Edinburgh and South East Scotland City Region Deal Joint Committee

10 am, Friday 5 March 2021

Easter Bush Business Case

Item number 5.3

Executive Summary

This report seeks approval to secure funding for, and enact, the Easter Bush project as set out in the Easter Bush Final Business Case. Preparation of this Business Case has been led by the University of Edinburgh and Midlothian Council - on behalf of the Edinburgh and South East Scotland City Region Deal consortium partners - in accordance with the HM Treasury 5 Case model guidance.

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Criteria	Details/Link to Document
Contribution to City Region Deal commitments and Inclusive Growth Framework	The Easter Bush project supports the inclusive growth ambitions of the City Region Deal including: • **Accelerating inclusive growth** the Agri-Tech programme will both accelerate growth in the Region and also allow the Easter Bush Campus to build upon and enhance a wide range of existing inclusive growth and equality activities (including out-reach, public engagement, citizen science and the Athena and Investors in Young People programmes); • **Removing the barriers to growth** through interventions to unlock current physical barriers to growth, including enabling road infrastructure and innovative Agri-Tech facilities; • **Community benefits through procurement** by integrating the University of Edinburgh and Midlothian Council approaches to employer engagement and procurement to increase the value achieved from our collective investments; • **Targeted skills interventions** through integrated and targeted employability and skills interventions focused on agriculture, food and environmental security; and, • **Social benefit through innovation** to drive agri-tech benefits across the City Region and Scotland over the medium and long-term. The University of Edinburgh has committed (in its Procurement Strategy) to add value to local and regional communities by identifying and achieving robust, relevant and proportionate Community Benefits (CBs) from the: • University's Procurement Strategy: *"For every procurement over £4million, the delegated authority of the University will consider how the acquisition can improve the economic, social or environmental wellbeing of our area through inclusion of community benefit clauses, to assist with our strategic objective of Community Engagement.";* and, • Procurement Category Strategies: *"Contributing locally [by] applying community benefits to major contracts, engagement in local collaborations in the city and with Scottish peer groups, including shared services and collaborative framework agreements."* Consequently, for the Easter Bush project, robust, relevant and proportionate CBs will be incorporated in future procurements of £4 million and above and will be considered in regulated procurements below £4 million at strategy stage (i.e. at £50,000 and above). Where CB requirements are included in a DDI contract, the contracting authority must include in the award notice a statement of the benefits it considers will be derived from those requirements. The project sponsors, procurement manager and any other participating University entity must agree who will be responsible post-contract award for the initiation of engagement with the supplier to achieve the CB commitments, as well as who will be responsible for delivering, monitoring and reporting the achieved CB. At the discretion of the University, CBs offered as part of the tender response may be enforceable as part of the final contract (or where submitted after contract award, pursuant to a legally compliant contract variation process). On high risk projects, written commitments may be required from suppliers that obligate them to follow through with offered CBs, which include means to penalise suppliers who are non-compliant. In addition, projects will also specifically address agreed inclusive growth objectives. Based on the University's existing inclusive growth-related policies and programmes, activity in scope includes: • Addressing skills shortages and gaps, and delivering improvements to boost the flow of individuals from disadvantaged groups into good career opportunities in the City Region and wider Scottish agriculture sector; • In collaboration with local education authorities and community groups extending School, College, Family & Adult Learning Programmes to cover a wider range of Agri-Tech

<table>
<tr><th>Criteria</th><th>Details/Link to Document</th></tr>
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science activities, as well as develop on-line interactive activities to reach rural communities in the Region and elsewhere in Scotland and the rest of the UK; and,
• Working closely with the Scottish and UK public sector to inform future food and environmental policies (including the Animal and Plant Health Agency (APHA), Scottish Government Animal Health and Welfare Division, Department for Environment, Food & Rural Affairs (Defra) and industry organisations such as the Agriculture and Horticulture Development Board (AHDB)).

The adopted Midlothian Development Plan (MLDP) sets out a long-term development strategy for Midlothian and provides a policy framework for assessing and determining applications for the development and change of use of land up to 2027. The proposed roads element of the Easter Bush project is identified in the plan as essential infrastructure necessary to enable new development in the A701 corridor to take place (policies IMP2 and TRAN2) and its delivery will accelerate development at the Easter Bush Campus as well as the Midlothian Science Zone and other locations.

The design and development of the roads infrastructure elements of this project will be led by Midlothian Council and its Civils Project Management Team. The economic and social themes of the current Midlothian Council Procurement Strategy includes a commitment to securing community benefits through the procurement process by, amongst other things:

• Securing learning, education, employment, skills and career development opportunities through contracts where possible;
• Encouraging suppliers to engage with local job centres and other local employment and training initiatives;
• Engaging with local suppliers, SME's, Voluntary Organisations and Social Enterprises, publishing our procurement plan to enable suppliers to prepare;
• Encouraging main contractors to hold local supplier engagement events prior to undertaking any major project work;
• Sponsorship and support for community/local group projects and initiatives;
• Environmental benefits – Midlothian's environment is protected through joint projects with the Community/Council (reduce, re-use, recycle) and its communities are supported through Active Travel measures; and,
• Maximise community benefits wherever possible through relevant requirements and specifications.

The appointment of the Civils Project Management consultant and the remaining project team is subject to this procurement requirement and they will have to demonstrate, to the satisfaction of Midlothian Council, how each of the professional disciplines will address and secure community based benefits.
</td></tr>
<tr><td>Alignment, integration with, or dependence on, other City Region Deal activities</td><td>
The other City Region Deal activities with the potential for alignment with investment in the Easter Bush project include:
<table>
<tr><th>CRD Theme</th><th>Scope of Potential Collaboration</th></tr>
<tr><td>Skills</td><td>• Potential to develop a STEM High School adjacent to Easter Bush offering substantial opportunities for further knowledge exchange within the local community</td></tr>
<tr><td>Transport</td><td>• By unlocking further development opportunities in Midlothian and promoting low/zero carbon travel choices via delivery of Public Transport and Active Travel and enhancements along the bypassed A701</td></tr>
<tr><td>Food & Drink Hub</td><td>• Establish collaborative research and development projects</td></tr>
<tr><td>Business Innovation Parks</td><td>• Establish parks as Agri-Tech start-up and scale-up company locations</td></tr>
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<tr><td>Scale and regional</td><td>As illustrated, in the table below, a range of ("net additional") outcomes have been identified for the Easter Bush project over the period of CRD funding, namely:</td></tr>
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<tr><th>Criteria</th><th>Details/Link to Document</th></tr>
<tr><td>distribution of expected outcomes, benefits, and leverage, from activity</td><td>

Talent: directly engaging with around 141,000 people in the application of data to develop genetics and health innovations in agriculture and aquaculture of whom 25,000 will attain certification;
Research: through hosting world-leading applied researchers and projects worth an additional £116 million over the lifetime of the DDI Programme hosting with world-leading applied researchers and DDI projects worth £138 million, including £50 million leveraged private R&D funds, through public sector and industry awards;
Adoption: engaging 100 public, private and third sector organisations, including early stage and scale-up companies;
Data: supporting new initiatives to curate, analyse, and translate huge datasets – such as the new centres of Data Driven Breeding and Aquaculture Genetics and Health – to encourage and enable the creation of Agri-Tech assets; and,
Entrepreneurship: establishing an additional 30 new high-growth firms in the ESES region over the life of the programme.

Based on the distribution of current activities across the areas of talent, research, adoption, data and entrepreneurship the anticipated direct net economic benefit of the Easter Bush Agri-Tech Hub is projected to be in the region of £248 million for the whole of the UK of which a minimum of £67 million to accrue to the City Region. These benefits exclude – by definition – the wider eco-system effects of the Programme on the current Data Driven Innovation (DDI) cluster within the Region. While no explicit quantitative analysis of these wider impacts has been undertaken, they are likely to be significant if the Programme achieves one of its longer term objectives of the City Region becoming a world-leading centre of excellence for applied data science.
In addition preliminary analysis by Ernst & Young/Midlothian Council, of the related benefits associated with the proposed transport enhancements, suggest that up to a further £189 million economic benefits could be generated from associated development uplifts and capacity improvements.
<table>
<tr><th>Outcome or benefits</th><th>Baseline (without DDI)</th><th>Target Uplift (with DDI)</th><th>Date</th></tr>
<tr><td>Total (certification) learners engaging with DDI Programme</td><td>4,493</td><td>25,345</td><td rowspan="5">Programme lifetime</td></tr>
<tr><td>DDI research funding</td><td>£507m</td><td>£623m</td></tr>
<tr><td>DDI collaborative adoption assignments</td><td>0</td><td>100</td></tr>
<tr><td>DDI data sets acquired</td><td>0</td><td>N/K</td></tr>
<tr><td>New spin out, scale-up and spin in companies</td><td>0</td><td>30</td></tr>
</table>
</td></tr>
<tr><td>Compliance with financial requirements and agreed expenditure profile</td><td>The vision of the City Region Deal partners is for Edinburgh to become the “Data Capital of Europe”. To realise this vision the University of Edinburgh and Midlothian Council are proposing a combined capital expenditure of £74 million. This business case is specifically seeking £28.3 million in Government funding towards this expenditure.</td></tr>
<tr><td>Equalities Impact</td><td>This Programme of work sits within the Equalities Framework laid out by the City Region Deal, through its Inclusive Growth Framework, which has five key themes aimed at accelerating inclusive growth and social benefit through innovation, with specific regard to minorities and</td></tr>
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Criteria	Details/Link to Document
	disadvantaged population. The University of Edinburgh also has an Equality and Diversity Strategy, Outcomes and Action Plan, which outlines the University's continuing commitment to equality and diversity for both students and staff. These frameworks highlight the central concepts of fair and equitable treatment regardless of race, disability, ethnicity, gender (including transgender), age, sexual orientation or beliefs. These will be key principles governing the development and delivery of programme activities outlined in this document. For all projects carried out within the Programme of work, equalities screening will be carried out to ensure that these issues are raised and addressed from project inception through to delivery and evaluation. As a local authority, Midlothian Council is required to implement the Public Sector Equality Duty in addition to the other provisions (relating to employment, education and training requirements) of the 2010 Equality Act. This duty comprises the general duty and the specific duty. The general duty was developed for public bolides recognising the significant impact that the delivery of public services has on people's lives and is designed to ensure that, if followed, services are designed to meet the diverse needs of the community and also builds inclusive services. The specific duty is designed to help authorities to put the general duty into practice. Midlothian Council's corporate Equalities Plan identifies eight equality outcomes of which number six (Midlothian has strong, vibrant communities where residents have a sense of belonging) and number eight (Midlothian Council services will meet the needs of all those in the community) are relevant in connection with the impact of the proposed roads infrastructure. At a Service level, the preparation of the Midlothian Local Development Plan was subject to a separate Equalities and Human Rights Impact Assessment (EqHRIA) to assess the overall impact of the policies and proposals of the MLDP as they relate to the Public Sector Equality Duty and people/groups who share the protected characteristics. The MLDP incorporates minor amendments as a result of the EqHRIA process.
Alignment and fit with City Region Deal governance arrangement	The University and Midlothian Council will respectively oversee the Agri-Tech developments and transport improvements identified in the Business Case. These two partners are currently in the process of agreeing a concordat to ensure complimentary development timescales, adherence to joint project management protocols and common methods of progress reporting to the City Region Deal Joint Committee (that is responsible for delivering value for money from the Edinburgh and South East Scotland City Region deal and wider regional collaboration). The DDI Delivery Board is responsible for assuring commissioning of the University elements of the project investment including working with the Easter Bush Senior Executive to establish and support the Agri-Tech Delivery Team and Agri-Tech Delivery Advisory Group and defining the key resources, financial and Key Performance Indicators (KPIs) delivery parameters within which the Agri-Tech components of the Campus will operate. The Agri-Tech Delivery Team is responsible for the overall direction and management of the all Agri-Tech activities described in this document. As such, it is ultimately accountable for success of the University elements of this project. Midlothian Council is engaging a team of Project Delivery Partners (PDP) to deliver the A701 Relief Road and A702 Link. Their roles are: Civils Project Manager (CPM) – to manage the delivery of the project; Design Consultant (Designer) - design and technical specifications for the scheme; Planning and Environmental Consultant (PEC) - managing the planning application and related environmental matters; Lands Consultant (PC) – consult and manage all landowners; Cost Consultant/ Quantity Surveyor (QS) - cost management and estimating; Appraisal Consultant - traffic and transportation modelling and appraisal services; Road Safety Auditor – undertake road safety audits; and, NEC Construction Consultant: supervise and administer the construction works for the project.

Criteria	Details/Link to Document
PMO compliance check	All evidence provided.
Government approval	Final comments were provided on the 17th February 2021 and responses returned on the 22nd February 2021 with sign off on the 26th February 2021.
Partner sign-off	In December 2020 the University of Edinburgh, and subsequently Midlothian Council Councillors in January 2021, agreed that this Business Case can progress for formal approval.
Advisory Board sign off	On the 1St February 2012 the Transport Advisory Board were provided with a summary presentation of the case and confirmed their on– going advisory role in relation to the transport dimensions of this project post any formal approval.
Executive Board sign off	Obtained on the 18th February 2021.

Report

Easter Bush Business Case

1. Recommendations

1.1 To approve the Easter Bush final business case and implementation of the associated Agri-Tech activities and transport improvements.

2. Background

2.1 As evidenced in various Scottish and UK Government policy documents, and publications by the OECD and global consultancies, Data-Driven Innovation (DDI) has become a key pillar of 21st century growth with the potential to significantly enhance social wellbeing; productivity; resource efficiency; and, economic competitiveness.

2.2 This potential is particularly pertinent in relation to food production. The world population is currently 7.8 billion. The United Nations Food and Agriculture Organization (FAO) predicts that this will rise to 9.7 billion by 2050.[1] Feeding this growing population well - while protecting biodiversity and natural capital - is one of the greatest global challenges we face. To ensure future food security the FAO estimate that by 2050 global agricultural production (including crops and animals) will need to be 70% higher.[2] As the World Economic Forum has recognised: *"at its core, Agri-Tech is about using advanced monitoring and data analysis to do more with less – to find ways to increase yields without burdening already overtaxed resources such as land and water"*[3]. The Easter Bush Agri-Tech Hub will be focused on helping local and international agriculture achieve these aims.

2.3 The Edinburgh and South East Scotland Science and Innovation Audit (SIA), published in 2016, identified that:

- The City Region is already a powerhouse in Data-Driven Innovation;

[1] http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

[2] i.e. globally the demand for food will grow disproportionately as more countries emerge from poverty and their populations can afford diets higher in protein especially that of livestock origin.

[3] https://www.weforum.org/agenda/2019/02/why-the-agtech-boom-isn-t-your-typical-tech-disruption/

- Growth in DDI is at a tipping point and requires further investment to meet demand and deliver its potential;
- There are a number of industry sectors that are key to the local economy and which align to national areas of focus; and,
- Realising DDI opportunities are most likely to generate sustainable socio-economic benefits and support inclusive growth.

2.4 The DDI Programme vision is establish the region as the Data Capital of Europe. It will do this by playing to the City Region Deal partner strengths in education and research and significantly boosting activities with public, private and third sectors. In relation to Agri-Tech University of Edinburgh will work with regional partners to create a world-leading innovation hub, where key organisations from the public, private and third sectors collaborate and access data in a trusted, secure environment, to enable data-driven advances in the delivery of agriculture and aquaculture improvements and create innovative commercial solutions.

2.5 The Agri-Tech Hub will bring together world-leading researchers from University of Edinburgh and other Higher Education institutions, public and third sector organisations, to focus on four activity areas crucial to the advancement of Agri-Tech - **acquisition:** by sourcing and curating multiple data sets and modalities; **analysis:** through increasingly sophisticated curation, data-cleaning and innovative interrogation and analysis of large Agri-Tech data sets within data-safe havens; **access:** providing information to enable access to the data revolution the Agri-Tech community is about to embrace (for example to better share and leverage leading practice in agriculture methods); and, **connectivity:** to ensure awareness across stakeholder communities.

2.6 Through this business case, Midlothian Council and the University of Edinburgh seek approval for capital investment of £74 million (of which the Scottish and UK Governments are asked to fund £28.3 million) for the development of the Hub and associated enabling transport infrastructure. For the University the capital investment will enhance, and further leverage, an already-extensive range of agri-tech facilities located at the Easter Bush Campus, and in complementary facilities across Midlothian, East Lothian and the City of Edinburgh. These investments encompass new data and other on-site facilities and related on and offsite transport improvements and energy infrastructure. The latter investments (in transport and energy) are essential in enabling investment in the local area and eliminating key constraints on further development of the Easter Bush campus, including increased occupation by partner organisations.

2.7 This Business Case has been endorsed by UK and Scottish Governments and is now presented to the Joint Committee for approval.

3. Main report

3.1 The City Region has a long history of excellence and leadership in informatics and data science including: one of the largest computing school in Europe (the University of Edinburgh's School of Informatics); the UK's principal super-computing facility

(Edinburgh Parallel Computing Centre); and, the largest concentration of internationally-significant and world-leading informatics research in the UK.

3.2 Moreover, in the last four years, local DDI capability has grown significantly as multiple new initiatives within the data science, robotics and computer systems areas have been secured. This is amplified by the progress already made in setting up and implementing core elements of the DDI Programme (including the Bayes Centre which has already secured significant levels of private investment) and a range of initiatives addressing COVID and post-COVID issues across a range of city region sectors.

3.3 The Easter Bush Campus already provides a dynamic and vibrant home - with world class facilities equipped with the latest technologies - to over 1,000 scientists, lecturers and clinicians as well as co-locating industry business partners across animal biosciences and food security. It is the academic home for animal science within Scotland and is Europe's largest concentration of animal science research expertise. In addressing these needs the City Region Deal investment in the Easter Bush Agri-Tech Hub will enable a **step-change in the scale and impact** in the Campuses teaching, research and innovation outputs.

3.4 As with the DDI programme as a whole, the Easter Bush Agri-Tech Campus is designed around five key areas of intervention (or "TRADE" themes):

- **Talent**: Develop a flow of talent in data driven entrepreneurship and the application of Agri-Tech;
- **Research**: Develop, in conjunction with industry, a world-leading research capability in data science;
- **Adoption**: Undertake a range of industry engagements focused on building collaborative partnerships to enable new research and innovation activity;
- **Data**: Support initiatives, such as the Agri-EPI Centre, to create data assets to help businesses with IoT, technology, robotics and novel systems of production; and,
- **Entrepreneurship**: Generate a pipeline of new high-growth start-ups and scale-ups, and support equity investment.

3.5 By demonstrably improving innovation and incrementally enhancing the City Region DDI ecosystem the Easter Bush Agri-Tech Campus will, over the next 15 years, deliver:

- **Talent:** by directly engaging with around 141,000 people, including around 25,000 undertaking credit bearing CPDs and other courses, in the application of data to develop genetics and health innovations in agriculture and aquaculture;
- **Research:** through hosting world-leading applied researchers and projects worth an additional £116 million over the lifetime of the DDI Programme;
- **Adoption:** increasing new company engagements (100) to enhance data adoption in agriculture;

- **Data:** supporting new initiatives to curate, analyse, and translate huge datasets – such as the new centres of Data Driven Breeding and Aquaculture Genetics and Health – to encourage and enable the creation of Agri-Tech assets;[4] and,
- **Entrepreneurship:** through the establishment of an additional 30 new high-growth firms and support to around 150 graduates in setting up or joining micro Agri-Tech companies.

Intervention 1: Talent

3.6 If the benefits of the Agri-Tech data revolution are to be realised it is vital that agri-food professionals are skilled and confident in data acquisition, handling, interrogation, application and data-driven innovation. A key aspect of the Hub vision will be to diversify and proliferate training capability to provide the talent pool needed to deliver Agri-Tech DDI. Through partnership and active involvement of the commercial pre-farm sector, talent development will be structured to provide targeted up-skilling and delivery to specific sector needs.

Intervention 2: Research

3.7 To enable a stepwise increase in Agri-Tech research and innovation outputs a range of topic focussed DDI initiatives will be developed to complement, build on and grow the current campus research capabilities undertaken by the:

- **Centre for Aquaculture Genetics and Health** – providing world leading teaching, training and knowledge exchange in aquaculture genetics and health research, supported by new strategic partnerships with world-leading companies across the Future Food and One Health agenda;
- **Centre for Data Driven Breeding** – delivering training, research and a translation hub for animal and crop breeding globally (in collaboration with wider University partners in Geoscience and School of Biological Sciences) targeting both Future Food and One Health agendas;
- **Epidemiology Centre for One Health and Sustainable Development** – transforming veterinary epidemiology and population medicine through the development of people-centric analytics to solve planetary One Health challenges (in collaboration with wider University partners in Geosciences); and,
- **Centre for 'Net Gen' Veterinary Diagnostics** – developing novel diagnostic tests to transform veterinary patient care globally through quicker diagnosis enabling disease mitigation and animal welfare delivery. This will enable collaborative activity with the wider College on "One Health", with many of these discoveries also impacting on human health, particularly those in zoonosis.

[4] Large datasets relating to host-pathogen interactions and animal behaviour will drive solutions to animal diseases and are a critical tool to mitigate the impact of drug resistance. More over rich data on microbiomes and metagenomes in states of health and disease will help to define the role of microbial communities in animals as well as yield opportunities in industrial biotechnology.

Intervention 3: Adoption

3.8 Enhanced research excellence, output and profile will provide both the 'magnet' and basis for transformative DDI commercial activity particularly in the fields of genetics, biotechnology, and health applied to both terrestrial agriculture and aquaculture. The Roslin Innovation Centre - through the provision of a supported flexible working environment at Easter Bush – will act as the gateway to facilitate a growing community of collaborators in Agri-Tech commercial activity.

3.9 Current tenant collaborators cover a mixture of 16 start-ups and SMEs. The success of securing these 16 partners within 18 months of opening highlights the opportunities available within the sector for collaborative campus-based growth.

3.10 The collaboration potential offered by the Roslin Innovation Centre is also enhanced by the 50+ commercial animal health and agribusiness collaborations that have been nurtured on the Campus over recent years and provide (potential) access to various relevant datasets.

3.11 Agri-EPI Centre will host and expand its national support ecosystem offering locally to businesses aligned with its mission and objectives, focusing on IoT, technology, robotics and novel systems of production. It has just opened its Hub and already incubates 4 companies, with ambition for many more. Linking with Agrimetrics at-market business model will add additional value at the higher TRL level of data integration solutions and securing mutually beneficial revenue streams through its data marketplace model.

Intervention 4: Datasets

3.12 The Hub will function as a 'meeting place' where innovative up-stream research mixes with entrepreneurial thinking, industry focused research and accelerated adoption, all driving the appropriate talent development and upskilling needed to transform agriculture and aquaculture. As a conduit for knowledge flow both from research to industry and vice versa, the Hub activity will be driven by data generation and sharing, analysis and interpretation and communication to all users by integrating multi-dimensional datasets (harbouring trillions of data points) to gain knowledge and drive innovation across pre-production agri-science sector by:

- Initial integration of genomics data (or huge volumes of sequencing data) with novel 'phenotyping' technologies to capture farm-level data on farmed animals and crops, and their environments; and, then,

- Moving to multidimensional data sets to: underpin agribusiness product development for improved health surveillance; inform policy for infectious zoonotic disease outbreaks and food borne disease; support the development of diagnostics and animal vaccines; and, develop next generation breeding strategies for improved production efficiency, disease resistance and reduced environmental footprints.

3.13 Both public sector sourced and business generated datasets will be accessed enabling data-driven innovation (DDI) to develop innovation which benefits the industry throughout the food supply chain. The outputs will drive growth of breeding, biotechnology, and animal health companies, while producers will also benefit from solutions to ensure their livestock, crops, or fish are high-performing and robust to environmental change.

Intervention 5: Entrepreneurship

3.14 A strong focus for the University will be mentoring to support start-up growth and creating a robust pipeline to attract corporate capital and other forms of inward investment. Many of the corporate partners involved in research and innovation are also interested in engaging with early-stage high-growth ventures that may be acquisition targets or who offer increased competitive advantage.

3.15 This will involve identifying, enabling and growing new Agri-Tech talent and facilitating new connections and supporting emerging commercial Agri-Tech activities in collaboration with the local ecosystem and Agritech centres to foster growth and impact through their national and international members by providing the space and ecosystem to innovate through a range of activities, including:

- **Venture Studio within** the Roslin Innovation Centre at Easter Bush. Termed the **FAST for Food and Agriculture Science Transformer** this will be first venture studio in Scotland and the first food and agriculture venture studio in Europe. The recently established FAST programme is structured to enhance the likelihood of producing innovative, high-value Agri-Tech companies within the ESES region. Through the current year activity, FAST (funded by the BBSRC and Roslin Foundation) three initial areas are being piloted: regenerative aquaculture, pollinator enforcement and controlled environment agriculture;

- **Hackathons/Plotathons** based around specific Agri-Tech challenges in partnership with other University of Edinburgh DDI Hubs, these events will identify and empower budding entrepreneurs, from within the Region, to develop their business propositions and progress to commercial activity within the Roslin Innovation Centre or elsewhere with the ESEC commercial infrastructure; and,

- **An Entrepreneur Club** to upskill individuals through a series of bespoke interactive events that focus on networking, emotional intelligence, marketing as well as understanding of funding for enterprise and pitching events – with the aim to help individuals towards commercial activity or spin out a company.

3.16 The cohorts emerging from the Entrepreneur Club represent a ‘ready-made’ pool of talent for FAST. All companies created and supported by FAST, as well as existing tenants of the Roslin Innovation Centre and commercial players born out of the Hackathons/Plotathons, will also provide the inspiration and role models, as well as an

informal supportive entrepreneurial ecosystem, for aspiring graduates, postdocs and individuals from the local community.

3.17 To further enhance this ecosystem and best exploit Agri-Tech opportunities support will be provided by the **Research Hotel.** Located within the Roslin Innovation Centre the Research Hotel currently provides established companies and start-ups with ready to use state-of-the art office and fully fitted out lab space with access to standard lab equipment. This facility will be expanded to support entrepreneurs and micro businesses that (successfully) emerge from the Hackathon, Plotathon and FAST activities

3.18 In addition a dedicated space called **the 'Makers Barn,'** tailored to facilitate co-production of innovative solutions for on-the-ground active small and micro Agri-Tech companies, will be developed to enhance the facilities offered at the Edinburgh hub of AgriEPI. This open facility will promote the interaction between community players, academics at Easter Bush and co-located Agri-Tech companies with the goal of developing new, better and/or less expensive products and services.

Intervention 6: Inclusive Growth

3.19 The DDI Agri-Tech programme will allow the Campus to build upon and develop a wide range of existing inclusive growth and equality activities. Foremost amongst these is the Easter Bush Science Outreach Centre (EBSOC).[5] The current geographical reach across Scotland is extensive and, on a 2 to 3-day week capacity, in 2018-19 engaged over 3,500 pupils mainly from SMID 1-2 areas.

3.20 The DDI Agri-Tech programme provides significant opportunity to expand the operational capacity and remit of EBSOC (from an animal bioscience focus to a wider DDI Agri-Tech portfolio). It is the intention to increase the capacity of the EBSOC to 5 days a week over the next 2-3 years (funding dependant) with a focus on engaging regional areas with low science capital and/or restricted access due to their rurality. This expansion will dovetail and contribute to the development of a STEM focused High School adjacent to the Easter Bush Campus.

3.21 Capacity will also be extended through the "Public Engagement Public Lending Library" - a student-led public engagement activity co-ordinated by EBSOC staff. Students participating in the Agri-Tech Talent courses with a research element, will be encouraged to shape a public engagement activity linked to their specific Agri-Tech research which can be communicated to school pupils and adults in the community. Agri-Tech students will receive mentoring and coaching from the EBSOC team in order to develop interactive, hands-on activities, to be placed in the lending library, which can be utilised by campus staff for any community events, science festivals, school visit or outreach events. In addition, as part of the Agri-Tech activity, it is proposed to expand veterinary outreach activities to the rural communities and those with limited ability to access Campus facilities.

3.22 Citizen science activity will also be expanded to involve the public with the collection, curation and analysis of data, so that communities can become actively involved and

[5] https://www.ed.ac.uk/easter-bush-campus/science-outreach-centre

contribute to the DDI Programme.[6] This activity links into and complements more focussed projects with partners which seek to address social issues - for example the student led "All for Paws" vet outreach clinic for animals of homeless and vulnerably–housed people, which has resulted in partnership with Turning Point Scotland, NHS Lothian and the Grassmarket Community Project.

3.23 With regard to equality ambitions, the Roslin Institute is one of only nine research entities in the UK to achieve Athena SWAN Gold status which recognises and celebrates good employment practice for women working in science, engineering and technology within the Higher Education & Research sector.[7] The principles of such practice will be embedded within the DDI Agri-Tech Programme, particularly impacting the Research and Adoption aspects. This will include woman acting as positive role models to early career scientists, provision of Carers Grants for staff with caring responsibilities when they attend conferences vital for career development, gender balance for all interviews and participation in "Coaching for Success", which provides individual career coaching for staff at key stages of their career.

