example: the novel approach to genetic sequencing developed in the Precision Breeding case study is now being tested in strawberries; the team that developed a new imaging tool to predict the ripeness of one vegetable in the case study focused on tomatoes are considering adapting the product for use in other greenhouse-grown crops; and in the case study on tools to predict tomato production, the tool has the potential to be adapted for other crops, as well as other sectors such as health sciences.

Effects on the wider agricultural sector

6.43 In the beneficiary survey, respondents were also asked whether their ATC project had impacted on the wider agricultural sector or were expected to in future. The results follow a similar pattern to observed/expected impacts on the organisations involved in the ATC projects, reflecting the nature of their activities. However, **there is greater confidence in future impacts on productivity, produce quality and environmental sustainability (and more limited effects on animal welfare).** To achieve this, the test will be whether the new/improved technologies deliver improved financial performance – if they do, and if this message is effectively disseminated to the relevant audiences, the technologies are more likely to be adopted. We explore the intended routes to wider impacts and potential risks to achieving these in the sub-section below.

Figure 6-6: Observed effects of the project on wider agricultural sector



Source: Industrial stage grants beneficiary survey, 2019

6.44 Through the case studies, we explored in more detail how these wider impacts are expected to occur and the intended routes to market (with further details discussed in the detailed write-ups and summarised in the project-level theories of change in Annex B). As shown in Table 6-4 the primary routes to market are:

- via the project lead implementing the new technology/process, which then benefits that business' supply chain or customer base, with an immediate and direct route to market for the new products/processes developed by ATC projects (and in some cases, engaging major global firms in ATC projects provides a direct route to global markets)
- via the lead or collaborator selling the new technology directly to the wider agricultural sector, which will also depend on demand-side awareness/ability to adopt new technologies (and in one of the case studies, the project has included the development of guidelines to enable this process).

6.45 Given the reliance on project leads (and in some cases collaborators) to generate the wider sector impacts that ATC is seeking to achieve, it is essential these businesses have the necessary skills, expertise and finance to reach and effectively market their new products/process in UK and (in some instances) global markets – an issue we discuss in more detail below.

Table 6-4: Primary routes to productivity/quality/welfare/environmental impacts for case study projects

Case study	Actual/potential impacts on partners involved in ATC project		Potential impacts on wider agricultural sector
Greenhouse Cladding Materials	Collaborating businesses benefit from increased yields via early trials	→	New product to be marketed globally by lead business as major UK supplier
MUST	Each partner benefits from improved market position/first mover advantage in their respective areas (production of plug plants, machinery etc) and productivity of existing operations during trials (crop producer)	→	Primarily via lead business pursuing global markets for the crop (and the associated new production process), alongside spin-off R&D to apply technology in other crops
Bacteriophage in Potato Production	Business lead benefits from the development and sale of new treatment product, other partner benefits from enhanced knowledge and relationship development	→	New product sold (with manufacturing and distribution model to be agreed) to international client base to improve yield for growers and deliver benefits across the value chain through reduced disease prevalence
Precision Breeding	Business lead will integrate into routine breeding to deliver commercial gains for the business	→	Productivity/environmental gains for wider poultry sector via lead businesses' position at the top of the poultry breeding pyramid and their global customer base
Tools for predicting tomato production	Business lead experiences efficiency gains by using technology during and after ATC trials	→	Project collaborator developing and manufacturing the technology takes it to market (enabling other producers to improve efficiency), alongside spin-off R&D to apply technology in other crops and non-agricultural sectors (e.g. health)
Integrating control strategies in oil seed rape	Business lead benefits from the development and sale of new treatment product	→	New product sold by the lead business to its existing (and wider) customer base, alongside disease management guidelines to increase awareness/demand across wider sector.

Source: case study evidence

Factors enabling or hindering pathways to impact

6.46 Through the survey, case studies and stakeholder consultations, we have gathered evidence on the key factors that have enabled or hindered the progress of ATC projects towards impact at this interim evaluation stage. In doing so, we are testing the added value of a collaborative approach in delivering projects, other factors that have supported or inhibited the progress and effectiveness of the programme in delivering activities and outcomes set out in the logic model (both project-related and the wider system in which the programme operates), and whether mechanisms are in place to enable future anticipated outcomes for those involved and impacts on the wider agri-tech/agricultural sector (and any risks/barriers to this).

6.47 Each of the case studies includes a detailed theory of change that sets out the enabling factors and barriers (see Annex B). Drawing on this evidence and the wider evidence from the survey, the key findings are set out below. Two points are important in this context. First, in most cases the evidence is based on projects that remained in delivery at the point of the research, with outcomes and impacts largely anticipated rather than realised and this needs to be recognised in considering the findings. Second, the context of industrial stage projects – relative to early and late stage projects – is important, with projects that are larger, delivered over a longer period, and often involving significant field-based experiments and trials.

Enabling factors

6.48 **The collaborative approach of ATC has added value to the delivery of industrial stage projects.** This message was found consistently across the beneficiary survey and case studies.

6.49 For example, of the 41 beneficiaries surveyed, 33 (80%) indicated that there was added value from undertaking the project as part of a collaboration; leads and collaborators were equally likely to value the collaboration. The key ways in survey respondents had witnessed the added-value from the collaboration included: capacity and knowledge, improving commercialisation prospects, and connections and industry reach. Some examples of key factors that enabled the success of the project in relation to the collaboration cited in the survey included:

"Working with the university who understand the market area very well. Being able to collaborate with the university and end users. Accessing the technological expertise of the university." (Collaborator respondent, industrial)

"Collaboration between consortium members, one of them left but we managed to get round it by XX taking up the role and developing procedures other consortium members should have done regarding genetics and outputs we could investigate further." (Lead respondent, industrial)

"The academic input we have received and the collaboration opportunities with the industry partners which we wouldn't have had" (Collaborator respondent, industrial)

6.50 The case studies provided similar evidence on the benefits of the collaborative approach, as discussed earlier in this report. In addition, evidence from the case studies showed how the collaboration approach was helpful in:

- enabling R&D project to adapt in light of emerging findings/challenges. For example, in the greenhouse cladding materials case study, when the project needed to change direction, the spread and depth of expertise in the consortium was instrumental in identifying alternative approaches. The case study on tools to predict tomato production also found that the varying skill set and expertise of each partner enabled the project to adapt and be flexible, leading to better outcomes overall.
- providing credibility to the commercial viability of new products/processes, as a result of being able to test/validate their effectiveness in "real world" contexts and well-respected businesses in the sector (e.g. Tools to predict tomato production case study).

6.51 More widely, the following enabling factors were also identified in the research:

- **Flexibility:** reflecting the scale and length of industrial stage projects, the level of flexibility in delivery was identified as important, particularly from the case study evidence. For example, in the MUST case study, flexibility was afforded to the project team to extend the project by six months to enable more substantive results to be delivered for a crop which takes 2-3 years to reach maturity and where the field trials were adversely affected by poor weather conditions in spring 2018. Innovate UK and BBSRC's pragmatic approach ensured that the project was able to respond flexibly to factors beyond their control. Similarly, the flexibility to suspend direct drilling trials when these proved unsuccessful and to focus entirely on plug plants was very important. In this context, Innovate UK responded positively to learning in the early stages of the project to focus later stages on the most promising areas. Some evidence of this was also identified in the beneficiary survey. One lead noted that the key factor that enabled the success of the project was the ability to be flexible:

  "to have a long-term experiment through multiple seasons …. and flexibility to adapt experimental design as results appear." (Lead respondent, industrial)

- **Dedicated and strong project management capability (and agility), and clarity of roles:** again, reflecting the scale and length of projects, effective project management was identified as important in enabling project success, across both the survey and case studies. For example, the oil seed rape case study involved dedicated project management resource at the lead business, which was regarded as crucial to delivering against project aims and objectives and managing the delivery of work across the collaboration. This demonstrates how, for projects of this scale and complexity, capacity in terms of management and oversight matters fundamentally. In addition, clarity on roles and expectation across the partnership was crucial given this complexity and range of the work delivered across the workstreams. Prior/strong relationships between partners was also helpful in this respect, in part because there was a pre-existing understanding of partners' strengths and capabilities (e.g. Precision breeding and tools for predicting tomato production case studies).

- **Clarity of focus and purpose:** alongside flexibility in delivery, a clarity of purpose across the long-term project was identified as an important enabler in the survey particularly, which in some cases was put down to the industrial leadership. For example, for the 'Third Generation Polyethylene Greenhouse Cladding Materials' project that involved although the proposed research activities were quite wide ranging the intended outcome was tightly defined and the project was always focused on this. The case studies also provided examples where the clarity of purpose, and the roles and responsibilities of each member of the consortium in delivering against this, was seen to be crucial in enabling delivery. Examples of some feedback from the survey in terms of key factors enabling success included:

  "The fact that we are tied very closely to our market goals, so that encourages us to work very closely with end users of this product." (Collaborator respondent, academic)

  "Understanding of our goals and the wealth of experience involved in the project from all the participants." (Collaborator respondent, industrial)

  "Focussed approach to problem solving, clear setting for protect objectives at outset." (Lead respondent, industrial)

- **Large-scale (and multi-discipline/multi-year) projects:** This was a key enabler for a number of the case studies: in addition to the case study evidence presented in the rationale section (relating to the importance of scale for validating results), the MUST case study demonstrated how a large scale, multi-year project with multiple commercial partners and academic underpinning was crucially important in unlocking transformation opportunities in crop production technology. A single company or a short-term project could not have achieved this. The investment stimulated by the project has also given the partners new ideas on collaboration on applied R&D both with each other and with other potential partners in the UK and Europe. A large scale, multi-year project was also important in enabling this benefit. The ability to test/validate new technologies at scale (and thereby generate statistically significant results) was also critical for the precision breeding case study.

- **Innovate UK's monitoring structures:** on the whole, monitoring structures and monitoring officer inputs were seen as helpful for the successful delivery of projects, particularly in encouraging time keeping, motivation, focus and accountability. This includes quarterly meetings which were cited by survey respondents as being important. Flexibility and pragmatism in the monitoring process was also helpful, although in some cases changes to the monitoring requirements for the Catalyst programme, particularly around financial monitoring were suggested by case studies to minimise burden on project delivery partners.

6.52 Some other enablers identified in the case studies – reflecting the individual contexts within which ATC projects are delivered – include the importance of senior-level backing to projects within organisations (which helped to alleviate issues arising as a result of disruption to day-to-day production processes, although where this was not present and/or where were changes in senior personnel, this did cause challenges), the actual or planned involvement of sector/levy bodies in dissemination activities, and the recognition of the need to generate demand within a project (rather than solely focusing on the supply of new innovations).

Barriers and risks

6.53 In addition to the question around follow-on funding discussed above, there were several other factors highlighted in the case studies[43] that have hindered progress to date, and/or risks that may inhibit pathways to impact in future:

- **Project management capacity:** some of the case study projects noted that the large-scale projects/consortia were very demanding of management time (sometimes unexpectedly) and in one instance the business lead struggled to invest as much time in the project as hoped due to capacity constraints (and the academic partner took on the project management role)
- **Environmental factors and 'in-field' issues:** for example, in the Third Generation Polyethylene Greenhouse Cladding Materials project, a delay to the project start meant that a growing season was missed, and in the MUST case study, the weather in early 2018 was too wet for the field trials and was then followed by drought, which has meant a project extension to June 2019 so that another year's harvest and growth can be assessed. The oil seed rape case study also experienced environmental challenges (resulting in the loss of field trial results) and emphasised the need for R&D funding programmes in the agri-tech sector to recognise the realities of agri-based research on the ground. As explained by the lead partner:

  "Agri-tech research is dependent on many uncontrollable factors … weather, pest populations, grazing animals- exchange rates if working in other currencies … Attention to "season" is everything for good planning of an Agri-tech project involving field trials."

- **Challenges/uncertainty around future agricultural policy and regulation:** In several case studies, the current uncertainty around future agricultural policy and trading arrangements owing to Brexit, were identified. More specifically, in the oil seed rape case study, the regulatory landscape and

[43] The beneficiary survey asked for qualitative evidence where project objectives had not been achieved; this was relevant to two respondents only, and no useful insight/evidence was provided. As such, the evidence from barriers is based on the case study evidence.

challenges in securing approval for treatments in crop production may lead to delays in approval and commercial outcomes as the project moves forward. The regulatory landscape was also identified a potential barrier for the Developing Bacteriophage Technology to Optimise Potato Production project, with any delays pushing back the point at which commercial outcome will be realised.

- **The ability of SMEs to meet match funding requirements:** In the MUST project, it was a challenge for the micro company (who was still investing and unprofitable) to meet the match funding requirements, which restricted the scale at which they were able to participate in the projects. Whilst the consortium was very successful, if the role played by this company could have been more substantial, the project could have successfully exploited more of the potential in the business' technology.

- **Technical issues:** two of the case studies encountered data-related issues. For example, the use of big data in the Precision Breeding project caused difficulties in terms of server capacity and transferring substantial volumes of data between the partners.

- **Impact on production:** undertaking field trials within commercial businesses is not without challenge – for example, one of the project leads underestimated impact on the production process at their business, as the new approach temporarily slowed down production, which created tensions with workers on piece rates.

- **Other challenges that may influence demand for crops:** a specific challenge for the oil seed rape case study relates to an unrelated pest issue for the crop in question, which may lead growers to diversify away from the crop, leading to a reduction in the addressable market for the products and any follow-on wider outputs (including the disease management guidelines) emerging from the project, at least in the UK which is the initial market-focus.

6.54 Many of these issues are context specific, and external to the programme, and therefore can only be 'anticipated and managed' rather than 'prevented' in any meaningful sense. This said, they do reflect the practical challenges in the delivery of large-scale and high-risk R&D projects, working in collaboration that needs to be considered in the overall assessment of project progress at this interim stage. Key lessons for the programme itself include the importance of ensuring sufficient and realistic project management capability, and allowing flexibility (where appropriate) to ensure that impacts can be maximised (this is particularly important in a sector where trials etc are so heavily dependent on environmental conditions).

7. Additionality and contribution

7.1 This section presents evidence on additionality of ATC industrial stage grants and explores the contribution and relative importance of ATC to achieving the outcomes and impacts described above compared to wider internal and external factors.

7.2 The analysis of additionality covers two perspectives: 'activity' additionality (i.e. R&D activities that would not have been progressed without ATC) and 'outcome' additionality (i.e. outcomes that have been realised, that would not have been possible without ATC support). The two forms of additionality are related but focus on different aspects of the logic model.

7.3 In each case, additionality has been assessed using self-reported evidence, drawing on beneficiary feedback in the survey and case studies, which has been calibrated with the evidence from those who were unsuccessful in applying for ATC support. There are issues in relying on self-reported information as a core source of evidence on additionality. However, other methods (such the use of econometric or statistical techniques) were not considered viable for the evaluation, as discussed in the earlier Evaluation Framework[44]. The relatively small number of programme participants and unsuccessful applicants means that quantitative analysis on a comparison/control group is not possible; the evidence from the survey of unsuccessful applicants has therefore been used to calibrate the self-reported evidence from a qualitative perspective.

Key messages

The ATC has catalysed new R&D activity at the industrial grants stage, delivering 'activity additionality', in that much of the activity might not otherwise have occurred at all, and where it would have, this would likely have been later and of a lower quality and scale.

The 'outcome' additionality of industrial stage grants appears to be high, reflecting the binary nature of R&D activity at this scale and stage in development. Overall, the evaluation evidence suggests that the programme has led to technology progression and the development of new products/services and processes that would not otherwise have been realised.

There is strong evidence of the effects of the ATC in progressing technologies and new products/services and processes when comparing the two groups of leads: of 14 leads of unsuccessful applications to ATC, just two progressed their project's technology towards market readiness, compared to 15 of the 16 leads of successful applications.

[44] Agri-Tech Industrial Strategy: Evaluation Scoping Study and Baseline, see https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/536388/bis-16-18-agri-tech-industrial-strategy-evaluation-and-baseline.pdf

The way in which the ATC project interacts with other changes and developments in participants organisation and its relative level of influence in delivering outcomes, is in practice very varied and context specific. For over half of the beneficiaries surveyed, other factors were as, if not more, important than the ATC project in realising the outcomes observed.

The relative contribution of the programme to outcomes is complex. The Catalyst does not in most cases stand alone in explaining the outcomes that have been realised, but the ATC support can lead – directly or indirectly – to the implementation of other changes/developments that also influence the realisation of outcomes.

Activity additionality

7.4 **The ATC has catalysed new R&D activity at the industrial grants stage, delivering ‘activity additionality’, in that much of the activity might not otherwise have occurred at all, and where it would have, this would likely have been later and of a lower quality and scale.**

7.5 This judgement draws principally on the survey evidence, comparing what lead beneficiaries *said* they would have done in the absence of ATC funding, and what unsuccessful applicants *have* in practice done without Catalyst funding. As the unsuccessful applicants had in most cases similar quality project ideas to the beneficiary leads (with assessment scores of 70+), this provides a meaningful comparison in understanding what would have happened in the absence of ATC funding for beneficiaries. The detailed data for leads of successful and unsuccessful applications are in Table 7-1.

Table 7-1 Activity additionality – survey results from project/application leads

Beneficiary survey respondents (n=16 leads)	Unsuccessful applicants survey respondents (n=14 leads)
Of the 16 beneficiary leads: 15 probably/definitely would not have taken forward their project without ATC 1 probably/definitely would have progressed their project without ATC anyway (with internal funds)	Of the 14 non-beneficiary leads: 9 have not progressed the project due to lack of finance and high technical risk 5 have progressed the project without ATC funding (all using internal funds, some using EU/UK public funds) Of these 5 projects, relative to the planned ATC funded activity 4 were at a smaller scale 4 were at a lower quality All 5 were delayed

Source: Beneficiary survey, 2019

7.6 As indicated in the table above, in nearly all cases beneficiary leads state that they would not have progressed with the project without the ATC. This links back to the underpinning rationale for the application discussed in Section 4, where issues related to the level of risk associated with large-scale projects was a key barrier to project progress. The evidence from leads of unsuccessful applications suggests that this level of self-reported project additionality by beneficiaries is likely to over-state to some extent the effects of the ATC funding: in practice over a third of these projects (5 of 14) did progress.

7.7 As such, the evidence from unsuccessful applicants suggests that a higher proportion of beneficiaries than the very low proportion implied by the survey (just one of sixteen) may have progressed without the grant award. This said, around two-thirds (9 of the 14) of projects did not progress without ATC, demonstrating the role of the programme in enabling the activity.

7.8 Further, the evidence is more complex than the headline data on progress/non-progress suggest, as there are clearly implications from not securing ATC support on the timing, scale and quality of the projects, even where they did go ahead amongst unsuccessful applicants. Notably, all of the projects were delayed (in three cases by over two years, and in two cases up to two years), which given the competitive nature of the sector can be important, enabling businesses to undertake R&D more promptly and potentially develop new products/services and access markets more quickly than competitors (including internationally). Whilst nearly all (8) of the non-beneficiary leads that have not progressed their project intend to do so in the future (funded either via IUK grants, internal or customer/collaborator funds), they will also be delayed significantly, if this progress is realised in practice.

7.9 The projects that did progress were smaller scale and lower quality in four of the five cases. These factors were interrelated - reduced scale meant that some of the required expertise was not involved in the project, and meant that testing was less rigorous.

7.10 It is also worth noting that of the nine leads of unsuccessful applications that did not progress with the project for which ATC funding was sought, nearly all (8) indicated that they had invested the time and resource that they planned for that project into other activities to develop or grow their business. For all eight this included other R&D activity, and at least five invested in marketing, people development of equipment/systems/ICT. This is not unexpected; as set out in Section 4, all unsuccessful leads were R&D active in advance of the programme.

7.11 Approximately two-thirds (16 of 25) of collaborators surveyed indicated they definitely/probably would not have engaged in *similar* collaborative R&D without the ATC support. This data demonstrates **the role of the programme in helping to 'capture' and/or 'lock in' organisations to engage in collaborative R&D in the agri-tech sector,** with a focus on new product/process development and innovation. This includes academics: of the seven academic collaborators surveyed, six stated that they definitely/probably would not have engaged in similar collaborative R&D without ATC.

7.12 The case study findings support the evidence above and provide further details on why the programme has brought about additional activities – such as how ATC funding was critical to enable R&D at scale (which was key to allowing sufficient sample sizes to validate new approaches).

Third Generation Polyethylene Greenhouse Cladding Materials:

The project would not have gone ahead without external funding. In part, this reflects scale and complexity, but also relatively high risk in that it encompassed activities ranging from novel academic research through to product development. The ATC also had a fundamental influence in that the existence of the programme, and the availability of funding, led the lead (BPI) to develop an ambitious and complex partnership structure encompassing all the key elements of the supply chain; they would not have considered such an approach without the ATC.

Integrating control strategies in oil seed rape

Without the funding from ATC, partners argued that it would have been very difficult for the project to have progressed, if at all. For the lead partner, making the case for investment in R&D projects involves competing against other areas to secure the necessary financial and strategic support. Given the scale of the potential market for this idea relative to other crop production areas, and the uncertainty around the potential outcomes (including the need to essentially 'generate demand') securing the requisite funding without support from the programme was considered very challenging.

Precision Breeding:

Both the lead and the collaborator argued that without ATC, the project would not have gone ahead at such scale – and arguably scale was critical to the concept (i.e. whole genome sequence information on large-scale broiler populations) and the ability to better predict the accuracy of genetic improvement. A smaller project would have had limited value in this context. The project may have taken place more slowly (possibly twice the time) in a piecemeal way, but this would not have delivered the same quality of results (given the scale point above) and potential step change in knowledge, and the opportunity to be first mover could have been lost.

Developing Bacteriophage Technology to Optimise Potato Production:

Without the funding provided by the programme, the breadth of partnership across the value chain would not have been possible. This would have impacted substantively on the scope and viability of the project. Although the project may have progressed to some extent the scale would have been lower (e.g. fewer field trials), and the focus would have been largely on lab-based work; it was noted that field trials at the scale necessary to produce robust results are high-cost. As a result, the validation of the technology in the relevant environment would not have been realised, delaying further the potential commercialisation of the innovation.