3.24 Finally, the Easter Bush Campus was the first University body in the UK to hold an Investors in Young People accreditation at a Silver level.[8] Again the commitment the Campus has made to providing opportunities and experience for young people within the community will also be embraced within the DDI Agri-Tech Programme through a strong, positive and supportive culture on the campus, and access to training and development opportunities, including provision of both Foundation and Modern Apprenticeships.

Intervention 7: Transport Improvements

3.25 Both Midlothian Council and the University of Edinburgh recognise that adequate road access to the site must be provided if constraints on the further development of Easter Bush are to be avoided. In particular, the Midlothian Local Development Plan transport modelling - of all committed developments in the area - highlighted potentially serious road traffic congestion, capacity issues and delays along the A701[9]. City Region Deal funding would enable the early prioritisation and, therefore, the effective implementation of the Local Development Plan strategy in the A701 corridor.

3.26 The proposed roads infrastructure changes will be a key enabler of the future development of the Easter Bush Campus comprising the A701 Relief road, A702 Link Road, Bush Loan Junction and Straiton junction. These improvements will also enable and support future investment across the wider Midlothian Science Zone (including the

[6] Current examples of such engagement include the Scottish Beekeeping Society being actively involved with the Easter Bush apiary and the Dogslife project where citizen science is key to data acquisition.

[7] https://www.ed.ac.uk/roslin/work-study/award-winning-environment/athena-swan

[8] https://www.ed.ac.uk/easter-bush-campus/where-people-thrive/staff/awards/investors-in-young-people-silver-award

[9] See the Midlothian Local Development Plan Main Issues Report, Transport and Infrastructure Technical Note - https://www.midlothian.gov.uk/downloads/file/2517/transport_and_infrastructure_technical_note and the Report of Examination, issue number 6, page 144 – 181, which addresses the A701 Relief Road/A702 Link Road and the approach of the Council in preparing the transport appraisal of the Midlothian Development Plan (to comply with Scottish Planning Policy) - https://www.midlothian.gov.uk/downloads/file/2292/report_of_examination_into_mldp_proposed_plan

Biocampus, Technopole and Moredun Institute) as well as throughout the whole A701 corridor including significant planned housing (1,570 units) and economic and commercial development in the A701/A702 corridor (circa 90Ha). In addition the new roads and junctions will add significant additional highway capacity to the local road network, improve journey times compared to the existing delays on the A701 and facilitate re-prioritising road space to deliver sustainable transport improvement measures (prioritising walking, cycling and bus based public transport) along the existing A701 from Straiton to Gowkley Moss roundabout. These measures will create safer (and potentially segregated) access to and from the Easter Bush Campus from the A720 Edinburgh City Bypass.

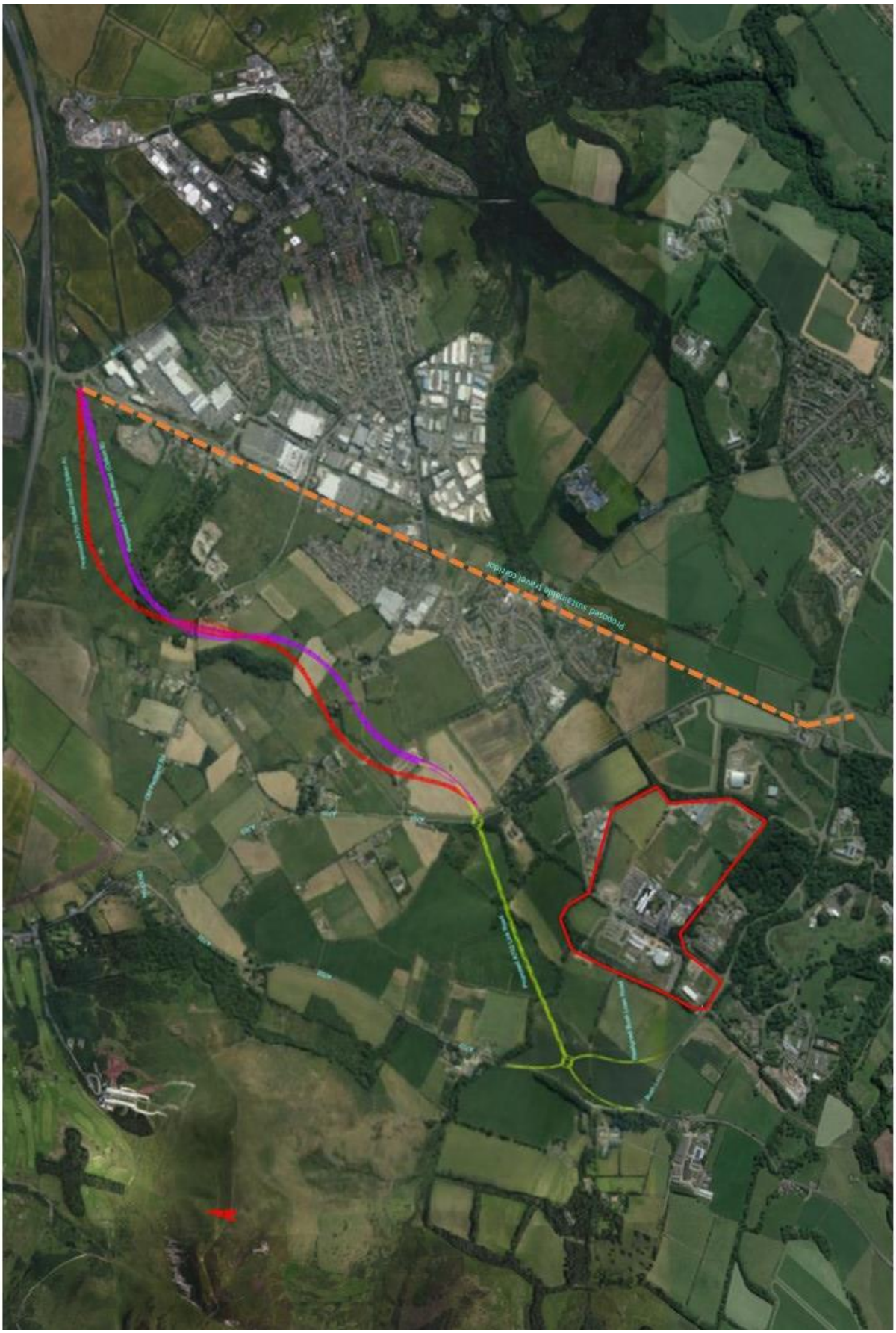
3.27 As illustrated, in the figure overleaf, the A701 Relief Road will comprise:

- New road infrastructure between Straiton Junction and Pentland Road;
- A new bridge crossing or four-arm roundabout junction at Pentland Road; and
- New road infrastructure between Pentland Road and A703 Seafield Moor Road.

The A702 Link Road will consist of:

- A roundabout junction with the A703/A701 Relief Road; and,
- The A702 Link road.

3.28 The A702/Bush Loan junction will incorporate a new four-armed roundabout junction connecting the A702 (north and south), Bush Loan and the A702 Link Road.


Proposed 'Sustainable Transit Corridor'

4. Financial impact

4.1 Through this business case, Midlothian Council and the University of Edinburgh seek approval for capital investment of £74 million (of which Government is asked to fund £28.3 million).

4.2 In addition to underwriting up to £16.6 million of the total capital requirement, and leveraging a further £10 million from the Biotechnology and Biological Sciences Research Council, the University of Edinburgh will:

- Fund on-going operating costs; and,
- Fully fund the continued operation of the Agri-Tech Hub beyond the duration of the DDI Programme.

4.3 Midlothian Council has secured funding of £10 million for the transport elements of the current proposals and will forward fund a further £9 million which includes sums it expects to secure from further residential and commercial developments along the transport corridor.

4.4 The actual spend profile will vary across the funding period and will be regularly updated in response to learning and changing circumstances to ensure maximum impact against its programme and wider inclusive growth goals.

4.5 Overall the initial due diligence undertaken by both Midlothian Council and the University of Edinburgh indicates that the two components of this project and associated risk profiles are affordable if the capital grant is approved at the currently requested level and phasing.

5. Alignment with Sustainable, Inclusive Growth Ambitions

5.1 City Region Deal partners are committed to ensuring that Inclusive Growth ambitions are embedded across the deal, reflecting the challenges being faced across the region.

5.2 In this context - beyond the inclusive growth interventions already identified at Section 3 the Agri-Tech Hub - will actively seek to improve the flow of disadvantaged individuals into good employment and careers by working with Midlothian Council:

- In maximising the potential benefits - of this project and future investments- within the local economy;
- To future proofing the regional economy through stimulating a positive step change in equality, capacity and productivity;
- Encouraging meaningful participation by stakeholders in designing and delivering services and interventions; and,
- Providing opportunities to strengthen career progression routes for those who face significant labour market disadvantage

6. Background reading/external references

6.1 Edinburgh and South-East Scotland City Region Deal Document, August 2018

6.2 *Enabling a World-Leading Regional Digital Economy through Data Driven Innovation*, Edinburgh & South East Scotland City Region Science and Innovation Audit, November 2016

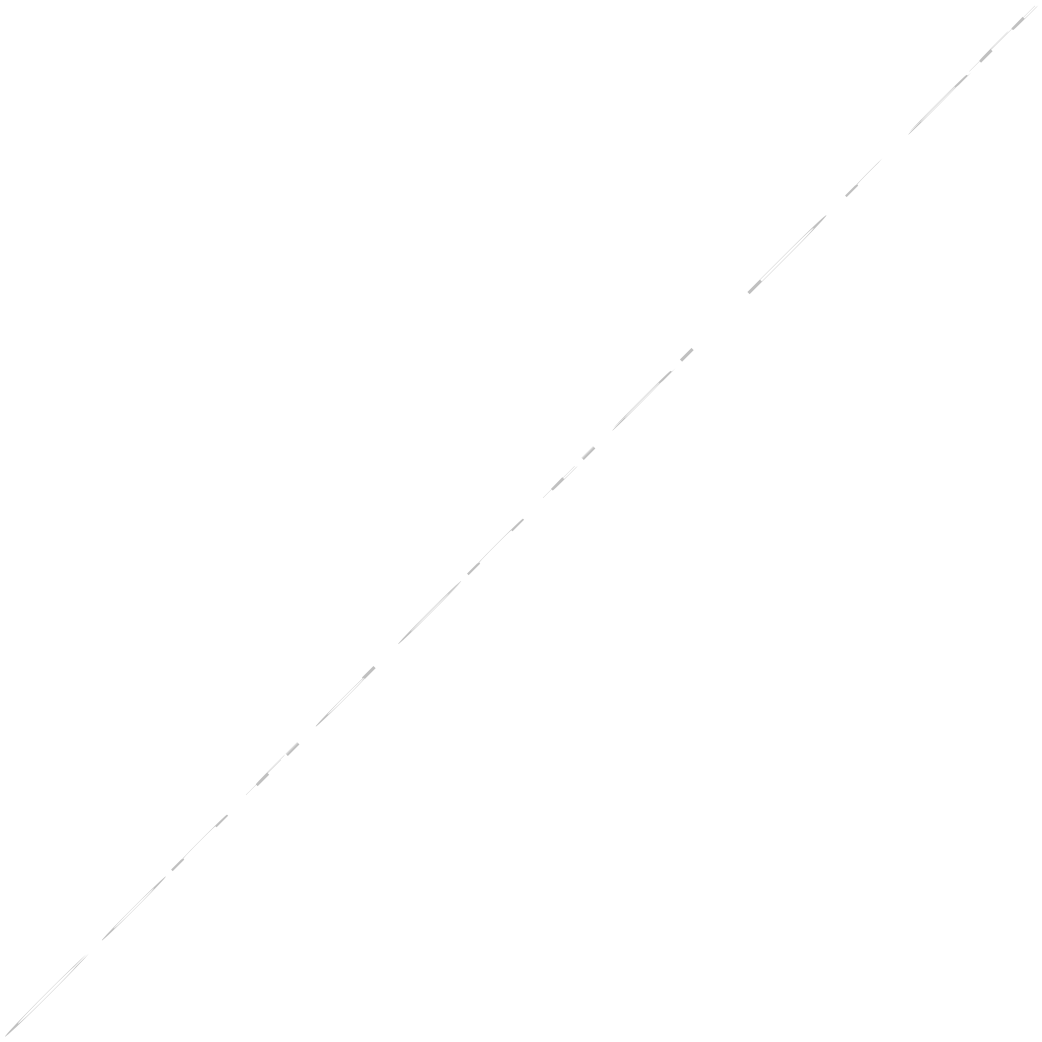
7. Appendices

7.1 Easter Bush Business Case Summary

Programme for Delivery of a Data-Driven Innovation Cluster in the Edinburgh and South-East Scotland City Region

Final Business Case for Investment in Easter Bush

Contents



1 Executive Summary

The world population is currently 7.8 billion. The United Nations Food and Agriculture Organization (FAO) predicts that this will rise to 9.7 billion by 2050.[1] Feeding this growing population well - while protecting biodiversity and natural capital - is one of the greatest global challenges we face. To ensure future food security the FAO estimate that by 2050 global agricultural production (including crops and animals) will need to be 70% higher.[2] Delivering this increase will also need to be balanced against reducing the environmental footprint of food production.[3] The dilemma of producing more food from less resource while also addressing zero-carbon and reduced emission goals is set against a backdrop of farming supporting over 25% of global employment[4].

Achieving these goals will require long-term improvements in the genetics and health of farmed populations in both agriculture and aquaculture. Advances in data-driven sciences such as high-throughput genomics and digital trait recording provide major opportunities to achieve this. When these technologies are effectively integrated they will: improve the efficiency of food production; accelerate the path to zero carbon and reduced emissions; and ensure product quality, animal health, robustness and welfare. Moving increasingly to real-time, data-based decision making by intersecting genomics, biotechnology, artificial intelligence, digitalisation, and robotics with local and global data (in terms of food species genetics, disease state, vet epidemiology and animal diagnostics, soil condition, weather patterns and market drivers) current productivity levels can be increased in a manner that will enhance the high-health status and reduce the harmful emissions of agricultural systems.

The Edinburgh and South East Scotland (ESES) City Region Deal investment proposed at Easter Bush will provide the infrastructure and capacity to create the **Easter Bush Agri-Tech Hub** (Hub) to transform innovation and knowledge exchange related to data-driven breeding and health of farmed populations. This Hub will function as an early-stage innovative funnel of research and talent, through to adoption and entrepreneurial activity, all based on data acquisition, sharing, and translation to achieve impact for the region and further afield. Working with the Edinburgh International Data Facility (EIDF), and other City Region Deal University Hubs, Agritech Innovation Centres and other commercial and academic partners across the UK, the aim of this Hub is to be the **Agri-Tech innovation destination of choice for the public, private and third sectors**.

The Hub will function as a 'meeting place' where innovative up-stream research mixes with entrepreneurial thinking, industry focused research and accelerated adoption, all driving the appropriate talent development and upskilling needed to transform agriculture and aquaculture. As a

[1] http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

[2] i.e. globally the demand for food will grow disproportionately as more countries emerge from poverty and their populations can afford diets higher in protein especially that of livestock origin.

[3] e.g.: "*emissions from agriculture account for 20% of total Scottish emissions and agriculture-related land use accounts for a further 5%, making agriculture-related emissions the third largest emissions sector (after industry and transport). This illustrates how important it will be to reduce emissions in this sector, especially as in recent years there has not been any significant progress in reducing agriculture emissions"*. Reducing emissions in Scotland 2018, Progress Report to Parliament, Committee on Climate Change, September 2018.

[4] https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS

conduit for knowledge flow both from research to industry and vice versa, the Hub activity will be driven by data generation and sharing, analysis and interpretation and communication to all users by integrating multi-dimensional datasets (harbouring trillions of data points) to gain knowledge and drive innovation across pre-production agri-science sector by:

- Initial integration of genomics data (or huge volumes of sequencing data) with novel 'phenotyping' technologies to capture farm-level data on farmed animals and crops, and their environments; and, then,

- Moving to multidimensional data sets to: underpin agribusiness product development for improved health surveillance; inform policy for infectious zoonotic disease outbreaks and food borne disease; support the development of diagnostics and animal vaccines; and, develop next generation breeding strategies for improved production efficiency, disease resistance and reduced environmental footprints.

Both public sector sourced and business generated datasets will be accessed enabling data-driven innovation (DDI) to develop innovation which benefits the industry throughout the food supply chain. The outputs will drive growth of breeding, biotechnology, and animal health companies, while producers will also benefit from solutions to ensure their livestock, crops, or fish are high performing and robust to environmental change.

Strategic intent

Through enabling investment in Talent, Research, Adoption, Data and Entrepreneurship (TRADE), the Hub – and wider activities across the Easter Bush campus (campus) - will support, over the next fifteen years, the development of new digital solutions in Agri-Tech through:

- **Talent:** by directly engaging with around 141,000 people[5] in the application of data to develop genetics and health innovations in agriculture and aquaculture;

- **Research:** through hosting world-leading applied researchers and projects worth an additional £116 million over the lifetime of the DDI Programme;

- **Adoption:** increasing new company engagements (100) and continuous professional development (CPD) to enhance data adoption in agriculture;

- **Data:** supporting new initiatives to curate, analyse, and translate huge datasets – such as the new centres of Data Driven Breeding and Aquaculture Genetics and Health – to encourage and enable the creation of Agri-Tech assets;[6] and,

[5] Including around 24,000 undertaking credit bearing CPDs and other courses.

[6] Large datasets relating to host-pathogen interactions and animal behaviour will drive solutions to animal diseases and are a critical tool to mitigate the impact of drug resistance. Moreover rich data on microbiomes and metagenomes in states of health and disease will help to define the role of microbial communities in animals as well as yield opportunities in industrial biotechnology.

- **Entrepreneurship:** through the establishment of an additional 30 new high-growth firms and support to around 150 graduates in setting up or joining micro Agri-Tech companies.

In addition, the Hub will undertake various **inclusive growth** activities in Science and Agri-Tech data skills (engaging with around 58,000 people in Scottish Index of Multiple Deprivation (SMID)[7] and rural communities over 15 years).

What will be different?

City Region Deal partners have set out a total capital investment funding proposal of £73.9 million of which £28.3 million is requested from the ESES City Region Deal. The associated capital investment will enhance, and further leverage, an already-extensive range of agri-tech facilities located at the UoE Easter Bush Campus, and in complementary facilities across Midlothian, East Lothian and the City of Edinburgh. These investments encompass new data and other on-site facilities, and related on and offsite transport improvements and energy infrastructure. The latter investments (in transport and energy) are essential in enabling investment in the local area, and eliminating key constraints on further development of the Easter Bush campus, including increased occupation by partner organisations.

The breakdown of the five funding sources anticipated to deliver the overall investment of £73.9 million are illustrated in Table One below.

Table One: Funding Sources and Breakdown

Source	Amount (£m)
Requested from the ESESCRD	28.3
Committed by Midlothian Council	7.0
(To be) Realised from third parties to fund transport upgrades	12.0
Underwritten by the University of Edinburgh	16.6
Leveraged from the Biotechnology and Biological Sciences Research Council (BBSRC)	10.0
Total	**73.9**

Overall the preferred project option and associated risk profile is affordable and capable of being self-sustaining over the longer term if the capital costs are met by capital grant and University of Edinburgh contributions. A dedicated Agri-Tech Delivery Team will be accountable for the day-to-day operations and delivery of the Agri-Tech programme. The Agri-Tech Senior Responsible Officer, who will lead delivery of the programme, is Professor Bruce Whitelaw - a global leader in the application of biotechnology and DDI in the agri-science environment. The Agri-Tech Delivery Team will report to the School Senior Management Team for approval of projects. Chaired by the Head of School (currently Professor David Argyle) the School Senior Management Group will review activity within the Agri-Tech

[7] https://www2.gov.scot/Topics/Statistics/SIMD

Programme and ensure it is adequately resourced and supported, as well as linked into to the wider School activity on the Campus. Finally, the Agri-Tech Delivery Team will interface with the DDI PMO to ensure that there is a 'chain of command' in terms of alignment with the wider DDI programme and ensuring consistency in communications, PR, CRM and marketing.

As illustrated, in Table Two, the net present value (NPV) of the gross value added (GVA) of the Easter Bush proposal is forecast to be £437 million of which £248 million is directly attributable to DDI Programme activity. By applying an undiscounted public sector cost of £51[8] million the UK Cost Benefit ratio, for the latter DDI related activities, is likely to be around 1 to 8.6.

Table Two: Cost-Benefit Analysis for Easter Bush

Benefit Ratio for Easter Bush DDI activities based on Government funding contribution: 1:8.6				
GVA (£ million)	**City Region**	**Rest of Scotland**	**Rest of UK**	**UK as a Whole**
Easter Bush DDI	66.7	27	154.3	248
Road upgrade[9]	189	0	0	189
Total	255.7	27	154.3	437

Finally, it is important to note, that the developments proposed in this Business Case will be the first and significant step to developing an Agritech & One Health[10] hub in the region (and a beacon in the UK). This will involve collocating Medical and Vetinary research (the importance of which is recognised already by the interactions of the DDI hubs most recently in the context of COVID).

One Health will provide a 'focussed lens' to attract inward investment and international (strategic partnerships). The vision for the University is, over the next few years, to be one of the top three global One Health providers with the expectation of drawing in significantly higher levels of (capital) investment and grant (revenue) funding over and above the initial projections and associated GVA benefits outlined in this case.

[8] i.e. £28.3 million City Deal funding, £6 million allocated EIDF costs, £7 million from Midlothian Council and £10 million from BBSRC.

[9] Source: EY, December 2015 as quoted in EDINBURGH AND SOUTH EAST SCOTLAND CITY REGION DEAL - DECEMBER 2015 SUBMISSION.

[10] "*One Health is a collaborative, multisectoral, and trans-disciplinary approach - working at local, regional, national, and global levels - to achieve optimal health and well-being outcomes recognizing the interconnections between people, animals, plants and their shared environment*" https://www.onehealthcommission.org/en/why_one_health/what_is_one_health/"

2 Introduction

About this Document

This business case outlines the investment required to create the **Easter Bush Agri-Tech Hub** (Hub) to undertake data-driven innovation in **Agri-science and Agri-business**.

This case has been developed by the City Region Deal consortium partners in accordance with the HM Treasury Five Cases model.[11] As described in Appendix A capital investment of £28.3 million from the UK and Scottish Governments is requested for:

- Enhanced data technology facilities, equipment and infrastructure across the Easter Bush campus to support the acquisition, curation, analysis, adoption and translation of Agri-science data into genetics and health innovations driving growth of Agri-business (£8.7 million);
- Combined heat and power infrastructure (£8.7 million); and,
- Roads infrastructure improvement - A701 relief road and A702 link road (£10.9 million).

The above (as illustrated at Table One previously) will be further complemented by investment of:

- Up to £19 million in other roads infrastructure improvements by Midlothian Council and third parties;
- £16.6 million from the University of Edinburgh over the 15 years project lifecycle; and,
- £10 million investment by the BBSRC in facilities, equipment and infrastructure to support Hub research and adoption activities.

2.1 Project Vision

The Hub will become the Agri-Tech innovation destination of choice for the public, private and third sectors. This vision will be realised by focusing on the benefits of the "Fourth Agriculture Revolution"[12] to create the infrastructure and capacity for DDI translation and adoption in UK and global livestock, aquaculture and crop agriculture.

[11] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

[12] Michael Gove, Secretary of State for Environment, Food and Rural Affairs, stated at The Oxford Farming Conference (3rd January, 2019) that we are moving into the: "fourth agricultural revolution". Or as another source indicates: *"The fourth industrial revolution (4IR) is starting to change how every agricultural player, from a family farmer to a global conglomerate, produces food and related products. The spread of the so-called essential eight technologies — including AI, blockchain, drones, and the Internet of Things (IoT) — to agriculture is leading to increased yields, lower costs, and reduced environmental impact. These tools are also empowering farms to unlock new plant-based innovations and increasing their resilience to extreme weather events and climate change"*. https://www.strategy-business.com/article/The-fourth-industrial-revolution-in-agriculture

The world's population is forecast to reach 9.7 billion by 2050 placing severe pressures on the global food supply chain. Agri-Tech innovation - using transformative data-driven technologies and analytics - is set to make agriculture more efficient and sustainable by enabling quicker and better responses to these pressures. This is particularly important where food security is endemic and livestock are especially vital to provide protein, create employment and generate income.

Infectious disease is a major burden to all agriculture and aquaculture sectors, in many cases also presenting broader risks to human populations such as AMR and zoonoses. Decisions based on the intercalation of new and diverse data sets will enable: reduced disease spread and enhanced mitigation as outbreaks occur; improved animal welfare delivery, reduction and re-use of waste driving targets in environmental footprints; and, optimisation in feed and food production.

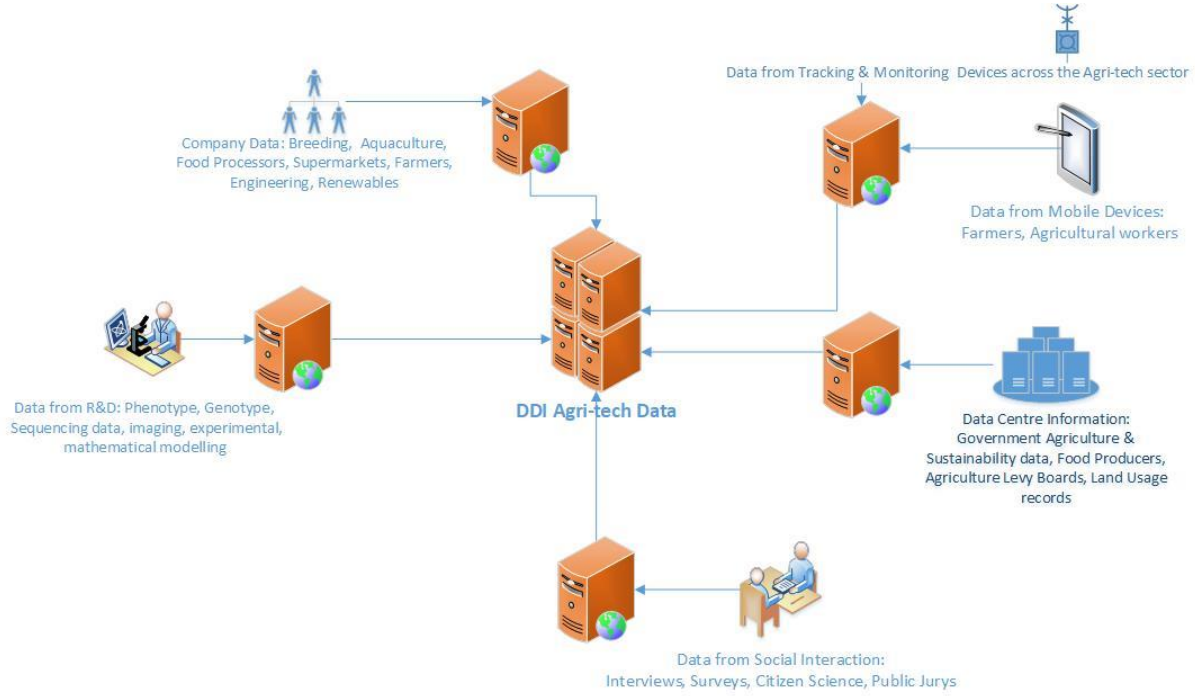
The impacts of using such data can be illustrated, for example, in relation to the higher health and welfare status of livestock. One of the focuses of Hub activity will be better diagnostic and vaccine solutions to manage livestock infectious diseases whilst removing antimicrobials from the food system. Additional solutions will emerge from prevention of outbreaks via improved genetic resistance and integration of genetic and environmental prediction of disease risk. Emerging and endemic diseases pose a threat not only to the health of animals but also humans. It is estimated that zoonoses[13] are responsible for some of the most high profile and devastating epidemics with 2.5b[14] cases of human illness and 2.7m human deaths worldwide each year. Fostering a one health approach of collaboration between human, animal and environmental health sectors is a critical step forward to creating sustainable food supplies.

As illustrated, in Figure One, access to datasets to support such an approach will involve a complex matrix of relationships with a variety of partners from across the globe. The ability to build these relationships, collate data, then understand, translate, interconnect, develop and implement innovative responses will be key to the successful delivery of the Hub.