7.13 Taken together the findings indicate that whilst there is likely to be some optimism bias amongst the Beneficiary Group i.e. considering that ATC was more important to the development of the R&D project than in fact it probably was, much of the R&D activity supported would not have progressed without the ATC funding. Further, even where it would have progressed, there are important speed and quality additionality effects for ATC. In the absence of ATC funding, projects that did progress were likely to have been delayed, and the nature of the R&D activity (and potentially the commercial product/service that may result) to have been of a lower quality.

Outcome additionality

7.14 The **'outcome' additionality of industrial stage grants appears to be high,** reflecting the binary nature of R&D activity at this scale and stage in development. Overall, the evaluation evidence suggests the programme has led to technology progression and the development of new products/services and processes that would not otherwise have been realised.

Self-reported outcome additionality

7.15 The key data on self-reported additionality are set out in Table 7-2, with the responses from beneficiaries when asked whether the outcomes attributed to the ATC project (as reported in the previous section) would have been achieved if they had not been supported by the programme. It is important to note that given the breadth of outcomes, and the need to ensure that the survey did not place undue burden on respondents, the question covered all of the outcomes that respondents had identified as being realised or expected (i.e. it was not asked on an outcome-by-outcome basis). Note that the scale, quality and timing effects were not mutually exclusive. The key points are as follows:

- across all beneficiaries surveyed, a high majority (36 of 41) reported that they probably or definitely would not have achieved the same outcomes in the absence of ATC – these outcomes are therefore considered to be "fully additional"; it is notable that over half of the beneficiaries (22 of 41) indicated they definitely would not have achieved the same outcomes
- only one of the 41 respondents reported they would have achieved the outcomes anyway without ATC, at the same speed, scale and quality; this suggests a very low level of 'deadweight'
- reflecting the high level of 'full additionality' partial additionality in terms of timing, scale and/or quality was modest
- there was no statistical variation between leads and collaborators and leads on self-reported additionality.

Table 7-2: Self-reported additionality for beneficiary survey respondents

	Respondents (n=41)
Full deadweight	
Would have achieved the outcomes anyway, at the same speed, scale and quality	1 (2%)
Partial additionality	
Would have achieved the same outcomes, but not as quickly	2 (5%)
Would have achieved the same outcomes, but not at the same scale	1 (2%)
Would have achieved the same outcomes, but at a lower quality	2 (5%)
Full additionality	
Probably would not have achieved the same outcomes	14 (34%)
Definitely would not have achieved the same outcomes	22 (54%)

Source: Beneficiary survey, 2019 Note: one beneficiary responded 'Don't know'

7.16 The case studies also confirmed the consistency between perspectives on additionality between leads and collaborators, although in one instance the case study found that additionality varied across the different types of outcomes observed.

Table 7-3: Case study evidence on additionality

Case study	Additionality	Key points
Anonymised	Full	Consistent view from lead and collaborator - costs were too substantial, smaller scale project would not have been able to achieve validation of technology
Third Generation Polyethylene Greenhouse Cladding Materials	Full	Reflects scale and complexity but also relatively high risk in that it encompassed activities ranging from novel academic research through to product development.
MUST: Miscanthus Upscaling Technology	Partial	ATC instrumental in developing revolutionary establishment technology system, allowing crop expansion and the development of new markets. Without ATC, outcomes would have been smaller in scale
Developing Bacteriophage Technology to Optimise Potato Production	Partial	Lead business may have progressed project, but at a lower scale and quality and consistent view from collaborators that ATC funding was necessary for the project as delivered to progress reflecting costs of research and scope of collaboration
Precision Breeding	Partial	Lead business would have realised some R&D capacity improvements anyway, but in general without ATC both lead and collaborator agreed that outcomes would have taken much longer, at a smaller scale and have been lower in quality (quality would have been compromised due to smaller sample sizes)
Tools and technology for predicting tomato glasshouse production	Full	Consistent view from lead and collaborator – because the outcome was uncertain, funding was essential to de-risk project, without which activities would not have taken place at all (and therefore outcomes not realised)
Integrating control strategies in oil seed rape	Full	Consistent view from lead and collaborator – the funding would not have been available for the industrial lead or collaborator to deliver the project without ATC owing to the level of risk, uncertainty, and costs of delivery at the require scale/nature

Source: SQW, based on case studies

7.17 The beneficiary survey evidence suggests that at the industrial grant stage the outcomes from ATC projects are very ‘binary’ in nature i.e. they either are delivered or not, reflecting potentially the high level of risks associated with R&D at this scale and stage in technology progression, and the lack of alternative funding options. The self-reported 'outcome additionality' evidence from beneficiaries is also consistent fully with the 'activity additionality' set out above, where nearly all lead beneficiaries indicated that the R&D project would not have progressed without ATC.

7.18 The case studies provide some further insight into the 'binary' nature of outcomes from industrial stage ATC projects. For example, in the Greenhouse Cladding Materials case study, the new plastic material will either be effective or not in improving optical properties (without unintended adverse impacts on the growing process), which will become clear once the field trials are complete this summer. However, if successful, partners consider the project could have a substantial global impact. In the ICAROS case study, the new seed treatment product is the principal route to market at this stage. The project will be complete in September 2019 and early indications suggest it will be technically successful. However, commercialisation will be dependent upon securing regulatory approval for treatments in crop production – without this, the full economic impact of the R&D cannot be realised.

7.19 There also appears to be **very limited substitution**, whereby engagement in ATC has diverted participants efforts away from other business development activities. Only three of the beneficiaries responding to the survey (n=41) reported the Catalyst had prevented them from engaging in other business development activity.

Unsuccessful applicant experiences

7.20 As discussed earlier in this section, unsuccessful applicant survey respondents were asked whether they had progressed their idea without ATC support, and if so, the nature and scale of outcomes generated by these activities.

7.21 Above, we reported that 5 of the 14 unsuccessful applicants had progressed their idea to some degree without ATC funding – and all at a later date. The table below summarises the progress of these five projects.

Table 7-4: Overview of progress of projects that progressed without ATC support

	How was the project funded?	Have new/Improved products or services been introduced to the market	Have new/Improved processes been introduced	Has the project led to employment and sales effects at this point, and to what extent?	Will the project lead to employment and sales effects in the future, and to what extent?	What wider outcomes have been realised through the project?
Project 1	Internal funding and customer/ collaborator funding	Yes	No, and will not experience	Yes, increased sales of £150k	Yes, expect an increase in sales and employment	Improved staff skills/knowledge Improved understanding of R&D and commercialisation processes Progress in moving a technology towards market readiness Improved profile, reputation, credibility New or improved collaborations established with industry
Project 1	Internal funding	Yes	No, and will not experience	No	Yes, expect an increase of sales	Improved staff skills/knowledge Improved understanding of R&D and commercialisation processes Improved profile, reputation, credibility Improved understanding of market position and opportunities New or improved collaborations established with industry New or improved collaborations established with academia/research base

						Patents or IP applied for and/or secured
Project 3	Internal funding, another IUK/UKRI R&D grant competition and KTN/KTP partnership	Yes	Yes	Yes, have increased headcount by three	Yes, expect an increase in sales (up to £1m) and employment (15 FTE)	Improved staff skills/knowledge Progress in moving a technology towards market readiness Patents or IP applied for and/or secured
Project 4	Internal funding, loans/over drafts and European funding grant	No, but it is expected in the future	No, but it is expected in the future	No	Yes, expect an increase in sales and employment (2 FTE)	Improved staff skills/knowledge Improved understanding of market position and opportunities Improved understanding of private sector investor opportunities and expectations
Project 5	Internal funding and European funding grant	No, but it is expected in the future	No, and will not experience	No	Yes, expect an increase in sales and employment	New or improved collaborations established with industry

Source: Non-beneficiary survey, 2019

7.22 This evidence for the small group of unsuccessful applicants who progressed their idea without ATC support (5 of the 14 of the survey sample), does show that in terms of product development, initial quantitative effects, and wider effects from R&D, the outcomes are similar to ATC funded projects. This may not be unexpected and reflect in part that despite the delays in all cases as a result of not securing an ATC grant, the use of their own internal funds as the principal source of finance may have increased the pressure to commercialise and generate a return on investment, meaning they might be more willing to take the product/service to market before the product is “fully” developed. It is possible that one effect of the programme is to provide the foundation for the R&D to have a greater, more sustainable impact in future. At this interim evaluation stage, it is too soon for this to be tested; this will be a key issue to consider in any subsequent final evaluation of the programme.

7.23 However, looking at the survey data overall, there is strong evidence of the effects of the ATC in progressing technologies and new products/services and processes when comparing the two groups of leads. Of the 14 leads of unsuccessful applications to ATC surveyed, just two progressed their project’s technology towards market readiness following their application to the programme[45], this is compared to 15 of the 16 leads of successful applications. Further, outcomes in relation to new/improved processes appear to be more common for supported leads, identified by 9 of 16 leads of successful projects, compared to 1 of 14 leads of unsuccessful projects.

Table 7-5: Progress in commercialisation of successful and unsuccessful leads

	Successful application leads	Unsuccessful application leads
Leads surveyed	16	14
Moving a technology to market readiness	15	2
Introduced new/improved product/service to market	5	3
Introducing new/improved process	9	1
Patents/IP secured/applied for	4	1

Source: Beneficiary and non-beneficiary surveys, 2019

[45] This includes all 14 leads, both those leads that did (n=5) and did not (n=9) progress their project, with the latter group assumed to not have progressed towards market readiness (as the project did not progress at all).

Contribution evidence

Context

7.24 A related issue to additionality is the relative contribution of the programme to the outcomes observed, that is, whether the outcomes that appear to have been generated by the support from the ATC have been influenced – to a greater or lesser extent – by other factors, whether this was alongside, or after the ATC project.

7.25 In this context, it is important to reflect on the evidence set out in Sections 4 and 5 regarding the innovation and collaborative behaviours of participants, both before and during their ATC-funded activity. To recap: nearly all beneficiaries surveyed had invested in R&D activities in the three years prior to their application to ATC and been involved in collaborative innovation activities. Further, 5 of the 16 leads surveyed had received other forms of support to develop the specific idea during delivery of the ATC project.

7.26 This level of collaborative R&D activity and engagement with wider sources of innovation advice/support was also demonstrated by the case studies: in most cases, the project leads had been involved in previous R&D projects and collaborations, including with the research base, and collaborators were drawn from organisations involved in a range of R&D and innovation projects and processes.

7.27 This context matters as it indicates that the organisations supported by ATC industrial grants have been exposed to a wide range of support and engagement that may have influenced – either directly or indirectly – the activity, and subsequent outcomes that appear to have been generated by the ATC project.

Findings on relative contribution

7.28 Consistent with this context, the beneficiary survey suggests that **the ATC industrial grant is nearly always one of several internal factors, which, taken together, may be contributing to outcomes for programme participants.** As shown in Table 7-6, other R&D activities, new innovation partnerships (outside of the project collaboration) and the implementation of new business plans strategies were all very common. Under 10% of survey respondents indicated that none of these factors were evident.

Table 7-6: Other changes or developments at the same time or after Catalyst project

Change/development	Total (n=41)
Other R&D activities implemented	31 (76%)
New innovation partnerships / collaborations established	29 (71%)
New business plan/strategy implemented	28 (68%)
Other changes in senior management	24 (59%)
New equipment purchased	23 (56%)
Change of leadership or management in R&D department/team	16 (39%)
None of these	3 (7%)

Source: Beneficiary survey, 2019

7.29 Detailed data on the 16 leads is set out in Figure 7-1. This highlights the combination of other factors influencing R&D activities and business outcomes alongside or after engagement with the ATC programme; in 14 of the 16 leads, at least two other factors were identified, and in three cases all six of these factors were relevant.

Figure 7-1: Other changes or developments at the same time or after Catalyst project for leads

	Change of leadership or management in R&D department / team	Other changes in senior management have occurred	New equipment has been purchased	Other R&D activities have been implemented	A new business plan/strategy has been implemented	New innovation partnerships or collaborations established
Lead 1				✓		✓
Lead 2	✓	✓	✓	✓	✓	
Lead 3					✓	
Lead 4	✓	✓	✓	✓	✓	✓
Lead 5	✓	✓	✓	✓	✓	
Lead 6	✓				✓	✓
Lead 7			✓	✓	✓	✓
Lead 8	✓		✓	✓	✓	✓
Lead 9					✓	
Lead 10		✓		✓	✓	✓
Lead 11	✓	✓	✓	✓		
Lead 12		✓		✓	✓	✓
Lead 13		✓		✓		✓
Lead 14	✓	✓	✓	✓	✓	✓
Lead 15	✓	✓	✓	✓	✓	✓
Lead 16				✓	✓	✓

Source: Beneficiary survey, 2019

7.30 These other changes/developments could, in principle, be fully separate and unrelated to ATC activities and outcomes, with participant organisations regularly involved in a wide range of R&D and other business development activities. However, the survey indicates that **these other factors were in practice often regarded as more, or equally, as important as the ATC in**

realising the outcomes identified by beneficiaries that were associated with the project (as discussed in the previous section).

7.31 The relative contribution of other changes/developments in relation to the ATC was mixed, as may be expected reflecting the different relationship to ATC activities across projects and participants. The changes most commonly identified ("Other R&D activities" and "New innovation partnerships/collaborations") were identified as being of "equal" importance to the ATC in realising the outcomes in around half of cases where these changes/developments were identified. Notably, in the 24 cases where other changes in senior management were evident, nearly half (n=11) of respondents indicated that this was in practice more important that the ATC in realising the outcomes from the project.

Table 7-7: Response to "Reflecting on the outcomes discussed earlier, how important were these changes to achieving these outcomes compared to receipt of the Catalyst award? Were they more important than the support from the Catalyst, equally as important, or less important."

	… more important	… equally important	… less important	… don't know/ refused
Other R&D activities implemented (n=31)	8 (26%)	12 (39%)	12 (29%)	2 (6%)
New innovation partnerships or collaborations established (n=29)	7 (24%)	12 (41%)	12 (28%)	2 (7%)
A new business plan/strategy implemented (n=28)	10 (36%)	9 (32%)	9 (25%)	2 (7%)
Other changes in senior management (n=24)	11 (46%)	4 (17%)	4 (25%)	3 (12%)
New equipment purchased (n=23)	6 (26%)	6 (26%)	6 (39%)	2 (9%)
Change of leadership or management in company R&D department/team (n=16)	4 (25%)	3 (19%)	3 (44%)	2 (13%)

Source: Beneficiary survey, 2019

7.32 Looking at the data in more detail:

- 17 of the 41 respondents identified at least one change/development that was more important than the ATC in achieving the outcomes identified in the survey

- 23 of the 41 respondents identified at least one change/development that was regarded as equally as important as the ATC (63%, n=57)[46]
- 11 of the 41 respondents identified no other changes/developments that were more or equally as important as the ATC, suggesting in these cases that the relative contribution of the ATC project was high
- there was no variation between leads and collaborators for these perspectives.

7.33 This data indicates that the relative contribution of other changes/developments needs to be recognised in judging the effects of the programme; **for over half of the beneficiaries surveyed, other factors were as, if not more, important than the ATC project in realising the outcomes observed. However, the relative contribution of the programme to outcomes is complex,** and the survey also indicates that the ATC support can lead – directly or indirectly – to the implementation of these changes/developments.

7.34 The data are set out in Table 7-8. Three points are noted:

- there is **positive evidence of the ATC project influencing other R&D and innovation behaviours and investment in equipment** that may support this, with over a third of respondents indicting these changes/developments had occurred attributing some influence to the ATC; a direct influence was most commonly cited in 'New innovation partnerships or collaborations established' (note, the survey explicitly noted this should exclude partners on Catalyst)
- the **influence of the ATC project on changes related to senior management and leadership positions in organisations appears to be modest**, evident in a small number of cases; this may be expected, particularly in relation to large businesses and research organisations, for example, all six academics that identified 'Other changes in senior management' reported this had not been influenced directly or indirectly by the ATC project
- however, the levels of **influence on new business plan/strategy** was higher, with over a third of respondents indicting this change/development had occurred attributed some influence to the Catalyst.

[46] Note, this does not mean that all beneficiaries identified one or the other as the data are based on whether one of six factors were identified as more or equally as important, and a single beneficiary can therefore be found in both groups.

Table 7-8: Were these changes implemented because of the Agri-Tech Catalyst award?

	A: Number reporting factor evident	B: No. reporting ATC led to other factor directly or indirectly (of which directly)	C: % where ATC led to other factor directly or indirectly (B/A)
Other R&D activities implemented	31	11 (7)	35%
New innovation partnerships or collaborations established	29	13 (11)	45%
A new business plan/strategy implemented	28	11 (4)	39%
Other changes in senior management	24	5 (-)	21%
New equipment purchased	23	9 (6)	39%
Change of leadership or management in company R&D department/team	16	3 (2)	19%

Source: Beneficiary survey, 2019

7.35 Taken together, the survey evidence suggests that the way in which the ATC project interacts with other changes and developments in participants organisation and its relative level of influence in delivering outcomes, is in practice very varied and context specific. This said, there is clear evidence that other factors alongside the Catalyst are commonly also important in realising outcomes that are associated with the project for a majority of beneficiaries; the Catalyst does not in most cases stand alone in explaining the outcomes that have been realised.

7.36 The case studies provided an opportunity to probe this issue of relative contribution, and the other factors that may have influenced outcomes, in more detail. In these examples, other factors that have been important in the success of the project have included wider technological developments, other complementary R&D projects, and changes in business ownership allowing greater capacity for R&D activities.

Precision Breeding:

This project was managed on a day-to-day basis by the research collaborator who secured funding for a number of other complementary and inter-dependent R&D projects. This enabled knowledge sharing, some pooling of resources to purchase a larger/more powerful computer, and the employment of a larger team of specialists who could be deployed on each project as required. As a result, the contribution of ATC was important in achieving outcomes but some of the funding/knowledge from other projects was equally as important as ATC in moving the novel approach forward.

Tools and technology for predicting tomato glasshouse production:

Developments in technologies since inception has supported this project. It was originally expected the tool would need a robotic platform to be transported around the crops. However, due to advances in miniaturisation technologies at the collaborator business, the tool was developed into a handheld device. This allowed for further time and resource to be allocated to the tool itself, rather than additional components.

Developing Bacteriophage Technology to Optimise Potato Production:

The ATC project drew on earlier IUK-funded collaborative R&D activity, and the full commercialisation of the plant protection product emerging from the ATC project will rely on the success of follow-on R&D activity (funded by IUK's open competition), and potentially further investment to support manufacturing, distribution, and licencing approaches. However, the relative contribution of the ATC was considered by partners to have been significant, and the programme played a key role in enabling the on-going development of the technology, alongside these wider factors.

7.37 The importance of external factors in influencing outcomes were also evidenced through the evaluation. Approaching half (17 of the 41) beneficiaries surveyed indicated that other major external factors had influenced the progress and impact of the innovation supported by their ATC project. The descriptions of these factors varied. The implications of Brexit and the current short-term uncertainties around the regulatory and market landscape as a result was identified by a minority of beneficiaries (8 of the 41 noted explicitly Brexit in the survey). Other external factors that were very specific to the technology area or market were also cited.

7.38 However, this data may reflect the stage of the projects when surveyed, with external factors more likely to influence the commercial roll-out and final outcomes in future. The case studies provided examples of this, with consideration of the potential effects of the project, and how these will be influenced by the external environment. This said, the case studies also identified the implications of Brexit as an important factor at this stage that is, or will, have an influence on outcomes of ATC project activity, although the effects here were complex, illustrated below.

Integrating control strategies in oil seed rape:

Two major external factors were identified that will influence the potential impact of the project in the future.First, the regulatory landscape and challenges in securing approval for treatments in crop production may lead to delays in approval and commercial outcomes. Second, a specific challenge to the production of the crop in the UK owing to an unrelated disease was cited that may lead growers to diversify away from the crop, leading to a reduction in the addressable market for the products and follow-on wider outcomes, at least in the UK which is the initial market-focus.

Tools and technology for predicting tomato glasshouse production:

The project has successfully developed a new technology and has plans to roll this out in the near future. Brexit was identified as a factor in the potential commercial success of the project. On the one hand, there was some concern that changes in exporting rules and requirements may lead to challenges in the export potential of the product. However, on the other hand, potential decreases in the availability of EU labour, who make up a substantial proportion of the fruit picking workforce in the UK, may lead to enhanced demand in the UK market for technologies that support less labour-intensive methods.

7.39 Overall, across the case studies, the evaluation team's assessment (based on the evidence) was that the support from the ATC did contribute to the achievement of outcomes (or in a number cases, the expected achievement of outcomes) in all cases. In five of the seven cases, the ATC project was supported by other internal factors to generate outcomes, and the outcomes were unlikely to have been brought about otherwise. In two cases, the contribution of the ATC project appears to be decisive, although this may reflect the stage of the projects, with further work required in the future to progress to commercialisation. External factors – for example around regulation, market demand, and technology trends – were also identified in six of the seven cases. These findings are not unexpected but corroborate the evidence from the survey that the ATC support is often working alongside other factors to deliver outcomes.

8. Conclusions

8.1 In this final section, we present a summary of the **overall contribution story for the ATC industrial stage awards** and reflect on overall performance against objectives and rationale and lessons learned so far. It is important to re-emphasise that this is the second phase of a two-phase *interim* impact evaluation, focusing on the industrial stage grants only. There is a parallel report on the early stage and late stage awards, and an extended Executive Summary that sets out the summary findings of the evaluation covering the full programme and considers the implications for the future. This section also sets out SQW's thinking on an outline plan for the longer-term evaluation of the Catalyst, assessing *what* should be evaluated, *when* and *how*.

Overall contribution story

8.2 In the paragraphs that follow, we summarise the findings against the key questions that form the basis of the contribution analysis, drawing on the evidence from across the evaluation's research strands:

- Is there a reasoned Theory of Change, and have activities been implemented as set out in the Theory of Change?
- Is there evidence that the expected results have occurred?
- Was it the Catalyst, rather than other influencing factors that made the difference, or the decisive difference?

Is there a reasoned Theory of Change, and have activities been implemented as set out in the Theory of Change?