[13] Are infectious diseases caused by bacteria, viruses and parasites that spread between animals (usually vertebrates) and humans. Major modern diseases such as Ebola virus disease and salmonellosis are zoonoses. In addition the WHO suggests that: *"all available evidence for COVID-19 suggests that SARS-CoV-2 has a zoonotic source"*. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200423-sitrep-94-covid-19.pdf

[14] PLoS neglected tropical disease 2014: The Global One Health Paradigm. https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0003257

Figure One: DDI Agri-Tech Data Interactions



The Hub will be at the forefront of devising new and early-stage technologies and approaches to improving livestock and agricultural productivity by:

- Uplifts in the national and international Agri-Tech DDI talent pool - through a range of onsite and virtual courses allied to the data and analysis capability available at Easter Bush - to ensure current practitioners, and the future workforce and leaders, are confident in data acquisition, handling, application and data-driven innovation;

- Facilitating an "inclusive research-based innovation and translation ecosystem" by co-location of world-leading academics and researchers with key strategic partners (in the public and private sectors) such as the UK Agri-tech Centres, which extends to their extensive industry members and through their current and expected local presence. These enhance all aspects of connectivity in order to encourage interdisciplinary collaboration and transformative research and innovation as well as acceleration of high growth firms and spin outs;

- The acquisition, curation and analysis of Agri-Tech Data. Development of a digital twin by intersecting – in real-time – a multitude of local and global data, related to the Easter Bush research expertise (in terms of food species genetics, animal diagnostics, livestock epidemiology and One Health) and in collaboration with AgriEPI, Agrimetrics and CIEL, to benefit from where there is synergy, and through pursing opportunities including UKRI's ISCF and GCRF call Transforming Food Production Fund and subsequent calls – current productivity

levels can be increased by having *the right food species and products in the right field at the right time;* and,

- Catalysing and enhancing adoption and translation of data-driven innovation in agriculture sciences through the creation of focussed activities in data-driven breeding in livestock and crops, aquaculture genetics and health, veterinary epidemiology, animal medicine and veterinary diagnostics.

Through these developments the Hub will interface and build on established local, national and international animal health and agribusiness partners to access and produce more datasets and research activity – achieving international recognition and respect as a robust and reliable data haven, integrated with world-leading compute, analysis expertise, and translational routes to maximise impact. In time the Hub will expand its relationships with farmers and whole food supply chain - in collaboration with other established and complimentary UK Agritech Centres (CIEL, CHAP, AgriEpi, & Agrimetrics) and farmer-facing organisations - to maximise on-farm innovation capabilities by providing cross-hub collaboration across world class informatics, robotics and satellite technologies. It will do so through developing synergies with the other DDI Hubs within UOE, and external agencies, to enable the Hub to develop analytical processes and strategies to enable more accurate and rapid decision making from the farmer to the consumer.

3 Project Description

3.1 Opportunity Realised through the Vision

3.1.1 Agri-Tech Opportunity

The world is changing faster than ever. New technology is creating new industries, changing existing ones and transforming products and services. Described as the Fourth Industrial Revolution, change is of a scale, speed and complexity that is unprecedented. It is characterised by a fusion of technologies – such as artificial intelligence, high-throughput screening, gene editing and advanced robotics – that is blurring the lines between the physical, digital and biological worlds. It will disrupt most industries and have a global impact creating new opportunities and challenges for our society.

Agri-Tech is central to this transformation, both in its growing dependence on multiple, large if not massive datasets and the potential to deliver a sustainable, carbon zero food supply to adequately nourish the growing world population. The Hub will contribute to this sustainability goal through focussing on the Future Food and One Health sectors, addressing global needs to achieve zero carbon livestock (part of the zero-carbon food chain) and markedly reducing infectious diseases in farmed animals.

The value of data comes from its use in real time, or aggregation over long periods, to understand and predict behaviour. While data is becoming ubiquitous, the challenge is to use this data effectively to shape, develop and deliver innovative products and services throughout the food supply chain – from the pre- and on-farm sector to consumers. The aim of the Hub will be to utilise data to produce the talent, knowledge and IP pipeline at the early stage of the agritech innovation funnel, driving entrepreneurial and adoption activities through external partnerships in the digital, life science and food and drink sectors and interfaces with the public, livestock, wildlife and the environment.

DDI has the potential to be a key pillar of 21st century growth by significantly enhancing productivity, resource efficiency, economic competitiveness and social wellbeing. In harnessing such opportunities, the Edinburgh and South East Scotland Science and Innovation Audit[15] (SIA) identified that:

- The City Region is already a DDI **powerhouse;** with the largest concentration of animal science research related expertise in Europe with world leading schools in veterinary science and informatics. Key research capabilities lie in genetics and systems biology, underpinned by informatics and engineering strengths. Specifically, Edinburgh leads the UK livestock and aquaculture genetics research expertise;

- Growth in DDI is at a **tipping point** and requires further investment to meet demand and deliver its potential specifically where data underpins science and policy to coordinate a common approach that addresses human, animal and ecology in balance and globally;

[15] https://www.gov.uk/government/publications/science-and-innovation-audits-first-wave-reports

- There are several **industry sectors** that are key to the local economy and which align to national and global areas of focus including food production and associated infectious diseases; and,

- Realising such DDI opportunities are most likely to generate sustainable socio-economic benefits and support **inclusive growth.**

3.1.2 Easter Bush Vision

The DDI Programme vision is to establish the Edinburgh and South East Scotland City Region as the Data Capital of Europe. This will be achieved by playing to the City Region Deal partners' strengths in education and research, as well as significantly boosting commercial activity. Easter Bush will contribute to this vision becoming an internationally recognised **Agri-Tech innovation destination of choice for the public, private and third sectors**.

Agriculture is a well-established and important UK sector. The entire agri-food supply chain in 2018, from agriculture to final retailing and catering, is estimated - as detailed at Table Three below – to have contributed £121 billion or 9.4% of UK GVA.

Table Three: Total Agri-Food Sector GVA[16]

2018	£ billion
Agriculture and Fishing	£10.4bn
Food and Drink Manufacturing	£28.6bn
Food and Drink Wholesaling	£14.5bn
Food and Drink Retailing	£30.6bn
Non-Residential Catering	£36.9bn
Total	**£121.0bn**

Based on the farm-gate value of unprocessed food in 2018 the UK supplied just over half (53%) of the food consumed in the UK. The leading foreign suppliers of food consumed in the UK were countries from the EU (28%) with Africa, Asia, North and South America each providing a 4% share. The ability to source food from a diverse range of stable regions is a key focus of UK government policy on food security.

[16] https://www.gov.uk/government/publications/food-statistics-pocketbook/food-statistics-in-your-pocket-summary.

Agri-Tech, through data-driven innovation, is now poised to transform this sector enabling UK and international farmers, and related industries, to provide food security while accelerating the path to zero carbon in the agriculture sector. This can be achieved by innovation in systems biology approaches to providing the 'right' genetics, vaccines, diagnostics and epidemiology to work in partnership with on-farm innovation. The Hub at Easter Bush is structured to provide the upstream drivers for the sector, initially through innovative livestock genetics, subsequently broadening into crops and on-farm through strategic partnerships. Increasing international engagement will attract additional capacity and encourage international businesses to 'land' in the local ecosystem.

The UK Government Industrial Strategy[17] identifies the data revolution and clean growth as two of its four Grand Challenges – both highly relevant to Agri-Tech DDI. The strategy prioritises industrially relevant R&D that will require more suitably skilled graduates and postgraduates.

As part of the UK strategy for agricultural technologies four Agritech Centre have been established and investment provided to transform food production. Easter Bush will actively partner with these Agritech Centres to collaborate with their membership across the whole agri-food chain, utilise their satellite farm network and enable research science into practice. This partnering, in addition to that with other local strategic partnerships (e.g. The James Hutton Institute, Scottish Aquaculture Innovation Centre) will ensure the stepwise transformation of agri-science research into agri-business.

3.2 Current Position – world leading but further investment needed

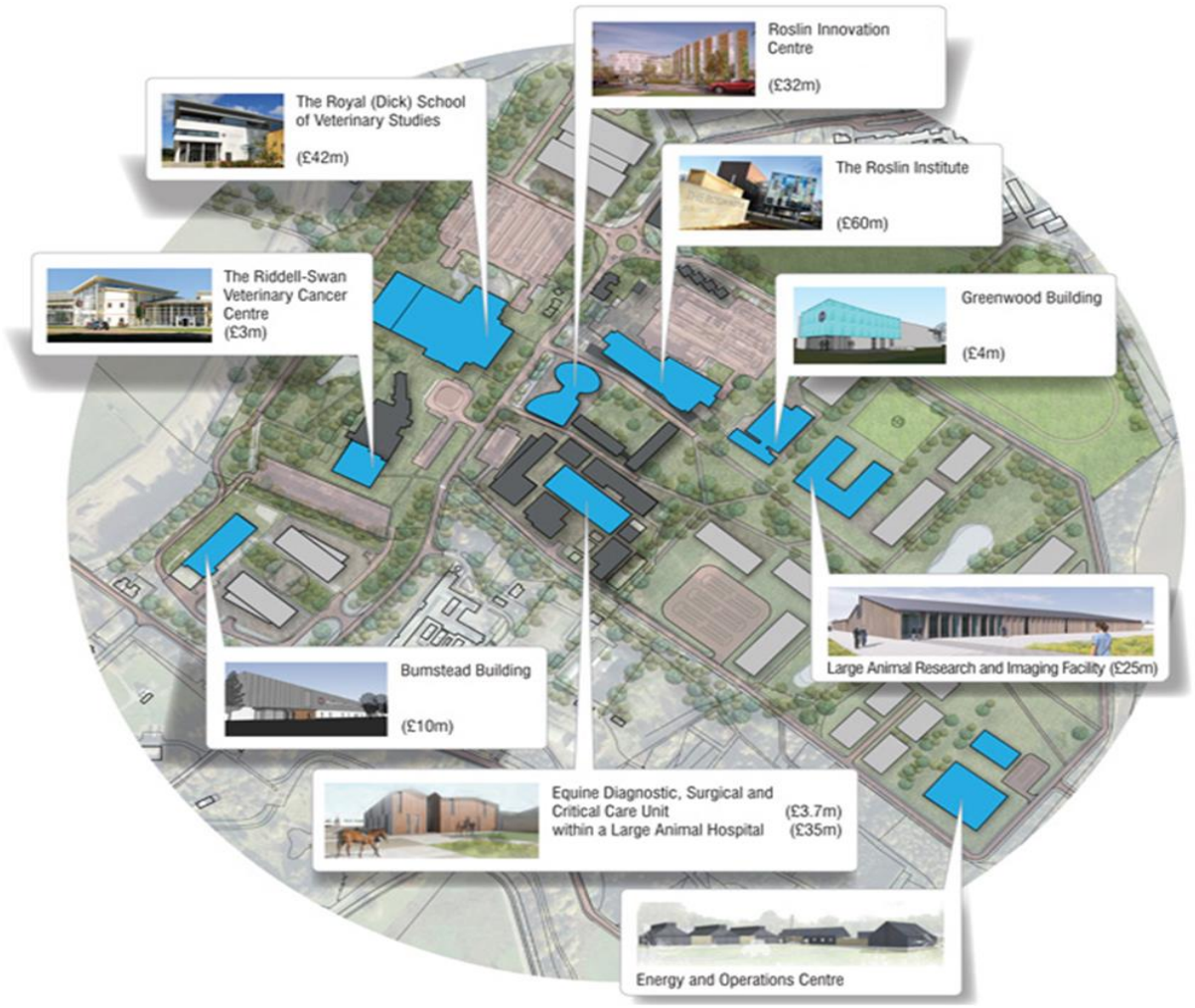
"We have Edinburgh as kind of a world capital for livestock health and genetics", Bill Gates, House of Lords, 10 November 2014.

As outlined, in Figure Two, the Easter Bush Campus provides a dynamic and vibrant home - with world class facilities equipped with the latest technologies - to over 1,000 scientists, lecturers and clinicians as well as co-locating industry business partners across animal biosciences and food security. It is the academic home for animal science within Scotland and is Europe's largest concentration of animal science research expertise.

[17] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf

Figure Two: Easter Bush Campus

(The values in Figure Two represent the levels of capital investment already committed to expanding the Campus over the last ten years).



The focal points of the campus are the Royal (Dick) School of Veterinary Studies (RDSVS), Roslin Institute and Scotland's Rural College (SRUC):

- The **RDSVS** aims to benefit society and the environment by educating veterinary surgeons to become members of world-wide public and professional health care teams and to advance veterinary and comparative medicine through research into disease and disease processes with the goal of improving the health and welfare of both animals and human beings;

- The **Roslin Institute** is perhaps the foremost animal research institute on the international stage and aims to improve the lives of animals and humans by applying world class research in animal biology through Blueprints for Healthy Animals, Control of Infectious Diseases and Improving Animal Production & Welfare; and,

- **SRUC** delivers comprehensive skills, education and business support for Scotland's land-based industries, founded on world class and sector-leading research, education and consultancy to the agriculture and rural sector.

The RDSVS, Roslin Institute and SRUC together achieved the top Research Excellence Framework ranking (first by research power, REF2014) for agriculture and research in the UK. The Easter Bush Campus is the location for:

- The recently formed **Global Academy for Agriculture and Food Security** (GAAFS), which brings together academics from across the University and partner institutions to work on this complex global challenge by applying systems thinking and data skills to agriculture, food and environmental security. GAAFS's multidisciplinary format provides academic leadership in the interplay between farming and the environment to input into policy and social dialogue;

- **The Roslin Innovation Centre.** Initially funded by the BBSRC, Scottish Enterprise and the University of Edinburgh, the Centre is a gateway for businesses to engage with the scientific output of the Easter Bush Campus by aligning with Campus research strengths in genomics for breeding, epidemiology and animal health. The Roslin Institute, as a BBSRC supported research Institute, synergistically aligns with other BBSRC Institutes such as John Innes;

- The Bill and Melinda Gates Foundation-funded **Centres for Tropical Livestock Genetics and Health** (CTLGH) and **Supporting Evidence-Based Interventions** (SEBI) initiative; and,

- The Easter Bush Campus hosts major facilities within two Innovate UK Agri-Tech Centres' portfolios - the **Centre for Innovation and Excellence in Livestock** (CIEL) and the **Agricultural Engineering Precision Innovation Centre** (AgriEpi). The former delivers global livestock production and product quality research to enable improved food quality and farming systems, while the latter explores how to optimise the performance of the highly complex production and processing systems in agriculture. Both are key partners for driving adoption and enterprise activity in the sector.

Finally, located adjacent to the Easter Bush Campus, the **Moredun Research Institute** is internationally recognised for work on infectious diseases of sheep and other ruminants.

This combination of capabilities, providing a scale unique within the UK, together with the internationally recognised academic leadership available, provides a platform for world-class teaching and training of the next generation of Agri-Tech students, practitioners and entrepreneurs.

3.3 Creating Easter Bush as the Agri-Tech Destination of Choice

3.3.1 Expand and Diversify Teaching Provision

The Wakeham review identified agriculture, animal and food sciences as lagging behind other sectors in the level of technical training of their workforces[18]. If the benefits of the Agri-Tech data revolution are to be realised it is vital that agri-food professionals are skilled and confident in data acquisition, handling, interrogation, application and data-driven innovation. A key aspect of the Hub vision will be to diversify and proliferate training capability to provide the talent pool needed to deliver Agri-Tech DDI. Through partnership and active involvement of the commercial pre-farm sector, talent development will be structured to provide targeted up-skilling and delivery to specific sector needs.

3.3.2 Grow Emphasis in Research Topics

Excellence in research underpins the delivery of training at Easter Bush. To enable a stepwise increase in research and innovation output a range of topic focussed DDI initiatives will be developed to complement, build on and grow the current campus research capabilities undertaken by the:

- **Centre for Aquaculture Genetics and Health** – providing world leading teaching, training and knowledge exchange in aquaculture genetics and health research, supported by new strategic partnerships with world-leading companies across the Future Food and One Health agenda;

- **Centre for Data Driven Breeding** – delivering training, research and a translation hub for animal and crop breeding globally (in collaboration with wider University partners in Geoscience and School of Biological Sciences) targeting both Future Food and One Health agendas;[19]

- **Epidemiology Centre for One Health and Sustainable Development** – transforming veterinary epidemiology and population medicine through the development of people-centric analytics to solve planetary One Health challenges (in collaboration with wider University partners in Geosciences); and,

- **Centre for 'Net Gen' Veterinary Diagnostics** – developing novel diagnostic tests to transform veterinary patient care globally through quicker diagnosis enabling disease mitigation and animal welfare delivery. This will enable collaborative activity with the wider College on "One Health", with many of these discoveries also impacting on human health, particularly those in zoonosis.

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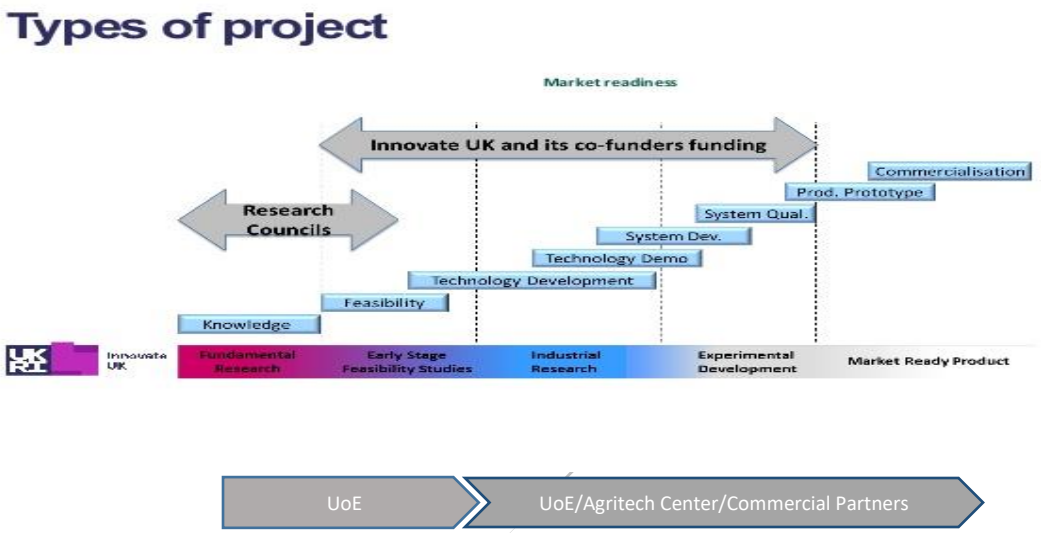
[18] In regard to these sectors the review suggested that while: *"The existing data is not sufficiently detailed to allow certainty about the situation now and the pace of change in the industry is likely to place new pressures on both HE and the industry to match demand with the supply of appropriately skilled graduates".* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/518582/ind-16-6-wakeham-review-stem-graduate-employability.pdf

[19] Which as a recent IP Pragmatics Market Analysis Report suggests: "*As for the core offering of the CDDB, within the context of industries that have growing demands to produce 'more from less', it was unanimous across the companies and other organisations we received feedback from that the Centre's data analysis software, tools and expertise would be beneficial to their work and aims. Quantitative genetic approaches are beginning to impact in these industries and the CDDB could become a leading global centre of excellence".*

As illustrated in Figure Three the research in these Centres will primarily be directed at fundamental research innovation and early-stage feasibility studies (i.e. technology readiness levels 1-3). The science will be transformed into practices by harnessing the knowledge exchange and entrepreneurial ecosystem surrounding Easter Bush Campus (through strategic partnerships and collaboration with commercial partners, globally-leading research organisations and the Agritech Centres) to enable proof of concept in real life conditions (i.e. technology readiness levels 4-7).

Figure Three: Research to Commercialisation Eco-System



3.3.3 Expanding Business Opportunities

Enhanced research excellence, output and profile will provide both the 'magnet' and basis for transformative DDI commercial activity particularly in the fields of genetics, biotechnology, and health applied to both terrestrial agriculture and aquaculture The Roslin Innovation Centre - through the provision of a supported flexible working environment at Easter Bush – will act as the gateway to facilitate a growing community of collaborators in Agri-Tech commercial activity.

Current tenant collaborators cover a mixture of 16 start-ups and SMEs (i.e. Abacusbio Ltd, Agrenta Ltd, Beta Bugs, Casta Spes Technologies Ltd, Censo Biotechnologies Ltd, Cytochroma, Green Bioactivies, Greengage Enlightened Farming Ltd, Ingenza Ltd, Kajeka Ltd, Hendrix Genetics, MV Diagnostics Ltd, N2 Pharmaceuticals Ltd, Roslin Technologies Ltd, Synpromics Ltd and Tropical Animal Genetics Ltd). The success of securing these 16 partners within 18 months of opening[20] highlights the opportunities available within the sector for collaborative campus-based growth.

[20] With a current ambition to extend this to over 30 partner tenants during the next 2 years.

The collaboration potential offered by the Roslin Innovation Centre is also enhanced by the 50+ commercial animal health and agribusiness collaborations[21] that have been nurtured on the Campus over recent years and provide (potential) access to various relevant datasets.

Agri-EPI Centre will host and expand its national support ecosystem offering locally to businesses aligned with its mission and objectives, focusing on IoT, technology, robotics and novel systems of production. It has just opened its Hub and already incubates 4 companies, with ambition for many more. Linking with Agrimetrics at-market business model will add additional value at the higher TRL level of data integration solutions, and securing mutually beneficial revenue streams through its data marketplace model.

3.3.4 Inclusive Growth

The Campus is also home to the **Easter Bush Science Outreach Centre** (EBSOC) that provides experience of real-life science in a purpose-built teaching laboratory. EBSOC provides workshops/experiences that are linked to both the SQA Curriculum of Excellence and Scotland's developing the Young Workforce (DYW) Programme. In collaboration with local education authorities and community groups the EBSOC will extend School, College, Family & Adult Learning Programmes to cover a wider range of DDI Agri-Tech science activities, as well as develop on-line interactive activities to reach rural communities in the Region and elsewhere in the UK. In addition the University is actively involved in Midlothian Councils plans to develop a STEM High School adjacent to Easter Bush offering substantial opportunities for further knowledge exchange within the local community.

3.4 Easter Bush Agri-Tech Hub

Globally the demand for food will grow disproportionately as more countries emerge from poverty and their populations can afford diets higher in protein. Infectious diseases remain a key impediment to animal production and welfare, not least owing to the rise of drug resistance and zoonoses in farmed animals that, in turn, exert high societal and economic costs.

This disease burden is not only felt by the farmers and their communities. Around 60% of all human diseases, and 75% of all emerging infectious diseases are zoonotic amounting to economic losses of $6.7b annually [22] (due to zoonotic outbreaks between 1997 and 2009).

Agriculture is the largest consumer of antibiotics globally with an estimated 67% usage[23]. The industrialisation of livestock production has driven the rise of intensive farming in confined spaces and reliance on routine antibiotic use for disease prevention and growth promotion (rather than for therapeutic treatment of sick animals). This overuse and misuse is a key contributor to Antimicrobial

[21] As detailed in Appendix E.

[22] The World Bank 2012: People, pathogens and our planet, the economies of One Health (https://openknowledge.worldbank.org/handle/10986/11892)

[23] PNAS 2015: Global trends in antimicrobial use in food animals (https://www.pnas.org/content/112/18/5649)

Resistance (AMR) which is estimated to cause 700,000[24] human deaths each year globally. In addition, unwanted microbial residue may be present in animal waste contaminating the environment further.

These challenges are all significant in their own right but need to be addressed in a world with a changing climate and growing pressure on natural resources. Delivering and sustaining increased agriculture output will need to be balanced against UK zero carbon targets.[25]

In addressing these needs the Easter Bush Agri-Tech Hub will enable a **step-change in the scale and impact** of education (Talent), knowledge generation (Research through Data Driven innovation) and translation activities (Adoption and Entrepreneurship) – to grow the Agri-Tech data-driven talent pool, enhance the research ecosystem and DDI adoption across the sector.

At the heart of the Campus the Hub will comprise a number of entities that have data 'in their DNA'. As detailed below these entities comprise the Centre for Aquaculture Genetics and Health, Centre for Data-Driven Breeding, the Epidemiology Centre for One Health and Sustainable Development, and the Centre for 'Next Gen' Veterinary Diagnostics.

3.4.1 Centre for Aquaculture Genetics and Health: "*providing world leading teaching, training, and knowledge exchange to support growth of aquaculture as a sustainable source of animal protein for human diets."*

Aquaculture is the fastest growing food production sector[26] and its importance is predicted to rapidly increase relative to terrestrial livestock in coming decades. The strategic importance of aquaculture is increasing at local and international levels, and it has a major role to play in addressing several of the UN sustainable development goals, in particular, as detailed in Section 4: Goal 2 (Zero Hunger) and Goal 14 (Life below Water). This focus also reflects the United Nations 2021 launch of its Decade of Ocean Science for Sustainable Development.

The use of modern technologies to improve aquaculture stocks is underutilised and has the potential to address several major production barriers across multiple sectors as highlighted in a recent United Nations Report on Aquatic Genetic Resources.[27] The University of Edinburgh already has a world-leading reputation in aquaculture genetics, and development of this Centre will build on this to deliver a step-increase in research output, commercial partnership, education and training, intellectual property generation and entrepreneurship. The CAGH will be co-developed via public-private strategic partnerships with four major aquaculture genetics entities (Hendrix Genetics, Benchmark PLC, Centre

[24] HM Government 2019: Tackling antimicrobial resistance 2019-2024 https://www.gov.uk/government/publications/uk-5-year-action-plan-for-antimicrobial-resistance-2019-to-2024

[25] *" As the UK prepares to leave the EU, greater competitive pressures are likely to be exerted on the* (agriculture) *sector. New ideas and practices will be essential to enable a move towards low emission and high productive farming"*. https://www.theccc.org.uk/wp-content/uploads/2017/11/Letter-to-Rt.-Hon-Michael-Gove-MP-Agriculture-and-Natl-Environment-November-2017.pdf

[26] *"Aquaculture continues to grow faster than other major food production sectors although it no longer enjoys the high annual growth rates of the 1980s and 1990s (11.3 and 10.0 percent, excluding aquatic plants). Average annual growth declined to 5.8 percent during the period 2000–2016"* http://www.fao.org/3/i9540en/I9540EN.pdf

[27] *"There are proven genetic technologies that have generated significant production gains, particularly from well-managed selective breeding programmes, but adoption of these technologies is relatively slow, limiting their impact on global aquaculture production to date".* http://www.fao.org/3/CA5256EN/CA5256EN.pd

for Aquaculture Technologies and Worldfish) These companies will provide substantial seed funding to catalyse the expansion necessary to capitalise on the opportunities provided by the increasingly technology and data-driven aquaculture innovation landscape

A core goal of the Centre will be improving genetics and health in finfish, crustaceans and shellfish. This will be achieve by tackling major infectious diseases through new breeding technologies, especially gene editing and genomic selection. CAGH will also enable a marriage between these biotechnologies and the step-change in applications of digital technologies such as computer vision diagnostics and sensor-driven aquaculture farm systems. Combining the use of advanced digital technology with our well-established genetics and biotechnology research will provide a global USP for the local region as the aquaculture industry "transformers" over the coming decade.

The CAGH will provide the infrastructure and long-term capacity to enable this step-change in research, training, innovation, knowledge exchange, and entrepreneurship by:

- Significant expansion of aquarium infrastructure, including the Aquaculture Genetics Research Facility developed in collaboration with AgriEPI, or to include high-throughput invertebrate (shrimp, oyster) phenotyping capabilities to support genetic improvement of seed stock;

- Enhancing capabilities for marine aquaculture research and innovation by facility development and partnership including with St. Abb's Marine Station and Agri-Epi for major 3rd party investment into marine disease challenge and data capture technologies;

- Strategic partnership with aquaculture companies sharing the common vision of CAGH as a vehicle for translation of research outputs and intellectual property into practice to generate revenue;
- Increasing entrepreneurial activity in aquaculture genetics and biotechnology via spin-off and incubator activity, including links to the FAST scheme and Roslin Innovation Centre; and,
  .
- Transformation of teaching and training capabilities in aquaculture to develop a talent pipeline through development of an aligned MSc course, together with CPD activities targeted at strategic and local commercial partners.

3.4.2 Centre for Data-Driven Breeding (CDDB): "*delivering world leading training, research and a translation hub for animal and crop breeding globally."*

Modern genetic improvement of both livestock and crops depends heavily on data science but the two domains use different approaches. In crop breeding transgenic and molecular technologies have increased the importance of molecular genetics to the detriment of quantitative genetics. In livestock breeding the success of genomic selection has enhanced the importance of quantitative genetics with transgenic and molecular approaches still to make a significant impact.

The Centre will focus on innovation directed at the next generation breeding to capitalise on technology advances in sequencing and –omics to form the base for progression to Breeding3.0.[28]

This will involve building upon the success of the previous decade by: expanding genome-enabled selection to additional species; establishing new traits through genetic improvement for all species; and, more complex models for predicting phenotype from genotype and environmental variables. These and other technologies are expected to enhance productivity, sustainability and profitability while improving animal well-being, health and overall fitness.