8.3 A logic model and Theory of Change were developed at the outset of this study, based on a review of programme documentation and scoping consultations with key strategic and management leads for the Catalyst. **The intended path from activities through to outcomes and impacts appeared to be plausible,** notwithstanding the potential risks identified in the Theory of Change including potential technical failure, on-going barriers to commercialisation (including related to finance), and the level of take-up of the innovations in the wider agricultural sector. This Theory of Change – and the assumptions underpinning it – have been tested throughout this evaluation.

8.4 **For industrial stage projects, there is strong evidence to support the underlying rationale**, particularly in terms of the level of risk involved in project activity, the uncertainty and time-lag to impact, and co-ordination failures that can inhibit collaborative R&D on high-risk projects. For industrial stage projects in particular, scale was a key factor underpinning the rationale for public intervention – even where businesses had invested (smaller scale) internal funds in R&D activities in the past – and in many cases, testing and

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validating new technologies at scale was critical in accelerating technological progression.

8.5 The evaluation evidence indicates there are commonly a range of **mutually reinforcing factors that prevent projects seeking ATC progressing without support**, both related to finance and wider issues, including the need to access wider expertise and support through collaboration. Further, although participants in the industrial grants are generally R&D active and experienced in co-operating on innovation activities, the evaluation suggests **that the projects supported by the ATC programme are seen to be qualitatively different in their risk profile than other more 'standard' R&D activities undertaken previously** (both public and privately funded).

8.6 These perspectives from beneficiaries on the case for ATC investment, and why projects had not progressed related to risk and the qualitative nature of the R&D **is validated by the evidence from leads of unsuccessful applicants on what happened in practice to their projects**. Of the 14 unsuccessful leads surveyed, nine did not progress their project at all owing to a lack of finance and high-risk nature of the activity, and of the five that did four were of a lower quality and/or scale, and all five were delayed.

8.7 Project inputs have focused on the intended audience **and activities have generally been implemented as set out in the Theory of Change**:

- Demand was strong, and the quality of projects supported was high, reflected in the fact that a high number of applications exceeding the Innovate UK assessment threshold were not funded due to limited resources.
- The funding catalysed new R&D activity in the agri-tech sector, with one in four project leads surveyed stating the availability of Catalyst funding stimulated the project idea; this was lower than for unsuccessful leads, which may reflect that more 'speculative' projects put together in response to the ATC call for funding specifically were less well developed and therefore secured lower scores overall.
- There is some evidence of spill-ins from other disciplines and sectors into agri-tech. For industrial stage projects this appears to be principally via technology spin-ins (with technologies developed in other sectors applied in agri-tech, or existing agri-tech processes/products applied in new agricultural contexts) rather than participant spill-ins (with actors involved that are new to agri-tech).
- The programme has stimulated new collaborations – approaching three-quarters of the beneficiaries surveyed worked with at least one new partner through the ATC project – and the opportunity to work with new partners appears to be particularly important for collaborators.
- Technological progress has been supported, at a quicker rate than would otherwise have been possible, with nearly all beneficiary project leads indicating the ATC had progressed a technology towards market readiness, often to a significant extent.

8.8 Other aspects of the Theory of Change that emerged from the evaluation include:

- The **importance for project leads of involvement of known (and potentially trusted) collaborators in project delivery**: of the 16 beneficiary leads surveyed, only two indicated that their partnership was entirely new, and 14 had worked with at least one of their collaborators previously. This may reflect the perceived high-risk nature of the projects, with existing collaborators used to help mitigate these risks, alongside seeking opportunities to work with new partners.
- The **very varied and bespoke structures and sizes of industrial stage projects**, with considerable variation across the 54 projects. The number of partners involved ranged from two through to over ten, and there was a very diverse mix between industrial and academic partners. The analysis highlighted that each ATC project is very bespoke, with different and complex relationships and context specific routes to impact evident in each case.
- The **technology stage of the projects was more varied than may be expected at the industrial grant stage given the Theory of Change**. The survey suggested that industrial stage projects have regularly included projects at the 'experimental research' stage (at TRLs 1-3). This likely reflects the scale of the projects funded under industrial grants, providing the opportunity to develop earlier stage ideas, in some cases alongside more developed ideas as part of an integrated and multi-faceted approach. However, this does have implications for the time-paths to impacts of individual projects (particularly at this interim evaluation stage), and potentially the requirement for follow-on funding.

8.9 Challenges to the Theory of Change evidenced in the phase one report are relevant for industrial projects, including the lack of progression though grant stages owing to the short timeframe of the programme, limited knowledge exchange across the ATC project portfolio, and a lack of engagement with and linkages to the Centres for Agricultural Innovation. More specifically, the evaluation also identified **some uncertainty at this interim evaluation stage regarding whether industrial stage projects will meet their original objectives**.

8.10 To some extent, this is a positive finding: all projects meeting (or expecting to meet) their objectives in full would imply the programme was overly risk averse (supporting low-risk projects), and realism amongst project beneficiaries is encouraging. It may also reflect the fact many of the industrial stage projects were still being delivered at the time of this evaluation, and so had not yet completed field trials/data analysis etc. This said, if the objectives anticipated from the projects are not realised consistently across the project portfolio, there are implications for the impact of the programme.

8.11 It remains too early to be definitive on this issue, as close out reports commenting on delivery against objectives were available for 20 of the 54 projects only. However, the survey indicated variation between the perspectives of leads and collaborators across projects – and some different views within projects – with leads more likely to report that all objectives have been or will be met than collaborators. How this may change over time, as all projects complete, and the technologies are progressed, will be important to consider at a final evaluation stage.

Is there evidence that the expected results have occurred?

8.12 There is **strong evidence that the outputs and outcomes identified in the logic model associated with innovation behaviours, capacity and partnerships have been realised in practice** at this interim evaluation stage. Benefits in terms of improved staff skills/knowledge, new or improved collaborations established with the research base, and perceptions of an improved profile/reputation/credibility were particularly common amongst the beneficiaries surveyed for the evaluation. The programme has also made beneficiaries more likely to invest internal funds in other R&D, and bid for Government funding for R&D, in the future, according to the survey evidence.

8.13 **At this interim evaluation stage, commercialisation outcomes are modest**. While the survey evidence indicated a high level of confidence that new/significantly improved products/services will be introduced to the market because of the ATC project, in most cases this has not yet been realised, with market introductions of new technologies expected generally within the next three years. The evidence was similar in terms of new/significantly improved processes, which were largely expected rather than achieved. Participants regularly expect to experience both product/service and process outcomes, demonstrating the integrated and multi-faceted nature of ATC project activity.

8.14 These findings are not unexpected given the purpose of industrial stage projects to take ideas to TRL 7 (not full commercialisation), and the timing of the interim evaluation with the survey focused largely on projects that had not been completed. However, further investment will be required in most cases to realise these outcomes, highlighting the **importance of pathways to follow-on funding from ATC**, including public funding where the proposition has not been de-risked sufficiently to ensure the private sector will meet funding needs.

8.15 Reflecting the commercialisation status of projects, the **beneficiary survey suggested that there have been only modest quantitative effects of ATC projects to date in terms of turnover**, with these effects anticipated for the future in nearly all cases where the evidence is available at the interim evaluation stage.

8.16 However, when combining data from the beneficiary survey and the close-out report evidence, employment effects to date are more evident. Data was available on 43 of the 54 projects, with some employment effects realised in over half (25) of these cases. These employment effects are in most cases part of the delivery of the project and/or anticipatory in advance of the commercialisation of technologies (e.g. providing capacity for expected manufacturing, sales and marketing requirements), and included safeguarded jobs (from the close-out reports). The scale of this effect is modest in aggregate terms at this stage, although over half of the projects are expected to generate further employment in the future, as the technologies are developed further and commercialised.

8.17 There appears to have been **limited impact on the wider agricultural sector to date**. This is expected, given the timing of the interim evaluation, and with most project yet to commercialise their product following industrial stage grants. There is confidence in future impacts on productivity, produce quality and environmental sustainability, and more modest impacts on animal health and welfare, which reflects the portfolio mix.

8.18 The Figure below provides a headline summary of progress against the intended outputs and outcomes set out in the original logic model for ATC, based on evidence gathered for industrial stage grants. In reviewing this assessment, it is important to recognise the timing of the interim evaluation, and the complex routes and time-paths to impact for R&D projects.

Table 8-1: Progress against outputs and outcomes set out in the logic model [✓✓✓ indicates strong progress; ✓✓ indicates some evidence of progress, ✓ indicates limited progress to date]

Activities		Outputs		Outcomes/impacts	
Industrial research awards to develop innovative solutions through technology development, lab-based prototyping, pilots, trial market testing (to TRL 7)	✓✓	• Additional private sector investment in R&D	✓✓✓	Intermediate outcomes • Increased business engagement with research base	✓✓
		• New patents filed	✓✓✓	• Strengthened & sustained collaboration	✓✓✓
		• Number/New collaborations between industry and research	✓✓	• Greater understanding of innovation processes	✓✓✓
		• Skills acquisition	✓✓✓	• Changes university attitudes, behaviour, knowledge of commercialisation process, understanding business needs, propensity to collaborate	✓✓
All projects involve collaboration between industry and research base	✓✓	• Commercial applications (incl. 'spill ins'), tech. progress, reduced risk of failure	✓✓✓	• Leverage of further investment	✓
				• New products/processes taken to market	✓
		• Research outputs	✓✓	• Business growth/productivity for participants	✓
		• New data available to industry	✓✓	• Take-up of new products/processes (UK/overseas)	✓
				• Turnover (incl. exports) and employment in wider AT sector	✓

Source: SQW

Was it the Catalyst, rather than other influencing factors that made the difference, or the decisive difference?

8.19 The evaluation suggests that **the additionality of industrial stage ATC grants is high.** The evidence from leads of unsuccessful applications was that in most cases the R&D activity was not progressed, and where it was the quality and scale was impacted, alongside significant delays. Those organisations that were involved in successful applicants were also generally of the view that the outcomes that had been realised at this stage would not have been achieved without the ATC project; indeed, over half of those surveyed (22 of 41) stated they 'definitely would not have achieved the same outcomes' without the ATC project.

8.20 Underpinning this strong – albeit self-reported – evidence on the additionality is the hypothesis that the outcomes generated by industrial stage ATC grants are highly binary in nature, in that in most cases, they are either delivered or not. This reflects the high-risk nature of the projects, their scale and the lack of alternative viable funding options, and the stage of technology development, meaning that without the ATC funding much of the R&D activity supported would not be progressed, and outcomes not achieved.

8.21 Both the survey evidence and the detailed case studies indicate that the way in which ATC projects interact with other changes and developments in participant organisations, and its relative level of influence in delivering outcomes, is varied and very context specific. However, there is **consistent evidence that other factors alongside the Catalyst are commonly also important in realising outcomes that are associated with the project.** The Catalyst does not in most cases stand alone in explaining the outcomes that have been realised, with other R&D activities and partnerships and wider business development playing an important and complementary role.

8.22 There is evidence that in some cases the ATC project is the decisive factor; for example, one in four beneficiaries surveyed indicated that no other factors were more or equally important as the ATC award in generating the outcomes reported, with other factors playing a supporting role only. However, more commonly, other factors have been necessary for the outcomes realised at this point, and **the ATC project is one of several reinforcing explanations for why outcomes have been realised.** For example, the case studies indicated that other factors that have been important include wider technological developments, other complementary R&D projects, and changes in the delivery context such as business ownership, allowing greater capacity for R&D activities.

8.23 This said, the evaluation does suggest that in most cases, the R&D activity that was supported through ATC would not have been progressed in that scale, form, of timing without the ATC supporting in the first place. Therefore, **although once underway other factors have been necessary for outcomes to be realised, these outcomes do derive ultimately from the initial investment made through the programme, and would not have been realised to the same extent without it.**

8.24 This conclusion is not unexpected given the nature of participants in industrial stage projects: they are experienced in R&D and undertaking other innovation activities and partnerships in parallel to the delivery of ATC-funded activity, and implementing changes to influence behaviours and performance across their wider activity-sets. Further, it is important to recognise that it remains too early to assess definitively the contribution of the programme in realising outcomes given the interim nature of the study, with commercialisation and quantitative outcomes largely expected rather than realised, and highly context specific. The relative role of other factors – including follow-on R&D and finance – in realising the full outcomes from industrial stage projects may change over time. This will be an important issue to consider at a final evaluation stage.

8.25 It is also noted that the programme also influences wider business strategies and plans and the establishment of other innovation partnerships or collaborations. This may lead to longer-term legacy effects of participation in the programme. Again, this will be an important issue to consider at a final evaluation stage.

Overall programme performance against objectives and rationale

8.26 The evidence gathered for this phase of the evaluation suggests that through industrial stage projects, the programme is delivering successfully against its aim to "*accelerate translation of research into practical solutions, best practices …"* and encourage greater R&D in the sector. While most of the technologies supported by the projects remain in development rather than delivered and in the market, this is consistent with the expectations of industrial stage project and reflects in part the time paths to impact.

8.27 It is too early to assess whether this is then translating into *"… applications of new technologies in agriculture",* increased turnover and exports, improved agricultural productivity and reducing environmental impacts, and an improved competitive position of the UK's agri-tech sector internationally. The evaluation provides encouraging evidence in some cases of the potential effects of ATC projects if they are realised as anticipated, although there remains uncertainty over the timing and scale of the effect. In this context, it is highlighted that not all objectives of projects will be met, but this is expected and arguably demonstrates that the programme has supported projects at the appropriate level of risk and uncertainty, where some failure or change in expectations is expected, as the R&D is delivered in practice.

8.28 **Positively, industrial grants are meeting the Agri-Tech Strategy's ambitions for the Catalyst** in terms of:

- supporting collaborative relationships between academics and industry. These relationships are not always new, and for projects of this scale and risk-profile, the development of existing relationships appears to be particularly important, with known partners evident within most projects, often alongside new relationships. The projects are also supporting collaborative relationships between different industry partners, including across value chains, which can generate significant benefits for partners including providing the basis for other innovation and commercial opportunities to be progressed
- securing significant co-investment from the private sector through match funding for the R&D projects. Interestingly, the evaluation evidence suggests that where funding was not provided in most cases the R&D opportunity was not progressed and where it was, this was at a lower scale.

- supporting SMEs to take part, with SMEs accounting for over half of industry participants and half of leads of projects
- and supporting a wide range of project types, including both the nature of the activity delivered – which is very specific in each case – and in terms of the size and nature of the partnerships.

8.29 **The programme has also addressed many aspects of the original rationale.** Although participants in the programme do appear overwhelmingly to be R&D and innovation active, the activity supported through the programme is regarded by participants as qualitatively different, and therefore high-risk and uncertain in realising outcomes. The collaborative nature of ATC projects is also important; consistent with the findings above related to the involvement of known partners by leads, this is often about securing the finance that will enable existing collaborations to be enhanced and realise practically new R&D activities.

Key lessons learned

8.30 Key lessons to date around what has enabled or hindered progress and pathways to impact in relation to industrial stage ATC projects are summarised below:

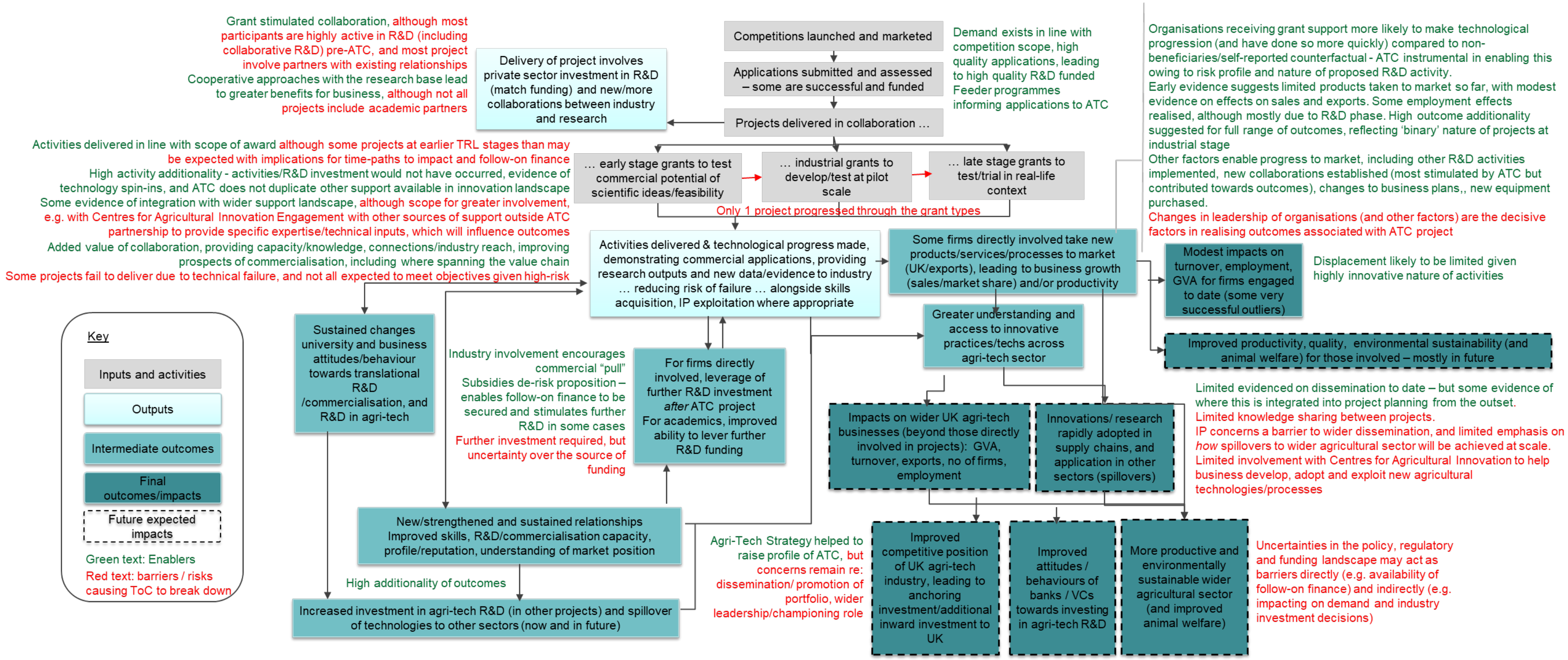
- The collaborative approach of ATC has added value to delivery in terms of capacity/knowledge, providing connections and industry reach, and improving the prospects of commercialising benefits, including where partnerships have spanned the value chain.
- The ability to undertake multi-disciplinary projects at *scale* was a key enabler for projects, and was crucially important in unlocking potentially transformational opportunities.
- Related to the above, the academic input to projects was identified as a key theme from industrial partners in terms of what the key factors have been in enabling the success of project activity.
- The level of flexibility in delivery of project; this was seen to be particularly important at the industrial stage given the scale and length of activity, and where projects were required to 'pivot' to reflect findings as they emerged and/or to deal with the realities of delivering agri-tech research in the field.
- The breadth of projects – which in some cases include a high number of multiple partners – has encouraged spill-ins of technologies from other areas and sectors to agri-tech. However, the breadth of the partnerships can also cause management issues and challenges, and there is no 'right' size or project mix given the very specific technical requirements involved in each case.
- Reflecting the scale and lengths or projects, 'process' issues around effective project management, monitoring structures and routines, and regular

meetings/catch-ups have been important in enabling effective progress to be made and outcomes generated.

- Looking forward, a key potential risk to realising intended outcomes is access to follow-on funding for later stage R&D. Most beneficiaries thought that further R&D would be required – but for many, ATC had not sufficiently de-risked the project for solely internal investment, and sources of potential external funding were not yet clear.
- External challenges, including related to regulation and uncertainty around the policy landscape were identified as barriers, or potential barriers, to the full realisation of outcomes. Also, from a practical perspective, some businesses encountered capacity issues in managing such large-scale, multi-disciplinary teams, and others noted operational disruption of field trials/research activities.

8.31 Finally, the diagram below presents a summary of findings from this phase of the evaluation, in terms of the outcomes and impacts achieved/expected, and key factors that have enabled or hindered pathways to impact for early and industrial stage projects (or might do so in future). It shows how the original Theory of Change (set out in Section 3 of this report) has played out in practice.

Figure 8-1: Theory of Change in practice – A summary of outcomes/impacts and key enablers/barriers for industrial stage projects



Source: SQW

SQW

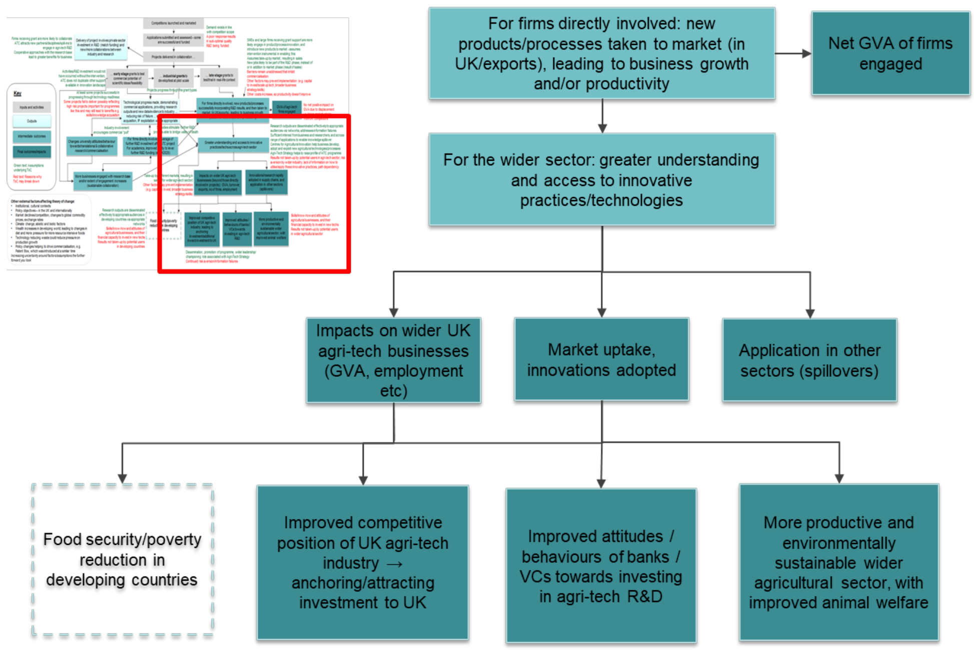
Future evaluation planning

8.32 As part of this evaluation, SQW was asked to develop an outline plan for the longer-term evaluation of the Catalyst, assessing *what* should be evaluated, *when* and *how*. This was to consider the original Evaluation Framework developed for the Catalyst (as part of the wider Agri-Tech Strategy) and reflect on the delivery of this interim evaluation.

8.33 Reflecting on the findings from the interim evaluation, in our view, the main purpose of any longer-term evaluation should be to gather more robust evidence on outcomes and impacts (i.e. the bottom right of the Theory of Change). This will involve two main elements of focus (summarised in Figure 8-3):

- the effects on supported organisations as the technologies supported by the programme are further developed and taken to market, generating (potentially) more robust evidence on effects in terms of employment, turnover and GVA
- the focus to date has been principally on ‘direct’ beneficiaries of the Catalyst, but for full effects to be estimated, the longer-term evaluation will need track through to wider impacts on the agricultural sector.

Figure 8-2: Focus of the longer-term evaluation of the Catalyst



Source: SQW

8.34 The need to gather data from beneficiaries over the long-term and the wider agricultural sector poses substantial evaluation challenges: practically, in terms of engagement and corporate memory, viability in accessing contact data, and proportionality in gathering evidence; and conceptually, as there will be significant 'noise' the further down the value chain from direct engagement you go, particularly in a crowded/evolving policy landscape and with other programmes influencing sector activity and performance (including Transforming Food Production within the Industrial Strategy Challenge Fund).

8.35 A range of evaluation methods have been considered including potential empirical approaches, and a top-down sector survey to update the baseline survey completed as part of the scoping study for the original Agri-Tech Evaluation Framework in 2014. However, the challenge related to sample sizes remain which make empirical approaches challenging, and unlikely to provide meaningful (statistically significant) results. A top-down survey would also be high cost, and the ability to attribute any changes to the programme specifically is highly uncertain.

8.36 Given the small sample size available, and the diverse/complex routes to impact evidenced by this interim evaluation, it is proposed that the **rationale remains for a theory-based approach** (consistent with the original Evaluation Framework). This would include:

- beneficiary surveys of leads and collaborators
- "market tracing" case studies (where new products/processes have reached the market, gathering evidence from both beneficiaries and their customers)
- datalinking, to enable tracking of company performance and access to finance for leads and collaborators
- wider stakeholder interviews across the agri-tech sector and innovation landscape, including other components of the Agri-Tech Strategy.

8.37 The datalinking should include consideration of the Business Structure Database (BSD). The BSD is the local unit data, which underpins the Business Register and Employment Survey (BRES), the official source of employee and employment estimates by detailed geography and industry and provides the potential to link the data to ONS surveys. However, there are restrictions on what the ONS allows to be taken out of the Virtual Microdata Laboratory (VML) that hosts BSD data, particularly when considering modest sample sizes, and individual firm-level data cannot be extracted. Given this, other databases which draw on Companies House information regarding financial performance, and databases that provide information on funding secured (e.g. venture capital) should also be considered. Projects leads and collaborators should also be tracked in Innovate UK and BBSRC data, to identify any follow-on funding secured.

8.38 Given available sample sizes, direct quantitative comparisons to a 'control group' is not considered viable to generate meaningful (statistically robust) results for the datalinking. However, the progress of 'fundable but not funded' leads could be tracked in the relevant databases to provide some evidence on the counterfactual, and the beneficiary cohort could be compared to wider trends in the agri-tech sector to provide further insight on the effects of the programme.

8.39 Partners could also consider a 'technology tracking' exercise to consider the contribution of the Catalyst in the progression of key agri-tech technologies including a desk and document review (including bibliometric data on academic outputs) and the use of an 'expert panel' to test role/contribution of ATC over time, to complement the market tracing case studies.

8.40 The original Theory of Change anticipated these types of impact to be evident c.2020-25. Given evidence from this evaluation that many projects expect to reach the market by three years' time, an impact evaluation around 2022 may be appropriate which would provide evidence on the 'final' direct effects in particular. At this point, the case for a further evaluation in 2025 to focus on the 'final' wider indirect effects, could also be considered, including whether this is proportionate and of value in on-going policy development at this point.

Annex A: Further detail on survey samples

Beneficiary survey

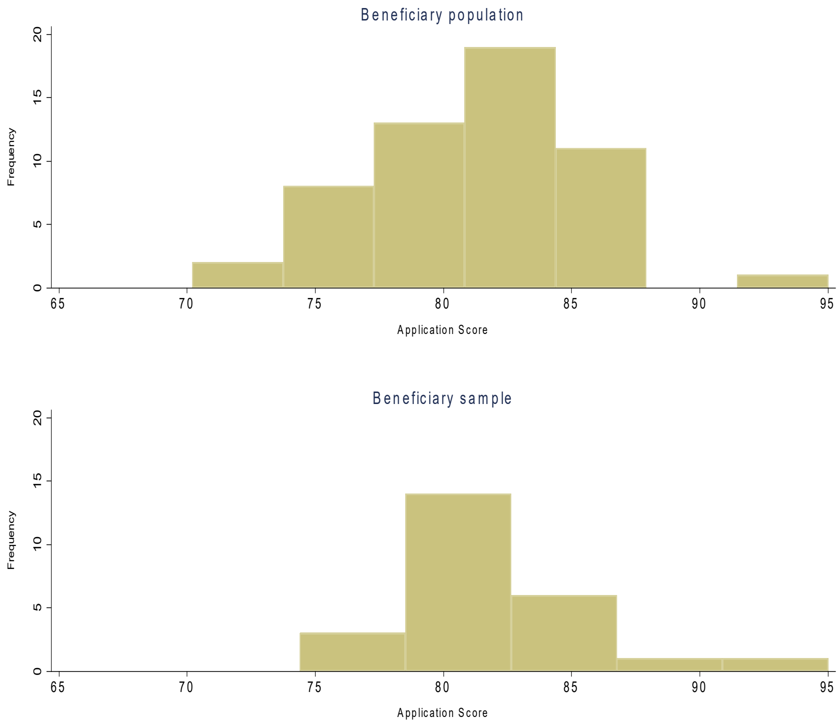
32. The composition of the beneficiary survey sample is broadly similar to the programme population:

- 83% of all respondents (leads and collaborators) were industry compared to 74% of the population.
- In terms of business size, 41% of respondents (leads and collaborators) were SMEs, compared to 40% of the population.
- For leads, respondents had a similar profile terms of business sector to the population. For example, 20% of the survey respondents were in the Agriculture, Forestry and Fishing sector compared to 28% of the population.
- Median turnover at application stage for lead respondents was greater than the population (£75.6m compared to £6.7m[47])

33. The beneficiary sample is representative of the population in terms of the average assessor scores on applications, i.e. the difference between the mean scores for the two samples is not statistically significant (see Figure A-1)[48]. The mean average score for beneficiary sample was 81.9 compared to 81.0 for the population. Table A-1 below provides some further descriptive statistics for the two samples.

[47] The funded sample of projects included the two projects with the highest turnover (of over 10bn).
[48] A t-test was used to determine if the sample mean is equal to population mean (the null hypothesis). A p-value of 0.15 indicates that the differences in mean values is not statistically significant (i.e. we could not reject the null hypothesis).

Figure A-1: Distribution of application scores (beneficiary sample vs population)



Source: SQW analysis of application scores

Table A-1: Further descriptive statistics on application scores (beneficiary sample vs population)

	Beneficiary Sample	Population
Observations	25	54
Mean	81.9	81.0
Min	74.4	70.2
Max	95	95
Std. Dev.	4.0	4.1
Variance	16.2	17.1
Skewness	1.2	0.15

Source: SQW analysis of application scores

Unsuccessful applicant survey

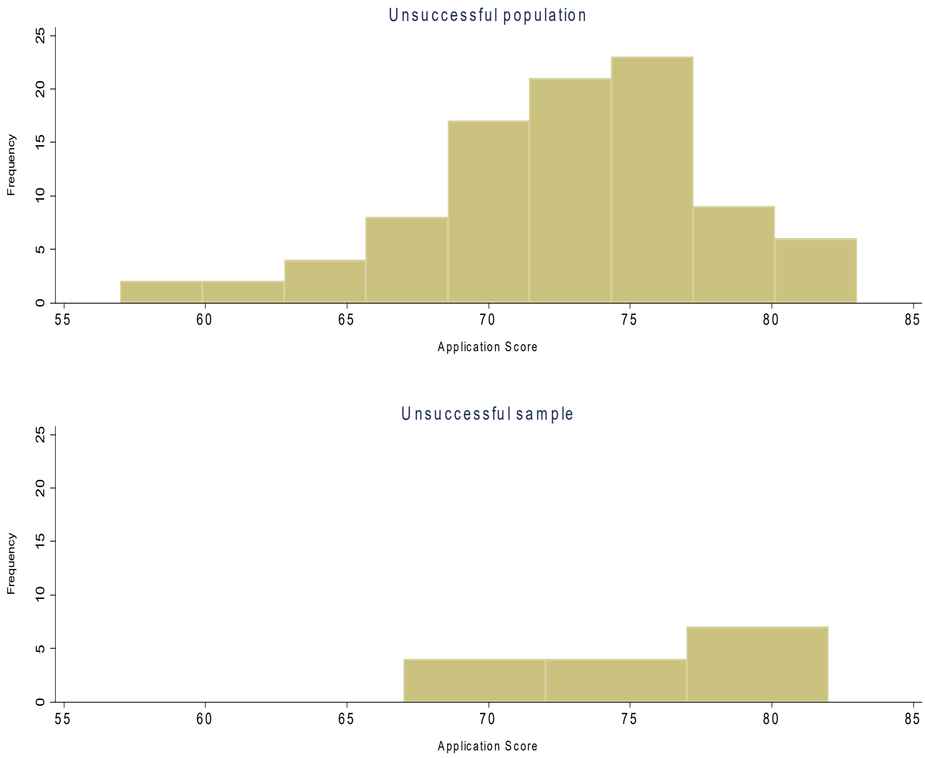
34. We have compared the unsuccessful applicant survey respondents to the population of unsuccessful applicants, which shows:

- 57% of respondents were SMEs, compared to 61% of the population.

- for leads, respondents had a similar profile terms of business sector to the population. For example, 23% of the survey respondents were in the Agriculture, Forestry and Fishing sector compared to 28% of the population, and 15% were in the manufacturing sector, compared to 17% of the population
- Turnover at application stage for unsuccessful respondents was greater than the population (£7.2m compared to £5.5m)

35. The unsuccessful applicant sample is representative of the population, which includes both fundable (scoring over 70) and non-fundable (scoring below 70) applications. The mean score of the population was 73.4 compared to 74.7 for the sample surveyed. The difference between the mean scores for the two samples is not statistically significant[49]. Figure A-2 provides a comparison of the distributions of the subset and sample, and Table A-2 provides some further descriptive statistics for the two samples.

Figure A-2: Distribution of application scores (unsuccessful applicant population vs sample)



Source: SQW analysis of application scores

[49] A t-test was used to determine if the sample mean is equal to population mean (the null hypothesis). A p-value of 0.12 indicates that the differences in mean values is not statistically significant (i.e. we could not reject the null hypothesis).

Table A-1: Further descriptive statistics on application scores (unsuccessful applicant sample vs "fundable" population vs total population)

	Unsuccessful applicant sample	Unsuccessful applicant total Population
Observations	15	92
Mean	74.8	72.9
Min	67	57
Max	82	83
Std. Dev.	4.1	5.2
Variance	16.8	27.5
Skewness	-0.4	-0.6

Source: SQW analysis of application scores

36. Also, when comparing survey responses of unsuccessful applicants to beneficiary leads, we can see that:

- 57% of unsuccessful applicants were SMEs in terms of employment size, compared to 47% of beneficiary leads
- 29% of unsuccessful applicants were established post-2000, compared to 13% of beneficiary leads.

Annex B: Case study reports

37. This Annex contains the following case study-reports:

- Third Generation Polyethylene Greenhouse Cladding Materials
- Miscanthus Upscaling Technology (MUST)
- Developing Bacteriophage Technology to Optimise Potato Production
- Precision Breeding: Broilers from Sequence to Consequence
- Tools and Technology for Predicting Tomato Glasshouse Production
- Integrating control strategies against soil-borne Rhizoctonia solani in oilseed rape (ICAROS)

Third Generation Polyethylene Greenhouse Cladding Materials

Key messages

The project aimed to develop polythene films for greenhouses with enhanced optical properties.

The project involved a large consortium involving academic researchers, grower organisations, greenhouse manufacturer and film manufacturer (BPI). The application also included a chemical coatings manufacturer, but the company withdrew before the project commenced.

The project was unable to develop new and cost-effective coating as anticipated at the outset but changed direction and has produced new film using existing technologies. Outcomes include patents applied for.

Initial field trials indicated new film substantially reduced pests in tunnels and increased yields. Final trials are scheduled for 2019 and if successful, the product could be launched in Autumn 2019 with strong commercial prospects in the UK and internationally.

Wide range of complementary expertise in the consortium was a real strength, although this also imposed burden on project management. The withdrawal of the chemicals manufacturer inhibited efforts to develop new coating.

Source: SQW

Introduction

This project aimed to develop novel polythene films for greenhouses which could reduce pests, increase yields and reduce water demands. It was an Industrial Research full stage project which began in November 2016. Field trials need to be completed and the project will end during 2019. The total cost was approximately £1.5 of which £1m was funded by the ATC.

Two of the project partners, Haygrove and the University of Reading, participated in the evaluation survey and were later interviewed. British Polythene Industries, the lead organisation, was also interviewed. The project application was also reviewed.

Project overview

The project aimed to **develop novel greenhouse film cladding with improved optical properties compared to existing products**. Specifically, it sought to develop new materials which would modify the light reaching crops by a combination of reflecting near infra red radiation (NIR) and optimising the scattering of ultra violet (UV) light and photosynthetically active radiation (PAR). Reducing NIR would reduce greenhouse temperatures and, therefore, water requirements, as well as improving growth rates. Blocking UV light can reduce pest problems since insects find their targets by sight, but UV is also essential for plant growth and the project aimed to investigate the relationship between these two effects. PAR diffusion has been shown to provide yield gains but the relationship between scattering angles and yields and the most appropriate material coatings had not been investigated. Success in all respects would increase yields, reduce pest damage and reduce irrigation requirements. The intention was to develop at least two commercially available products by the end of the project and also enhanced greenhouse design to fully exploit the potential of the new film. The global market for existing products was estimated at £1.4bn pa and project outputs expected to be highly competitive.

The project consortium was large and multidisciplinary, summarised in the table below.

Table B-1: Consortium

Organisation	Role
British Polythene Industries plc	Project lead and film manufacturer
Haygrove Tunnels Ltd	Greenhouse manufacturer, film distributor and grower
Berry Gardens Ltd	Grower representative
Finlays Horticulture Ltd	Grower representative
University of Reading	Polymer Chemistry (Chemistry department) and field trials (Agricultural faculty)
University of Lincoln	Mathematical modelling of directional light scattering and CAD
East Malling Research	Field trials

The aim of the consortium was to combine the complete supply chain from novel academic research through grower trials to manufacture of the film and greenhouse design. In the original application Schulman[50], a chemical manufacturing MNE, was also included. Its role included the pilot manufacture of new coatings developed in the project. Unfortunately, the project start was delayed and Schulman withdrew before project start.

British Polyethene Industries (BPI) and the university partners had collaborated previously originally on a LINK project at Reading which ran from 1996 to 1998. This project also involved the lead academic from Lincoln on the current project, Professor Simon Pearson, who was then based at Reading. The initial idea for the ATC project in fact came from Professor Dr Pearson. BPI and Reading (chemistry) have continued to work together since the LINK project, but on a much smaller scale

[50] Subsequently acquired by Lyondellbasell

than the ATC project. Haygrove is the main UK distributor of BPI film but has not previously collaborated on research.

The project start was delayed, work began in June 2016, and missed one growing season. Some experimental work was undertaken late in 2016 and these, crucially, showed no detrimental effects on yields from UV blocking. The project did not achieve its initial technical objectives but has developed a new film which significantly reduces pest damage and increases yields. The initial delay means that further grower trials are necessary to assess whether there might be adverse impacts on pollinators. BPI applied for a project extension to cover these trials. This was rejected but the trials are currently underway funded by BPI. BPI has applied for patents on the new film and the academic partners have papers in preparation.

Effects and role of the Catalyst

The **project is still underway but there is real optimism that an innovative and competitive product will result**. The project began with a theoretical examination of UV diffusion and NIR and sought to identify appropriate chemicals for the film. In the absence of the small scale extruding expertise, which Schulman could have provided, it was difficult to screen new options and the project was largely restricted to low cost variations of existing materials. One novel material using nanoparticles was investigated but did not show sufficient promise.

As a result, the project changed direction and sought to develop new products which relied on existing technologies and materials. Final trials have yet to be completed, but there is real optimism that the project has been successful in this respect. Working closely with collaborating etymologists, grower organisations and mathematical modellers at Lincoln, BPI has developed a novel film with a different colour and properties to existing products. Field trials during 2018 demonstrated a 50% decrease in pests and also an increase in yields. Increased yields was something of a surprise since the new colour reduces UV transmission to some extent and this might have adversely affected yields. Further trials, currently underway, are necessary to confirm the yield impacts and 15 commercial growers have been signed up. The main focus is on strawberries, but trials will also take place with raspberries, blueberries and roses (in Kenya). If the trials are successful, the new product will be launched in Autumn 2019.

The primary project output is likely to be a new film produced by BPI and marketed globally. Growers would also obviously benefit from reduced pests and enhanced yields. But, there have been other outputs and anticipated benefits:

- **Lincoln worked with Haygrove during the project to optimise greenhouse design**. Outputs so far have not been considered practicable for manufacture, but work is continuing outside the project and further progress on greenhouse optimisation has been made. Haygrove has become more aware of the potential benefits of academic collaborations and more open to such relationships as a result of its participation in the ATC project.
- **Reading made progress with a technique for adding glass flakes to polythene film to enhance light scattering which could from the basis for future research**. It is considering using the ATC project in its 2021 REF

impact statement. Reading is also building on the ATC research, in collaboration with other universities, through a project funded by the Ceres Agritech Knowledge Exchange Partnership51.

- **BPI has formed closer relationships with the commercial partners,** in particular Berry Gardens.

This project would not have gone ahead without external funding. In part, this reflects scale and complexity but also relatively high risk in that it encompassed activities ranging from novel academic research through to product development. However, ATC also had a fundamental influence in that the existence of the programme, and the availability of funding, led BPI to develop an ambitious and complex partnership structure encompassing all the key elements of the supply chain. **BPI would not have considered such an approach without the ATC.** The large consortium was demanding of management time, and the withdrawal of a partner with chemical manufacturing expertise adversely affected project progress and outputs, but the partnership was nevertheless a strength. When the project needed to change direction, the spread and depth of expertise in the consortium was instrumental in identifying alternative approaches.

It is also interesting to note that original impetus for the project came from an individual at the University of Lincoln. Professor Pearson has considerable experience, and standing, in the commercial sector but it is difficult to see how the project could have been initiated by a university without ATC funding.

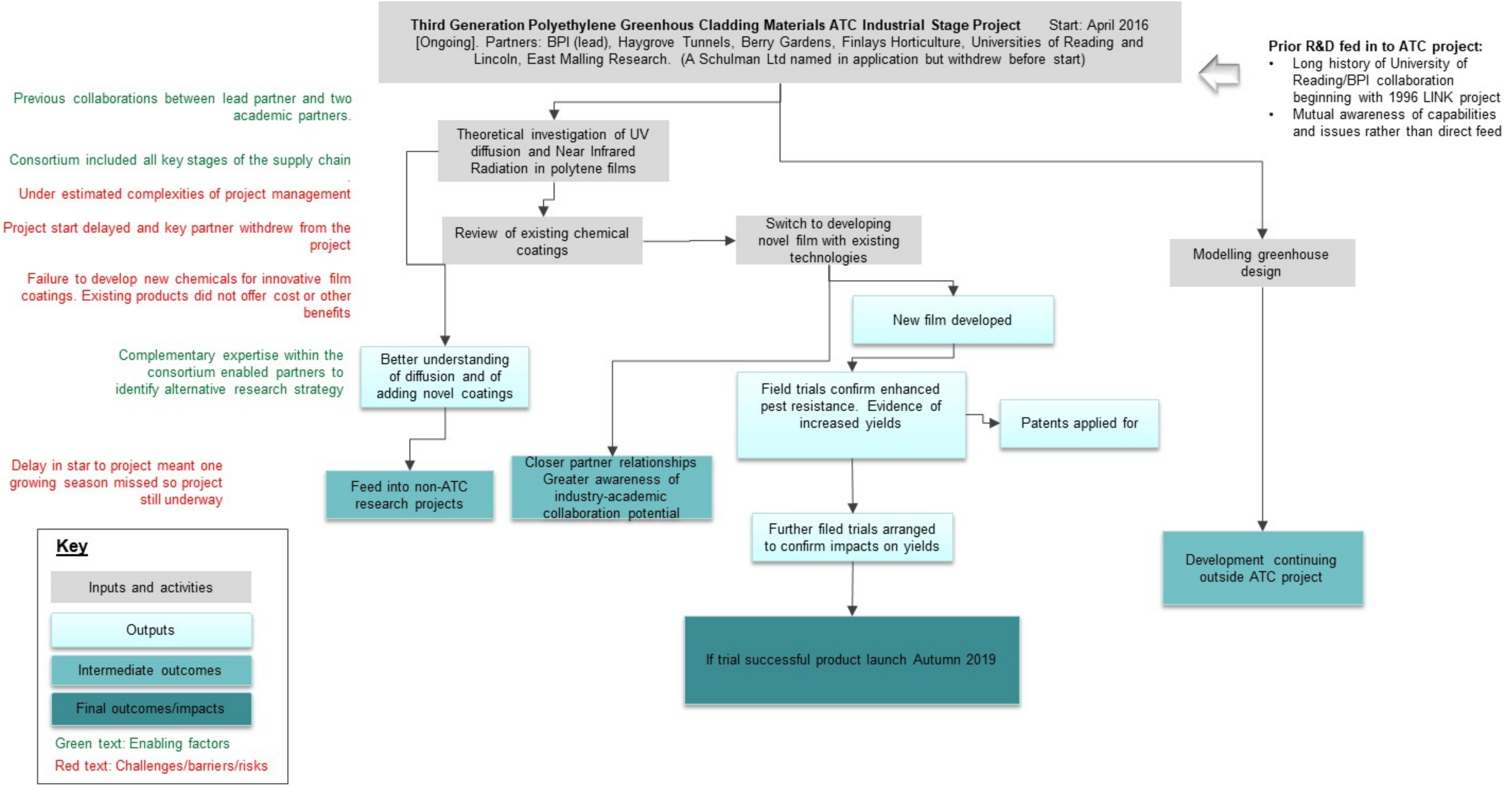
Legacy and next steps

The field trials which have so far been undertaken provided convincing evidence that the new film substantially reduced pests entering poly tunnels. They also indicated that yields increased, and this was something of a surprise as the new film reduces the amount of UV light entering the tunnel and it is this which reduces pest numbers. The purpose of the second round of field trials is to confirm that the new film does not have a similar impact on pollinators which could, of course, reduce yields. These trials are ready to start and, at the time of interviews, were only waiting for confirmation that a project extension would be granted**. If they are successful, then BPI would be able to launch the new product in Autumn 2019 and is confident that it would be commercially successful.**

There is some disappointment amongst the partners that the project was not more successful in developing new coatings to optimise light scattering and other properties as originally planned. Some of the knowledge generated during the project would be useful in this respect, there are, however, no plans to revisit the original objectives.