The application of current and emerging genomic, proteomic and metabolomic technologies from human and model species will improve annotation of agricultural animal genomes and identification of functional variants and provide information that can be used to develop strategies that improve animal production, including:

- Predicting the effect of functional variants that are responsible for desired variation for a wide diversity of breeds to meet a range of target environments;
- Improving animal productivity through better understanding of the structure and function of animal genomes and genome biology to accelerate economically important traits and reduce the effects of animal disease;
- In-depth understanding of genome biology to effectively implement selection and expand the capacity to characterise and measure phenomes;
- Developing genomic tools, technologies and resources for agricultural crops and livestock;
- Advancing biotechnology to improve sustainability and efficiency; and,
- Characterising and preserving genetic diversity for future animal production.

These strategies create the opportunity to develop data science for genetic improvement with a unified, transformative approach to crop and livestock breeding. The Centre will realise this opportunity through the co-location of established research expertise in The Roslin Institute, SRUC, CTLGH, GAAFS, RDSVS, and strategic partnerships with leading commercial livestock companies (e.g. Aviagen, Genus) and crop breeding (e.g. Bayer Crop Science). Adoption and Entrepreneurial activities will build through strategic partnerships (e.g. with the James Hutton Institute and John Inness Centre).

Such partnerships are central to research activity, training platforms and translational output. Breeding organisations provide access to breeding and genomic datasets. This a precious resource for research in quantitative genetics and artificial intelligence that supports breeding theory and breeding programme design, not just because these datasets represent multi-billion pound investments by

[28] USDA blueprint for animal genome research 2018-2017: Frontiers in Genetics May 2019. https://www.ars.usda.gov/ARSUserFiles/02080000/Animal%20Genome%20to%20Phenome%20Executive%20Summary.pdf

these companies, but also because without such datasets there would be no way to test new developments in crop and livestock Agritech.

Functioning through "a virtuous circular network" – CDDB allows organisations to adopt more effective breeding program designs, fuelling demand from organisations that breed other species, enabling access to new breeding and genomic datasets that will support further research. While upstream connections create the necessary conditions to access the diverse and large datasets that industry produce, downstream connections bring opportunities for exploitation through training, adoption and entrepreneurial activity.

The CDDB will provide the infrastructure, which cannot be obtained by a series of research grants, to underpin the:

- Development and delivery of (i) training for the academic and agricultural workforce required for application of genomics technologies; and (ii) the infrastructure for collection, storing, analysing, and sharing huge volumes of genomic, pedigree, and trait data;

- Equipment and infrastructure for the creation of genomic resources, tools and materials, functional genomics;

- More effective organisation of activities by:

    - Including cross-hub working and engagement with Agritech centres and multiple commercial partners;

    - Ensuring that decision makers and partners understand the benefits and implications of genomic data science (KE-hub); and,

    - The development, deployment and sharing of data for applied research and translation.

- Infrastructure, capacity building, and training that will provide a platform to build and secure additional research funding more effectively.

3.4.3 Epidemiology Centre for One Health and Sustainable Development (ECODe): *"transforming veterinary epidemiology and population medicine through training and research in systems-based approaches and human -centric algorithm design to solve One Health and planetary health challenges."*

ECODe aims to strengthen animal, human and public health at their interface and inform animal and public health policies that support and enhance sustainable development. ECODe will integrate multiple data streams generated from the lab, the field and the farm, with statistical and quantitative modelling techniques on a secure data platform to promote intelligent information sharing and decision-making. The ECODe mission is to co-construct, with end-users and beneficiaries, locally- and

culturally-appropriate data-driven strategies aimed at improving resilience and timely responses to emerging and existing One Health and Planetary Health risks.

ECODe will address intergenerational global-health challenges (such as AMR, climate change-related disease risks and chronic non-infectious diseases), as well as (re-)emerging sanitary crises (such as infectious zoonotic, transboundary animal diseases and foodborne disease outbreaks) which have direct and indirect impacts on human and animal health, food security and sustainable development.

An important and unique feature of the Centre is the synergistic relationship between multi-disciplinary, multi-sectoral networks of expertise across *academia, policy, industry and practitioners*. The Centre will bring together subject experts in epidemiology (e.g. molecular/genomic, clinical, nutrition, field and public health epidemiology) with biologists, pathogen experts and vaccinologists and experts from the humanities and social sciences, to undertake a systems approach to risk assessment at multiple levels of causation (e.g. sociodemographic, clinical and biological), risk management and risk communication.

The Centre will offer a multi-level career-track programme, promoting research and teaching in epidemiology, statistics, quantitative modelling, population medicine and veterinary public health policy. Training provision will be across undergraduate, postgraduate, CPD and short courses to deliver talent into the veterinary, public and one health/planetary health landscapes. The Centre's outbreak science and policy programme will provide policy- and decision-makers, as well as students and academics from other fields, the opportunity for training in risk assessment and outbreak preparedness and response.

ECODe will work closely with the EIDF and external partners – building on strategic links internationally with intergovernmental agencies, NGOs and private funders and data providers as well as within Scotland and the UK (including the Animal and Plant Agency (APHA), Scottish Government Animal Health and Welfare Division, Department for Environment, Food & Rural Affairs (Defra) and industry organisations such as the Agriculture and Horticulture Development Board (AHDB).

ECODe will provide the organisational capacity and infrastructure to consolidate what would otherwise remain disparate and potentially fragmented sources of data and human/veterinary population medicine and epidemiological expertise and intelligence across Easter Bush and University. ECODe aims to turn One Health evidence into action through a series of activities including:

- Building capacity through provision of research-led veterinary epidemiology and data analysis training, education and CPD for veterinary and non-veterinary undergraduates, postgraduates and government and industry professionals;

- Strengthening multi-sectoral partnerships in academia, industry and policy to develop and implement culturally appropriate One Health technical and social solutions;

- Improving outbreak planning and preparedness through the use of existing data (e.g. ScotEID) and modelling tools to respond to emerging One Health threats;

- Developing new frameworks and approaches for systems epidemiology that combine knowledge within and across disciplines to respond to adaptive One Health challenges such as AMR and emerging zoonoses;

- Developing and strengthening new and existing decision-support tools to translate policy aims into operational objectives for public health benefits by:

    - *Assisting* decision-makers explore and communicate changing policy scenarios, while questioning the socially-produced basis of these changes;

    - *Identifying* most effective and least harmful interventions to achieve veterinary public health policy aims;

    - *Evaluating* and *translating* evidence for decision-makers to improve long-term resilience to infectious zoonotic /animal disease outbreaks, food security threats and biosecurity concerns (including release of GM crops, live vaccines, and biological control strategies); and,

    - *Providing* training in science and risk communication and dissemination.

3.4.4 Centre for 'Next Gen' Veterinary Diagnostics: "*supplying state-of-the-art veterinary care to animal owners."*

Many production animal diseases cannot be accurately diagnosed. Similarly assessment of treatment efficacy and prognostication remains suboptimal for many veterinary conditions. Consequently there is a strong and unmet clinical need to develop superior diagnostic assays for the veterinary sector.

Focussing on cage/field side diagnostics, digital pathology and application of innovative genetic markers, animal patient care will improve through 'next gen' diagnostic interventions and enable the development of novel therapeutic interventions and disease preventative strategies. Telemedicine and 'virtual patient care' approaches will be deployed, initially across the City Region, before roll-out nationally and internationally. In parallel this activity will provide the innovative ecosystem to training and upskill the talent pool for this sector and drive the development of commercial activity.

With the growth of the livestock sector there is a greater need for more sensitive, specific and high-throughput diagnostics for better detection and management control of animal health & welfare caused by disease. This can be met by molecular diagnostics, and the discovery of biomarkers with proven clinical utility, to identify multiple pathogens quickly in animal patients. In turn the advances in biomarker discovery is reliant on multi-omics data which includes genomics, transcriptomics, proteomics, metabolomics and epigenetics to help understand pathogens and their hosts.

Easter Bush is well placed to lead on next generation veterinary diagnostic by utilising the EIDF to analyse the big data sets required for biomarker discovery and providing a route to gather clinical utility data by developing a transparent and ethical biobank infrastructure (to ensure ethically

approved clinical samples whose clinical history is well known and can be interrogated). Activities will include:

- Whole genome sequencing, flow cytometry and mass spectrometry;
- Developing better tools to accurate diagnosis disease outbreaks in the field and to link this data into our epidemiological modelling infrastructure;
- Generating a large volume of clinical samples which can be interrogated in future research programmes;
- Assays focussed on metabolite measurement and diagnostic tools which better phenotype the entire patient holistically;
- Academic collaborations to develop the Immune Toolbox to support diagnostic and vaccine development;
- Strategic relationships with commercial animal health companies to gain market adoption and next generation collaborative research; and,
- Collaborating with non-traditional partners, notably in the area of chemistry, physics and engineering. These partners offer excellent opportunities to develop technologies such as novel optical probes and sensors that will allow diseases to be better phenotyped in-situ and treatment complications to be detected earlier.

3.4.5 Conclusion

The Centres highlighted above build on the core skills and relationship established at Easter Bush and will lead on collaborating across the other hubs and schools to develop awareness of agriculture, livestock and aquaculture research. This will ensure that Easter Bush can maximise value from world leading innovative research in artificial intelligence, machine learning, robotics and satellites that can advance on-farm technology across the food value chain. This will include developing relationships with technology commercial innovators entering the AgriTech sector and through farmer-facing organisation such as Scottish Agricultural Organisation Society (SAOS), Scottish Salmon Producers' Organisation and the National Farmers Union.

The research excellence applicable to agritech across the University of Edinburgh is summarised in Table Four.

Table Four: Relevant Agri-Tech Research Capabilities

Agritech sub-sector	Location of research capabilities at UoE.
Agricultural systems, ecology and soil science	Global Academy of Agriculture and Food Security, School of Geosciences, School of Biological Sciences

Land use, environmental and agri-food systems	Global Academy of Agriculture and Food Security, School of Geosciences
Climate Change impacts, adaptation and mitigation	Global Academy of Agriculture and Food Security, School of Geosciences, School of Engineering, School of Chemistry
Agricultural and natural resource economics and sustainability	Global Academy of Agriculture and Food Security, School of Geosciences
International law and governance of natural resources	Global Academy of Agriculture and Food Security, School of Law
Data Science, Mathematical modelling and decision support	Global Academy of Agriculture and Food Security, The Roslin Institute, R(D)SVS, School of Mathematics, School of Informatics
Innovation, regulation, policy and governance	Global Academy of Agriculture and Food Security, School of Social & Political Science, Innogen Institute (UoE/Open University collaboration)
Animal Science and livestock systems	Global Academy of Agriculture and Food Security, The Roslin Institute, R (D) SVS.
Veterinary public health, population medicine and animal health policy	Global Academy of Agriculture and Food Security, The Roslin Institute, R (D) SVS, Medical School.
Functional genetics and mathematical biology analysis in plant, livestock and aquaculture	The Roslin Institute, R(D)SVS, School of Biological Sciences
Understanding animal health development and disease	The Roslin Institute, R(D)SVS
Gene editing agri-science disruptive technology	The Roslin Institute, R(D)SVS
Alternative Protein disruptive technology	The Roslin Institute, R(D)SVS, School of Biological Sciences
Artificial Intelligence, Data Mining, Machine Learning and Blockchain	The Roslin Institute, School of Informatics
Satellite, GPS, EO, UAVs and Ag-Robotics	The School of Informatics, School of Engineering, School of Geosciences, School of Mathematics, School of Physics
Sensors and IoT	The School of Informatics, School of Engineering, School of Chemistry, School of Biological Sciences

3.5 How University and Partners will deliver their Vision

The proposed investment at Easter Bush will enable the creation of a stepwise transformation in Agri-Tech DDI. Achieving this vision will involve three distinct components:

1. **Addressing capability gaps:** to enhance and develop capabilities across the five key areas identified in the ESES SIA – Talent, Research, Adoption, Data and Entrepreneurship (TRADE);

2. **Organising activities effectively:** to create an effective operating model to successfully organise, optimise and execute all these activities, underpinned by the creation of robust governance with clear accountability and delivery plans, and;

3. **Strategic asset development:** through refurbishment and co-location to create the infrastructure and capacity for data-driven innovation, translation and adoption in agriculture and aquaculture to enable the stepwise expansion in delivery of training, research and industry engagement captured through the TRADE activities.

3.5.1 Investing in and addressing core capabilities and gaps: TRADE

Table Five illustrates the current campus baseline TRADE (and inclusion) position and the significant opportunities afforded by the Hub proposals to improve and enhance these capabilities.

Table Five: Easter Bush Agri-Tech Capability Assessment

Capabilities	Position	Journey
Talent	Data Skills across the Agri-Tech sector (students/professionals/public) are uneven	Embed data capability, enabling students, professionals and public to realise the value of data
Research	High quality interdisciplinary research capability	Increase interdisciplinary engagement with industry & third sector
Adoption	Strong partnerships with public sector and industry but not across whole Agri-Tech sector	Effectively bring together and link up the public, private and third sectors across the Agri-Tech sector
Data	Access to industrial and public data sets are in place but Agri-Tech data is difficult to integrate and interpret	Expand acquisition, curation and analysis of relevant data across the Agri-Tech sector which is easy to integrate and interpret
Entrepreneurial	Limited success with spin out activity, active innovation hub with collaborative companies in field co-located	Increased spin out activity with an expanded collaboration network within the co-located innovation hub
Inclusive Growth	Outreach activity in place for some components of Agri-Tech with a young people focus (Investors in Young People) and established activity recognised for equality within STEM (Athena SWAN Gold)	Increased outreach activity for all aspects of Agri-Tech - with expansion of activities for those with low science capital and /or rural communities. Continuation of young people and equality in STEM activities

3.5.2 Talent

There is an urgent demand globally for skilled workers equipped to help tackle global agri-food challenges. Several recent UK reports have identified a demand for more skilled agri-food scientists, with DDI/ICT skills being especially relevant including the 2012 sector UK Skills Assessment[29] (and the Agri-Skills Forum's Strategy, which draws on this Sector Skills Assessment).[30] To meet these needs DDI Agri-Tech courses will be developed and delivered through a range of teaching methods:

- Embedding data science and DDI in campus-based **BSc Agricultural Science/Agricultural Economics** and **BVM&S** degree programmes, by strengthening existing DDI-relevant courses and providing new DDI electives;
- Developing new campus based and/or online Cert/Dip/MSc programmes in **Applied Animal and Plant Breeding** and **Planetary Health Policy** or similar, with strong DDI bases;
- A **Distance Learning At Scale (DLAS) / Massive Open Online Courses (MOOC) series: "Digesting the Data"** across a range of key DDI challenges/opportunities;
- A series of **Continuing Professional Development (CPD) / Executive Education /summer school events** over a range of key Agri-Tech challenges/opportunities;
- **Open and Distance Learning (ODL) courses / 'classrooms in a box' for FE students / teachers** spanning a range of key Agri-Tech challenges/opportunities;
- **ODL courses / 'classrooms in a box' for high school students / teachers** covering a range of key Agri-Tech challenges/opportunities;
- **Doctoral programmes** in each of the three Agri-Tech TALENT theme areas; and,
- Delivery of an **extensive programme of events** for Agri-Tech professionals from across the City Region. This will encompass lectures highlighting data-driven research and exemplar projects in the practical application of data in Agritech.

3.5.3 Research

Research focussed activities within the Agri-Tech Data Innovation Hub will involve the:

- **Centre for Aquaculture Genetics and Health** – DDI research will focus on the interface of biotechnology, genetics and infectious diseases in aquaculture, by generating and hosting large-scale genomic and phenotype databases in collaboration with strategic company partners. The research strategy will include applications of advanced digital technologies with CAGH strengths in genetics and biotechnology to provide a global USP in this rapidly expanding field. Harnessing datasets across multiple aqua species to capture the diverse data impacting on the aquaculture ecosystem (enabled by the development of new invertebrate and marine research capabilities) will deliver genetic, biotechnology and agritech solutions to

[29] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/312548/briefing-paper-ssa12-agriculture.pdf)

[30] http://www.agriskillsforum.co.uk/.

overcome major aquaculture production barriers. In turn, the research outputs will support the rapid global growth of aquaculture as a sustainable source of nutritious animal protein;

- **Centre for Data Driven Breeding** will focus on integration and interrogation of large commercial crop and livestock datasets, which combined enable 'deep phenotyping', with the long term ambition to develop an accessible data platform which expands beyond breeding organisations to include other entities in the food production lifecycle including producers, food processors, supermarkets and animal welfare bodies;

- **Epidemiology Centre for One Health and Sustainable Development to** provide a home for UK and international datasets (public and commercial) on animal health (particularly livestock and infectious disease analytics) and a 'bridge' between animal and human health (One Health). The focus will be on improving data integration of animal health data, maintenance and further development of analytical models and tools, as well as providing quality assurance and support for the Agri-Tech sector. This will allow improved horizon scanning (e.g. evolutionary changes in pathogens, emergence of a new livestock disease threat) dynamic adaptive management of disease outbreaks (emphasising real time exploitation of data) as well as integration of human dimensions (behaviour, economic and social structure) that also influence likely disease emergence; and,

- **Centre for 'Next Gen' Veterinary Diagnostics** will deliver a diverse research agenda ranging from the agonistic interrogation of large datasets and clinical samples to identify novel targets through to specific, individual target led assay development which will, for the first time, quantify defined biomarkers.[31] Biomarkers are currently challenging to measure in standard clinical samples. The research will aim to develop detection modalities onto scalable and cost-effective platforms to ensure wide-scale industry uptake.

The data sets from the above can potentially be linked together within the **Agri-Tech Hub at Easter Bush** to maximise interdisciplinary opportunities and enhance TRADE objectives. In doing so, the AgriTech Hub will be both the driver for innovative research and the focus for external engagement and adoption. For example, dissemination of the latest developments in breeding strategies from the Centre of Data Driven Breeding could be modelled by the Epidemiology One Health Centre and/or utilised in the latest aquaculture research by the Centre of Aquaculture Genetics and Health.

3.5.4 Adoption

Agri-Tech aims to secure the food supply chain emerging from agricultural activities. To ensure maximum benefit is realised from the talent and research portfolio at Easter Bush three pathways to adoption will be established:

[31] Biomarkers are indicators of biological processes and pathological states that can reveal a variety of health and disease traits. Biomarkers are particularly relevant in medical and veterinary research where they have an important role in the characterization of human and animal diseases.

(1) Adoption by local and smaller commercial partners with direct benefit to ESES region, while looking for expansion and growth opportunities more widely.

Working with both Edinburgh Innovations and Roslin Technologies connectivity will be enhanced between Easter Bush and commercial players across the food supply, animal health and Agri-Tech sectors to drive adoption of data-drive innovation into the commercial Agri-Tech sector.

This will strengthen links with the two local nodes of the Innovate UK Agri-Tech Innovation Centres AgriEpi and Centre for Innovation Excellence in Livestock (CIEL), and co-location with leading small companies, such as Greengage and IceRobotics, and large Agri-Tech companies, such as Benchmark and Aviagen in the aqua and poultry sectors respectively. The majority of this activity will take place within the Roslin Innovation Centre located within the Charnock Bradley building at the heart of the Easter Bush Campus.

(2) Adoption by established, often international players.

Wider adoption of DDI research outcomes will be structured through Easter Bush's established interaction with international funding bodies, such as the Bill & Melinda Gates Foundation initiatives based at Easter Bush,[32] and the established links between the academic community at Easter Bush and international pre-farm gate companies such a Genus, Cobb Vantress, and Hendrix Genetics in the first instance and then through strategic partnerships expanded to on-farm and crop sectors.

(3) Adoption by local and wider societal stakeholder communities

To enable the wider use of data to drive insights, benefits and inclusive growth a range of community activities will be pursued through the Easter Bush Science Outreach Centre (EBSOC). EBSOC gives school pupils and community group's hands-on experience in a real laboratory setting. The Centre uses research-grade laboratory equipment to deliver interactive, curriculum-linked, learning experiences for pupils from 10 to 18, as well as workshops for community groups of all ages.

3.5.5 Data

The organisations and facilities hosted at Easter Bush Agri-Tech Hub, together with EIDF, will increase the ESES region's ability to access and utilise a combined pool of diverse Agri-Tech data assets in a trusted and safe environment.

Gaining convenient access to 'real' data is a recurring issue. The Open Research Data Task Force has recognised that several technical, cultural and behavioural issues require attention to make data sharing more accessible,[33] while the FAIR Guiding Principles for scientific data management and

[32] Supporting Evidence-based Interventions (SEBI) and Centre for Tropical Livestock and Genetic Health (CTLGH).

[33] https://www.universitiesuk.ac.uk/policy-and-analysis/research-policy/open-science/Pages/open-research-data-task-force.aspx

stewardship emphasises the need for data to meet standards of Findability, Accessibility, Interoperability and Reusability.[34]

The Edinburgh Parallel Computing Centre (EPCC) currently provides the infrastructure and support for the secure environment in which both current public and private Agri-Tech datasets are linked and accessed. There is a significant opportunity to build on this foundation through EIDF with the integration of a wide range of structured and unstructured Agri-Tech datasets relating to both local and international agriculture systems. By combining data from multiple sources and using these in a single analysis will enable co-analysis of multiple datasets increasing the statistical detection power for signals that are currently too faint to detect in individual datasets.

3.5.6 Entrepreneurship

A sustainable and growing Agri-Tech enterprise culture at Easter Bush will be established through (1) fostering entrepreneurial endeavour; and, (2) providing an innovative ecosystem for emerging commercial activities.

(1) Fostering entrepreneurial endeavour

This will involve identifying, enabling and growing new Agri-Tech talent and facilitating new connections and supporting emerging commercial Agri-Tech activities in collaboration with the local ecosystem and Agritech centres to foster growth and impact through their national and international members by providing the space and ecosystem to innovate through a range of activities, including:

- **Venture Studio within** the Roslin Innovation Centre at Easter Bush. Termed the **FAST for Food and Agriculture Science Transformer** this will be first venture studio in Scotland and the first food and agriculture venture studio in Europe. The recently established FAST programme is structured to enhance the likelihood of producing innovative, high-value Agri-Tech companies within the ESES region. Through the current year activity, FAST (funded by the BBSRC and Roslin Foundation) three initial areas are being piloted: regenerative aquaculture, pollinator enforcement and controlled environment agriculture;

- **Hackathons/Plotathons** based around specific Agri-Tech challenges in partnership with other UoE DDI Hubs, these events will identify and empower budding entrepreneurs, from within the Region, to develop their business propositions and progress to commercial activity within the Roslin Innovation Centre or elsewhere with the ESEC commercial infrastructure; and,

- **An Entrepreneur Club** to upskill individuals through a series of bespoke interactive events that focus on networking, emotional intelligence, marketing as well as understanding of funding for enterprise and pitching events – with the aim to help individuals towards commercial activity or spin out a company.

[34] https://www.go-fair.org/fair-principles/

(2) Innovative ecosystem for emerging commercial activities.

The cohorts emerging from the Entrepreneur Club represent a 'ready-made' pool of talent for FAST. All companies created and supported by FAST, as well as existing tenants of the Roslin Innovation Centre and commercial players born out of the Hackathons/Plotathons, will also provide the inspiration and role models, as well as an informal supportive entrepreneurial ecosystem, for aspiring graduates, postdocs and individuals from the local community.

To further enhance this ecosystem and best exploit Agri-Tech opportunities support will be provided by the **Research Hotel.** Located within the Roslin Innovation Centre the Research Hotel currently provides established companies and start-ups with ready to use state-of-the art office and fully fitted out lab space with access to standard lab equipment. This facility will be expanded to support entrepreneurs and micro businesses that (successfully) emerge from the Hackathon, Plotathon and FAST activities

In addition a dedicated space called **the 'Makers Barn,'** tailored to facilitate co-production of innovative solutions for on-the-ground active small and micro Agri-Tech companies, will be developed to enhance the facilities offered at the Edinburgh hub of AgriEPI. This open facility will promote the interaction between community players, academics at Easter Bush and co-located Agri-Tech companies with the goal of developing new, better and/or less expensive products and services.

3.5.7 Inclusive Growth

The DDI Agri-Tech programme will allow the Campus to build upon and develop a wide range of existing inclusive growth and equality activities. Foremost amongst these is the Easter Bush Science Outreach Centre (EBSOC).[35] The current geographical reach across Scotland is extensive and, on a 2 to 3-day week capacity, in 2018-19 engaged over 3,500 pupils mainly from SMID 1-2 areas.

The DDI Agri-Tech programme provides significant opportunity to expand the operational capacity and remit of EBSOC (from an animal bioscience focus to a wider DDI Agri-Tech portfolio). It is the intention to increase the capacity of the EBSOC to 5 days a week over the next 2-3 years (funding dependant) with a focus on engaging regional areas with low science capital and/or restricted access due to their rurality. This expansion will dovetail and contribute to the development of a STEM focused High School adjacent to the Easter Bush Campus.

Capacity will also be extended through the "Public Engagement Public Lending Library" - a student-led public engagement activity co-ordinated by EBSOC staff. Students participating in the Agri-Tech Talent courses with a research element will be encouraged to shape a public engagement activity linked to their specific Agri-Tech research that can be communicated to school pupils and adults in the community. Agri-Tech students will receive mentoring and coaching from the EBSOC team in order to develop interactive, hands-on activities, to be placed in the lending library, which can be utilised by campus staff for any community events, science festivals, school visit or outreach events. In addition, as part of the Agri-Tech activity, it is proposed to expand veterinary outreach activities to the rural communities and those with limited ability to access Campus facilities.

[35] https://www.ed.ac.uk/easter-bush-campus/science-outreach-centre

Citizen science activity will also be expanded to involve the public with the collection, curation and analysis of data, so that communities can become actively involved and contribute to the DDI Programme.[36] This activity links into and complements more focussed projects with partners which seek to address social issues - for example the student led "All for Paws" vet outreach clinic for animals of homeless and vulnerably–housed people, which has resulted in partnership with Turning Point Scotland, NHS Lothian and the Grassmarket Community Project.

With regard to equality ambitions, the Roslin Institute is one of only nine research entities in the UK to achieve Athena SWAN Gold status, which recognises and celebrates good employment practice for women working in science, engineering and technology within the Higher Education & Research sector.[37] The principles of such practice will be embedded within the DDI Agri-Tech Programme, particularly impacting the Research and Adoption aspects. This will include woman acting as positive role models to early career scientists, provision of Carers Grants for staff with caring responsibilities when they attend conferences vital for career development, gender balance for all interviews and participation in "Coaching for Success", which provides individual career coaching for staff at key stages of their career.

Finally, the Easter Bush Campus was the first University body in the UK to hold an Investors in Young People accreditation at a Silver level.[38] Again the commitment the Campus has made to providing opportunities and experience for young people within the community will also be embraced within the DDI Agri-Tech Programme through a strong, positive and supportive culture on the campus, and access to training and development opportunities, including provision of both Foundation and Modern Apprenticeships.

3.5.8 Easter Bush Objectives and Key Performance Indicators

Table Six below highlights the high-level Agri-Tech TRADE objectives and KPIs over the 15-year lifetime of the CRD programme.

Table Six: DDI Agri-Tech Investment Objectives and KPIs

Theme	Investment Objective	KPIs
Talent	Create a vibrant learning environment which enables the Agri-Tech sector to realise the potential of their data	117,000 credit / non-credit bearing engagements (excluding CPDs below)
Research	Facilitate collaborative integrated research to deliver data- driven research that impacts the Agri-Tech sector	£116m research income

[36] Current examples of such engagement include the Scottish Beekeeping Society being actively involved with the Easter Bush apiary and the Dogslife project where citizen science is key to data acquisition.

[37] https://www.ed.ac.uk/roslin/work-study/award-winning-environment/athena-swan

[38] https://www.ed.ac.uk/easter-bush-campus/where-people-thrive/staff/awards/investors-in-young-people-silver-award

Adoption	Drive innovation through increased partnerships with the public, private and third sectors to address challenges in the Agri-Tech sector by linking of data	100 Company Interactions 24.000 DDI credit bearing CPDs and courses
Data	Through the acquisition and curation, analysis and adoption - increasing the translational power of the Agri-Tech datasets	To be monitored on an ongoing basis (but subject to appropriate information sharing agreements likely to include UK Government datasets in Agri-Tech and industrial partners depositing datasets for research, curation and analysis).
Entrepreneurship	Expand the growth of the Agri-Tech business activity through increased spin-out and co-location activity	30 new Agri-Tech Business activity Support to over 150 graduates in setting up or joining micro Agri-Tech companies
Inclusive Growth	Increased outreach activity for all aspects of Agri-Tech - with expansion of activities for those with low science capital and /or rural communities. Continuation of young people and equality in STEM activities	58,000 public interactions via outreach centre activity; retention of Athena SWAN Gold Status and Investors in Young People Silver accreditation; increase in rural community vet outreach and student led vet practice activity and 2 new lending library activities per annum

3.6 Organising Activities Effectively

Outlined below are the **key players** and **operating model** that will (both) support the delivery of these Agri-Tech TRADE and inclusion objectives.

3.6.1 Key Players

While the Easter Bush Campus is already a centre of excellence in the Agri-Tech field DDI investment will allow more and closer partnerships with several internal and external partners.