[51] Funded by Research England's Connecting Capability Fund. *https://www.enterprise.cam.ac.uk/news/research-england-awards-4-78m-to-found-the-ceres-agritech-knowledge-exchange-partnership/*

Figure B-1: Project theory of change … in practice



Lessons

This was an ambitious project which although not meeting its original specifications has excellent prospects of generating a novel and commercially successful product. We think there are two factors for its probable success. First, although the proposed research activities were quite wide ranging **the intended outcome, to develop a film which would reduce pest problems and enhance yields, was tightly defined and the project was always focused on this.**

The second point is less straightforward. Between them, **the partners encompassed all key aspects of the supply chain**. This necessarily meant a large consortium and the complexities and time demands of project management were not fully anticipated. However, it did mean that the experience and commercial knowledge necessary to take development through to product was available. This was particularly evident when a change in project direction was necessary and those we consulted felt that the diverse expertise within the consortium enabled an alternative strategy to be quickly identified and adopted. As mentioned above, the withdrawal of the chemical manufacturing company did create difficulties so far as the original objectives were concerned, but we feel this emphasises **the importance of partnership structure while also recognising the need to balance capabilities with manageability**

Miscanthus Upscaling Technology (MUST)

Key messages

The project was an industrial research grant, awarded in Round 4, focused on developing new production systems, using seed propagation, to increase the potential to grow the miscanthus sector through enabling faster propagation than offered by traditional rhizome division.

Key benefits delivered to date include:

The development of new miscanthus seed production processes

The development of successful methods to grow plug plants with higher vigour and to use modified equipment to establish these plugs successfully in poor quality soils

Improved credibility with customers from involvement in active R&D.

The Agri-Tech Catalyst (ATC) grant was instrumental in helping a multi-actor, commercial and academic partnership to accelerate development of new crop production processes.

The project has already led, even before it ends, to the development of new markets, which in turn has facilitated the recruitment of a new commercial manager at Terravesta to develop UK and export markets.

The challenges for the future are focused on being able to exploit the technology before others do so, with the European market seen as key to this given the much higher availability of land.

The partners are very keen to secure further R&D support to continue to develop a range of areas including, new varieties suited to alternative high value uses of miscanthus (in biorefining) as well as the potential of enabling technology such as that developed by Nutriss.

Source: SQW

Introduction

In 2015 an Industrial Research Agri-Tech Catalyst (ATC) grant of £1,278,692 was awarded to *‘develop new systems for Miscanthus based agriculture that increase profitability and so enable transition of today’s niche crop into a large scale biomass supply system’* as part of the 4th Round ATC competition. The project was run by Terravesta Assured Energy Crops Ltd, working with Edwards Farm Machinery Ltd, Nutriss Ltd, Bell Brothers Nurseries Ltd and Aberystwyth University. The **aim was to improve the technology used to establish miscanthus crops to enable a more rapid expansion of the crop area to meet proven market demand.**

The project started on 1st January 2016 and will conclude on 30th June 2019 (following a 6-month extension). The focus of this case study is on the way in which the consortium approached the project, the changes they made during delivery to respond to feedback from the marketplace and initial trial results and the impacts the project has had on the partner's growth prospects. The project has already successfully developed the market potential of the partners and led to some new collaborations both within the project team and with other partners, both in the UK and overseas.

The case study included reviewing the original project application, project reports and company website, together with interviews with Terravesta Assured Energy Crops Ltd, and the project partner Nutriss Limited.

Project overview

Terravesta Assured Energy Crops Ltd (Terravesta) led the project as a specialist miscanthus company who supplies miscanthus rhizomes, provides technical expertise, offers contracts to farmers and manages the marketing of the crop. The **demand for this perennial crop exceeds supply**, not only in the UK but internationally, and the economics of the crop for farmers once established is competitive with other crops, but it can take 3 years to reach full production which creates a significant investment hurdle, due to cashflow constraints.

The crop is also generally grown on 'poorer' quality, typically grade 3 and 4, arable land. With agricultural policy reform the potential for a perennial cash crop based on long term contracts, with a guaranteed market and low inputs, is very attractive to farmers if the constraints around establishment cost can be overcome.

The basic concept behind the project was therefore to **develop new propagation systems for the crop, based on plug plants raised from seed, so that crop establishment rates could be substantially increased compared to rhizome based establishment**. This would enable faster expansion of the crop benefitting both farmers, the technology suppliers and the supply chain.

To deliver the project Terravesta worked with a range of specialist technology partners including: Edwards Farm Machinery Ltd (EFM) who adapted existing vegetable planting and crop husbandry equipment to enable the planting of miscanthus plugs in grade 3 and 4 land; Nutriss Ltd who trialled their bacteria inoculation technology on miscanthus to create plug plants which grow faster and which confer long term nutrition and crop health benefits on the crop once planted in the field; Bell Brothers Nurseries Ltd (BB) who trialled technology for plug plant production for miscanthus from seed; and, Aberystwyth University who built on their expertise in developing new miscanthus varieties and seed production technology.

For the commercial partners the project offered the potential to develop technologies which could enable expansion of their role in the commercialisation of the miscanthus crop (all partners) or which allowed another crop to be added to their experience for the use of existing technologies (EFM, BB and Nutriss), as well helping Aberystwyth University to develop partnerships to commercialise its miscanthus research and IP.

The **project drew on previous trials** undertaken by a Giant LINK project at Aberystwyth on miscanthus varieties, the EU Optimisc project funded by FP7 on new miscanthus varieties and work at Newcastle University which developed the technology Nutriss is currently commercialising. Terravesta is also now a partner in the BBI JU (EU) H2020 supported demonstration project GRACE which is focused on growing advanced energy crops on marginal land for bio-refining with 22 partners between 2018 and 2022.

The project had three main phases: year 1 (2016) focused on trialling varieties of miscanthus, specifying and designing machinery for planting and husbandry and developing agronomy protocols for plug plant produced crops; year 2 (2017) field trials building on year 1 plot trials; year 3 (2018) focused on characterising the varieties in the field and improving the performance of the crop through machinery, agronomy and plug production to optimise the production process. In practice weather conditions in early 2018, too wet for the field trials followed by drought, has meant an extension to June 2019 so that another year's harvest and growth can be assessed. In parallel to this programme, trials and refinement of varieties, seed production technology and crop biology has continued throughout the project.

Effects and role of the Catalyst

The **most important impact of the Catalyst was to bring together a multi-actor, commercial and academic partnership, who would not have been able to deliver the project without support**. The scale of work needed and its breadth, to help the UK position itself to lead the international development of the miscanthus crop, is beyond the capacity of any of the partners on their own.

The sharing of IP is also believed to have worked well within the partnership, with each partner bringing clearly defined IP to the project and having some clear IP and/or first mover advantages arising from the benefits the project is delivering.

If no support had been provided it is likely that the crop would have continued to grow, but development would have been much slower and the international potential which is being realised would have taken much longer. Without support there would also have been a real risk that another country would develop much more efficient, seed-based propagation technologies for miscanthus and secure first mover advantage.

Nutriss, as a spinout micro start up, also reported that the project monitoring process, whilst potentially very onerous particularly on the project manager, had been very beneficial. The review meetings in particular received praise, because whilst they were very long and detailed, they allowed the company to understand a lot more about what their partner were doing and identified new areas in which they could work together.

The industrial research project has delivered a range of benefits for the partners:

- The **company has successfully developed new production processes which will be instrumental in growing the potential area of miscanthus**, so that it can meet market demand which currently massively exceeds the available supply. Across Europe demand continues to grow and without new production processes it would not be possible for farmers to respond to this market effectively.
- The development of seed production processes, led by Aberystwyth, means that the **funding invested primarily by the public sector over many years into crop breeding is now able to be deployed more effectively**.
- The production of plug plants (BB), with improved growth rates (Nutriss) and linked to new machinery and agronomy (EFM and Terravesta) means that **all four companies have developed their market and are part of a new scaleable commercial sector.**
- The recruitment of an additional commercial manager at Terravesta **has allowed the company to explore new markets,** which are mainly international.
- **Working together has allowed the partners to identify new areas of applied R&D on which they can work**. The scale of the project and its innovative approach has also meant that some of the partners are now active

in larger projects across Europe, which will facilitate future new market development in high value products (e.g. through bio-refining).

Figure B-2 summarises the activities delivered by the MUST project using ATC support and how these have led to outputs and outcomes for the partners. It also summarises how the partners intend to continue to exploit the developments which were started using ATC support. Green text highlights the key factors which have enabled progress (or will in future) and the red text are the key challenges experienced to date or which may restrict future delivery.

Legacy and next steps

Future developments are expected to include:

- A **major expansion of the miscanthus crop in the UK and European market**. In parallel with the project and supported by the technology developed, Terravesta has begun a major programme of crop expansion across Europe with new large-scale end users committed and programmes underway with farmers to develop the crop. In the UK the current uncertainty around future agricultural policy due to Brexit and the creation of a new domestic UK agricultural policy, is restricting market growth. This is because as a long-term crop, with a commitment for more than 10 years, most farmers are reluctant to commit to miscanthus until the new policy framework is clear. These short-term constraints in the UK are likely to be resolved in the next year and this is expected to lead to increased farmer interest.
- Across Europe there is currently 30million hectares of unused land which is not suitable for food production, but which, with the right support, could be developed for biomass crops such as miscanthus. This provides **potential for major upscaling of the crop,** particularly now given that the MUST project has demonstrated that the crop can be propagated from seed.
- The **partners are committed to continuing to invest in R&D given the impact the ATC project has had on their operations and customer base**. Terravesta and Aberystwyth University recognise the need to do another generation of plant breeding to develop miscanthus crops suited to alternative, higher value markets, primarily in bio-refining.
- The technology from Nutriss which was trialled as part of the project, albeit at a very small scale, is seen both by Nutriss and Terravesta as having major potential and has **the ability with appropriate support (commercial and R&D) to be applied to many other crops in the UK and internationally**. Nutriss are also developing their relationship with Bell Brothers to investigate the potential to apply their technology to other existing crops propagated by Bell Brothers Nurseries. More broadly the ATC has helped Nutriss develop its technical expertise which is also being trialled on crops such as Cocoa in Colombia and bananas in China.
- In the short term the major focus will be on **continuing to develop new and existing UK and European markets which exploit the miscanthus systems** developed in the ATC project. It is anticipated that most of this

growth will occur outside the UK given the much larger land areas which are potentially available for the crop across Europe and beyond.

Lessons

The main lesson from the project is that **a large scale, multi-year project with multiple commercial partners and academic underpinning is important in unlocking transformation opportunities in crop production technology**. A single company or a short-term project could not have achieved this.

The decision taken by the project team in conjunction with Innovate UK, to add 6 months to the end of the project, will enable more substantive results to be delivered for a crop which takes 2-3 years to reach maturity and where the field trials were adversely affected by poor weather conditions in spring 2018. The project team is pleased that the funders were flexible on this point as it ensured that the project was able to respond flexibly to factors beyond their control. Similarly, the flexibility to suspend direct drilling trials when these proved unsuccessful and to focus entirely on plug plants was very important. The monitoring officer assigned to the project was very accommodating in responding positively to learning in the early stages of the project to focus later stages on the most promising areas.

Through developing game changing new production systems and technologies for the miscanthus crop (and potentially other crops for some partners), **the market potential of the partners has been significantly enhanced**.

For miscanthus specifically, the technology now available to the UK partners has a very large export potential and will allow the UK to work with farmers and international end users of the crop to develop the miscanthus supply chain in new markets. Looking forward Terravesta believes that the project will enable a big acceleration of the rate at which the miscanthus area expands, based on the new production systems developed in the ATC project.

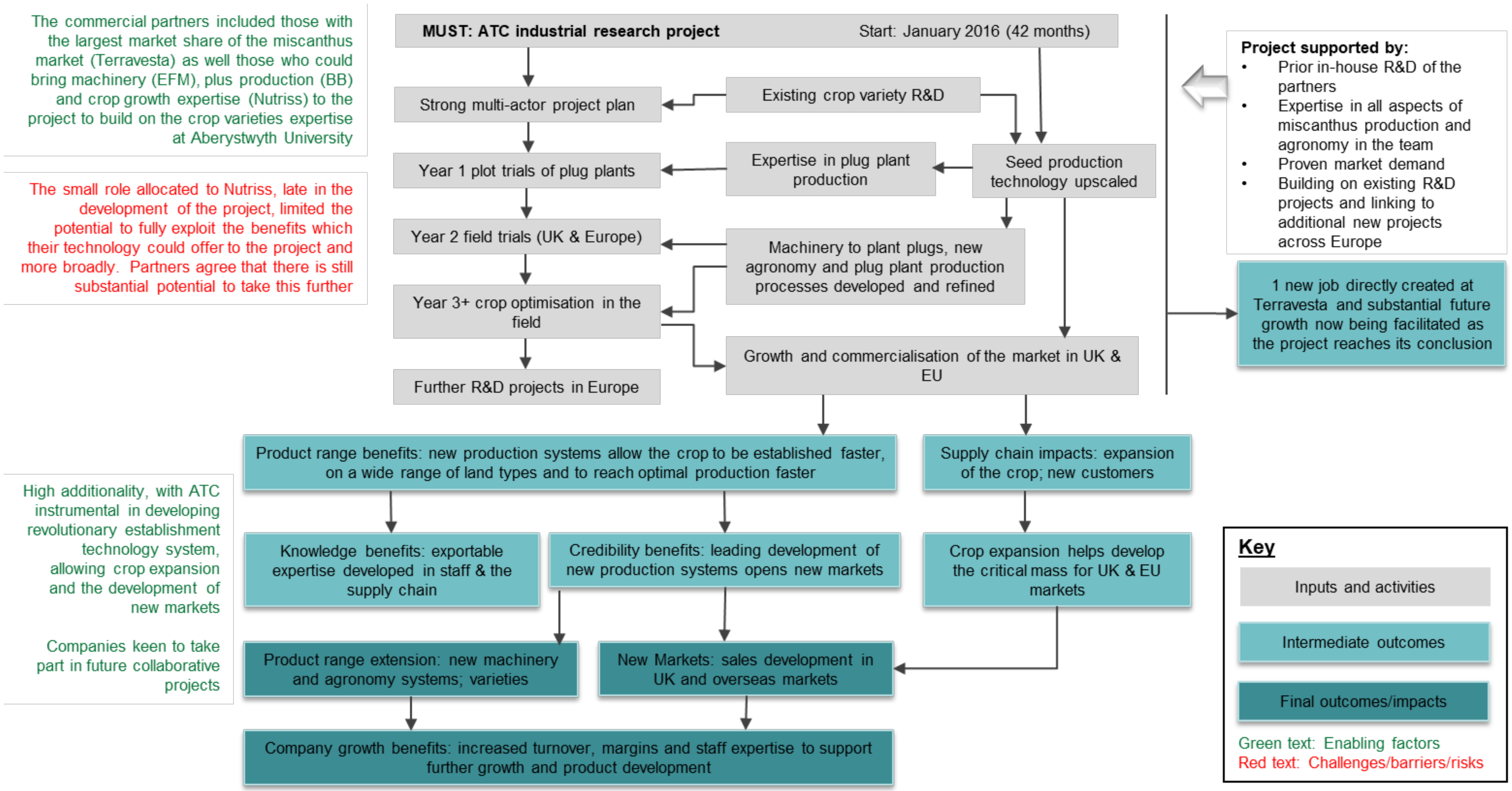
The investment stimulated by the project has also given the partners new ideas on collaboration on applied R&D both with each other and with other potential partners in the UK and Europe. A large scale, multi-year project was important in unlocking this benefit.

For the future, the biggest obstacle for many commercial companies remains how to find the right partners to develop a successful project. For micro companies which are still investing and unprofitable, such as Nutriss, the match funding requirements can also restrict the scale at which they are able or prepared to participate in R&D projects.

The consortium was very successful, but if there had been more time or assistance to develop the project it is likely that the role played by Nutriss would have been larger for example, and this would have meant that the project could have successfully exploited more of the potential in the Nutriss technology.

The advertising of the funding opportunity also still needs more attention as many SMEs are not aware of the bidding opportunities available and many lack the skills and knowledge to develop a successful project application.

Figure B-1:Project Theory of Change … in practice



Developing Bacteriophage Technology to Optimise Potato Production

Key messages

The project was an industrial stage R&D grant, awarded in Round 1, seeking to develop an innovative biocontrol technology based on naturally-occurring antimicrobial agents (bacteriophage) to control blackleg in potatoes.

The project was led by APS Biocontrol Limited, in collaboration with a consortium that combined industry partners (Branston, Agrico, McCain Foods), public-sector research establishments (Science and Advice for Scottish Agriculture [SASA]), and Scottish Agronomy.

The ATC project followed an earlier IUK-funded proof of concept project that had identified the scientific basis for a new treatment product for blackleg, however, further industrial engagement was required to develop and test further the commercial application and viability of the concept.

The project has involved the successful progression of the technology, from the 'proof of concept' stage to the 'technology validated in relevant environment' stage. Based on the emerging results of the research, the project pivoted from a focus on a disease "clean up" product in mass market ware potatoes, to a focus on higher-grade seed potatoes, addressing the disease earlier in the growing cycle. This opened-up the potential for significant exporting potential to Europe.

The ATC project informed a successful submission to IUK for follow-on funding (via the 'open competition'). This follow-on project is underway to progress the product and will run to late-2020. The expectation is that regulatory approval will be sought and confirmed within three years, at which point the treatment product will then be taken to market.

Without ATC, it is highly unlikely that the project would have progressed to its current point. This reflects the scale of the resource required, including for high-cost field-trials, and the on-going risk of the investment to the private sector at this stage in the R&D process. The ability to involve collaborators across the value chain was also a key element of the additionality of ATC.

The primary route to impact will be through APS and the commercial exploitation of the product. However, the treatment is expected to lead to significant benefits for the industry across the full value chain, leading to lower levels of downgraded/failing crops, and improved performance and consistency of potatoes all the way through to the final end-user and consumer.

The project involved a mix of existing and new partners and has played an important role in establishing relationships between actors across the industry that had not previously collaborated.

The follow-on project includes additional new partners from the research base, alongside continued involvement of all partners that participated in the ATC project; the continuity of partners was seen by consultees as evidence of the successful delivery of the ATC project and the commercial potential and expected industry-wide benefits of the project if it is successfully commercialised and taken-up across the industry.

Introduction

In 2014, an industrial stage Agri-Tech Catalyst (ATC) was awarded to support the *"Developing Bacteriophage Technology to Optimise Potato Production"* project (the project). The project was supported in Round 1 of the Catalyst. The project was led by APS Biocontrol Limited (APS), an SME based in Scotland with significant experience in R&D activity including collaborative R&D, working alongside a consortium that combined industry partners (Branston, Agrico, McCain Foods), public-sector research establishments (Science and Advice for Scottish Agriculture [SASA]), and Scottish Agronomy (a membership organisation providing arable advice to farmers). The aim of the project was to develop further a technology to treat bacteria-induced blackleg in potatoes, using naturally-occurring antimicrobial agents (bacteriophage). The award focused on technology issues related to dose rate, disease pressure and environmental stresses, together with supporting plans for the formulation and integration of the product into commercial practice.

This case study involved consultations with representatives from APS (lead partner), SASA, Branston, and Agrico, and a desk review of the project documents, including the original project application and close-out reports.

Project overview

The Catalyst project emerged from an earlier proof of concept stage IUK-funded collaborative R&D project led by APS and involving Branston and SASA, delivered over 2010-13. This project identified the potential for an innovative biocontrol technology based on naturally-occurring antimiciobial agents (bacteriophage) to control bacteria-induced blackleg in potatoes. Blackleg is the commonest fault observed during potato growing and crop inspections, and a reason for crops being downgraded/failing; this is a major issue for the industry in terms of costs and efficiency with no existing effective treatments on the market. It was also noted by consultees for the case study that blackleg causes issue for the industry all the way through to the end-user and consumer, with damage witnessed on potatoes in the home which generates customer complaints for supermarkets and other suppliers, impacting further back down the supply chain.

The earlier proof of concept project had identified the scientific basis for a new treatment product for blackleg, however, further industrial engagement was required to develop and test further the potential commercial application and viability of the concept.