Internal partners within the University

The Edinburgh Medical School: is a "World Top 20" medical school in multiple league tables. Across its three Deaneries and five research institutes,[39] there are various opportunities to consolidate and develop Agri-Tech human-animal zoonotic "One Health" objectives. The Easter Bush Agri-Tech Data Innovation Hub will have particularly strong collaborative links and interactions with both the Usher Institute and the Institute of Genetics and Molecular Medicine, as well as actively participating in cross-cutting network activity such as Edinburgh Infectious Disease and Edinburgh Neuroscience.

Edinburgh Parallel Computing Centre (EPCC): is an international centre of excellence in all aspects of high-performance and data-intensive computing and will make available the EIDF in which all Agri-Tech Innovation Hub data will be housed.

Edinburgh Innovations (EI): is the University of Edinburgh's commercialisation division offering a wide range of services to assist researchers, students and industry drive innovation. EI will provide dedicated on Campus resources to support relevant Agri-Tech research, adoption and entrepreneurship activities.

[39] https://www.ed.ac.uk/medicine-vet-medicine/about/organisational-structure

School of Biological Sciences: there has been a longstanding EB Campus collaboration with the School of Biological Sciences (SBS), especially in the field of Animal Genetics (with the University celebrating 100 years of animal genetics research in 2019). Research in this School offers knowledge contribution to expanding impact in animal and crop based agriculture.

School of Geosciences: there has been an evolving collaboration in talent and research activity in order to address the challenges within agriculture, food security and planetary health. There are shared appointments in place between the GAAFS and Geosciences in order to deliver forward collaboration in these fields.

School of Informatics: Europe's largest centre for informatics and computing science research with over 250 academic and research staff and 1,400 students from 70+ countries. It is a world-leading research institution in Data Science and AI with a breadth and diversity that is at the forefront of new advances in the field. It will support the programme in various aspects of the TRADE objectives, including the support of research partnerships in health informatics.

Usher Institute: works with people, populations and their data to understand and advance the health of individuals and populations through innovative collaborations in a global community. Linkage will focus on One Health sector opportunities.

External partners

The Easter Bush Campus has well established regional partnership with local external partners:

Midlothian Science Zone https://midlothiansciencezone.com/about/. This includes a number of SME's in the Agri-Tech and Life Science field based within the Biocampus and Technopole, as well as the well- established nationally recognised research organisations of the Moredun Research Institute and SRUC. The Midlothian Science Zone creates a centre of excellence for research and innovation in animal health and life sciences, which has been instrumental for attracting and facilitating interactions between business and academia.

Heriot-Watt University, The Campus has established ongoing collaborations with the engineering department with a recent joint funded collaboration on the use of micro-sensors within vet diagnostics. The campus is at the early stages of evolving this partnership further with the Robotarium - the increasing use of drones within agricultural research being a key interaction for the future.

Agritech Centres: The centres will provide key facilities and access to network farms to help transform science into practice, facilitate relationships with commercial parties across the food chain and enable proof of concept in real life conditions. In particular, established partnerships with AgriEPI and CIEL will be strengthened to enhance Adoption and Entrepreneurial activities. With regard to AgriEPI the initial focus will be to complement UOE enterprise activities with AgriEPI's Makers Yard and joint aquaculture facilities. Furthermore, collaboration with Agrimetrics will provide additional opportunities for data acquisition, management, and commercialisation.

Scottish Aquaculture Innovation Centre: SAIC is dedicated to aquaculture innovation and collaborates with a range of research partners to facilitate relationships across the aquaculture sector.

James Hutton Institute: combines strengths in crops, soils, land use with environmental research and will be a key partner for the expansion of the Easter Bush Hub into data-driven aspects of crop agriculture to identify synergies between crop and livestock research and accelerate adoption within these sectors.

Industry, Third Sector, citizen bodies and public partners. The list of over 50 external partners in Appendix E of this Business Case is not exhaustive. Allied to current partnerships and networks, extensive stakeholder mapping has taken place and an engagement strategy is being developed to ensure appropriate prioritisation.

Internal and external partners identified above will help address core Agri-Tech capabilities as shown in Table Seven.

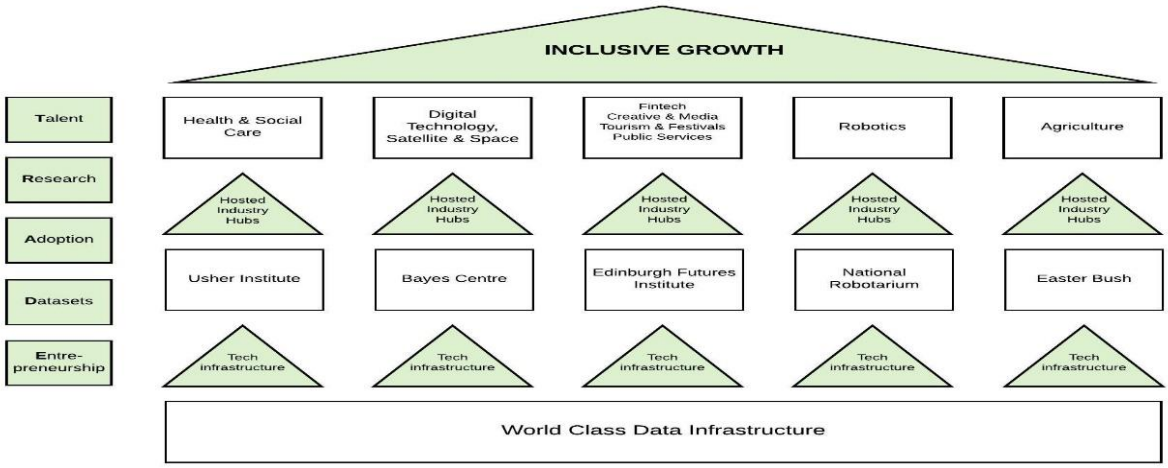
Table Seven: DDI Agri-Tech Partnership TRADE Linkages

Delivery Partner	Talent	Research	Adoption	Datasets	Entrepreneurship
Easter Bush	✓	✓	✓	✓	✓
Edinburgh Parallel Computing Centre		✓	✓	✓	
Edinburgh Innovations			✓		✓
Edinburgh Medical School		✓	✓	✓	
Bayes Centre	✓	✓	✓		✓
School of Geoscience	✓	✓	✓	✓	✓
School of Informatics		✓	✓		
School of Biological Sciences		✓	✓	✓	
Usher Institute	✓	✓	✓	✓	
Edinburgh Futures Institute	✓	✓	✓		
Agritech Centres			✓	✓	✓
Midlothian Science Zone		✓	✓		
Commercial, public and 3rd sector (appendix E)		✓	✓	✓	
HWU and Robotarium		✓	✓		

3.7 Operating Model

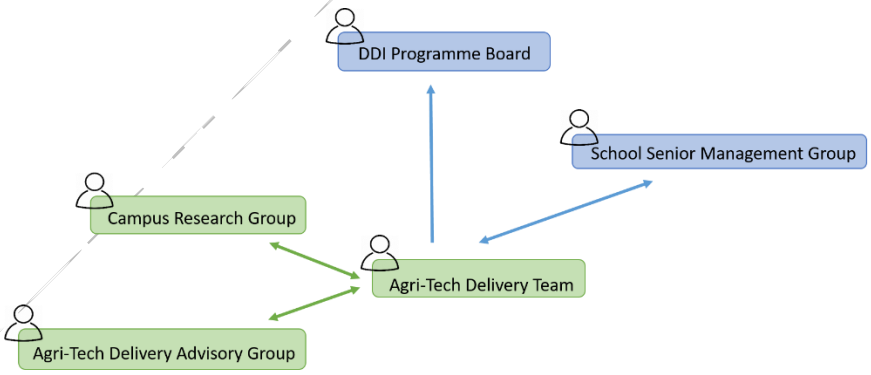
The Agri-Tech operating model is founded on the need to generate value for the City Region, nationally and globally. As illustrated, in Figure Four, this will be achieved by the Agri-Tech Programme operating in alignment with the wider DDI Programme.

Figure Four: Structure of the overall DDI Programme



As illustrated, in Figure Five, the **Agri-Tech DDI Delivery Team**, will be accountable for the day-to-day operations and delivery of the Agri-Tech programme. Based at the Easter Bush Campus this team will report to the School Senior Management Group and the DDI Programme Management Office (PMO).

Figure Five: Programme Management & Governance



3.7.1 Agri-Tech Delivery Team

This team are the principal owners of the Operational Delivery Plan by which activities across the TRADE themes will be aligned to ensure that there is an appropriate balance of effort and objectives are being met. Key activities include:

- Sector programme management (identifying sector market and commercialisation opportunities);
- Resource management;

- Communications;
- Project alignment, coordination and oversight;
- TRADE KPI reporting;
- Financial management; and,
- Compliance against relevant regulatory and legal standards.

The Agri-Tech Delivery Team consists of the Campus Chief Operating Officer (COO), the Agri-Tech Innovation and Enterprise Lead (AIEL), the Easter Bush Estates Programme Lead and the Agri-Senior Responsible Officer (Agri-Tech SRO)

The **Campus Chief Operating Officer** (currently Val Hughes-White) will oversee the reporting, regulatory and legal, communication and financial management elements of the Programme (as well as facilitating the co-ordination of projects within the programme).

The **Agri-Tech Innovation and Enterprise Lead** (currently Helen Dundas) will target and align market and commercial opportunities with delivery capability. This post was created to realise key new Agri-Tech opportunities afforded by City Region Deal investment in the EB Campus through the development of a Sector Plan.

The **Easter Bush Estates Programme Lead** (currently Helen Wood) drawn from within the Universities Estates office will be responsible for the delivery of the capital aspects of the Programme.

The **Agri-Tech Senior Responsible Officer** (currently Prof Bruce Whitelaw) will lead delivery of the programme, providing the overall co-ordination, alignment and oversight of the projects within the Programme. To enable the design and delivery of specific DDI projects the Agri-Tech SRO will– where appropriate – also set up **short term action groups** comprising colleagues from the other DDI Hubs and from across the University. Pending development stage of individual projects, colleagues may be seconded onto the Agri-Tech Delivery Team to develop project proposals.

The **Agri-Tech Delivery Team** will work with **Easter Bush Campus Research Group** to develop strategic direction and provide oversight to ensure that the Operational Delivery Plan is aligned with Agri-Tech plans by:

- Review and advise on the Agri-Tech Strategy, as well as any other strategic capital activity; and,
- Ensure the DDI Programme appropriately links into the wider Campus and University portfolio of activities through addressing the goals of the Edinburgh & South East Scotland city Deal

The Agri-Tech Delivery Team will form the core of the **Agri-Tech Delivery Advisory Group** who will advise and contribute to the co-design of the Agri-Tech projects. The Agri-Tech Delivery Advisory Group consists of the Agri-Tech Delivery Team and the leads for Talent, Research, Adoption, Entrepreneurial and marketing communication activities. As the Agri-Tech programme grows, the

Agri-Tech Delivery Advisory Group will grow to include representatives from the other DDI Hubs and external Agri-Tech partners.

The **Agri-Tech Delivery Advisory Group** consists of the user representatives, delivery partners, and the Agri-Tech Delivery Team. The **user representatives** are responsible for identifying the needs of the users of Easter Bush and wider University through monitoring that the deliverables will satisfy those needs. The representatives will also specify the benefits that will be realised by Easter Bush deliverables and will be held to account for their realisation. The **delivery partners** are responsible for enabling the co-ordination of Easter Bush DDI activity with those of the wider DDI Programme and will identify any emergent inter-dependencies or cross-programme opportunities.

The Agri-Tech Delivery Team will report to the **School Senior Management Team** for approval of projects. Chaired by the Head of School (currently Professor David Argyle), the School Senior Management Group will review activity within the Agri-Tech Programme and ensure it is adequately resourced and supported, as well as linked into to the wider School activity on the Campus. The School Senior Management Group will:

- Approving the Operational Delivery Plan;
- Authorise any major deviations from the agreed Operational Delivery Plan;
- Approve any additional resource required by the School to support the Agri-Tech DDI Programme to ensure required resources are available;
- Assist in the resolution of any internal and external stakeholder conflicts as identified by the Agri-Tech Delivery Team; and,
- Provide overall strategic direction for the programme.

Finally, the interface with the Agri-Tech Delivery Team and **DDI PMO** will also ensure that there is a 'chain of command' in terms of alignment with the wider DDI programme and ensuring consistency in communications, PR, CRM and marketing.

3.7.2 How do we manage the pipeline activity and relationships with partners?

The campus benefits from a well-established Knowledge Exchange and Commercialisation (KEC) team which is part of the University's Edinburgh Innovations (EI) team - a team of three business development managers are permanently located on the campus in order to actively participate in engagement as it takes place between our academics and external partners. The sector lead is also based on the campus within the Roslin Innovation Centre and has developed strong collaborative links with the KEC team. Table Eight below illustrates how the scope and scale of business innovation engagement opportunities will be transformed.

Table Eight: Changes in approach to engagement and partnerships with industry

Approach & Focus	Summary Description		Current Activities		Future Activities	Example Initiatives
Identify opportunities &	Better understand opportunities and	◐	Opportunity identification tends to	●	Engage a broad range of	⍰ Industrial Challenge

challenges (SME & corporates)	challenges around Agri-Tech issues to inspire new ideas.		be driven in collaboration with Agri-Tech providers.		organisations to identify and validate high-impact opportunities and challenges.	Research Fund applications (UKRI) Bill & Melinda Gates Fund (BMGF)
Generate ideas (SME & corporates)	Explore and develop ideas that address opportunities and challenges in Agri-Tech.	◐	Occasional engagements with organisations in the generation of new ideas and concepts.	●	Work with the above to realise high-impact opportunities.	Focused Industry Days Participation in Hackathons
Development & testing (mainly SME focus)	Test ideas in practice so that plans can be refined and improved.	◔	Limited focus, mainly through tenants co-located in local area (Roslin Innovation Centre and wider Midlothian Science Zone).	◕	Make extensive use of dedicated on-site accelerator capabilities and local tenants to validate early stage concepts.	Increased interaction tenants in Roslin Innovation Centre and wider Midlothian Science Zone DDI student placements
Making the case (mainly SME focus)	Persuade others that new idea works better than existing approaches.	○	Not a focus area currently.	◕	Make extensive use of dedicated on-site accelerator capabilities to validate new business models.	Dedicated Agri-Tech sector Venture Studio InnovateUK (UKRI)
Deliver & implement (SME & corporates)	Moving ideas from concept to reality.	○	Not a focus area currently.	◕	Make extensive use of dedicated on-site accelerator capabilities to market-test new products.	and Agriculture Science Transformer (FAST)
Grow & scale (SME & corporates)	Enact strategies that grow and spread innovations.	◑	Track record of collaborations with SE for the support of companies incubated at the University of Edinburgh.	◕	Systematically collaborate with SE and other public sector partners to incubate a long pipeline of digital Agri-Tech activity.	Roslin Technologies Dedicated Food and Agriculture Science Transformer (FAST)
Systems change (mainly corporate focus)	Identify changes in the Agri-Tech sector that enable new ways of thinking & working.	◐	Record of accomplishment of collaboration with Knowledge Exchange and Commercialisation to support Agri-Tech innovations.	◕	Apply challenge-based innovation approach that engages organisations of all types and sizes.	Data-led approaches to breeding in crop and livestock Data-led approaches in Aquaculture Data-led vet diagnostics

Key

○	**Low level of activity**	◐	**Occasional activities with SMEs & corporates**	●	**Extensive activities with SMEs & corporates**
◔	**Occasional activities with SMEs or corporates**	◕	**Extensive activities with SMEs or corporates**		

This expanded range of innovation activities will create engagement opportunities for SMEs and corporates alike, including potential inward investors that are seeking to grow their commercial activities in the City Region.

4. Strategic Case

This strategic case is in two parts:

- **Part A: The Strategic Context** – setting out the alignment of the Easter Bush proposals with government policy and existing University assets and strengths; and,

- **Part B: The Case for Change** – setting out the objectives to be addressed by the Easter Bush Campus, existing arrangements and identified investment needs, risks, constraints and dependencies to intervention.

4.1 PART A: The Strategic Context

This section provides an overview of the key global, national and regional strategies - and the University's current DDI related capabilities - that have (both) informed and shaped the Easter Bush proposal. More detailed evidence of these strategies and capabilities are provided at:

- Appendix B: Easter Bush fit with Global Policies;

- Appendix C: Easter Bush fit with UK and Scottish Government Policies;

- Appendix D: Organisational fit; and,

- Appendix E: Partner Engagement and Current Demand.

4.1.1 Global Context and Alignment

"Eight hundred million people go to bed hungry every night. If the situation does not improve and population grows as predicted, the number of people that go hungry every night may dramatically increase by 2050. By making data open and building capacity for open data use by all stakeholders, we will stimulate economic growth and support farmers, scientists, consumers and entrepreneurs who are working to solve the world's long-term food security needs. If we can forecast the weather around the world utilising today's available data and technologies, we have the capacity to solve global food insecurity. We need a global comprehensive data ecosystem to enable and empower us to find the right balance of solutions" – Open Access Government.[40]

In 2011 John Beddington, then UK's Chief Scientific Advisor, placed the links between global demand for food, energy and water within the context of climate change, describing the concurrent and rapid increase in demand for these commodities as a perfect storm.

His subsequent FORESIGHT report identified six key pressures on global food production systems that have already led to the failure to feed the global human population: population increases, changes in consumer demand, changes in local and global governance, climate change, competition for key

[40] https://www.openaccessgovernment.org/can-open-data-feed-world/41419/

resources (e.g. clean water), and changes in the ethical stance of consumers.[41] The report concluded that to address these issues: *"more food must be produced sustainably through the spread and implementation of existing knowledge, technology and best practice, and by investment in new science and innovation and the social infrastructure that enables food producers to benefit from all of these".*[42]

The FAO predict that, by 2050, existing global agricultural production (including crops and animals) will need to be 70% higher as the demand for food will grow disproportionately as more countries emerge from poverty.

Globally, agriculture already has major environmental impacts which need to be reduced (which in turn could have serious negative effects on productive capacity[43]). Infectious diseases remain a key impediment to animal production and welfare, not least owing to the rise of drug resistance and zoonoses.

The FAO has set these challenges within the context of the UN Sustainable Development Goals which in turn[44] emphasise the importance that Agri-Tech may play under several of these goals, for example:

- Goal 2: "*Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries";*

- Goal 9: *"Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending;"* and,

- Goal 14: *"Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries."*

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[41] *"Any one of these pressures ('drivers of change') would present substantial challenges to food security; together they constitute a major threat that requires a strategic reappraisal of how the world is fed".*
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288329/11-546-future-of-food-and-farming-report.pdf

[42] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288329/11-546-future-of-food-and-farming-report.pdf

[43] Some studies estimate, for example, that the aggregate negative impact of climate change on African agricultural output up to 2080-2100 could be between 15 and 30 percent.
http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf

[44] Transforming our world: the 2030 Agenda for Sustainable Development, United Nations, General Assembly, and 18th September 2015.

In addition, in 2021 the United Nations launched its Decade of Ocean Science for Sustainable Development, reflecting both the opportunity to increase food production from aquatic animals and plants, and the imperative that we do this is in a sustainable manner.

Addressing these challenges will need world-leading, integrated research, education, knowledge exchange and consultancy, all underpinned by data science to make a real difference in practice: *"at its core, Agri-Tech is about using advanced monitoring and data analysis to do more with less – to find ways to increase yields without burdening already overtaxed resources such as land and water".*[45]

As detailed at Appendix B the Easter Bush Agri-Tech Hub will help local and international agriculture achieve these aims by focussing on four areas:

- **Acquisition:** by sourcing and curating multiple data sets and modalities in partnership with the farming community and Agri-Tech industries (to improve crop, livestock and aquaculture productivity) with datasets accessed from commercial and public sources, in addition to new datasets generated through innovative research;

- **Analyse:** through increasingly sophisticated curation, data-cleaning and innovative interrogation and analysis of large Agri-Tech data sets within data-safe havens, thus providing a secure platform for academia to interact with industry (for example to improve crop yields and monitor disease transmission during outbreaks);

- **Access:** providing information - using digital and other EIDF interfaces - to enable access to the data revolution the Agri-Tech community is about to embrace (for example to better share and leverage leading practice in agriculture methods);[46] and,

- **Connectivity:** to ensure awareness across stakeholder communities to all the above.

Appendix C details how the Hub aligns with key UK and Scottish Government DDI and agricultural policies and in particular the vision of the (previous) UK Government 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".*[47]

Similarly, there is a close match with Scottish Government's Economic and Digital strategies,[48] as the Easter Bush Hub will establish confidence in data, facilitate ethical debate with the public on the use

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[45] https://www.weforum.org/agenda/2019/02/why-the-agtech-boom-isn-t-your-typical-tech-disruption/

[46] *"This report makes specific recommendations for the creation of a global, spatially explicit, open-source data base for the analysis of agriculture, the food system, and the environment, and the setting up of an International Food System Modelling Forum to enable a more systematic comparison of different models, to share results and to integrate their work better to meet the needs of policy-makers".* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288329/11-546-future-of-food-and-farming-report.pdf

[47] A UK Strategy for Agricultural Technologies, 2013.

[48] In line with the Data Management Board: A Data Vision for Scotland http://www.gov.scot/Resource/0044/00448438.pdf

of technology and encourage the exploration of new technologies, techniques and skills to develop and grow the next generation of digital agriculture businesses in Scotland.

4.1.3 Existing DDI TRADE Strengths, Assets and Activities

As detailed in Appendix D the combination of capabilities at the Easter Bush campus, together with the internationally recognised academic leadership available, provides a unique UK platform for engaging with the agriculture sector while providing world-class teaching and training of the next generation of Agri-Tech students, practitioners and entrepreneurs.

Within the livestock Agri-Tech sector the Easter Bush campus already houses the world's largest cluster of academic institutions including the:

- World-renowned Roslin Institute, one of the BBSRC's strategically supported National Institutes of Bioscience;[49]
- Royal (Dick) School of Veterinary Studies the UK's leading vet school (as demonstrated through the Research Excellence Framework); and,
- Scotland's Rural College, arguably the leading Scottish agricultural college.

Building on the above, and in order to increase on-site Agri-Tech impacts, the new £30 million Roslin Innovation Centre opened in August 2017. The Centre acts as the business location of choice for companies undertaking strategic, commercial and collaborative research in animal and veterinary Agri-Tech. With the Innovation Centre now being open for two years it is already at 75% committed occupancy with 23 local and international companies seeking to benefit from co-location and collaboration at Easter Bush including: Ingenza, Censo, Synpromics (now AskBio), Landcatch (now Hendrix Genetics) and Roslin Technologies.

With initial private sector funding of £10 million Roslin Technologies[50] was formed by the University of Edinburgh with JB Equity as the commercialisation arm of The Roslin Institute and Royal (Dick) School of Veterinary Studies. As well as developing a range of new products Roslin Technologies offers strong platforms for industry engagement through a range of services, licencing and collaboration opportunities.

Easter Bush is home to major facilities of two Innovate UK innovation Centres - the Centre for Innovation and Excellence in Livestock (CIEL) and the Agricultural Engineering Precision Innovation Centre (AgriEpi). The former delivers global livestock production and product quality research to deliver improved food quality and farming systems while the latter is bringing together key organisations in the food supply chain to become a world-leading centre for excellence in engineering and precision agriculture.

[49] In addition to the £6.5M per annum of Institute Strategic Programme Funding from the BBSRC towards the running of the Roslin Institute, it has also committed £10M of capital to the Easter Bush Campus over the next ten years in order to leverage the overall strategic vision of "Data Driven Agri-Tech"

[50] http://roslintech.com/

As a result the Easter Bush campus already has the physical and analytical capability to devise, plan, house and perform proof-of-concept studies in the livestock and companion animal sphere (as reflected in the numerous Agri-Tech companies either working with Easter Bush or who are co-locating to the Roslin Innovation Centre as listed in Appendix E).

The proposed capital investment from City Region Deal, coupled with the University of Edinburgh and BBSRC funding, will enable a **step-change in the scale and impact** of Agri-Tech education, research and consulting through a range of new programmes of data-led innovation, translation and adoption in agriculture and aquaculture.

4.2 PART B: Case for Change

4.2.1 Market Failure & the Need for Change

The latest (2020) HM Treasury Green Book indicates that the rationale for government intervention: "*can be based on strategic objectives, improvements to existing policy, market failure or distributional objectives that the government wishes to meet*[51]*."* This section therefore sets out the strategic and policy objectives for Governments investment in the DDI Programme and consequent market failures and distributional benefits that will be specifically addressed by this support in relation to the Easter Bush Agri-Tech Hub.

Government Strategic Objectives and Policies

Public sector investment in digital infrastructure and innovation is a strategic priority for both UK and Scottish Governments. As highlighted by the House of Commons Science and Technology Committee Second Report of Session: *"the digital skills gap (estimated at levels of 750,000 in 2017) is approaching crisis levels and this not only has economic implications but also puts the quality and security of this data at risk. This* (also) *risks UK Business being unable to grow the big data sector at the rate it should. In the meantime this skills gap is due to grow exponentially as big data reaches further into the economy".*[52]

Consequently, government investment in the DDI Programme is predicated on various grounds, not least:

- **Pooling risk**: as recognised in the Industrial Strategy addressing this skills gap requires Government intervention and investment: *"governments can make long-term investment that no single commercial or academic player can take alone. The modern nation state is the most powerful means we have of pooling risk".*[53] Adopting this investor of first resort role reflects

[51] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf

[52] https://publications.parliament.uk/pa/cm201617/cmselect/cmsctech/270/270.pdf

[53] *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf*

the importance of Governments in supporting technological change – such as Agri-Tech[54] – and achieving public-private partnerships that are more symbiotic;[55]

- **Providing cornerstone funding:** as recognised by the ESES City Region Deal Document[56] the Universities do not have access to sufficient levels of other funding sources (either internally or externally) to deploy the data infrastructure and physical Hubs necessary to create the sustainable system of TRADE innovation activities - to the scale and timescales - that will support the Scottish and UK economies address the critical skills gaps identified above and, by extension, the agriculture productivity growth both Governments seek; and,

- **Maintaining and enhancing the City Regions and UK competitive advantage:** the Department for Business, Energy and Industrial Strategy (BEIS) sponsored Science and Innovation Audit (SIA), which identified the City Region's pre-eminent position (within the UK) to best respond to global DDI opportunities as well as competitive threats, concluded that: *"if* (public) *investment is deferred, we run the risk of losing both competitiveness and output to other* (global) *digital clusters that have the confidence to invest. We also risk losing jobs in myriad parts of the economy as a result of automation extending into knowledge-intensive services".*[57]

Given the above (rationale) the market failures that will be addressed by - and distributional or equity benefits that might be generated through support for - the Agri-Tech Hub are detailed below.

Market Failures Addressed

In the context of the Easter Bush Hub proposals there are two specific (missing market[58]) failures that government intervention (and investment) will address, namely:

- **Positive Externalities:**[59] in relation to the wider, spill over benefits from Easter Bush TRADE

[54] *"From robotics to genetics and feeding the world, the UK is a pioneer in technological innovation. We know that this work in innovation is key to increasing productivity and sustainability in agriculture and will allow the UK to continue to compete globally."* https://www.gov.uk/government/news/lord-duncan-hails-golden-age-of-agricultural-innovation-at-royal-highland-show

[55] As indicated, for example, by Professor Mariana Mazzucato's: "*The Entrepreneurial State: debunking public vs. private sector myths."*

[56] *"This ambitious City Region Deal identifies **new and more collaborative ways** that partners will work with UK Government and Scottish Governments to deliver transformational change to the city regional economy. The Governments will jointly invest £600 million over the next 15 years and regional partners committed to adding in excess of £700 million, overall representing a deal worth £1.3bn".* https://static1.squarespace.com/static/55c87967e4b05aa55020f656/t/5c263201898583ec74c01146/1546007049724/ESESCR+Deal+Document+6+August+2018+signed.pdf

[57] SIA Summary.

[58] i.e. an efficient free market enables a Pareto efficient distribution of resources. In contrast under a "missing market" such distribution cannot result for various reasons including poor or imperfect information, high transaction costs or the inability to price all social costs/benefits e.g. through externalities.

[59] *"**Externalities** arise when an economic activity results in costs and benefits for others which are not reflected in market prices……. **Positive externalities** are also possible, for example education provision can bring additional benefits to the wider economy and society, in addition to those gained by the direct beneficiaries and the provider".*
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf

outcomes (and related DDI research and EIDF computing infrastructure) resulting in uplifts in productivity and public benefits for the agriculture sectors in the Scottish, UK and global economies[60] which will not be captured in financial returns to the University; and,

- **Imperfect Information:**[61] given the nascent nature of Easter Bush Agri-Tech market opportunities and related uncertainties, there are information deficiencies and private sector investment (risk adverse) inertia that could, however, be broken by the innovation at scale objectives of the Agri-Tech Hub TRADE activities.