The project funded by the Catalyst involved the following activities:

- **blackleg pathogen diversity and characterisation** this involved morphological characterisation of the bacteriophage and full sequencing and annotation to screen for (and remove risks associated with) any potential toxin genes; assessment of bacteriophage persistence under relevant field condition (e.g. light, temperature) and in soil, allowing conclusions of an effective field-application interval; and an assessment of the compatibility of bacteriophage with existing agrochemicals and the ease with which the new technology could be incorporated into existing practices
- **analysis of bacteriophage behaviour on and within plants**, including a series of glasshouse studies to assess bacteriophage persistence on plant leaves and movement into and within the plant
- **field trials** over three successive seasons, with the aims of establishing the optimal mode of treatment and how best to assess efficacy; to address the challenges of blackleg treatment this included artificially contaminating seed, planting infector plants, frequent irrigation and relying on natural levels of infection
- **preparatory activity to inform future regulatory approval**, which is expected to follow-on from project activity (see discussion below); the project involved a review of data to ensure regulatory compliance, early engagement with EU regulatory bodies, and industry-partner discussions and data dissemination.

Reflecting the mixed nature of activity and the commercial focus of the project, **core to the case for the Catalyst funding was the need for collaboration** between industry and researchers in delivering the project. Further, the collaboration enabled the project consortium to **span the full value chain from the research base, through to growers, packers, and processors** with direct relationships to distributors and end-users. The partnerships involved a **mix of existing and new collaborations.** For example, APS had worked previously with Branston (including as part of the earlier 'feeder' project to the ATC funding), but not with McCain or Agrico, who operate in different parts of the potatoes value chain to Branston and therefore provide a complementary offer and industry perspective. Consultations with project partners also highlighted the importance of the project in **facilitating new relationships between collaborators**, providing the opportunity for the identification of potential other joint innovation and commercial activities. SASA also provided the project consortium with scientific expertise and knowledge of the regulatory requirements and challenges in the development of new seed treatments.

Consultations for the case study indicate that the project delivery was successful. However, **the project did evolve over its delivery period**, reflecting the on-going findings of the research. The initial expectation was that the project would focus on developing a treatment for mass market 'ware potatoes' (potatoes that are grown for direct consumption). However, at the start of the project, there was uncertainty over at what stage in the potato life cycle the treatment would be most effective, and the early results suggested that the focus should shift to 'seed potatoes' (potatoes intended for re-planting), a smaller but higher-value part of the sector. This would involve a treatment of blackleg earlier in the growing cycle and opened-up the potential for the application of the treatment in overseas markets including the

Netherlands (the world's major supplier of certified seed potatoes). This pivot in in the project was explained in the close-out report as follows:

> *"The project was initially aimed at a disease "clean up" product, following the same format as the majority of agrochemical products. Following field investigations during years one and two, however, it became clear that, due to the nature of the disease (being transmitted through potato seed, together with a variety of secondary environmental routes) and the multiplication system of high-grade seed, the most commercially-viable approach would be to focus further R&D efforts on high-grade seed. A premium "cleaner" seed would be a significant benefit to the UK seed potato industry, as well as improving its export opportunities." (Close-Out report)*

The project also required an eight-month extension to deliver the full programme of field trials in line with the seasons in order to provide robust data for the analysis.

Effects and role of the Catalyst

The project was successful in **developing further the technology for the proposed product**; the lead's close out report indicates that the innovation progressed from TRL 3 (proof of concept) through to TRL 5 (technology validated in relevant environment). Further, following the completion of the Catalyst project, **partners successfully secured follow-on funding** from IUK's open competition to take forward the commercial potential of the innovation. The follow-on project is being delivered over the period December 2018 to November 2020 and will seek to develop the innovation to the point at which regulatory approval can be sought, with the treatment registered as a plant protection product in the UK and Europe.

The **timing of market introduction of a new product will be dependent on the regulatory process**, which is anticipated to be around three years from early-2019 (some 18 months on from the close of the follow-on project in November 2020). The route to market of the product (assuming regulatory approval) will also be confirmed. Project partners intend to make an initial application for regulatory approval in late-2019, which will draw directly on the findings from the ATC project. A patent application has also been submitted based on the findings from the ATC funded-activity.

Alongside the potential direct effects of the project in terms of a new product – which are potentially significant given the scale of the addressable market, with the EU seed potato market alone worth £37m per annum[52] – the case study identified a range of other benefits:

- **enhanced understanding of the underpinning science and evidence base** on blackleg and the use of bacteriophage in an agricultural context
- the **development of networks and relationships in the UK and internationally** for the lead partner, including through the access to international sector actors from the commercial partners involved in the

[52] APS Close-Out Report

project and engagement in Innovate UK events where connections were made with firms and individuals in related sectors that would not otherwise have been realised

- **enhancing the existing partnerships and relationships between collaborators and providing the platform for developing wider partnerships**, both within the ATC project and the follow-on project that this informed; the follow-on project that builds on the findings of the ATC project included two further partners (James Hutton Institute and University of Leicester)
- linked to the above, **engagement between the research base and industry was regarded as a benefit for collaborators**, providing an opportunity for the research base to understand more fully industry need and expectations, and informing wider research agendas; industry partners noted that the project had helped to '*bring down a few barriers with research organisations'* which may have positive follow-on effects via other collaborative research activities in the future
- **dissemination activities have taken place**, including presenting at IUK conferences, relevant trade events and conferences in order to raise the profile of the project and the potential product to be taken to market at a later date
- assuming future R&D is successful, and the product is commercialised, **the overall impacts of the projects are expected to lead to reduced blackleg in potatoes**, which will have a potentially significant effect on the yield and productivity of the sector.

Based on the feedback from project stakeholders**, the additionality of the Catalyst funding is high**. Without the funding provided by the programme, there was a consistent view from the partners consulted for the case study that the breadth of partnership across the value chain would not have been possible. This would have impacted substantively on the scope and viability of the project. Although the project may have progressed to some extent, the scale would have been lower (for example, a reduced number of field trials), and the focus would have been largely on lab-based work; it was noted that field trials at the scale necessary to produce robust results are high-cost. As a result, the validation of the technology in the relevant environment would not have been realised, delaying further the potential commercialisation of the innovation.

Full commercialisation of the product will rely on the success of the follow-on project, and potentially further funding to support manufacturing, distribution, and licencing approaches; the ATC also drew on earlier IUK funded collaborative R&D activity. However, the relative contribution of the ATC was considered by partners to have been significant, and **the programme played a key role in enabling the on-going development of the technology,** alongside these wider factors.

A graphical depiction of the 'Theory of Change' for the project drawing on the evidence from the case study is set out in Figure B-3 below. This highlights the anticipated routes to impact for the project, and the enabling factors and barriers that have, or may in the future, influence this.

Legacy and next steps

The successful commercialisation of this ATC project is **dependent upon further R&D** to further de-risk the technology. Partners recognised that there remains a 'way to go' in terms of the successful commercial exploitation of the innovation, however, **the advantage of engaging partners across the value chain in the project is a key legacy and benefit of the ATC project,** providing the platform for the successful launch and take-up of the treatment product, in the UK and overseas. The expectation is that the regulatory approval process will begin formally in late-2019, with the route to market (in terms of manufacturing, distribution, and licencing) to be confirmed. The principal 'direct beneficiary' in terms of commercial outcomes of the product will be APS, however, industrial partners expect to benefit from their engagement through improved understanding of the product/usage agreements with APS, and in line with the agreed IPR collaboration agreement.

It was also noted that the continuation of the partnerships through the follow-on funding – including two new partners – has helped to ensure that there is **clarity on the roles and responsibilities for this new project**, which should help to facilitate effective delivery and support the ability of the innovation to reach the market more quickly.

Lessons

As summarised in the Theory of Change, several factors acted as important enablers to the successful delivery of the project to this point, and were highlighted as key lesson in terms of 'what worked well' by project partners:

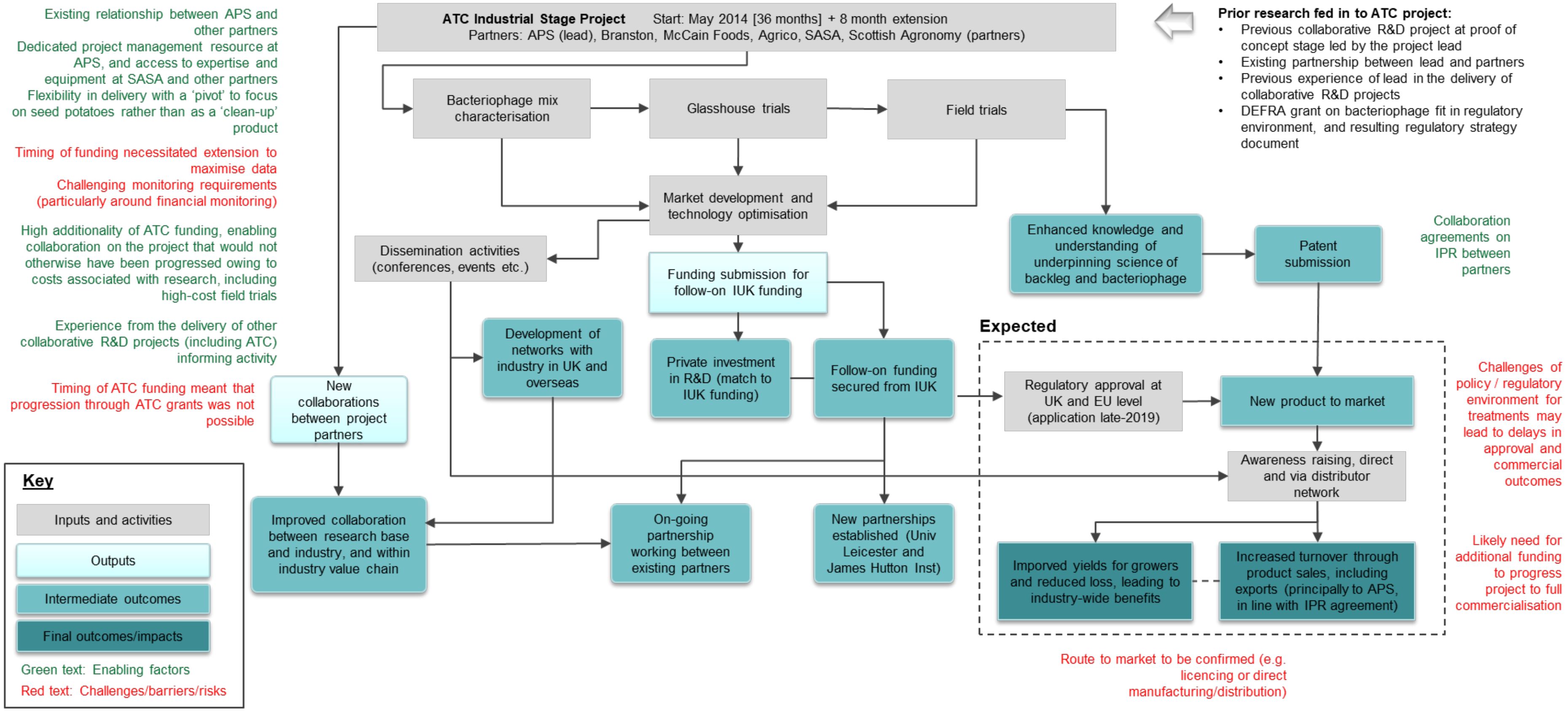
- **flexibility in the project delivery**, enabling the 'pivot' to a focus on seed potatoes and the provision of an extension in delivery to ensure that robust results could be generated; the willingness of all partners to 'adapt and change' during delivery, based on the evidence, was consistently seen as an important positive learning lesson from the project

- **effective industry engagement**, allowing the project to maintain a clear focus on the potential commercial opportunity for the project, and routes to exploitation; the collaboration spanning the value chain was an important factor, and this has been continued with the follow-on project, demonstrating the commitment and buy-in of the partnership

- the project involved **dedicated project management resource at APS**, which was regarded as crucial to delivering against project aims and objectives, and managing the delivery of work across the collaboration.

There were also some challenges experienced in the project, although these focused mainly on **'process' issues** related to the monitoring and financial management associated with the ATC programme, and the timing of funding, which necessitated the extension as it did not align to the 'real world' issues related to the timing of field trials. The project also intended to move sequentially through the ATC programme to a late-stage grant, however, this was not possible given the programme funding period and approach. Alternative funding was secured via IUK's 'open competition', highlighting the importance to project delivery partners of 'thinking ahead' at this stage in the R&D process to ensure that the commercialisation of the project could progress following the end of the ATC industrial stage grant.

Figure B-1: Theory of change … in practice



Precision Breeding: Broilers from Sequence to Consequence

Key messages

The project was an industrial stage R&D grant, awarded in Round 3, seeking to develop a novel, innovative and cost-effective approach to obtaining whole genome sequence information on large-scale broiler populations, leading to higher accuracy in the prediction and control of economic gains arising from genetic improvement.

The project was led by Aviagen in collaboration with the Roslin Institute (RI) at the University of Edinburgh (although RI managed on a day-to-day basis) and was delivered between December 2015 and November 2018. Both partners had prior experience of collaborative R&D activities in the agri-tech space (including together).

The ATC project built on earlier R&D projects and was delivered alongside a number of other public sector R&D projects (led by RI). The latter included another ATC project testing the same approach in pigs and a BBSRC grant to develop the software tools. This enabled knowledge sharing, some pooling of resources, leveraging specialist inputs – and more effective and efficient delivery overall. However, it also means that, whilst the ATC project as an important factor in realising outcomes, a number of other interventions played an equally important role.

Key benefits delivered to date include:

Technological progression, from TRL 2 to 6, which has been enabled by the ATC's collaborative approach between industry (and associated access to data) and academia (and their technical, analytical and computational expertise)

Improved knowledge and R&D capacity

Greater confidence to expand R&D activities/investment within Aviagen

Reputational benefits for both partners

Strengthened relationships between partners, with plans for further R&D in future.

Without ATC, the project would not have gone ahead at such scale – and arguably scale was critical to the concept, the quality of results and the potential for a step change in knowledge.

The primary route to impact for this project will be through Aviagen, which is at the top of the "poultry breeding pyramid", the worldwide market leader in poultry breeding. Whilst the project is heavily reliant on Aviagen adopting the new approach, the company provides an immediate and direct route to market and the potential for a substantial global impact.

Looking forward, further R&D is required to increase the predictive accuracy of the approach further, in order for Aviagen to fully integrate the novel approach into routine breeding.

Source: SQW

Introduction

In late 2015, an **industrial stage** Agri-Tech Catalyst (ATC) grant was awarded to the *"precision breeding: broilers from sequence to consequence"* project as part of the **third ATC competition**. The project was led by Aviagen in collaboration with the Roslin Institute (RI) at the University of Edinburgh. Aviagen is a major poultry breeding company, supplying 130 countries worldwide. The company's main R&D activities (including advanced genetic selection techniques) are based in Edinburgh, UK. RI provide expertise in innovative genomic sequencing methods, including "LCSeq" (focused on sequencing of populations rather than a few individuals) and "LRMap" methods (to improve micro-chromosome mapping for chickens). The project also involved subcontracted inputs from Edinburgh Genomics[53], who provided analytical sequencing support to RI. The project received £2.02m in ATC funding, which was matched by £975k from Aviagen, and was delivered between December 2015 and November 2018.

The overarching aim of this project was to **catalyse the development of a novel, innovative and cost-effective approach** to obtaining whole genome sequence information on large-scale broiler populations[54], leading to **higher accuracy in the prediction and control of economic gains arising from genetic improvement**. This could then be incorporated into Aviagen's routine breeding and selection pipeline, with an expected doubling in the commercial value of genetic gains over the project's life as a result. As part of this project, Aviagen provided access to a huge dataset of the whole genome sequence for around 280,000 chickens. This unprecedented quantity and detail of genomic information was expected to drive a breakthrough in genetics[55], which in turn would lead to improved productivity/efficacy of breeding programmes, reduced environmental impacts (by reducing waste via greater feed efficiency) and improved broiler health/welfare. Ultimately, the goal of precision breeding was to enable a step change in the sustainable intensification of broiler production and improve food security globally.

This case study involved face-to-face consultations with lead partners at Aviagen and RI, and a review of the project application and close out report.

[53] Owned by the University of Edinburgh
[54] Rather than detailed data on a small number of individuals.
[55] Standard genomic selection is typically used in the sector, described as a "black box" breeding method where predictions of genetic merit mostly rely on qualifying the similarities between relatives, rather than capturing the effect of individual genes.

Project overview

Whilst Aviagen was the lead partner, RI managed the project on a day-to-day basis. RI had secured funding for a number of projects, including another ATC project focused on the same process in pigs which ran consecutively with the broiler precision breeding project[56],[57]. This enabled knowledge sharing, some pooling of resources to purchase a larger/more powerful computer, and the employment of a larger team of specialists who could be deployed on each project as required. As discussed further below, RI argued that resources were used more efficiently and effectively, delivering a higher quality outcome than would otherwise have been the case. There were also interdependencies to a separate BBSRC grant[58] led by RI to develop software tools which operated from January 2015 to January 2018.

The ATC precision breeding project has involved four main workstreams:

- Workstream 1 was led by Aviagen in Year 1, and involved the collation of genotypic and phenotypic data records for the 280,000 chickens across Aviagen's breeding line since 2003
- Workstream 2 was led by RI (with inputs from Edinburgh Genomics) to generate sequence data using LCSeq methods in Years 1 and 2. This included the purchase of large-scale computer storage and processing infrastructure purchased by RI
- Workstream 3 involved the analysis and interpretation of results, and was led by RI (using software developed by the Institute)
- Workstream 4 was expected to be the integration of the results into routine breeding at Aviagen, with support from RI to transfer knowledge and help implement the findings from Workstream 3.

Both partners had prior experience of R&D activities in the agri-tech space, and Aviagen and RI had a well-established collaborative relationship. This included working on BBSRC-funded project on developing a high-density SNP panel that acted as a "stepping stone" to the ATC project, in terms of familiarising both partners in applying next generation sequencing technologies to chicken populations. The idea for the ATC project was developed in partnership and knowledge exchange between Aviagen and RI.

Whilst Aviagen had used internal (and public sector) funds used for R&D in the past, the scale of **the ATC project has significantly larger in scale and higher risk than prior R&D activities**. For RI, "LCSeq" and "LRMap" sequencing methods had been developed and tested by simulation in the 18 months leading up to the ATC application, but had not been tested on real avian genomes in real populations, and in 2015 the sector saw a substantial drop in the cost of sequencing making large-

[56] The two ATC projects had a Memorandum of Understanding to share knowledge between the two projects.
[57] Plus two Medical Research Council projects, and Irish cattle breeding project, and a BBSRC grant for next generation wheat breeding
[58] A BBSRC project entitled "genomic selection and environmental modelling of next generation wheat breeding"

scale testing possible for the first time, so the Catalyst was a timely opportunity to progress this concept further.

Both consultees argued that **without ATC, the project would not have gone ahead at such scale** – and arguably scale was critical to the concept (i.e. *whole* genome sequence information on *large-scale* broiler populations) and the ability to better predict the accuracy of genetic improvement. A smaller project would have had limited value in this context. **The project may have taken place more slowly (possibly twice the time) in a piecemeal way**, but this would not have delivered the same quality of results (given the scale point above) and potential step change in knowledge, and the opportunity to be first mover could have been lost. Aviagen would not have funded a project at this scale without a grant to de-risk the project, and it was argued that no other public funding streams were available to fund this type of project (at scale, and this stage of R&D). Moreover, the project would not have been possible without the two partners working together: AV brought historical data that RI would not have otherwise had access to, and RI provided expertise in innovative sequencing techniques and computational capability that AV did not have in-house.

The project was broadly delivered as planned. The start was delayed by three months whilst IP ownership arrangements were agreed, but beyond this (revised) milestones were met and partners delivered the workstreams described above. That said, given the scale and complexities of the project, Aviagen noted that the time inputs were greater than anticipated (Aviagen would have liked to be more involved in RI's analytical process, but encountered capacity issues) and there were technical issues in RI infrastructure, in terms of server capacity and transferring substantial volumes of data between the partners. The Innovate UK timetable and monitoring structure was seen as helpful from both partners to ensure ATC accelerated progress (for example, by maintaining a project plan and spending profiles). In terms of dissemination, RI has published 18 academic papers that are attributable to the ATC project and has disseminated method-based learning to the Institutes industrial partners. For Aviagen, dissemination will take place via their customer base and internally within Aviagen's holding company, rather than sharing findings externally, given their commercially sensitive nature.

Effects and role of the Catalyst

The project successfully delivered against the analytical milestones described above (Workstreams 1-3). **Before commencing the ATC project, the idea (in the poultry context) was at Technology Readiness Level 2 (technology concept and/or application formulated) and by the time the project closed it had reached TRL 6 (testing prototype in a simulated operational environment).** Without it, consultees argued the idea would now be at TRL 4. This aligns with the objectives of industrial stage ATC grants to progress ideas through prototyping, and doing so more quickly than would otherwise have been the case.

In addition to the funding, both partners agreed that the **multi-disciplinary collaboration enabled by the ATC funding has been important in accelerating progression.** By enabling access to whole genome sequence data, and private sector engagement during the analysis and interpretation stage (for example, using industry experience to interpret unexpected results in the modelling process), the team has been able to deliver a better-quality output. As noted above, it has also enabled the partners to undertake R&D activity on a far larger scale than would otherwise have been the case without ATC.

As part of the ATC project, the team expected to integrate the results into routine breeding at Aviagen towards the later stages of the programme. Aviagen stated that this has been done to some degree – for example, learning regarding genomes associated with certain broiler characteristics has informed Aviagen's operations, although further details were not available due to commercial sensitivities. However, it was noted that (i) learning should be attributed to *both* ATC projects, given their inter-dependencies, and (ii) **the ATC project demonstrated a smaller gain in accuracy than expected, and so further R&D activity will need to take place before Aviagen will fully integrate this novel approach into routine breeding.**

In addition to the technology progression, the project has brought about a range of benefits for those involved:

- The project has **improved knowledge and R&D capacity at Aviagen**, which has boosted the lead's confidence in genomics R&D.
- At Aviagen, the project's success has **helped to further strengthen the case to expand the in-house genomics programme and increase R&D investment**. This has led to Aviagen **retaining and expanding their R&D team** (retaining six members of staff, and recruiting a further four after the project, which are a mix of high and lower skilled jobs). RI has also continued to fund the post-doc from the project (funded internally) who has continued to work on improving the accuracy of the algorithm developed by during the ATC project.
- In addition, the project has led to **spin-off research in other agricultural sectors** – for example, RI is now deploying the approaches developed through the ATC project in R&D relating to strawberry production.
- Project learning **has informed the development of academic course materials** at RI.
- **Reputational benefits** for both parties. Aviagen has already discussed their genomics project with existing customers, which has helped to strengthen customer relationships and trust. More broadly, the lead argued the ATC project has helped to strengthen their reputation as a global leader in genetic sequencing innovation. For RI, the ATC project has contributed towards building their reputation as a world centre of excellence in animal and plant breeding, which is seen as important in terms of attracting the best quality researchers to RI (and the UK as a whole).
- **Strengthened relationships, particularly between Aviagen and RI, but also with Edinburgh Genomics**. Whilst the partners were not actively collaborating at the time of interview, there were **plans for further collaborative R&D in future**, possibly using BBSRC grant funding to explore some of the spin-off questions arising from the ATC project.

Overall, the 'additionality' of the outcomes achieved so far is high. Aviagen were slightly more confident that some outcomes (particularly in terms of R&D capacity and progress) could have been realised in the absence of ATC given the need for Aviagen to remain competitive, but both consultees agreed that without ATC, it would have taken much longer and the quality of results would have been lower (with implications for the potential scale of impact in future). Given the way in which this ATC project was delivered (by pooling resources and knowledge from other public-funded projects), **the contribution of ATC was important in achieving outcomes above but some of the funding/knowledge from other projects was equally as important as ATC in moving the novel approach forward** (especially the other ATC project relating to pigs, and the BBSRC grant to develop software tools).

As noted above, further R&D work is required before the results will be commercialised, and consultees believe public *and* private investment will be needed. The ATC project has not removed all uncertainties/risk around the effectiveness of the new approach in order for Aviagen to invest internal funds without public sector grants. However, next stage funding sources were unclear at the time of the case study and were yet to be explored. Looking forward, the risk remains that, despite further R&D activities, the predictive accuracy of this novel approach is insufficient to convince Aviagen to fully integrate into routine breeding.

Assuming future R&D is successful, the **primary route to impact for this project will be through Aviagen**. Given its position at the top of the "poultry breeding pyramid" (about half of broilers grown annually worldwide have a genetic contribution from Aviagen), it is expected that gains made in Aviagen's nucleus flock will be multiplied across the commercial producers it supplies globally. However, this will take time – due to the structure of the poultry breeding, any improvement in the output of breeding activities (where Aviagen operates), takes four years to reach the final customers.

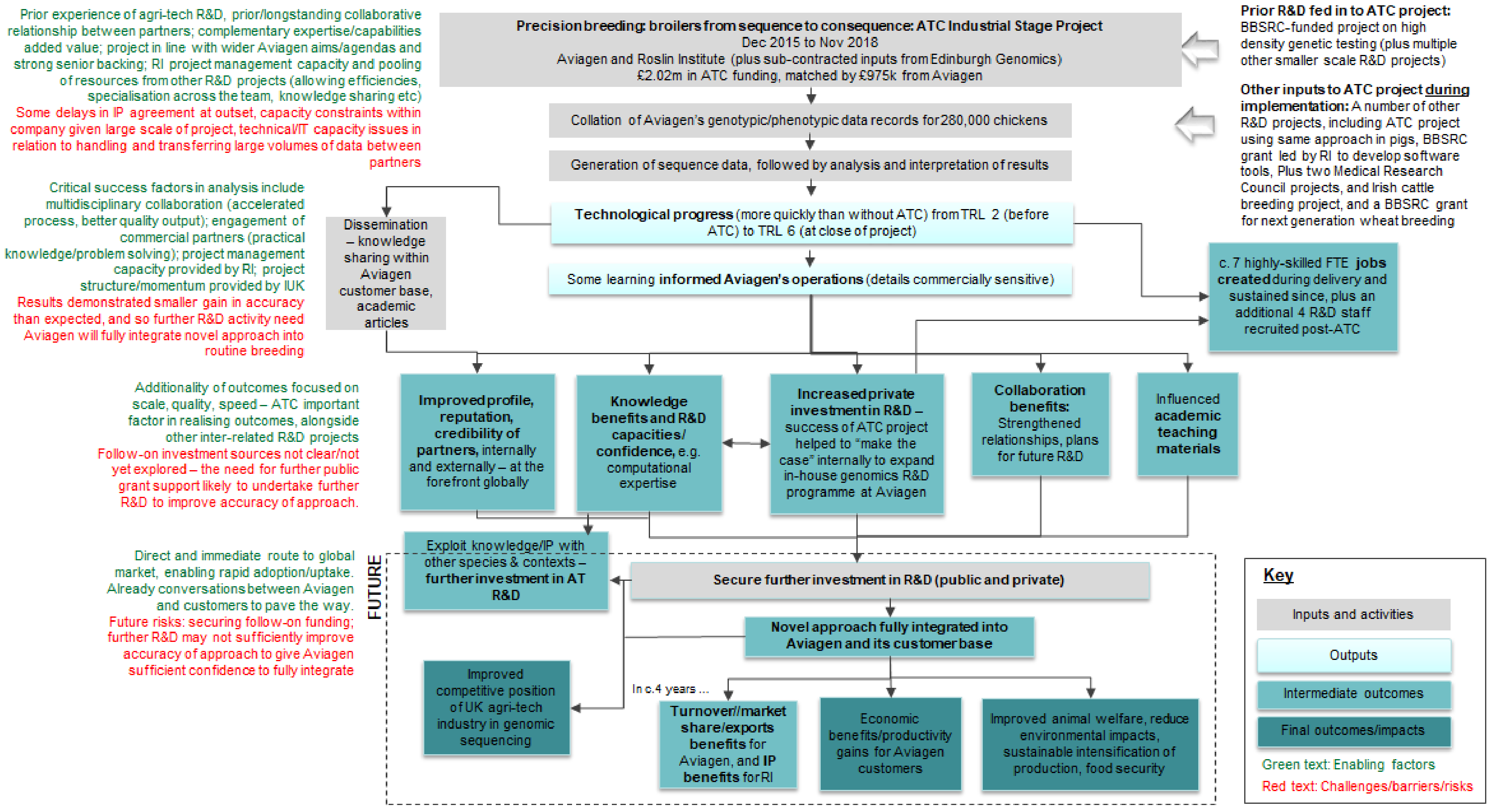
Legacy and next steps

In additional to technological progress in the context of broiler production, the project will have a legacy effect through the increased R&D capacity and investment at Aviagen and strengthened relationships between the partners involved in the project. There is also potential to transfer the methodological knowledge gained to other global poultry challenges, such as resistance to disease, and other agricultural sub-sectors.

The successful commercialisation of this ATC project is **dependent upon further R&D** to improve the predictive accuracy of the approach sufficiently to convince Aviagen to fully integrate into routine breeding, and is then **heavily reliant on Aviagen taking this forward.** However, **the advantage of engaging a major, global firm in the project is having an immediate and direct route to market and the potential for a substantial global impact,** both for Aviagen as a business (turnover, market share and exports) and more widely in terms of the sustainable intensification of poultry production and food security globally.

Figure B-4 below summarises the activities delivered by the Precision Breeding project, and how these have led to outputs/outcomes to date and expected to have impact in future. On the whole, the routes to impact remain as expected at the outset – the main difference has been that further R&D activity will need to take place before Aviagen will fully integrate this novel approach into routine breeding. The annotations in green text highlight key factors that have enabled progress (or will in future), and the annotations in red text are key challenges to date/risks to achieving intended impacts in future.

Figure B-1: Project Theory of Change … in practice



Tools and Technology for Predicting Tomato Glasshouse Production

Key messages

The project was an industrial stage round 5 grant, which aimed to develop a fully-automated imaging tool ("TomVision") to more accurately predict tomato production through determining the ripeness of a tomato by its colour. The tool increased the accuracy of weekly yield forecasts to over 90% accuracy, three days in advance of a harvest. The project was led by Thanet Earth, in collaboration with East Malling Research (NIAB EMR) and Rail Vision Europe.

The project was successful, and delivered against its original objectives. Benefits delivered to date include:

Progress towards market readiness, moving from TRL 4 to TRL 8.

Improved skills and knowledge, including upskilling staff at NIAB EMR in the use of big datasets and improved knowledge and understanding of miniaturising technologies and their uses in glasshouses at Rail Vision.

Improved profile, reputation and credibility through the dissemination of findings at international conferences and via a published scientific article.

Future expected benefits include increased turnover and job creation, improved efficiencies in the prediction of tomato production, reduction in surplus waste and improved relationships throughout the supply chain, as products will be delivered as promised.

Having the right consortium added value to the project, as each partner contributed varied skills and expertise, resulting in a close to market output. A key enabler was the ability of the project team to flex and adapt as necessary to the needs of the project, which kept the project to time. A key challenge for the project was the tight resource at the end of the project, which proved a barrier to commercialisation.

Project partners would not have taken the project forward without Catalyst funding, and therefore would not have achieved the same outcomes. This is due to the high-risk nature of the project, as outcomes were not guaranteed. New developments in technologies also contributed to the success of the project.

Source: SQW

Introduction

In 2016, an **industrial stage** Agri-Tech Catalyst (ATC) grant of £930k was awarded to support the development of *"tools and technology for predicting tomato glasshouse production"*, as part of the **fifth ATC competition**. The project was led by Thanet Earth, in collaboration with East Malling Research (NIAB EMR) and Rail Vision Europe. Both Thanet Earth and Rail Vision Europe contributed match funding to the project, totalling just over £460k[59]. The project was delivered between July 2016 and March 2019.

The aim of the project was to develop a fully-automated imaging tool ("TomVision") to more accurately predict tomato production through determining the ripeness of a tomato by its colour. Currently, forecasting production is based on an experienced grower walking a selected area of the crop, recording the fruits that are likely to be harvestable and providing a best estimate that can be extrapolated to the glasshouse. This can lead to large errors; only 30% of estimates at Thanet Earth were within 10% of actual harvest, leading to shortfalls or surplus product. A surplus of production results in increased volume of product that cannot be sold to the primary market, and the additional volume may not be able to be used as food (as all waste goes to composting or stock feed). Furthermore, shortfalls can impact on the supply chain, with customers not receiving what was expected. The purpose of TomVision is to improve the accuracy of weekly yield forecasts to over 90% accuracy, three days in advance of a harvest, in order to reduce the amount of waste and provide a more consistent service to customers.

The case study involved consultations with the three project partners and built on a survey response received at an earlier date (from Thanet Earth). In developing this case study, the project application was also reviewed[60].

Project overview

Thanet Earth (a large-scale producer of tomatoes, cucumbers and peppers) managed the project overall, and each partner provided their expertise and resource throughout the project. This included access to three tomato crop varieties across two glasshouses and extensive production experience at Thanet Earth, expertise in developing advanced image analysis and automated technologies at Rail Vision (a company who specialise in railway imaging analytics), and expertise in horticultural research and modelling at NIAB EMR (a research and technology organisation, part of the wider NIAB group).

All project partners had prior experience of conducting R&D activity, including some in collaboration with each other. This included:

- Thanet Earth and NIAB EMR had worked together on R&D projects previously, although prior projects undertaken did not feed into this ATC project directly, in terms of the specific R&D focus.
- Thanet Earth had experience of three Innovate UK projects, however none of these fed into the ATC project directly.
- Rail Vision had undertaken a prior 3-year Innovate UK agricultural project with Rothamstead Institute and Certis UK Ltd, using imaging sensors to detect diseases in plants, which included tomato plants.

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[59] Total project cost - £1,397,062. Match funding from Thanet Earth (£66k) and Rail Vision (£401k).
[60] A close out report was not available for this project.

After active monitoring of public funding calls, Thanet Earth and NIAB EMR became aware of the ATC funding, and decided to engage in the project together due to experience of working together on R&D activity previously. Neither Thanet Earth or NIAB EMR had worked with Rail Vision prior to this project. NIAB EMR approached Rail Vision for the consortium, as they were aware of their previous work in agricultural technologies. Rail Vision, who have been diversifying into the agri-tech sector for the past 5-6 years, brought specific expertise in imaging sensors and the ability to manufacture systems and create software.

Partners had varying motivations for involvement in the project. Thanet Earth had identified the accuracy of predicting tomato production as a key priority in their business which needed to be addressed. Unavoidable inaccuracies using manual or sample-based approaches in predicting the yields of tomatoes can result in surplus crop, which generates excess waste, or shortfalls, which can impact on relationships between producers and their customers when they are unable deliver what was expected. NIAB EMR had extensive research experience and interest in the field and were keen to become involved in a project in which there was potential for commercial gain for their organisation. Rail Vision's involvement centred on the opportunity to expand their experience in the agri-tech sector, and to develop imaging tools for use in specific conditions.

The project involved forecasting the ripeness of tomatoes and the location of these tomatoes using colour. To do this, project activity was delivered through a series of workstreams. Project coordination was undertaken by Thanet Earth, who were responsible for risk mitigation, financial reporting and development of exploitation plans. The development of the TomVision tool was undertaken by Rail Vision. This involved developing an image capture device and accompanying software which would recognise the ripeness of the fruit. NIAB EMR captured data for three varieties of tomato in two different greenhouses to account for changes in light, humidity and temperature, and manually tested tomato colour and ripeness. This, alongside the data captured by the device, was used to create a data dashboard, which they have used for modelling production and predicting ripeness. Project findings have been disseminated through a scientific article and speaking at conferences (e.g. NIAB EMR spoke at a conference for tomato growers in Europe).

Effects and role of the Catalyst

The project was successful, and delivered against its original objectives. Project partners developed a fully automated prototype of the TomVision imaging tool, which can more accurately predict the ripeness of tomatoes than current practices. The consortium has developed a dashboard of data using the outputs of the tool and have completed the data modelling using this. As the tool is implemented, the data will continue to be collected, adding to the dashboard in order to improve the accuracy of data models. Thanet Earth are currently using TomVision in their glasshouses to predict tomato production.

Project partners have made progress in **moving the technology towards market readiness**. Prior to the Catalyst funding, the project was at Technology Readiness Level 4 (basic technological components integrated to establish that they work together), due to previous use of the hardware by Rail Vision on railways. However, Rail Vision reported that the concept is now at TRL 8 (technology proved to work under expected conditions, further developmental testing/evaluation). TomVision can predict with over 90% accuracy the yield of tomatoes in a glasshouse, three days in advance of a harvest, and can map the location of tomatoes that are ready to be harvested.

Project partners reported they had **improved their skills and knowledge** as a result of the project. NIAB EMR had not previously used big datasets, which required training for technicians to use big data software and handle the large amounts of data captured during the project. NIAB EMR reported that in addition to upskilling their data teams, this has made their overall data systems more efficient, which could potentially contribute to changing the way they do research. Rail Vision have benefited from improving their knowledge of miniaturisation of technology. In the original application the consortium outlined they would develop a robotic platform on which TomVision would be able to move. However, this was not needed as Rail Vision were able to miniaturise TomVision to a handheld device weighing 3kg, compared to its original 28kg.

Furthermore, Rail Vision have also improved their knowledge of the use of technologies in glasshouse conditions. This included practical knowledge that would not have been gained in any other way. For example, Rail Vision were initially considering using ultrasonic or beacon equipment to detect the location of tomatoes in the glasshouse for future harvesting. However, through knowledge gained on site, Rail Vision opted for a different type of detection equipment, as they discovered that the ultrasonic and beacon equipment disturbed bees, which are an integral factor in the glasshouse ecosystem.

Partners have established **new or improved collaborative partnerships**. Thanet Earth and NIAB EMR have continued to develop and improve their established partnership, and plan on working together again in the future. Additionally, new partnerships have been established with Rail Vision, which has led to the consortium beginning to 'speak the same language' and develop their relationship. Furthermore, partners reported that they have benefited from **improved profile, reputation and credibility** as a result of the project, through showcasing at international conferences.

In addition to benefits already generated by the Catalyst, partners expect further impacts for their organisations.

- It is anticipated that when commercialised (expected within six months), the TomVision tool will **generate increased turnover**, principally for Rail Vision who will manufacture the tool. As the tool has been 'tried and tested' by Thanet Earth and modelled by NIAB EMR, Rail Vision expects that this will instil credibility in the tool from the outset. There is also opportunity for increasing exports for Rail Vision, particularly into the Netherlands due to Thanet Earth's operations there. In addition, NIAB EMR expect to generate income from the tool, which is becoming more of a priority within NIAB. Whilst both partners are confident they will experience an increase in turnover, they are not able to quantify this at present.
- In addition, Thanet Earth will benefit from increased revenue, as a result of more accurate predictions. Increased accuracy will reduce product waste and

process inefficiency, whilst improving the availability of produce to customers. Whilst the TomVision tool will be sold to Thanet Earth's competitors in the future, Thanet Earth expect to benefit financially from more accurate prediction pre-commercialisation.

- An **increase in employmen**t is also expected at Rail Vision, jobs will be created in manufacturing the tool, however this is not currently quantifiable. There is also potential for increased employment at NIAB EMR, due to a growing big data technical team (the big data team on this project grew from two to four).
- Using TomVision will support Thanet Earth in **improved efficiencies**, as they will have more accurate predictions of tomato yield, they will be able to make more informed decisions and deal with predicted surpluses and shortfalls before they become reality. It is also expected that the increased accuracy of tomato production prediction will result in **less waste** product.
- Furthermore, due to the increase in accuracy of tomato prediction, there will be a decreased likelihood of shortfalls in product supply to customers as issues will be identified in time for solutions to be put in place. Failure to meet customer expectations, which can lead to reductions in revenue and/or customer confidence, will become less likely. It is anticipated therefore, that relationships across the supply chain will improve.
- There is **potential for the tool to be adapted** to predict the production of other crops, such as cucumbers and peppers, which are grown in glasshouses. In future, there may also be opportunities to develop the tool to other agricultural industries, such as vineyards or orchards, although due to different growing conditions this would need to be explored further. In addition, the technology could also be adapted for use in other sectors, such as health sciences.

In addition to realised and expected benefits for those involved, partners reported the potential for **wider impacts for the agricultural sector**. After commercialisation, increased accuracy of predicting tomato production will be accessible to producers across the industry, with potential for producers of other crops and industries to benefit further in the future. In addition, less waste or shortfalls across the supply chain will increase efficiency in the sector and could impact on productivity.

There are a number of key factors that enabled project delivery. This includes strong project management from Thanet Earth, and the positive relationships built between the scientific team undertaking data collection, and the glasshouse teams responsible for picking the fruit. This meant there were no tensions between both teams working alongside each other within the glasshouse.

Key challenges to delivery were also outlined. The large sample size of tomatoes required a lot of time and resource which needed to be continual, although continuity of tomato production at Thanet Earth (tomatoes can be produced for 52 weeks of the year) alleviated the time pressures. In addition, the consortium faced a key challenge when the greenhouse being used for the assessment required a crop change earlier than planned, due to a disease issue. The data capture team were therefore required to change glasshouses. However, the scale of Thanet Earth meant there were other identical glasshouses available to re-locate to, and the positive relationships built between the data capture team and the glasshouse teams supported this transition.

Overall, the additionality of outcomes is high. Project partners asserted that they definitely would not have achieved the same outcomes if the project had not been awarded Catalyst funding. All partners stated they would not have taken project delivery forward at all, as the outcome was not guaranteed and therefore the funding was essential for de-risking the work. Whilst the technology was at TRL 4 due to its use elsewhere (e.g. railways), it was not yet able to be applied to predicting the ripeness of fruit. Without the Catalyst funding, R&D on the technology for this industry would not have gone ahead.

Project partners highlighted additional factors which contributed to project outcomes. The developments in technologies since project inception has supported the project. It was originally expected that TomVision would need a robotic platform in order to be transported around the glasshouse. However, due to advances in miniaturisation technologies at Rail Vision, the TomVision tool was developed into a handheld device. This allowed for further time and resource to be allocated to the tool itself, rather than additional components.

Whilst the project has achieved what it aimed to do, project partners voiced concern that political uncertainties could have an impact on the project going forward (e.g. changes exporting tariffs due to Brexit).

The theory of change presented below summarises the activities delivered by the project, and how these have led to outputs/outcomes to date and expected to have impact in future. The annotations in green text highlight key factors that have enabled progress (or will in future), and the annotations in red text are key challenges to date/risks to achieving intended impacts in future.