The ultimate outputs and related impacts of Government intervention will (therefore) be to:

- Provide agricultural and related sector students, academics, workers and existing and new businesses with better DDI Agri-Tech focused skills, facilities and infrastructure; and, in turn,

- Attract new investors, Agri-Tech companies, students and academics to the City Region through enhanced DDI focused training, research and development, incubation and commercialisation support and computing provision.

Through the above there will be improved information flows and positive externality benefits and consequent economic growth and public sector benefits through three broad sources, namely:

- Sector efficiency gains in terms of improved performance, environmental sustainability, food security (and reduced costs and expanded revenues);[62]

- Consequent uplifts in R&D from reinvestment of profit uplifts and potentially public exchequer savings; and,

- New market entrants leading to efficiency gains and new products and services.

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[60] *"Our aim is that the whole Agri-Tech sector should lead, participate and co-invest. The potential rewards are in increased productivity, reduced costs, growth, new investment and jobs and* ***tackling the challenges of sustainable intensification and global food security".*** A UK Strategy for Agriculture Technology, 2013.

[61] *"**Information deficiencies:** where there is a lack of information of sufficient quality to enable informed decisions to be made"* https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/220541/green_book_complete.pdf

[62] From a private sector perspective as detailed by a recent CEBR and SAS report: *"we consider six mechanisms through which the information and insights gathered through the use of big data and the IoT can help businesses to improve performance and add greater value to the economy. These channels, or mechanisms, allow firms* ***to optimise their operations by, for example, reducing costs and/or expanding revenues*** *in relation to: customer intelligence; supply chain management; quality management; risk management; performance management; and fraud detection".* https://www.sas.com/content/dam/SAS/en_gb/doc/analystreport/cebr-value-of-big-data.pdf. These effects are equally applicable in the agriculture sector. For example the Agriculture and Horticulture Development Board estimate that If the UK agriculture sectors rate of growth had kept pace with the US since 2000, the contribution of UK farming to the rural economy would have been £4.3 billion higher by 2013.

Consequently, as detailed in the Economic Case section of this case, the extent of the productivity gains (alone[63]) that the Easter Bush Hub will generate are estimated to exceed over £248 million gva in net present value terms.

Distributional Benefits

East Bush Hub activities – as with all components of the DDI Programme – are aligned to the Scottish Governments inclusive growth strategy of ensuring that Scotland will be: *"more ambitious, with government, businesses and wider society working together to lead on the key technological and social changes of the future"* and ensuring economic growth is *"inclusive, so that everyone benefits and has a fair chance to contribute"*.[64]

In particular all proposed Easter Bush Agri-Tech Hub activities (as in the case of every DDI hub) will need to demonstrate how they will firstly ensure inclusive growth[65] but also, as importantly, meet (at least one) of the other identified overarching City Region Deal inclusive growth objectives, namely:

- **Removing Physical Barriers to Growth:** through interventions to unlock current physical barriers to growth, including housing and transport connectivity as key components of the Deal. This Case addresses such barriers by increasing transport connectivity and network capacity to and from the Campus (as well as in the local area) in order to realise the benefits of the Hub and potential longer-term on-site facility expansion;

- **Pro-Active Procurement:** a significant programme of construction is planned across the city region. The City Region Deal Partners are working with both Governments to develop a clear vision for Community Benefits and supporting guidance to maximise Inclusive Growth objectives. At Easter Bush there will be various ways to realise such opportunities including development of the Energy Centre which will use local apprenticeships and enable regional skills development for emerging low carbon heat technologies and construction practices;

- **Targeted Employability & Skills Interventions:** a programme of integrated and targeted employability and skills interventions will be directed at widening access, addressing skills shortages and gaps, and delivering improvements to boost the flow of individuals from disadvantaged groups into good career opportunities. Easter Bush activities will be focused on supporting partners – where relevant – in addressing employment issues and standards in the City Region and wider Scottish agriculture sector; and,

- **Social Benefit through Innovation:** by recognising the potential presented by a significant investment in DDI and opportunities to drive out challenged-based social benefit projects and programmes across the City Region over the medium and long term. Currently the University

[63] i.e. excluding transport benefits.

[64] First Minister, 31st August 2017.

[65] Under the first inclusive growth objective of the Deal Document it is recognised that: *"The Data Driven Innovation (DDI) programme of investment will be a key driver in helping to deliver a step-change in regional economic activity".*

of Edinburgh and other Partners are examining the type of challenge programmes that could be developed under this objective and, in particular whether they should be explicitly aligned to the community benefits approach suggested above, embedded in hubs activities and co-produced with Governments to focus on demonstrator projects with potentially wider application than the CRD Region.

Conclusion

In conclusion, the premise of the Easter Bush Hub (as reflected by Callon[66] and others) is that:

- Private and public sector markets tend to "use up" the existing sources of research, leading to convergence and irreversibility and locking society into particular technological options;

- Government action is required to break this cycle through funding (such as that identified for Easter Bush) that creates novel approaches to addressing and resolving technical problems by increasing the variety of (technological) options available to the agriculture sector; and,

- Adoption of an interdisciplinary portfolio approach (as reflected in the previous section and as a central tenant of the DDI Programme overall) increases the likelihood of such options addressing a wider range of food production needs[67] generating positive externalities, improved market information flows and better more inclusive outcomes.

4.2.2 Challenges & Business Needs

In its current form Easter Bush faces various challenges:

- The site lacks the energy and road infrastructure capacity to ensure the buildings, and the site as a whole, continue to remain capable of offering the environment and servicing to house the academic and industry research being carried out, secure new funding and to attract the co-location of more industry and development partners;

- There is inadequate infrastructure to create and manage the increasingly diverse and ever-increasing datasets that the agricultural industry generates and to enable the industry partnerships through which the commercial value of this data can be harnessed; and,

[66] "Is science a public good?" Callon, M., 1994 Science, Technology and Human Values 19, 345–424. See also: "The economic benefits of publicly funded basic research: a critical review", Ammon J. Salter and Ben R. Martin, Research Policy, 2001.

[67] *"In determining where and how much to invest in producing more food, policy makers will need to consider a range of criteria, rather than increases in production alone. These criteria will need to acknowledge the existence of both positive and negative externalities associated with different forms of food production……. The development of better metrics and a new more embracing set of standards for sustainable food production that incorporates best practice from all types of production systems should be a priority".*
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288329/11-546-future-of-food-and-farming-report.pdf

- The lack of shared data infrastructure prevents certain critical interdisciplinary research, entrepreneurship and adoption activities from taking place (particularly in relation to working collaboratively with external partners).

Adequate road access to the site must be provided if constraints on the further development of Easter Bush are to be avoided. The intended development of Easter Bush will increase demand for travel to the site: whilst the modal share of sustainable transport (public transport and active modes) access to the site is good (52% by bus, 5% of students by active modes[68]) private car access is and will remain important.

The rationale for the A701 Relief Road and A702 Link Road emerged from the Midlothian Local Development Plan transport modelling of all committed developments in the area that highlighted potentially serious road traffic congestion, capacity issues and delays along the A701[69].

City Region Deal funding would enable the early prioritisation and, therefore, the effective implementation of the Local Development Plan strategy in the A701 corridor. Failure to deliver at an early stage of the plan period will act as a significant constraint to growth, particularly at Easter Bush, and across the regional economy generally.

These challenges also need to be considered against a UK context of pressing Agri-Tech TRADE challenges and needs:

- **Talent: emerging data-intensive Agri-Tech activities need appropriately skilled workforces.** The ever increasing role of data collection and utilisation in the rapidly changing commercial agriculture environment demands different skills to those traditionally deployed;

- **Research: DDI R&D will be essential to address future sector needs.** As: *"investment in research on modern technologies is essential in light of the magnitude of the challenges for food security in the coming decades;"*[70]

- **Adoption: new adoption processes and commercialisation routes will be needed.** With new data-driven systems and approaches new exploitation strategies are also required in order, for example: *"to give greater priority to the food production sector as an engine for both rural and urban development; invest in the economic, physical and social infrastructure to facilitate food production; and promote entrepreneurship along supply and value chains;"*[71]

[68] Source: *Bush Transport Strategy,* JMP report, Jan 2017.

[69] See the Midlothian Local Development Plan Main Issues Report, Transport and Infrastructure Technical Note - https://www.midlothian.gov.uk/downloads/file/2517/transport_and_infrastructure_technical_note and the Report of Examination, issue number 6, page 144 – 181, which addresses the A701 Relief Road/A702 Link Road and the approach of the Council in preparing the transport appraisal of the Midlothian Development Plan (to comply with Scottish Planning Policy) - https://www.midlothian.gov.uk/downloads/file/2292/report_of_examination_into_mldp_proposed_plan

[70] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288329/11-546-future-of-food-and-farming-report.pdf

[71] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288329/11-546-future-of-food-and-farming-report.pdf

- **Datasets: capturing and using big data is new to the farming community.** There is a need for both pre-farm (UoE) and real-on-farm (through partnership) data to inform talent development and research and for access to this data to be made more straightforward; and,

- **Entrepreneurship: to increase the supply of leaders and access to investment.** Many commercial opportunities will be generated from the transformation of current agricultural practices to those based on data-driven innovation. These opportunities need to be realised through a diverse platform of entrepreneurial activity and investment support.

4.2.3 Investment Objectives & Benefits Criteria

In response to the challenges and business needs described, Table Nine below sets out the SMART objectives identified for Easter Bush.

Table Nine: DDI Programme investment objectives and benefits criteria

Theme	Investment Objective(s)	Benefits Criteria
Talent	Develop a vibrant learning environment with a range of data skills to realise the potential of the data driven e Agri-Tech sector	• KPI - Total numbers engaged 141,000 credit /non-credit bearing • Benefit measure – Salary uplifts and graduate retention in the UK
Research	Develop, in conjunction with industry, a world-leading Agri-Tech research capability. Facilitate collaborative integrated research which delivers impact to the sector	• KPI – Total £117m research funding • Benefit Measure- return on investment
Adoption	Undertake a range of industry engagements focused on building collaborative partnerships to enable new research and innovation activity to address challenges in Agri-Tech sector	• KPI – 100 company interactions • Benefit Measure – return on investment • KPI – 24,000 CPDs • Benefit measure – Salary uplifts
Data	Support initiatives to encourage and enable the creation, acquisition and curation of new forms of data asset. Increase the translational power of the datasets through analysis and adoption	• KPI – New data sets utilised as industrial partners deposit data for research • Benefit Measure – N/A
Entrepreneurship	Expand pipeline of business activity and support equity investment	• KPI – 30 new business activities through increased co-location of Agri-Tech partners • Benefit Measure – return on investment
Inclusivity	Increased outreach activity for all aspects of Agri-Tech, with specific expansion for those with low science capital and/or rural communities	• KPI – 58,000 public interactions, retention of Investors in Young People Silver accreditation and Athena SWAN Gold status • Benefit Measure – delivery of SIMD social inclusion targets as per section 3.5.6[72]

[72] NB some of these inclusivity targets are depend on securing funding from non CRD sources.

Easter Bush Activities

To realise the full potential of the Campus to develop data-driven agriculture - through DDI investment and other associated funding sources - the Agri-Tech Hub will:

- Build on current Campus strengths in **Data Science** to underpin research and development, creating capacity for curation and data analysis followed by adoption of evidence-based 'precision agriculture';

- Provide the infrastructure for data curation, including the expansion of animal facilities underpinning **animal biotechnology and gene editing**, and growth of in **aquaculture genetics and health**; and,

- Embrace emerging technology platforms in order to underpin strategically supported research including evolving **phenotypic and genomic** technologies, as well as modernisation of **proteomic and bio-imaging** technologies.

Investing in and addressing core capabilities and gaps: TRADE

The activities, through which the objectives of the Easter Bush proposals will be achieved, are summarised below in Table Ten. Future use cases, that describe the practical application of these activities, are provided in Appendix F.

Table Ten: DDI Programme Activities

SIA Theme	Activity Proposed
Talent	To address the shortage of DDI skills in the economy, develop a sustainable pool of talent in the City Region and build a workforce more resilient to data driven change by: • Developing a new series of undergraduate, postgraduate and professional training opportunities through delivery of Easter Bush DDI courses at different qualification levels to address gaps in current provision; • Increasing data skills capacity through the delivery of the training; • Improving access to in-work training through an improved CPD offer; • Offering better scope for informal learning through MOOCs and an increased on-line portfolio; • Maintaining a leading training offer in the City Region through access to the latest research and facilities; • Attracting talent from outside of the City Region to study and relocate to the City Region; • Increasing the ability to apply data to "real world" food security problems; and, • Improving the employability of students through the provision of real-world data skills.
Research	To maintain, build upon and extend the reputation of the Easter Bush Campus for leading research and to attract talent, data and investment to the City Region and unlock more insight from data by: • Extending the scope and scale of DDI Agri-Tech research undertaken in the City Region; • Improving the range, quality and critical mass of Agri-Tech facilities available to leverage more research investment; • Increasing the connectivity of research data to facilitate a more integrative collaborative approach to deliver data –driven research solutions to Agri-Tech issues; • Improving the pathways through which Agri-Tech research translates into economic, sustainable and social outcomes; and, • Creating the conditions for chance interaction and coproduction.
Adoption	To unlock the wider benefits of DDI for the economy and society through increasing the awareness

SIA Theme	Activity Proposed
	and uptake of DDI amongst agricultural businesses by: • Extending the number and level of partnerships with public, third sector private sector partners through co-funded applied research and coproduction activities; • Enabling closer working of partners, increased connectivity of data and dissemination of best practice through realising opportunities for addressing wider sector issues; • Providing access to "living lab" capability which is in high demand from industry to help test and develop products in real world, safe, conditions which can be hard to produce in isolation; • Allowing better public access to the Agri-Tech activity being undertaken to build awareness of and trust in the DDI economy; and, • Demonstrating the potential of data to unlock opportunity.
Data	To increase the City Region's stock of data, the value generated from it and its accessibility by: • Developing the facilities needed to securely store and manipulate data; • Agreeing more data partnerships with partners in order to acquire and curate more data in the sector; • Increasing the breadth of Agri-Tech related datasets available for correlation and interrogation; • Improving the accessibility, usability and cost of access to data assets and thus "the translational power" for wider user groups to underpin more research, adoption and entrepreneurship activity; and, • Promote the data-assets available to attract investment and talent.
Entrepreneurship	To increase the level of DDI related economic activity in the City Region by: • Identifying and encouraging the formation of more Agri-Tech spin out activity; • Improving the level and consistency of support available to these spin outs; • Productive utilisation of space available to accommodate early stage spin outs at the Easter Bush Campus as well as encouraging Agri-Tech partners to co-locate on the campus to maximise partnership potential; • Promoting better industry awareness, participation in and investment in spin-out activity; • Improving access to support services; and, • Widening access to data assets and reducing the cost of access to foster entrepreneurial activity.

4.2.4 Scope of Investment Requirements

As illustrated previously the Easter Bush Campus is already host to various buildings, on site agricultural facilities and Institutes through which DDI Programme-related Agri-Tech outcomes will be realised. Table Eleven illustrates how - with City Region Deal, BBSRC, Midlothian Council and third-party investment - the impact of these Institutes will be expanded through a capital investment programme including:

- Enhanced data technology facilities, equipment and infrastructure to support the acquisition, curation, analysis, adoption and translation of Agri-Tech data across Easter Bush;

- Combined heat and power infrastructure; and,

- Road infrastructure improvement (A701 relief road, A702 Link Road, Bush Loan Junction and Straiton Junction) and the provision of sustainable transport improvement measures (prioritising walking, cycling and bus based public transport) along the former A701 corridor.

Table Eleven: Programme Funding

	Projects within City Region Deal Scope	BBSRC Funded Projects within the investment
Underpinning Campus Infrastructure for Data Driven Innovation	Campus Infrastructure (Water/SUDS) £2m	Research Sample Archive Facility £1m
Expansion of Data Driven Global Agri-Tech Hub facilities	Agri-Tech hub £4m	
Creation of the Agri-Tech Data Innovation Hub +	High Performance Computing £2m	
Equipment to enhance and expand the acquisition of data through phenotypic and genotypic range and resolution	New and Emerging Technologies £4m	Phenotype Platform £4m Genotype Platform £1m
Enhanced Translational Facilities		LARIF phase 2 £3m Aquaculture £1m
Combined Heating and Power	CHP Infrastructure £12m	
Other Campus Infrastructure	Campus Infrastructure £10m	
Subtotal	**£34m**	**£10m**
Road Infrastructure	**£30m**	
Total	**£64m**	**£10m**

Enhanced Data Technology Facilities, Equipment and Infrastructure

The first component of this capital investment will be distributed across five key areas, namely:

a) **Underpinning Infrastructure for Data Driven Innovation:** to provide the basic infrastructure to support the expansion of operations (water/heat), creation of Combined Heat and Power (CHP) facilities (as per the next section below) and storage of biomaterials (Research Sample Archive Facility). An element of these infrastructure costs will also be required for minor works and/or refurbishment of laboratories and offices;

b) **Expansion of Data Driven Global Agri-tech facilities:** to enhance the co-located space and resources from across the University of Edinburgh and partner institutions;

c) **Creation of the Agri-Tech Hub –** funding will increase the high performance computing capability, network capability and the associated services necessary to allow the expansion of the acquisition, curation and analysis of data required (in epidemiology, animal, aquaculture and veterinary digital health provision);

d) **Equipment to enhance and expand the acquisition of data through phenotypic and genotypic range and resolution -** to allow new end-to-end scientific analyses (from the level of molecules to whole animal populations) in a wide range of biological contexts; and,

- **Enhanced Translational Facilities -** including expansion of the Aquaculture Genetics Research Facility to facilitate Shellfish and Crustaceans, to support the growing aquaculture research, and to allow co-location of the remaining LARIF facilities from Dryden to Easter Bush Campus to support animal research.

In addition to the specific capital investment above the Easter Bush Campus will significantly benefit from the funding that has already been awarded through City Region Deal via EIDF to upgrade networks and provide much needed super computing capabilities for the Easter Bush campus.

Combined heat and power (CHP) infrastructure

The Easter Bush CHP Energy Centre is an essential component of the next phase of development for the Campus. The new building will provide robust, flexible and low carbon infrastructure to heat and cool buildings on the Campus while also meeting a significant proportion of the base electrical demand on site.

The University of Edinburgh has committed to becoming carbon neutral by 2040. The Easter Bush Energy Centre is a major milestone in the delivery of the University's 'Zero by 2040' Climate Strategy and Energy Masterplan.[73]

The University will utilise the Energy Centre as a 'living laboratory' for innovation in advanced analytics of smart energy grids and act as a learning hub embedding 'living laboratory' opportunities for the local community.

In 2019 Vital Energi were commissioned to provide dynamic energy modelling of the Easter Bush campus to evaluate the energy supply and demand characteristics of existing buildings, the energy centre, HV and DHN infrastructure and pending 1.5MW solar PV installation. Financial and environmental benefits were identified in extending the HV ring main (to interconnect all Easter Bush electrical loads to the Energy Centre) and the DHN to supply the Vet School, Small Animal Hospital and Bumstead building. This will allow the CHP Centre to significantly increase operating hours to maximize the utilization of onsite heat and electrical generation. The environmental benefit includes a reduction in GHG emissions of 2,100 TCO^2e.

Other Campus Infrastructure

As part of the wider University of Edinburgh 2025 Estates strategy, the University is currently delivering, or has delivered, a number of Capital Projects at the Easter Bush Campus. These projects will be supported and connected by new roads, paths and services networks provided as part of the

[73] That includes advanced renewable technologies, 'next generation' energy networks and smart district heating controls all of which are critical to enabling the transition to 'net zero'.

Easter Bush Infrastructure Project. The scope of this project includes all of the physical systems a campus of this scale requires, including transportation, communication, sewage, water, electric and public realm. Each of these elements will be delivered as individual design lots or work streams. This suite of works will focus on improving links between campus assets, ensure business continuity and to safeguard campus resilience.

Road infrastructure requirements

The A701 corridor is a highly urbanised location with all settlements and employment/retail destinations serviced from the A701. The Easter Bush Campus (and Midlothian Science Zone[74] or MSZ) is also accessible from the A702 and A703. To date, incremental interventions have not resolved the capacity and junction issues on the local and trunk road networks, particularly at Bush Loan/A702. The physical limitations of the A701 carriageway also prohibits multi modal solutions to mitigate the scale of planned developments.

The proposed roads infrastructure changes will be a key enabler of the future development of the Easter Bush Campus comprising the A701 Relief road, A702 Link Road, Bush Loan Junction and Straiton junction. These improvements will also enable and support future investment across the wider Midlothian Science Zone (including the Biocampus, Technopole and Moredun Institute) as well as throughout the whole A701 corridor.

Through the planning process recent development projects on the Easter Bush Campus have been subject to a Transport Scotland objection, based on safety concerns at the Bush Loan junction. Transport Scotland has stated that: "*the latest assessments undertaken to inform these applications has demonstrated that we are now at the point where any further development cannot be considered without significant mitigation at the A702/Bush Loan junction. Given the concerns there are with the level of queuing on the local road, we are concerned that this could cause issues to the safe operation of the trunk road (which is not easily measured using traditional standalone junction assessments)".*

The transport proposals will provide a physical infrastructure solution to unlock not only the Midlothian Science Zone but also significant planned housing (1,570 units) and economic and commercial development in the A701/A702 corridor (circa 90Ha). The infrastructure improvements will therefore facilitate:

- Accelerated growth in the life sciences sector;
- Promotion of and greater collaboration and innovation across the DDI Hubs and the University of Edinburgh as a whole; and,
- The delivery of public transport and active travel infrastructure (on the bypassed section of the existing A701) that will lead to more sustainable travel options and choices and (when aligned with additional A720 improvements) improved travel times, connectivity and accessibility with Edinburgh and around the City Region.

[74] https://midlothiansciencezone.com/

In addition to the above benefits, the new roads and junctions will add significant additional highway capacity to the local road network, significantly improve journey times compared to the existing delays on the A701 and facilitate re-prioritising road space to deliver safer (and potentially segregated) access to and from the Easter Bush Campus via the A720 Edinburgh City Bypass, the A702, the A703 and/or the A701 Relief road. Most significantly the roads proposals will not compromise the operational network management of the Trunk Road network in the vicinity of the Easter Bush Campus and will reduce existing concerns in respect of traffic movements, particularly at the A702/Bush Loan junction[75].

As illustrated, in Figure Six overleaf, the A701 Relief Road will comprise:

- New road infrastructure between Straiton Junction and Pentland Road;
- A new bridge crossing or four-arm roundabout junction at Pentland Road; and,
- New road infrastructure between Pentland Road and A703 Seafield Moor Road.

The A702 Link Road will consist of:

- A roundabout junction with the A703/A701 Relief Road; and,
- The A702 Link road.

The A702/Bush Loan junction will incorporate a new four-armed roundabout junction connecting the A702 (north and south), Bush Loan and the A702 Link Road.

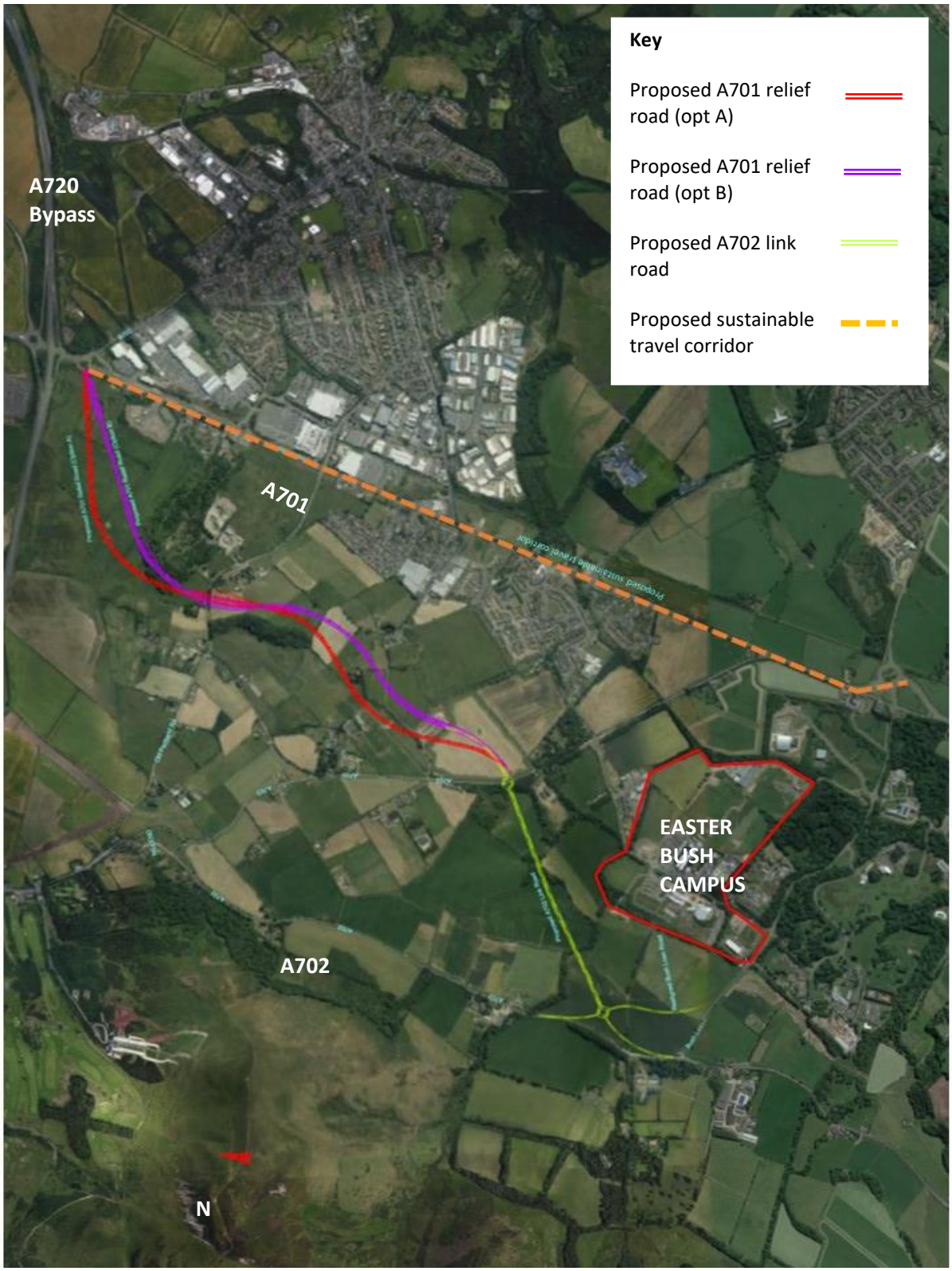
The A701/A720 Straiton Junction will also require to be upgraded as part of the overall scheme. Early microsimulation work (conducted by Jacobs in April 2018[76]) identified a preferred signalised junction solution which would require minimum reconfiguration of existing road space and positively assist the delivery of improved Active Travel measures at this junction. Whilst the Council is confident that this solution would work, and could be delivered within budget, the exact cost and final design will be determined through more detailed modelling (led by Acardis), ongoing discussions between Midlothian Council and Transport Scotland as well as other stakeholder engagement.

The Council is also collaborating with SEStran on a feasibility study into possible sustainable transport and travel improvements. As illustrated in Figure Six there is the potential to re-prioritise road space along the bypassed section of the A701 (Straiton to Gowkley Moss) to promote sustainable travel choices. The Council will investigate any additional funding initiatives to assist in the delivery of the preferred option including bus based, walking and cycling initiatives as well as post Covid-19 measures.

[75] The full modelling analysis is available on request. Transport Scotland have advised that additional microsimulation modelling may be required at a later stage in the design process.

[76] This assessment is also available on request.

Figure Six: Proposed Road Developments



4.2.5 Constraints

The development and appraisal of options in this business case has been prepared under various key constraints:

- The location of new facilities need to complement the existing Easter Bush Campus to develop the 'cluster' effect recognised as necessary in the SIA;
- The potential Government funding envelope has been set through the City Region Deal Heads of Terms;
- A requirement that each element of the DDI Programme has to become self-financing over the longer term to satisfy University of Edinburgh governance and charitable obligations to seek to maintain a surplus;
- The technical, ethical and legal constraints of collecting and accessing appropriate data sets;
- The new energy infrastructure works cannot impact the existing campus. Uninterrupted servicing must be maintained or prior notice agreed with User Groups so as not to impact on active research and teaching;
- Underground infrastructure routes should follow the agreed "2025 Vision Masterplan";
- University of Edinburgh proven estate management design, procure and build process and associated timescales; and,
- The development of Easter Bush Campus must not lead to unacceptable congestion on local roads, including the A701, A703 Seafield Moor Road and Bush Loan.

4.2.6 Dependencies

The heat and power infrastructure works and campus infrastructure works are dependent on prompt responses and collaboration from the relevant Utilities suppliers. In turn the DDI programme, research and teaching initiatives are dependent upon the new energy centre and infrastructure providing the servicing required to grow the campus.

The delivery of the A701 Relief Road and A702 Link Road are dependent on:

- Approval by Midlothian Council and Transport Scotland as well as successful land acquisition; and,
- Parallel funding from the Council and third parties being realised.

5 Economic Case

This section provides an overview of the:

- DDI Programme level impact pathway and associated benefits that have informed the development of this business case;
- Selection process involved in short-listing the Agri-Tech delivery options that are most likely to realise these Programme benefits;
- Assessment of the anticipated types and levels of economic costs and benefits that might be generated by each of these options;
- Consequent rationale for the selection of a preferred approach;
- Resultant net economic benefits that will be generated to the Scottish & UK economies; and,
- Consequent SMART objectives.

In addition, it is important to note that the original and detailed impact analysis of the economic impacts likely to be associated with Easter Bush were conducted using the guidance outlined in the 2013 Green Book. Post the release of the revised 2018 Green Book[77] it was agreed with (UK and Scottish) Government representatives that the:

- Initial analysis (as summarised in this section) would remain unchanged; however,
- Revisions implied[78] by the new guidance should be captured within sensitivity analysis of the aggregate Easter Bush impacts identified above.

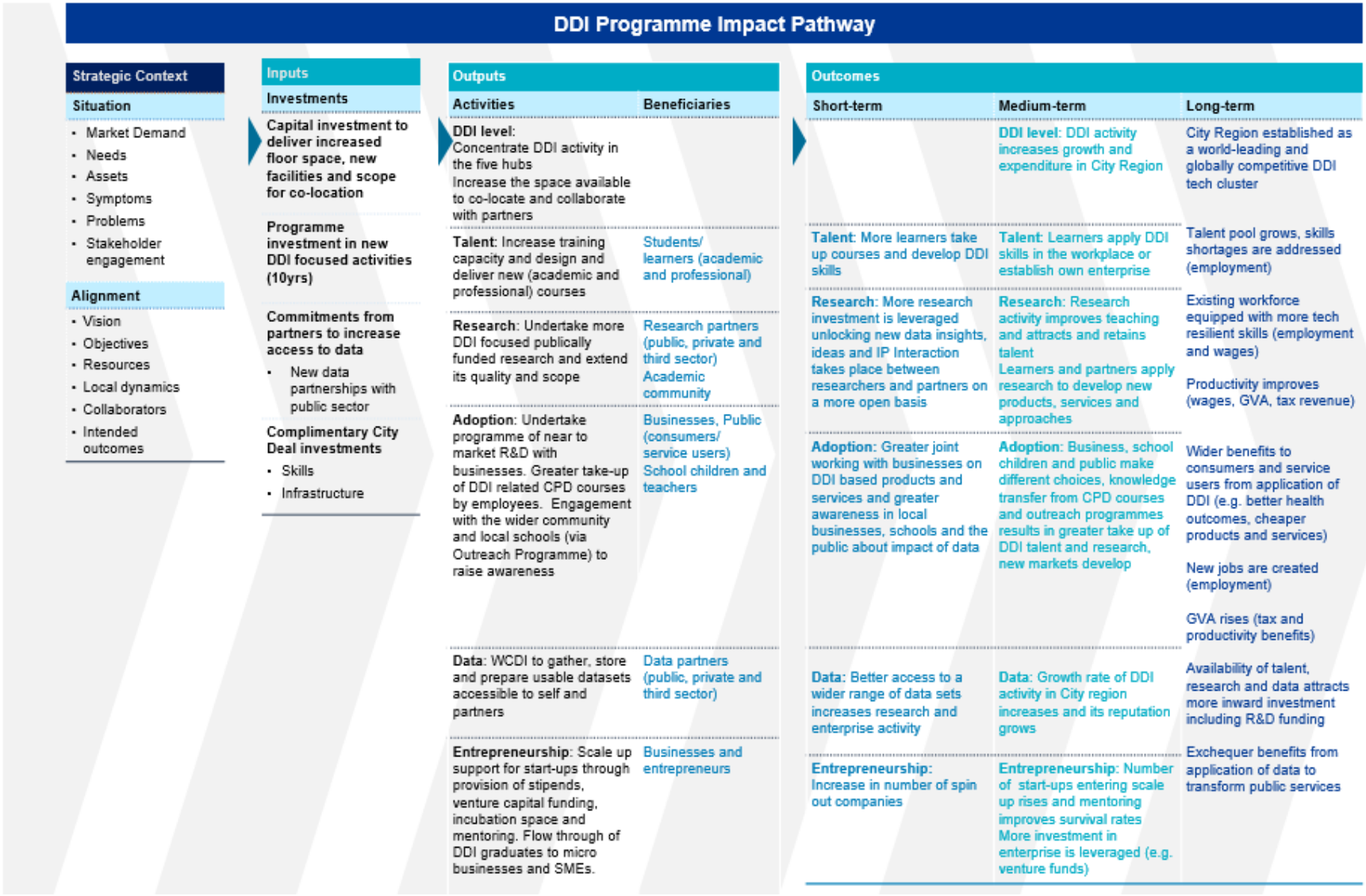
5.1 Programme Level Context

An impact pathway was developed at the Programme level - as set out in Figure Seven overleaf - to determine the range of potential impacts that might be realised and the consequent SMART objectives and "success factors" (in terms of inputs, activities and market interactions with potential beneficiaries) required to deliver these impacts.

[77] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf

[78] Such as capturing net additional uplifts in GVA for employment impacts, 100% displacement at a UK level and use of Type 1 multiplier values at a local level.

Figure Seven: DDI Programme impact pathway

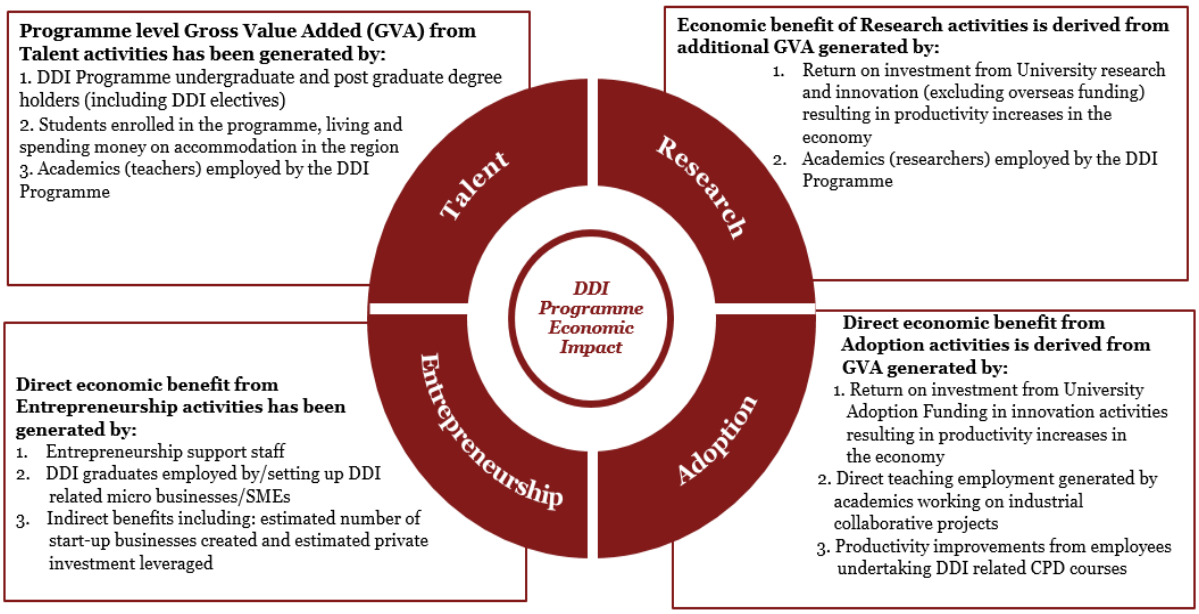


As illustrated the objectives of the DDI Programme will be met by the proposed Easter Bush TRADE activities delivering a range of economic and social benefits, including:

- **Talent:** creating and retaining a sustainable pool of DDI talent in the Agri-Tech sector across the City Region, Scotland and the UK;
- **Research:** expanding and enhancing DDI Agri-Tech research activities across the Easter Bush Campus;
- **Adoption:** increasing the use and adoption of DDI by the public, private and third sectors in the City Region and beyond;
- **Data:** providing the data accessibility and analytical capacity to underpin all Easter Bush DDI activities; and,
- **Entrepreneurship:** enabling City Region based and other entrepreneurs to develop new DDI-Agri-Tech based businesses.

Figure Eight below summarises the key outputs and related impacts that have been used - across each talent, research, adoption and entrepreneurial theme[79] – to assess and measure the net impacts of the Easter Bush Hub.

Figure Eight: Allocation and Measurement of Easter Bush Impacts



[79] No direct impacts are attributed to EIDF (and hence the "Data" theme) given the enabling role that this facility plays in supporting the Easter Bush Agri-Tech Hub to deliver activities and the consequent benefits that are derived across the other four "TRAE" themes.

In summary, it is anticipated that the Easter Bush Agri-Tech proposals will generate a range of direct and indirect economic impacts as a result of utilising data to deliver activities in relation to:

- **Talent (via):**
    - Direct impacts – through the GVA generated from the employment of additional academic staff to deliver DDI Agri-Tech related teaching courses and on site students spending impacts in the City Region while undertaking courses; and,
    - Indirect impacts – through the GVA generated as a result of the provision of DDI Agri-Tech related undergraduate and post graduate degrees and pathway courses resulting in long-term productivity improvements once DDI students enter the UK workforce.
- **Research (via):**
    - Direct impact – through the GVA generated as a result of the creation of additional DDI Agri-Tech related research staff posts; and,
    - Indirect impacts – from the return on investment from the successful awards of DDI Agri-Tech related public and private research funding and the private funds leveraged as a result of the former funds.
- **Adoption (via):**
    - Direct impact – through the creation of GVA from adoption support staff posts; and,
    - Indirect impacts – from the return on investment from the allocation of DDI Agri-Tech adoption funding to the Easter Bush Hub including private leveraged funds and productivity impacts from employees undertaking DDI related CPD training.
- **Entrepreneurship (via):**
    - Direct impact – through the creation of GVA from entrepreneurship support staff posts;
    - Indirect impacts – through the successful creation of new DDI Agri-Tech spin out and start-up businesses that attract private investment funds; and,
    - GVA from DDI graduates employed by and/or setting up DDI related micro businesses/SMEs.

5.2 Identification of Delivery Options

City Region Partners concluded Heads of Terms with the UK and Scottish Governments for an overall City Region Deal in July 2017 and signed a full "Deal Document" in August 2018[80]. In addressing the market failures (identified in the Case for Change in Section 4) both documents provided financial parameters within which the capital development of the DDI Programme could be progressed and set the capital costs for Easter Bush at a total of £33 million. Subsequent to further discussions with both Governments this has been revised to £28.3 million and for the purposes of this assessment the projected level of £10 million BBSRC funding has also been included (giving a total public sector contribution of £38.3 million[81]).

Recognising that *"the cut-off or budget constraint for considering which options are affordable should be the capital budget"*[82] the approach, to identifying options for Easter Bush, focused upon the:

- Operational or delivery approaches that could be adopted within this (constrained) capital budget; and,
- Any alternative approaches that might be considered to both secure funding and ensure ongoing operational sustainability.

In identifying realistic delivery options that might be taken forward (given the above) assessment was given to:

- Developing, through workshops with internal and external stakeholders, the range of activities needed to deliver the vision and associated outcomes for Easter Bush;
- The scale of the facilities required to deliver optimum impact across the 15 years of City Regional Deal funding;
- Operational options for the provision of (net) additional Agri-Tech facilities and future Easter Bush services at the Campus; and,
- The alternative funding routes open to the University of Edinburgh to deliver these facilities and services.

Based on the above a long list of 9 options were identified (including the "as is" plan for Easter Bush in the absence of City Region Deal funding), namely:

1. **As Is**: i.e. the Campus continues on a "business as usual" basis;

[80] Both documents are accessible via: http://www.acceleratinggrowth.org.uk/

[81] The road infrastructure contribution of £7 million is excluded from this analysis given the focus on Campus developments and the transport costs and benefits have previously been provided in a separate Strategic Outline Case.

[82] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf

2. **Partnership with other Institutes:** Easter Bush would partner with non-UK Institutes to complement the capacity available in the local region;

3. **Third Party provider of data services and Infrastructure:** comprising all the current elements of the DDI Programme except EIDF (whose role would be undertaken by a third party provider);

4. **Private Sector Operates**: a private sector organisation takes responsibility for the operational delivery of all aspects of Easter Bush Agri-Tech activities and impacts;

5. **Incremental Investment:** involves the breakdown of the Programme into sequential steps (for example only taking forward discrete elements in terms of near-to-market opportunities);

6. **University led:** with operational responsibilities and delivery residing with the DDI Programme;

7. **Special Purpose Vehicle (SPV):** namely a separate entity oversees - and contracts in delivery partners to operate - the Programme against specified output (performance) measures;

8. **Seek alternative (non-UK) funding:** funding is secured to operate the Easter Bush Campus proposals from other sources (for example India given existing linkages to Easter Bush); and,

9. **Philanthropic funding:** funding is received to operate Easter Bush by donations from appropriate sources (for example the Bill and Melinda Gates Foundation).

In order to select a short-list of preferred options[83] a range of selection criteria were identified (using extant guidance[84]) to rank this long list (in terms of the likelihood or otherwise of meeting DDI Programme objectives) namely:

- **Strategic Fit**; namely the degree to which each option is likely to meet Easter Bush's strategic objectives, vision and aspirations and current and future market needs;

- **Benefits Realisation**; in terms of both the levels of likely benefit (in relation to key SMART objectives) and the timescales required to secure these levels;

- **Deliverability**; relative to existing organisational capabilities and expertise across and outwith the Universities and City Deal partners;

- **Sustainability**; in relation to the potential likelihood of securing re-investable returns from revenue (in particular post the initial 10 years of operation);

[83] for further review and analysis to identify, in broad cost benefit terms, that option which is most likely to deliver the best NPV outcome at the least risk.

[84] Including Public Sector Business Cases: Using the Five Case Model, HM Treasury, 2013 and other guides such as CIPFAs: Appendix_A4_3_general_guidance_on_option_appraisal_12_02_10_v1.pdf.

- **Affordability**; to the extent that any given option is likely to fall within (or not) current budget projections for Easter Bush operation;

- **Additionality**; by demonstrating that an option is complimentary to and adds value to existing activities and, if implemented, would be unlikely to cause significant "displacement" effects;

- **Cluster Potential**; to assess whether options might be supportive of the potential to develop a range of (thematic) clusters as envisaged within the SIA[85];

- **Flexibility**; to respond to future external factors in relation to market needs, political context, IT innovation and other changes that might impact on future Easter Bush operations and impact delivery;

- **Risk**; in terms of the ranges and levels of risk (and, ultimately, potential failure) that might be associated with each option;

- **Social Impact**; namely the extent or otherwise that an option will deliver the inclusive growth objective targets set and meet the wider Scottish Government objectives in regard to such impacts;

- **Stakeholder Acceptance**; in terms of the relative likelihood of support for each option from stakeholders, funders and potential Easter Bush user groups (e.g.: students, private sector companies and public and third sector bodies);

- **Mobilisation**; that captures the relative timescales that might be involved in delivering the Agri-Tech facilities and services required; and,

- **Data Availability**; namely whether third parties – including both the private and public sectors – would be prepared to share data under each option.

As illustrated in Table 12 overleaf by ranking[86] options against these criteria three options were short-listed[87]:

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[85] "*Moving forward rapidly we propose to create a disruptive regional ecosystem that unlocks value from public data and delivers sustainable gains in private sector activity, public sector transformation and digital skills. We will do this through investment in a Regional Data Science Innovation Cluster comprising three closely-linked nodes which will bring together over 5,000 people from business, the public sector, academia and the community. With investment in this Cluster we will harness our trusted existing partnerships across the public sector to create the foundation for a unique data-driven regional economy operating at a significant scale*". Enabling a World-Leading Regional Digital Economy through Data Driven Innovation Edinburgh & South East Scotland City Region A Science and Innovation Audit Report sponsored by the Department for Business, Energy & Industrial Strategy MAIN REPORT, 2016.

[86] With a ranking of + 1 for a given option where a criteria was likely to be met, -1 where the criteria would not be met and a zero value where it was uncertain whether an option might meet a given criterion.

[87] These options were selected on the basis that each scored more highly than business as usual and generated, on aggregate, a positive score (implying that each of these options is more likely than not to deliver Programme aims and objectives).

- **University led:** involving all **collocated components of the DDI campus** as reflected within the ESESCR SIA and detailed University of Edinburgh assessments[88] of the relative capital and operating costs associated with building and operating the Easter Bush Agri-Tech Hub;

- **Incremental Investment:** in the absence of City Region Deal funding - at the levels and timing anticipated under the July 2017 Heads of Terms and subsequent 2018 Funding profile agreement – it is anticipated there will be slower and (**comparatively more expensive**) piecemeal development of the Easter Bush Hub and associated service profiles given the requirement to secure alternative (and as yet untargeted) public and private funding sources; and,

- **SPV:** namely a separate entity that would oversee - and contract in delivery partners to operate – some of the services envisaged under the current Agri-Tech proposals. This option would necessarily exclude the talent element of the current proposals, would be slower to implement and require additional management fees and potentially risks (in relative terms to other options) a focus on near to market opportunities rather than the more strategic Agri-Tech research activities that might be supported (and funded) by the public sector and other sources.

Table 12: Ranking of long listed Easter Bush Hub options

SELECTION CRITERIA	Business as Usual	Partnership with other Institutes (for Additional Capacity)	Third Party provider of Data Services	Private Sector Operator	Incremental Investment	University led	SPV	Seek alternative (non UK) funding	Philanthropic Donation
Strategic Fit (incl. Themes & Geography)	1	0	-1	-1	1	1	1	1	1
Benefits Realisation	-1	0	0	-1	0	1	0	-1	0
Deliverability	0	0	-1	-1	0	0	0	-1	0
Sustainability reinvestment	-1	0	0	-1	0	0	0	-1	0
Affordability	0	0	0	0	0	1	0	0	0
Additionality	0	1	-1	0	0	1	1	0	0
Cluster potential	-1	-1	-1	-1	-1	0	0	-1	-1
Flexibility	1	0	0	-1	1	1	1	1	1
Risk	-1	-1	-1	-1	0	0	-1	-1	-1
Social impact	0	0	-1	-1	0	1	0	0	0
Political acceptance	0	0	0	-1	0	0	0	0	0

[88] Including estates, procurement and finance assessments reflected in the Commercial and Management sections of this Business Case.

Mobilisation	-1	-1	-1	-1	0	0	-1	-1	-1
Data availability	-1	-1	-1	-1	-1	0	-1	-1	-1
Total	**-4**	**-3**	**-8**	**-11**	**0**	**6**	**0**	**-5**	**-2**

Short Listed Options Cost Benefit Analysis

Analysis of each of these shortlisted options was undertaken in terms of the:

- Likely public sector costs associated with each option including an allocation of £6 million or 10% of EIDF costs (given projected Easter Bush EIDF use levels);
- Flow of net additional TRADE benefits in (net present value) GVA terms;
- Timescales required to deliver these benefits (across the fifteen-year Programme lifetime);
- Risks associated with delivery; and,
- Net additional GVA benefits over and above the status quo position.

This analysis suggests that the greatest net benefit in (net present value) GVA terms will be generated by the DDI option given that:

- The costs of the DDI option will be lower than the incremental approach as – by definition – this latter option assumes the requirement for the same facility requirements (as the DDI option) but building on a piecemeal basis and longer time scale (and therefore no economies of scale) it is assumed additional capital costs will be up to 20% more than the DDI approach (at around £53.6 million);
- In contrast, the SPV approach is unlikely to incur more or less capital costs than the DDI option given that this option is focused on the alternative operation of the facilities and equipment proposed under the DDI approach;
- In practice it is likely that the time required to set up and operate the Easter Bush Hub - under either the incremental or SPV - is likely to be longer than the DDI option. In addition, the relative level of benefits likely to be generated by the latter SPV approach will (always) be lower than either alternative option given that it will exclude any Talent component;
- As a result, the net benefits of these (other) two options will be lower than under the DDI Programme within the 15-year appraisal period considered. The assumptions drawn are that realisable net benefits might be 10% lower in the case of the incremental option (at around £223 million GVA to the UK economy) and at least 30% lower under the SPV option given both (relative) time delays and lower service levels (reducing GVA to around £174 million); and, finally,

- Consideration of the relative risks (of failing to deliver the objectives and outputs anticipated under the DDI approach) suggests that both the incremental and SPV options have a greater risk of failure than the DDI approach given the piecemeal and lower scale of benefits (if not also quality) of the likely operational profiles of each of these approaches. Accordingly benefit levels have been (further) discounted by 10% under each of these two options (to GVA levels respectively of £201 million and £157 million).

As indicated by current HM Treasury Guidance[89] : *"where optimising over a constrained budget, as is usually the case for government spending, the BCR can be constructed as a measure of social value divided by the relevant public spending constraint (e.g. NPSV/£ or the Present Value of Benefits/£). This assesses the benefits bought per £ of public spending".*

Consequently, as illustrated in Table 13 below, the option with the highest cost benefit ratio is the **DDI approach** at 1:6 compared to 1: 3.8 under the incremental option and 1:3.5 for the SPV approach.

Table 13: Relative net benefits of short-listed Easter Bush options

Options	Public Sector Costs[90]	Timing	Benefit (GVA)	Risk[91]	Benefits - Costs	Cost Benefit Ratio
DDI	*44.3*	*Baseline DDI timescales*	*248*	*Baseline risk*	*248*	*1:6*
Incremental	*53.16*	*Longer than DDI*	*223*	*Higher*	*201*	*1:3.8*
SPV	*44.3*	*Longer than DDI*	*174*	*Higher*	*157*	*1:3.5*

5.3 Preferred Option

This section sets out the key steps that have been undertaken to identify and quantify the TRADE related outputs and outcomes for the selected Easter Bush DDI option and consequent rationale for Government intervention to address the market failures identified in the previous section. In particular, consideration is given to the:

- Economic impacts likely to be generated under the "as is" scenario under which no government investment is provided (and consequently the previous market failures will be manifest); and,

[89] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf

[90] Including an allocation of £6 million – based on Easter Bush EIDF service usage levels – of the total net present value EIDF capital costs but **excluding any road improvement costs** (or associated benefits).

[91] Where a higher risk option will lead to a reduced level of benefits being potentially delivered.

- Impacts where such support is provided under the preferred option and the consequent net additional benefits that intervention will deliver in addressing these failures (compared to the above).

Key Assumptions

The key assumptions that have been made in measuring the economic impact of Easter Bush across all TRADE elements are:

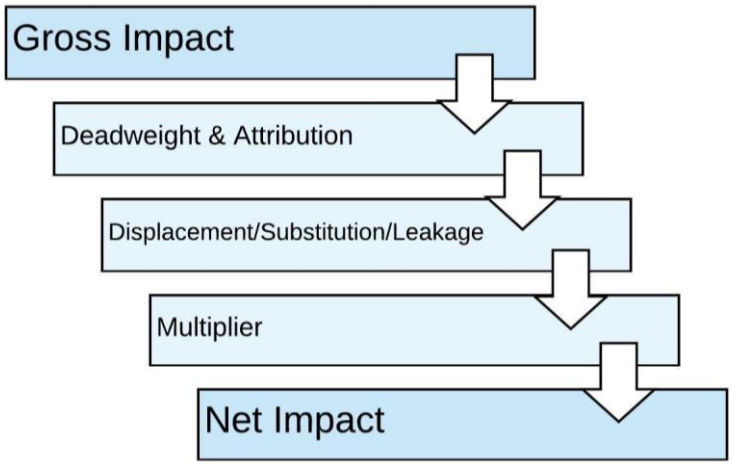
- **Timescale:** the analysis is based on the economic impact that is likely to be generated over the 15-year City Region Deal Funding period;

- **Geographic areas:** the analysis has been undertaken at the ESES City Deal Region, Scotland and UK levels to reflect the distributive impacts of the economic value created for each region;

- **Net impact:** the economic impact of TRADE has been adjusted for additionality factors including deadweight, displacement, leakage and multiplier effects in order to generate the net economic impact of the DDI Agri-Tech Programme (as per Figure Nine below); and,

- **NPV of benefits and costs:** all net benefits and public sector costs have been discounted at 3.5% (per Green Book Guidance (2018)) to reflect the value of impacts in current terms.

Figure Nine: Key Stages in undertaking Gross to Net Analysis



Estimating Benefits/Outputs

In order to estimate the gross outputs and outcomes for the Easter Bush Agri-Tech Hub a "bottom-up approach" has been taken to identify and quantify anticipated outputs and outcomes. In summary this approach consisted of three stages:

- **Identification of outputs and outcomes** – a qualitative and quantitative questionnaire was provided to the University of Edinburgh Easter Bush leads to capture the range of activities and expected outputs envisaged under the Do Nothing and Reference case scenarios (as per Appendix G);

- **Quantification of gross outputs and outcomes –** building upon the above templates, a

detailed breakdown of anticipated outputs, costs and income over a fifteen-year period was developed to estimate **the uplifts** in jobs created, GVA, and wider benefits (where possible) as **a result of DDI funding**; and,

- **Analysis of net impacts** – comprising additionality analysis (as per the steps outlined at Figure Nine above) of the gross DDI outputs and outcomes to identify levels of net impact based primarily on estimates of the levels of leakage, displacement and multiplier impacts from current and historic data (including the "BiGGAR Economics - Economic Impact of the University of Edinburgh 2013-14" report and student and staff data from the University of Edinburgh in relation to graduate destination survey data).

The output of the above steps is provided in summary form in Table 14 for three scenarios (i.e. Do Nothing, Reference case and **consequent** DDI Uplift by employment and TRADE outputs).

Table 14: Easter Bush Employment and TRADE Gross Outputs

Category	Baseline	Reference Case	DDI Uplift
Employment			
Talent	8	17	9
Research	144	186	42
Adoption	0	3	3
Data	N/A	N/A	N/A
Entrepreneurship	0	1	1
Talent			
No. of students taking DDI pathway course[92]	3,597	3,677	80
No. of new DDI undergraduates commencing courses	40	40	0
No. of new DDI residential masters students	0	490	490
No. of DDI masters level online distance learners	256	915	659
No. of new DDI PhD students	600	680	80
No. of DDI credit bearing CPDs and courses	0	24,036	24,036
No. of non-credit bearing DDI CPDs and other courses[93]	45,000	160,939	115,939
Research			
DDI Funding from UK Research Councils	£172.4m	£212.6m	£40.2m
DDI Funding from UK Government Departments	£38.3m	£47.2m	£8.9m

[92] In order to estimate the GVA impact of those students in receipt of DDI pathway courses compared to those undertaking a full DDI undergraduate degree the proportion of their degree spent on a DDI pathway course has been captured by assuming each student would take one pathway course over their undergraduate degree programme worth 20 points out of 480 for a full degree programme or 4% of any future uplifts in GVA compared to their peers that take a "full" DDI course.

[93] The majority of Easter Bush outreach will be delivered through uptake of DDI MOOCs supplemented by public facing DDI learning and engagement events across a range of tailored Easter Bush inclusive growth engagement programmes with schools and HE organisations. The potential economic impacts from these non-credit bearing courses has not been included in the rest of this section given the uncertainty surrounding the potential productivity uplifts associated with such courses (such as online non-credit bearing MOOCs) and attendance at DDI related workshops and events.

Total Public Sector Research Funding	***£210.7m***	***£259.8m***	***£49.1m***
DDI Funding from Industry & Commerce	£2.2m	£2.7m	£0.5m
DDI Funding from Overseas (EU)	£10.5m	£12.9m	£2.4m
DDI Funding from Overseas (outwith EU)	£19.7m	£24.3m	£4.6m
DDI Funding from UK Charities	£23.8m	£29.3m	£5.5m
DDI Funding from HEI partners	£14.0m	£17.3m	£3.3m
Total Third Party Research Funding	***£70.3m***	***£86.6m***	***£16.4m***
DDI Leveraged private R&D funds	£225.8m	£276.1m	£50.3m
Total DDI Research Funding	**£506.7m**	***£622.5m***	***£115.8m***
Adoption			
DDI Adoption income	0	£52.9m	£52.9m
Entrepreneurship			
No. of teams entering DDI accelerator programme	0	30	30

A detailed breakdown of the above profile of these annual outputs is provided at Appendix G.

The subsequent economic impact assessment has been undertaken for the DDI uplift scenario only and as such isolates the uplift in TRADE related activities as a result of the DDI Programme (i.e. net of the counterfactual scenario).

Net Impacts

This section details the **direct** (employment and student spending) and **indirect** (TRADE) **impacts** of DDI funding of the Easter Bush Hub to provide an overview of the steps taken (in terms of both economic metrics and additionality assumptions applied) to generate net economic impacts from the initial outputs identified (under the DDI Uplift column at Table 14 above).