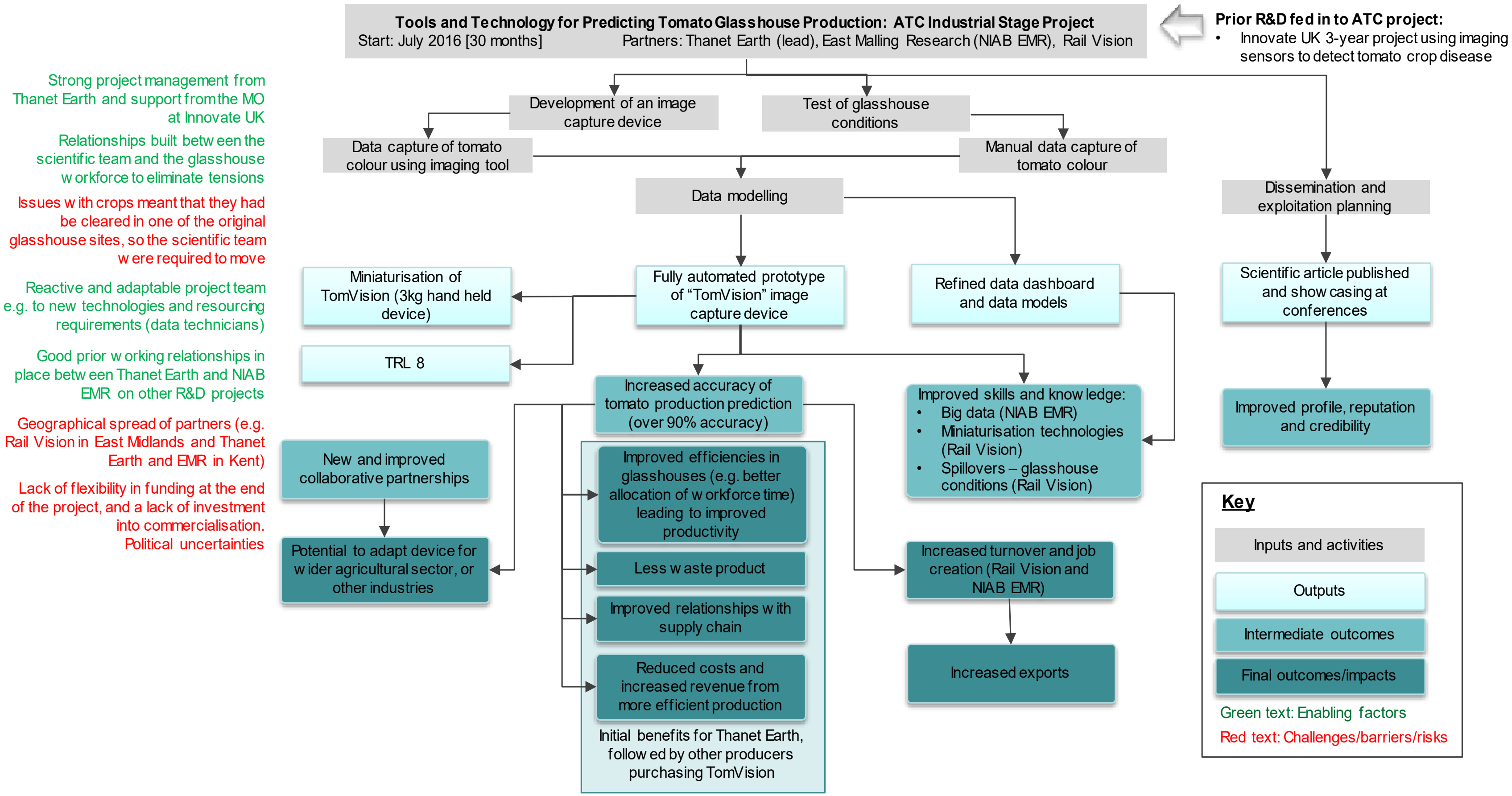
Legacy and next steps

Project partners outlined next steps for project dissemination and commercialisation. NIAB EMR and Thanet Earth plan to showcase TomVision to UK industry bodies, for example the Tomato Growers Association. NIAB EMR have already begun dissemination, through attending European conferences. This resulted in follow-up conversations with interested tomato and strawberry growers in France.

It is expected that the TomVision tool could be commercialised within six months and will be manufactured by Rail Vision. Refinement of reports and models to make them 'consumer friendly' is required by NIAB EMR prior to commercialisation; this has progressed through the use of internal funding. Thanet Earth are continuing to use TomVision in their glasshouses, which was reported to give gravitas to the commercial viability of the tool, due to their reputation in the industry.

In the future, there are opportunities for the tool to be developed and adapted for other sectors (e.g. vineyards) however due to the nature of these sectors, the tool would have to be further miniaturised to be carried by drone, which would require further R&D. In addition, there is potential for the tool to be integrated with robotic equipment which would pick the ripe tomatoes itself using data from the tool. There could be increased demand for robotic picking machines such as this in the future, due to potential decreases in the availability of EU labour, who make up a substantial proportion of the fruit picking workforce in the UK. There is clearly potential for significant further application that would utilise the underpinning technology, but would require substantial additional R&D investment and activity, which is not currently planned or committed.

Figure B-1: Project Theory of change … in practice



Source: SQW

Lessons

Having the right project consortium was identified as a key success factor for the project, as there was a varied mix of expertise and skills which partners could contribute to the project. In addition, the ability for project partners to be flexible and adaptable to project needs supported the success of the project. For example, NIAB EMR originally had two staff dedicated to measuring and maintaining the database, however this had increased to four by the end of the project.

It was noted that the strong working relationship between Thanet Earth and NIAB EMR, which was developed prior to the project, contributed to the success of the project, as partners 'spoke the same language' and were confident in discussing difficulties and overcoming these as a partnership. Whilst the geographical spread of project partners could have been a challenge, close contact was upheld between partners, further supporting delivery. A further success factor was cited as the drive and 'hunger' of all project partners to deliver, which was attributed to the commercial aspect of the project and its partners. Although NIAB EMR is a research organisation, they are an income generating business.

The monitoring framework and structure to the project provided by Innovate UK was cited as a key driver for success. Their monitoring officer was 'genuinely interested' and able to contribute and challenge due to expertise. This kept the project on track.

However, the lack of flexibility towards the end of the project limited what the consortium was able to deliver. Project partners stated that in future, they would focus on something which is closer to the market and could be commercialised as an output of the project, as the lack of further funding from the Catalyst to develop a commercially ready product within the project was a key barrier. It was therefore recommended that a small amount of top up funding could be allocated to projects who are close to commercialisation so that further successes could be achieved.

Integrating control strategies against soil-borne Rhizoctonia solani in oilseed rape (ICAROS)

Key messages

The project was an industrial stage R&D grant, awarded in Round 5, seeking to identify novel resistance traits/loci to an aggressive soil-borne pathogen that is implicated in the yield decline of oil-seed rape (OSR) to inform the development of guidelines, targeted seed treatments and varietal resistance for use in crop breeding, providing improved disease management and protection.

The project was led by Syngenta in collaboration with the University of Nottingham and AHDB. Syngenta and the University had a long track-record of joint working, and the project idea emerged from previous research led by the University regarding the pathogen in wheat, which is often used in crop rotations with OSR.

The project remained in delivery at the time of the case study research and will be completed in September 2019. The project has been delivered largely as planned to date, although a short extension was required to support the completion of the final field trials.

The project has involved the progression of the technology and a seed treatment product is currently seeking regulatory approval. It is anticipated that the treatment will be rolled-out into the market in the future, supported by the publication of guidelines that will raise awareness on the issue of the soil-borne pathogen in OSR across industry.

Without ATC, it is highly unlikely that the project would have progressed – reflecting the uncertainty of the outcomes associated with the research and the scale of the resource required. The ability to bring together the collaboration – and the respective expertise, equipment and capacity this offered – was a key element of the additionality of the programme.

The primary route to impact will be through Syngenta and the commercial exploitation of the seed treatment. However, through the adoption of the treatment and dissemination of guidelines in disease management, the project is anticipated to lead to improved OSR yield and cost savings for growers.

Looking forward, some further investment will be required to generate market traction, alongside dissemination and awareness raising activities across the academic and grower community.

Introduction

In 2016, an industrial stage Agri-Tech Catalyst (ATC) grant was awarded to support the "*Integrating control strategies against soil-borne Rhizoctonia solani in oilseed rape"* **(ICAROS)** project. The project was supported in Round 5 of the Catalyst. ICAROS is led by Syngenta partnered with the University of Nottingham. The project

(£619,000) was funded by BBSRC and co-funded by Innovate UK, Syngenta and the Agriculture and Horticulture Development Board (AHDB). Originally intended to be delivered over June 2016 to June 2019, the project was awarded a three-month extension, and will close in September 2019. The project was therefore on-going at the time of the case study research, and had yet to produce its final outputs.

The aim of the project was to identify novel resistance traits/loci to *Rhizoctonia solani* anastomosis group (AG) 2-1 (referred to as '*R. solani*' throughout this case study) in oilseed rape (OSR) to inform the development of guidelines, targeted seed treatments and varietal resistance for use in crop breeding, to provide improved disease management and protection. *R. solani* is an aggressive soil-borne pathogen that is implicated in the yield decline of OSR when grown with increased frequency in field rotations.

This case study involved consultations with representatives from Syngenta and the University of Nottingham, and a desk review of the project application and selected project outputs/publications.

Project overview

The initial idea for the ICAROS project emerged from research undertaken by the University of Nottingham in 2011-2012 regarding *R. solani* in wheat, which is often used in crop rotations with OSR. This research found higher concentrations of the pathogen in wheat crops in rotation with OSR: soils of fields of winter wheat following OSR contained up to 1000-fold higher DNA concentrations of *R. solani* than fields of continuous wheat or crops following other cereal such as maize or oats[61]. With *R. solani* recognised as one of the main causal agents of pre- and post-emergence damping off[62], and hypocotyl/root-rot seedling diseases, the research indicated that it may be contributing to the 'yield plateau' experienced in OSR; for which no other explanations have been identified robustly. At this point, control of Rhizoctonia diseases in OSR was only possible through the use of fungicides, which increases input costs and is not sustainable over the long-term, particularly, with an increase policy and regulatory push to eliminate the use of fungicides in crop management.

Through an existing collaboration between researchers at the University of Nottingham leading the work cited above, and Syngenta, an opportunity was identified to undertake a collaborative R&D project to test whether it was possible to identify a genetic resistance in OSR or other Brassica species that could be exploited to limit the effects of *R. solani* and/or to develop seed treatments that could be developed commercially for improved disease management and protection of OSR yield.

The subsequent project funded by the Catalyst involved four main work packages, of which the first three are largely complete, and the fourth is to be completed at the conclusion of the field trials from mid-2019:

[61] Cited in the application for the ICAROS project
[62] A disease of seedlings caused by fungi and fungus-like organisms that causes emerging seedlings to collapse.

- **identification of resistance/tolerance traits/loci to R. solani for crop breeding**, involving high throughput screening of UK and European varieties of OSR and diverse Brassica germplasm for tolerance or resistance to *R. solani.* Led by the University of Nottingham (also working with academics as the University of York who provided access to the ASSYST panel of germplasm).
- **epidemiology and yield loss due to R. solani** including field trials with contrasting disease phenotypes identified in the package above that are seed treated or untreated to quantify host colonisation rate, disease and seed treatment activity. Led by the University of Nottingham, the package included field trials to quantify yield loss. The analysis included the use of specialist 3D X-ray CT at the University of Nottingham's Hounsfield Facility to visualise the below ground effects of *R. solani* and understand how the pathogen develops in different soil conditions.
- **integrated disease management for R. solani in OSR** involving field trials to determine the effectiveness of novel seed treatments used on conventional and hybrid OSR against *R. solani* under natural infection. Led by Syngenta, involving field trials at locations in both the UK and Europe (France, Germany, Poland), with combinations of variety and seed treatment over two years to quantify the response of different genotypes to seed treatment.
- **the development of disease management guidelines against R. solani in OSR,** drawing on the data and findings from the first three work packages, to be disseminated internally and externally via Syngenta, the University of Nottingham, and the AHDB. The guidelines will be led by the University of Nottingham, with inputs from both Syngenta and AHDB.

Reflecting the mixed nature of activity – with considerable research, analysis and modelling capabilities required, alongside access to field trial team and facilities – core to the case for the Catalyst application was the need for collaboration between industry and academia in delivering the project, and the financial support for this, with high costs and uncertain outcomes given the novel nature of the research, and the low level of awareness in the market of the potential for addressing the effects of *R. solani* on OSR yield.

The project balanced the potential for both commercial outcomes (for Syngenta, via the development of new seed treatments and varieties) and academic outcomes (for the University, via publications and potentially future research funding), with a broader industry-wide focus on raising the profile of the issue of *R. solani* and soil-borne disease management in OSR. The development of the disease management guidelines is therefore integral to the overall aims and potential outcomes of the project, leading to both increased demand from industry that will support the commercial outcome of the project for Syngenta, and through changing practices/behaviours that will lead to improved yield and reduced costs and environmental damage from the use of fungicides for growers.

Effects and role of the Catalyst

The project remains on-going. However, at this stage **the project is considered by project partners to be technically successful and offer the potential to deliver significant benefits for both project partners and the wider industry.**

The project has **progressed through TRL stages**, and the principal direct outcome of the project will be a **new seed treatment product**, to be manufactured and rolled-out commercially by Syngenta to its existing and potential client base. This is currently undergoing regulatory approval in the UK (via the Chemicals Regulation Division) and Syngenta will subsequently seek regulatory approval at an EU level. This has the potential to generate revenue for Syngenta, although the scale of this is not known at this stage, and may be impacted by external factors (as discussed below).

This product is expected to lead to **improved OSR yield and cost savings for growers** over the longer-term, although it is recognised that there is a challenge in raising the profile of the issue and 'generating demand', which will include both direct engagement with distributors and the dissemination of the findings of the research via the guidelines. The project team at Syngenta are engaging with members of the firm's marketing team to help generate interest and demand from industry.

At this stage, the strand of the work focused on the development of new varieties of OSR seeds for crop production is *not* expected to lead to a new product in the short- or medium-term, as this will require further research and investment, including specialist breeding facilities. This may be considered in the future, however, the focus for Syngenta at this stage is on the seed treatment as the principal route to market from the project's research.

Alongside the potential commercial effects of the project for the lead, the case study identified a range of other benefits:

- **enhanced understanding of the underpinning science and evidence base** on *R. solani*; the project has led to a wide range of discoveries including on the complex relationship between on *R. solani* and the soil environment, and the effects of *R. solani* on OSR including for example related to delay in flowering and synchrony, with evidence that the new treatment will promote synchronous flowering which will provide a further benefit for producers that adopt it.
- related to this, there were reported benefits in terms of **developing the wider capacity, reputation, and knowledge-base of Syngenta** in agronomy and agrochemical research, crucial in a business based on the understanding and application of science.
- from an academic perspective, **the project is expected to lead to significant academic outputs** including journal publications, conference papers/presentations (including a presentation to the International Rapeseed Congress in June this year), and providing the underpinning evidence for further research funding applications, for example on resistance/tolerance for improved varieties.

- the development and dissemination of the disease management guidelines is expected to lead to **enhanced understanding of effects of an important soil-borne pathogen on OSR production and yield for growers**, even where the specific product developed through the project is not taken-up. The project has also led to a range of other publicity outputs including articles in Crop Production Magazine (a specialist journal for UK arable farmers), the Farmers Guardian and Arable Farming, in order to raise awareness and generate interest/demand for the project outputs.
- **improved relationships between Syngenta and the University of Nottingham;** whilst the partners were existing collaborators, the project has led to further embedding the relationships and sharing knowledge and understanding across the partnership. The case study indicated significant added-value from the collaborative approach, providing access to the mix of technical expertise, specialist equipment, and capacity that was required for the project to be delivered across its workstreams. The project partners consulted also identified benefits of improved collaboration with the AHDB through the project.

Based on the feedback from project stakeholders, **the additionality of the Catalyst funding is high**. Without the funding provided by the programme, partners considered that it would have been very difficult for the project to have progressed, if at all. For the lead partner, making the case for investment in R&D projects involves competing against other business units to secure the necessary financial and strategic support. Given the scale of the OSR market relative to other crop production areas, and the uncertainty around the potential outcomes (including the need to essentially 'generate demand') securing the requisite funding without support from the programme was considered very challenging. For the academic partner, an earlier application related to R solani to the BBSRC's LINK programme was not successful, meaning that the Catalyst was regarded as the only viable source of finance to support the required academic inputs, which included the need for Postdoctoral Research Scientist to work on the project.

However, **external factors were identified that will influence the potential impact of the project in the future**. Two issues were highlighted. First, the regulatory landscape and challenges in securing approval for treatments in crop production may lead to delays in approval and commercial outcomes. Second, a specific challenge to the production of OSR in the UK (Cabbage Stem Flea Beetle) may lead growers to diversify away from OSR, leading to a reduction in the addressable market for the products and any follow-on wider outputs (including the disease management guidelines) emerging from the project, at least in the UK which is the initial market-focus.

A graphical depiction of the 'Theory of Change' for the project drawing on the evidence from the case study is set out below. This highlights the anticipated routes to impact for the project, and the enabling factors and barriers that have, or may in the future, influence this.

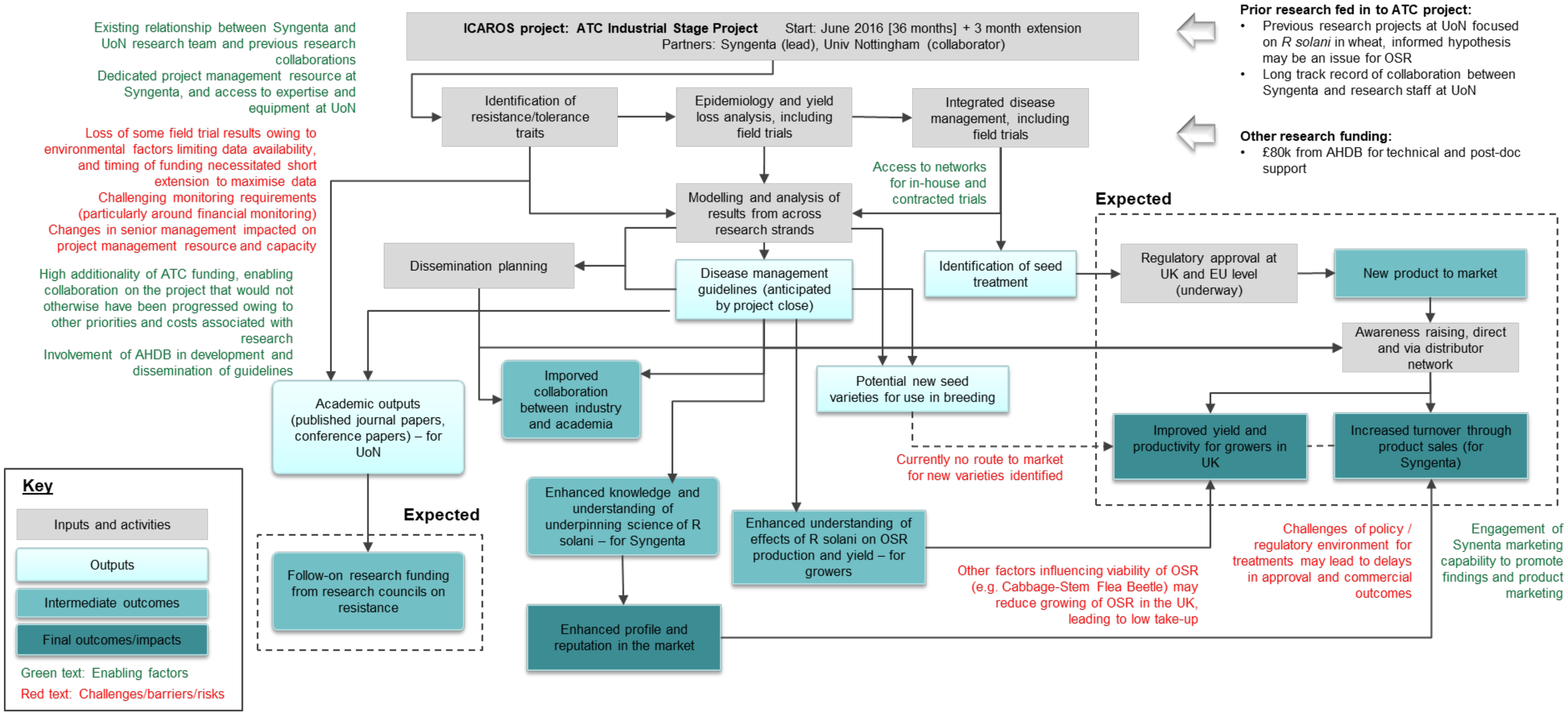
Legacy and next steps

The project will be completed by the end of September 2019. The final months of the project will involve the synthesis and analysis of the final set of data from field-trials, and the drafting and subsequent publication of the disease management guidelines.

Following the completion of the Catalyst project, and dependent on securing regulatory approval, the intention is for the crop treatment product to be rolled-out to the market by Syngenta, with production and manufacturing led by Syngenta in-house, and sold via distributors. Syngenta plans to invest in a number of ‘follow-on’ trials in order to gain traction in the market, through demonstrating the benefits of the treatment once it is available commercially.

Project partners have also planned to hold dissemination events in October 2019 that will involve presenting the findings of the project to the research community and the wider OSR growing industry in order to generate initial interest and understanding prior to the commercial roll-out. This will involve inputs from across the collaboration – Syngenta, AHDB and University of Nottingham.

Figure B-1: Project Theory of change … in practice



Source: SQW

Lessons

As summarised in the Theory of Change, several factors acted as important enablers to the successful delivery of the project to this point, and were highlighted as key lesson in terms of 'what worked well' by project partners:

- the project built on an existing relationship between Syngenta and University of Nottingham through previous research collaborations, and in the delivery of the project there was **clarity on roles and expectations across the partnership** which was crucial given the complexity and range of the work delivered across the workstreams
- the project involved **dedicated project management resource at Syngenta**, which was regarded as crucial to delivering against project aims and objectives, and managing the delivery of work across the collaboration; for projects of the scale and complexity, capacity in terms of management and oversight matters fundamentally
- the **respective experiences and expertise of the partnership** – covering the individual firm lead, academic inputs, and reach across and access to the wider industry through AHDB – was also regarded a key strength of the project.

The case study also indicates that a **focus from the outset on dissemination and awareness raising through the development of the guidelines has been important.** The ultimate effects of this on levels of adoption is not yet known. However, the project appears to be in a strong position to generate demand and promote adoption and take-up levering both Syngenta's networks and marketing capacity, and the dissemination of the guidelines.

There were also challenges experienced in the project, including the loss of field trial results owing to environmental factors limiting data availability, and the timing of funding that necessitated a short extension to maximise data. The lesson from this drawn out from the case study was the **need for R&D funding programmes in the agri-tech sector to recognise the realities of agri-based research on the ground**. As explained by the lead partner:

> *"Agri-tech research is dependent on many uncontrollable factors … weather, pest populations, grazing animals- exchange rates if working in other currencies … Attention to "season" is everything for good planning of an Agri-tech project involving field trials."*

There were also some **issues encountered around the monitoring requirements for the Catalyst programme**, particularly around financial monitoring. Whilst the rigour and momentum that the regular reporting provided was generally regarded as helpful, the suggestion was made that further guidance could be provided to delivery partner by Innovate UK, and potentially peer-to-peer mentoring, and further flexibility provided in expenditure in practice, to ensure that monitoring issues and financial management do not impact adversely (in terms of time, uncertainty, and scope) on project delivery.

This publication is available at: www.gov.uk/government/publications/agri-tech-catalyst-atc-programme-interim-impact-evaluation

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