Direct Impacts

Employment Outcome Analysis

Table 15 to 19 below present the steps taken in quantifying the GVA generated from the estimated additional employment that will be generated as a result of the DDI Uplift scenario. The key assumptions drawn in relation to measuring employment impact are:

GVA:

- **Academic staff** - the economic impact for academic staff has been calculated for a 15 year period and discounted at 3.5% based on the average GVA per job for the Education and ICT sectors in Scotland (i.e. to represent the average GVA per job from academic staff posts); and,

- **Research, Adoption and Entrepreneurship Staff** - the economic impact for implied research and adoption employment has been calculated for a 15 year period and discounted at 3.5% based on the average GVA per job/per head of the ICT and Professional and Technical sectors in Scotland and the rest of the UK.

Additionality:

- **Counterfactual** – A nil counterfactual scenario is assumed (at all geographic levels) as without the DDI Programme investment in these additional academic, research, entrepreneurship and adoption staff posts would not be created;
- **Leakage** – Leakage values have been based upon the 'staff by area of residence' data as provided by the University of Edinburgh in the "BiGGAR Economics - Economic Impact of the University of Edinburgh 2013-14" report that indicates the majority of the University's staff reside within the City Region at 78%, falling to 19% and 2% at the rest of Scotland and UK levels respectively;
- **Displacement** – Displacement levels for academic staff are based on the HCA Additionality Guide (2014) and vary by geographic level from between 10% (for the City Deal Region reflecting the likelihood of fewer competing academic and research institutions) to up to 50% (for the Rest of UK based on the greater likelihood of competing institutions whose activities might be displaced); and,
- **Multiplier** – Type II multipliers have been applied for SIC code 72 (R&D) 2014 for employment benefits for the City Deal and Scotland levels based on Scottish Government data for the Scottish economy. The UK level multiplier has been based on PwC Analysis of UK Type II Employment Multipliers.

Further details regarding the assumptions used to estimate both the GVA per employee figures and additionality ratios that have been applied can be found at Appendix H.

Table 15: Easter Bush Talent Employment Economic Outcome Analysis Process

Steps	Calculation	Worked Example
Step 1: Identification of gross Talent employment outputs - total over 15 years		
Incremental Talent Employment Outputs (Baseline & Reference Case) over 15 years	Provided by the UoE and summarised at Table 12	Reference case: Total Easter Bush: 17 Baseline: Total Easter Bush: 8
Step 2: Calculation of incremental DDI Uplift Talent employment outputs - total over 15 years		
Incremental DDI Uplift Talent Employment Outputs over 15 years	• Reference case minus baseline outputs	Uplift: Total Easter Bush: 9
Step 3: DDI Talent employees net of leakage (based on staff location data from UoE) – total over 15 years		
Talent jobs location/Leakage	Incremental talent positions multiplied by Teaching Jobs Location factor by region, as follows: • City Deal region: 78% • Rest of Scotland: 19% • Rest of UK: 2%	Easter Bush: • CD region: 9 * 78% = 7.02 • Rest of Scotland: 9 * 19% = 1.71 • Rest of UK: 9 * 2% = 0.18
Step 4: DDI Talent employees net of leakage and displacement – total over 15 years		

Steps	Calculation	Worked Example
Displacement	Teaching Jobs Location numbers multiplied by (1 minus the Teaching jobs Displacement factor) by region, as follows: • City Deal region: 10% • Rest of Scotland: 20% • Rest of UK: 50%	Easter Bush: • CD region: 7.02 * 90% = 6.32 • Rest of Scotland: 1.71 * 80% = 1.37 • Rest of UK: 0.18 * 50% = 0.09
Step5: DDI Talent employees net of leakage and displacement converted into GVA – total over 15 years		
Net Employment GVA Impact[94]	Displacement numbers multiplied by net discounted Teaching position GVA (over duration of the programme) per region, as follows: • City Deal region: £558,274 • Rest of Scotland: £620,305 • Rest of UK: £686,587	Easter Bush: • CD region: 6.32 * £558,274 = £3.5m • Rest of Scotland: 1.37 * £620,305 = £0.8m • Rest of UK: 0.09 * £686,587 = £0.06m
Step 6: GVA from Net DDI Talent employees with discount factor applied over 15 years		
Net Employment Impact NPV	Net Employment GVA Impact numbers multiplied by the discount factor of 3.5% per region per year.	Easter Bush: • CD region: £3.1m • Rest of Scotland: £0.7m • Rest of UK: £0.05m
Step 7: Discounted GVA from Net DDI Talent employees including multiplier effects – total over 15 years		
Multiplier	Net Employment Impact NPV numbers multiplied by the multiplier Employment Type II per region, as follows: • City Deal region: 1.40 • Scotland: 1.7 • UK: 2.2 With: • Scotland = CD region + Rest of Scotland; and • UK = CD region + Rest of Scotland + Rest of UK	Easter Bush: • CD region: £3.1m * 1.4 = £4.3m • Scotland: (£3.1m + £0.7m) * 1.7 = £6.4m • UK: (£3.1m + £0.7m + £0.05m) * 2.2 = £8.4m
Total DDI Talent Employment GVA (UK)		**£8.4m**

Table 16: Easter Bush Research Employment Economic Outcome Analysis Process

Steps	Calculation	Worked Example
Step 1: Identification of gross Research employment outputs - total over 15 years		
Incremental Research Employment Outputs (Baseline & Reference Case) over 15 years	Provided by the UoE and summarised at Table 12	Reference case: • Easter Bush: 186 Baseline case: • Easter Bush: 144
Step 2: Calculation of incremental DDI Uplift Research employment outputs - total over 15 years		
Incremental DDI Uplift Research Employment Outputs over 15 years	• Reference case minus baseline outputs	Uplift: • Easter Bush: 42 research staff
Step 3: DDI Research employees net of leakage (based on staff location data from UoE) – total over 15 years		

[94] In calculating the GVA impact from direct employment the full DDI academic employment GVA has been calculated over 15 years in line with the 2013 Green Book approach to quantifying the employment impacts of interventions.

Steps	Calculation	Worked Example
Research jobs location/Leakage	Incremental Research positions multiplied by Teaching Jobs Location factor by region, as follows: • City Deal region: 78% • Rest of Scotland: 19% • Rest of UK: 2%	Easter Bush: • CD region: 42 * 78% = 32.43 • Rest of Scotland: 42 * 19% = 7.90 • Rest of UK: 42 * 2% = 0.83
Step 4: DDI Research employees net of leakage and displacement – total over 15 years		
Displacement	Research Jobs Location numbers multiplied by (1 minus the Research jobs Displacement factor) by region, as follows: • City Deal region: 10% • Rest of Scotland: 20% • Rest of UK: 50%	Easter Bush: • CD region: 32.43 * 90% = 29.18 • Rest of Scotland: 7.90 * 80% = 6.32 • Rest of UK: 0.83 * 50% = 0.42
Step 5: DDI Research employees net of leakage and displacement converted into GVA – total over 15 years		
Net Employment GVA Impact[95]	Displacement numbers multiplied by net discounted Research position GVA (over duration of the programme) per region, as follows: • City Deal region: £810,595 • Rest of Scotland: £660,247 • Rest of UK: £769,409	Easter Bush: • CD region: 29.18 * £810,595 = £23.7m • Rest of Scotland: 6.32 * £660,247 = £4.2m • Rest of UK: 0.42 * £769,409 = £0.3m
Step 6: GVA from Net DDI Research employees including multiplier effects – total over 15 years		
Multiplier	Net Employment GVA Impact numbers multiplied by the multiplier Employment Type II per region, as follows: • City Deal region: 1.40 • Scotland: 1.7 • UK: 2.2 with: Scotland = CD region + Rest of Scotland; and • UK = CD region + Rest of Scotland + Rest of UK	Easter Bush: • CD region: £23.7m * 1.4 = £33.1m • Scotland: (£23.7m + £4.2m) * 1.7 = £47.3m • UK: (£23.7m + £4.2m + £0.3m) * 2.2 = £61.9m
Step 7: Discounted GVA from Net DDI Research employees with discount factor applied over 15 years		
Net Employment Impact NPV	Multiplier numbers multiplied by the discount factor of 3.5% per region per year.	Easter Bush: • CD region: £29.0m • Scotland: £41.4m • UK: £54.2m
Total DDI Research Employment GVA (UK)		**£54.2m**

Table 17: Easter Bush Adoption Employment Economic Outcome Analysis Process

Steps	Calculation	Worked Example
Step 1: Identification of gross Adoption employment outputs - total over 15 years		
Incremental Adoption Employment Outputs (Baseline &	Provided by the UoE and summarised at Table 12	• 3 adoption staff (reference case) • 0 adoption staff (baseline)

[95] In calculating the GVA impact from direct employment the full DDI academic employment GVA has been calculated over 15 years in line with the 2013 Green Book approach to quantifying the employment impacts of interventions.

Steps	Calculation	Worked Example
Reference Case) over 15 years		
Step 2: Calculation of incremental DDI Uplift Adoption employment outputs - total over 15 years		
Incremental DDI Uplift Adoption Employment Outputs over 15 years	• Reference case minus baseline outputs	• 3 – 0 = 3 adoption staff (uplift)
Step 3: DDI Adoption employees net of leakage (based on staff location data from UoE) – total over 15 years		
Adoption jobs location/Leakage	Incremental Adoption positions multiplied by Teaching Jobs Location factor by region, as follows: • City Deal region: 78% • Rest of Scotland: 19% • Rest of UK: 2%	Easter Bush: • CD region: 3 * 78% = 2.72 • Rest of Scotland: 3 * 19% = 0.66 • Rest of UK: 3 * 2% = 0.07
Step 4: DDI Adoption employees net of leakage and displacement – total over 15 years		
Displacement	Adoption Jobs Location numbers multiplied by (1 minus the Adoption jobs Displacement factor) by region, as follows: • City Deal region: 10% • Rest of Scotland: 20% • Rest of UK: 50%	Easter Bush: • CD region: 2.72 * 90% = 2.44 • Rest of Scotland: 0.66 * 80% = 0.53 • Rest of UK: 0.07 * 50% = 0.03
Step 5: DDI Adoption employees net of leakage and displacement converted into GVA – total over 15 years		
Net Employment GVA Impact[96]	Displacement numbers multiplied by net discounted Adoption position GVA (over duration of the programme) per region, as follows: • City Deal region: £810,595 • Rest of Scotland: £660,247 • Rest of UK: £769,409	Easter Bush: • CD region: 2.44 * £810,595 = £2.0m • Rest of Scotland: 0.53 * £660,247 = £0.4m • Rest of UK: 0.03 * £769,409 = £0.02m
Step 6: GVA from Net DDI Adoption employees including multiplier effects – total over 15 years		
Multiplier	Net Employment GVA Impact numbers multiplied by the multiplier Employment Type II per region, as follows: • City Deal region: 1.40 • Scotland: 1.7 • UK: 2.2 with: • Scotland = CD region + Rest of Scotland; and • UK = CD region + Rest of Scotland + Rest of UK	Easter Bush: • CD region: £2.0m * 1.40 = £2.8m • Scotland: (£2.0m + £0.4m) * 1.7 = £4.0m • UK: (£2.0m + £0.4m + £0.02m) * 2.2 = £5.2m
Step 7: Discounted GVA from Net DDI Adoption employees with discount factor applied over 15 years		
Net Employment Impact NPV	Multiplier numbers multiplied by the discount factor of 3.5% per region per year.	Easter Bush: • CD region: £2.3m • Scotland: £3.2m • UK: £4.2m

[96] In calculating the GVA impact from direct employment the full DDI academic employment GVA has been calculated over 15 years in line with the 2013 Green Book approach to quantifying the employment impacts of interventions.

Steps	Calculation	Worked Example
Total DDI Adoption Employment GVA (UK)		**£4.2m**

Table 18: Easter Bush Entrepreneurship Employment Economic Outcome Analysis Process

Steps	Calculation	Worked Example
Step 1: Identification of gross Entrepreneurship employment outputs - total over 15 years		
Incremental Entrepreneurship Employment Outputs (Baseline & Reference Case) over 15 years	Provided by the UoE and summarised at Table 12 above	• 1 entrepreneurship staff (reference case) • 0 entrepreneurship staff (baseline)
Step 2: Calculation of incremental DDI Uplift Entrepreneurship employment outputs - total over 15 years		
Incremental DDI Uplift Entrepreneurship Employment Outputs over 15 years	• Reference case minus baseline outputs	• 1 – 0 = 1 entrepreneurship staff (uplift)
Step 3: DDI Entrepreneurship employees net of leakage (based on staff location data from UoE) – total over 15 years		
Entrepreneurship jobs location/Leakage	Incremental Entrepreneurship positions multiplied by Teaching Jobs Location factor by region, as follows: • City Deal region: 78% • Rest of Scotland: 19% • Rest of UK: 2%	Easter Bush: • CD region: 1 * 78% = 0.40 • Rest of Scotland: 1 * 19% = 0.10 • Rest of UK: 1 * 2% = 0.01
Step 4: DDI Entrepreneurship employees net of leakage and displacement – total over 15 years		
Displacement	Entrepreneurship Jobs Location numbers multiplied by (1 minus the Entrepreneurship jobs Displacement factor) by region, as follows: • City Deal region: 10% • Rest of Scotland: 20% • Rest of UK: 50%	Easter Bush: • CD region: 0.4 * 90% = 0.36 • Rest of Scotland: 0.10 * 80% = 0.08 • Rest of UK: 0.01 * 50% = 0.01
Step 5: DDI Entrepreneurship employees net of leakage and displacement converted into GVA – total over 15 years		
Net Employment GVA Impact[97]	Displacement numbers multiplied by net discounted Entrepreneurship position GVA (over duration of the programme) per region, as follows: • City Deal region: £728,925 • Rest of Scotland: £671,880 • Rest of UK: £740,834	Easter Bush: • CD region: 0.36 * £728,925 = £0.3m • Rest of Scotland: 0.08 * £671,880 = £0.05m • Rest of UK: 0.01 * £740,834 = £0.004m

[97] In calculating the GVA impact from direct employment the full DDI academic employment GVA has been calculated over 15 years in line with the 2013 Green Book approach to quantifying the employment impacts of interventions.

Steps	Calculation	Worked Example
Step 6: GVA from Net DDI Entrepreneurship employees including multiplier effects – total over 15 years		
Multiplier	Net Employment Impact NPV numbers multiplied by the multiplier Employment Type II per region, as follows: • City Deal region: 1.40 • Scotland: 1.7 • UK: 2.2 With: • Scotland = CD region + Rest of Scotland; and • UK = CD region + Rest of Scotland + Rest of UK	Easter Bush: • CD region: £0.3m * 1.40 = £0.4m • Scotland: (£0.3m + £0.05m) * 1.7 = £0.6m • UK: (£0.3m + £0.05m + £0.004m) * 2.2 = £0.8m
Step 7: Discounted GVA from Net DDI Entrepreneurship employees with discount factor applied over 15 years		
Net Employment Impact NPV	Net Employment GVA Impact numbers multiplied by the discount factor of 3.5% per region per year.	Easter Bush: • CD region: £0.1m • Scotland: £0.2m • UK: £0.3m
Total DDI Entrepreneurship Employment GVA (UK)		**£0.3m**

Table 19 below summarises the total (direct employment) net (discounted) GVA of £67.1m that will be generated as a result of the DDI Programme investment in Easter Bush.

Table 19: Summary of Easter Bush DDI TRADE Employment - Net GVA (discounted)

Category	GVA – UK
Talent	£8.4m
Research	£54.2m
Adoption	£4.2m
Entrepreneurship	£0.3m
Total	**£67.1m**

Student Spend Outcome Analysis

The indirect impacts from the DDI talent theme student spending impacts generated from on campus undergraduates and postgraduates is based upon:

GVA:

The economic impact of student spending for campus based graduates and post graduates has been calculated for a 15 year period and discounted at 3.5% based on an average student spend of £6,990 per annum. This figure represents the economic impact of the spending of students

during their time at University and has been calculated based on data presented in the "BiGGAR Economics - Economic Impact of the University of Edinburgh 2013-14" report.

Additionality:

- **Counterfactual** – A nil counterfactual scenario is assumed (at all geographic levels) as without the DDI Programme investment these additional Easter Bush graduate and post graduates would not be in receipt of teaching at the University;

- **Leakage** – Leakage levels are assumed to be in line with the student spend profile provided within the: "BiGGAR Economics - Economic Impact of the University of Edinburgh 2013-14" report which indicates the majority of the University's graduates spend takes place within the City Region at 93%, falling to 7% and 0% for the rest of Scotland and UK levels respectively;

- **Displacement** – based on the HCA Additionality Guide[98] – with an assumption of low levels of displacement of between 10% (for the City Deal Region) to up to 25% (for the Rest of Scotland) with 0% assumed for Rest of UK based on the local nature of on campus undergraduate students location and therefore spend profiles. Postgraduate student spending displacement is assumed to be medium (at 50%) given the greater likelihood of part-time post graduate students with a more diverse accommodation profile across the three regions; and,

- **Multiplier** – The GVA Type II multiplier has been applied for SIC code 72 (R&D) 2014 for GVA benefits generated from student spending effects for the City Deal and Scotland levels, based on Scottish Government data for the Scottish economy. The UK level multiplier has been based on PwC Analysis of UK Type II GVA Multipliers[99].

Table 20 presents the steps taken in calculating gross to net GVA from DDI student spending.

Table 20: Easter Bush Student Spending Economic Outcome Analysis Process

Steps	Calculation	Worked Example
Step 1: Identification of gross DDI Student Spending outputs – total over 15 years		
Uplift numbers	As per step 4 of table 24 below (for graduates)	Easter Bush on-campus graduates (uplift case): • CD region: 0 • Rest of Scotland: 0 • Rest of UK: 0 Easter Bush on-campus **post graduates** (uplift case): • CD region: 180 • Rest of Scotland: 56 • Rest of UK: 71
Step 2: DDI Talent outputs converted into student spend GVA net of leakage – total over 15 years		

[98] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/378177/additionality_guide_2014_full.pdf

[99] As detailed in Appendix I.

Steps	Calculation	Worked Example
Student Spend Location	DDI uplift on-campus graduates and post graduates x £6,990 (student spend GVA p.a.) x Student Spend Location factor as follows: • 93% City Deal Region • 7% Rest of Scotland • 0% Rest of UK	Easter Bush on-campus post graduates • CD region: 180 * £6,990 * 93% = £1.2m • Rest of Scotland: 56 * £6,990 * 7% = £0.08m • Rest of UK: 71 * £6,990 * 0% = £0
Step 3: DDI Student Spend GVA net of leakage and displacement (based on graduate destination data from UoE) – total over 15 years		
Displacement	Student Spend Location numbers multiplied by 1 minus the Graduate displacement factor as follows: • 50% City Deal Region • 50% Rest of Scotland • 50% Rest of UK And for post graduates: • 10% City Deal Region • 25% Rest of Scotland • 0% Rest of UK	Easter Bush on-campus post graduates • CD region: £1.2m * 90% = £1.1m • Rest of Scotland: £0.08m * 75% = £0.06m • Rest of UK: £0 * 100% = £0
Step 4: DDI Student Spend GVA net of leakage and displacement with discount factor applied – total over 15 years		
Student Spending NPV	Displacement numbers multiplied by the discount factor of 3.5% per region per year	• CD region: £0.7m • Rest of Scotland: £0.04m • Rest of UK: £0
Step 5: GVA from Net DDI Student Spend with discount factor and multiplier applied – over 15 years		
Multiplier	Student Spending NPV multiplied by the graduate GVA impact multiplier per region, as follows: • 1.27 for City Deal Region • 1.5 for Scotland (Rest of Scotland + CD Region) • 2.6 for UK (Rest of Scotland + CD region + Rest of UK)	• CD region: £0.07m * 1.27 = £0.9m • Scotland: (£0.7m + £0.04m) * 1.5 = £1.2m • UK: (£0.7m + £0.04m + £0) * 2.6 = £2.0m
Step 6: Discounted Net GVA from DDI Student Spend – total over 15 years		
Total GVA	Sum of the Net GVA after multiplier for each degree per region, minus the CPD Net GVA (which is allocated to Adoption)	• CD Region: £0.9m • Scotland: £1.2 m • UK: £2.0m
Total DDI Student Spend GVA (UK)		**£2.0m**

Indirect Impacts

Talent Outcome Analysis

This section presents the approach that has been undertaken to quantify the **indirect** DDI based teaching impacts based on the net additional earnings GVA impact from the training of DDI undergraduates and postgraduates at the Easter Bush Hub. It is important to note that this analysis:

- Does not include the impact of credit bearing CPDs which has been captured under Adoption given CPD courses are predominantly undertaken by individuals in employment; and,

- Is based on 88% of students taking DDI degrees and pathway courses with the remaining 12% being allocated to Entrepreneurship to reflect the proportion of graduates likely to join/establish DDI focused micro businesses or SMEs as a result of the DDI Programme[100].

In regard to **talent outcomes** consideration has, therefore, been given – in line with BEIS Guidance[101] regarding "wage uplifts" – to the likely increases in the net present value of the lifetime income and GVA of those students securing DDI related employment in the City Region, Scotland and the UK.

Consequently, as detailed at Appendix H and outlined below, the key assumption drawn are:

- **Counterfactual GVA:** comprises the average GVA per employee across all SIC codes for each area (City Region, Scotland and UK) representing the GVA that could be generated by graduates not in receipt of DDI related teaching. This has been calculated on a lifetime basis (i.e. 40 year employment profile) and discounted at 3.5%. Table 21 below sets out the counterfactual GVA assumptions.

Table 21: Counterfactual Employee GVA for the DDI Programme

Area	Average GVA (2017)	Discounted lifetime average GVA (2017)
City Region	£42,408	£905,626
Scotland	£53,057	£1,133,036
UK	£54,843	£1,171,176

From: ONS NUTS1 Level GVA by Standard Industrial Classification (SIC), 2017 and PwC analysis of ONS GVA data discounted by 3.5% over 40 years.

- **DDI GVA:** it is assumed that on graduation each Easter Bush graduate will secure a new FTE DDI related Agri-Tech position. Given the absence of sector specific GVA data it is assumed that an appropriate proxy for an Easter Bush graduate is the average GVA for the Professional and Technical and ICT sectors (as per Table 22 below).

Table 22: Projected Annual GVA of an Easter Bush DDI Graduate by Sector[102]

Sector	ONS SIC Category for DDI Sector	City Deal Region	Scotland	UK
Easter Bush	Professional Technical & ICT	£70,380	£57,326	£66,804

Source: ONS GVA per worker, 2015.

[100] Student destination data from UoE (2017) indicates approximately 7% of graduates are employed by micro businesses (i.e. businesses with less than 10 employees) in the City Region with a further 5% employed within small businesses (between 10 to 50 employees) indicating approximately 12% of graduate destinations within micro and small businesses.

[101] Per HM Treasury, The Green Book: Central Government Guidance on Appraisal and Evaluation, 2018 and BEIS email to the ESESCR Deal Chief Executive and PMO on 19th March 2018.

[102] The DDI sector related GVA has been based on publically available data from the Office of National Statistics (ONS) on GVA per worker for Standard Industrial Classification (SIC) codes. Given the limitations of this data in terms of sectoral composition we have made assumptions regarding the most appropriate sector DDI graduates are likely to be based in post completion of their course (e.g. it is assumed a Easter Bush graduate is likely to work in a job with a GVA equivalent to that of the average GVA of a Professional Technical and ICT worker).

Average current GVA and lifetime discounted GVA for these sectors has been provided in Table 23 below, for the City Region, Scotland and UK levels - indicating between £1.22m and £1.43m of uplifts in GVA at the Scottish and UK levels respectively.

Table 23: DDI Easter Bush Employee GVA

Area	Average GVA (2017)	Discounted lifetime average GVA (2017)
City Region	£42,408	£1,502,970
Scotland	£53,057	£1,224,201
UK	£54,843	£1,426,604

From: ONS NUTS1 Level GVA by Standard Industrial Classification (SIC), 2017 and PwC analysis of ONS GVA data discounted by 3.5% over 40 years.

The total net DDI uplift in GVA that might therefore be generated by Easter Bush Graduates has been calculated by discounting the DDI Easter Bush GVA in Table 23 from the counterfactual GVA in Table 21 to calculate the **net uplift** in lifetime GVA (for Easter Bush graduates) as a result of DDI training.

As indicated in Table 24 below, this implies a wage uplift of between £597,344 and £255,428 for each Easter Bush graduate over their lifetime at the City Region and UK level respectively.

Table 24: DDI related GVA Uplift in Easter Bush Employee lifetime earnings

Area	Discounted lifetime average DDI GVA (2017)	Discounted lifetime average counterfactual GVA (2017)	Discounted lifetime average Net DDI GVA (2017)
City Region	£1,502,970	£905,626	£597,344
Scotland	£1,224,201	£1,133,036	£91,165
UK	£1,426,604	£1,171,176	£255,428

From: PwC analysis of ONS GVA data by SIC discounted by 3.5% over 40 years.

To estimate the net additional DDI Talent GVA per graduate, assumptions have been made in relation to:

- **Leakage:** this has been based on data from the University of Edinburgh student destination figures for 2017, indicating – as illustrated in Table 25 below - that approximately 65% of their undergraduate student body leaves the City Deal Region post-graduation rising to 75% at the UK level.

Table 25: Student Destination Data for UoE

Qualification Type	City Deal Region	Scotland	UK
UoE Undergraduates	35%	13%	25%
UoE Masters	35%	13%	25%
UoE PhD	35%	13%	25%
UoE Distance learning Masters	5%	5%	29%
Credit Bearing CPD	35%	13%	25%
Non-credit Bearing	5%	5%	29%

Based on data from University of Edinburgh (UoE), 2018.

- **Displacement:** given the unique and innovative nature of the proposed DDI training courses, displacement is assumed to be low, (at 10%) at the City Deal Region level for non-Scottish and EU Funded students. While, at minimum, displacement levels might be as high as 50% at the UK level given the greater likelihood of other/competing academic providers offering similar courses; and,

- **Multipliers:** Type II multipliers have been applied for the SIC code 72 (R&D)[103] 2014 for GVA and Employment impacts for the City Deal and Scotland levels based on Scottish Government data for the Scottish economy. The UK level multiplier has been based on PwC Analysis of UK level Type II GVA and Employment Multipliers.

Table 26 presents the steps taken (in terms of the additionality factors and economic metrics applied) to calculate the GVA generated as a result of DDI related teaching activities.

Table 26: Easter Bush Talent Economic Outcome Analysis Process

Steps	Calculation	Worked Example
Step 1: Identification of gross Talent outputs – total over 15 years		
Outputs	Provided by the UoE and summarised at Table 12	Easter Bush (reference case): • 80 pathway courses undergraduates • 3 pathway courses FTE equivalents (20/480 ratio) • 1,028 undergraduates • 490 masters • 680 PhDs • 24,000 CPDs • 160,939 non-credit bearing • 915 distance-learning masters Easter Bush (baseline case): • 0 pathway courses undergraduates • 0 pathway courses FTE equivalents (20/480 ratio) • 1,028 undergraduates • 0 masters • 600 PhDs • 0 CPDs • 45,000 non-credit bearing • 256 distance-learning masters
Step 2: Calculation of cumulative DDI uplift Talent outputs – total over 15 years		
Uplift numbers	• Reference case minus baseline outputs numbers	Easter Bush (uplift case): • 80 pathway courses undergraduates • 3 pathway courses FTE equivalents (20/480 ratio) • 0 undergraduates • 490 masters • 80 PhDs • 24,000 CPDs • 115,939 non-credit bearing • 659 distance-learning masters
Step 3: DDI Talent outputs net of leakage (based on graduate destination data from UoE) – total over 15 years (PhDs only)		

[103] The R&D multiplier has been used as a proxy for the DDI programme impacts due to limitations in the SIC breakdown of multiplier data which does not allow cross tabulation for each of the DDI sectors.

Steps	Calculation	Worked Example
Graduate destinations/Leakage	Uplift numbers multiplied by graduate destination factors per region (for PhDs), as follows: • 35% City Deal Region • 13% Rest of Scotland • 25% Rest of UK	Easter Bush: • CD region: 80 * 35% = 28 • Rest of Scotland: 80 * 13% = 10 • Rest of UK: 80 * 25% = 20
Step 4: DDI Talent outputs net of leakage and displacement (based on secondary data sources) – total over 15 years (PhDs only)		
Displacement	Graduate destination number multiplied by 1 minus the graduate displacement factor, as follows: • 50% for City Deal Region, Rest of Scotland and Rest of UK for undergraduate displacement (not applicable for PhDs); AND • 10%, 25% and 50% (respectively CD Region, Rest of Scotland and Rest of UK) for UK and Overseas UGs, Masters and PhD displacement.	Easter Bush: • CD region: 28 * 90% = 25 • Rest of Scotland: 10 * 75% = 8 • Rest of UK: 20 * 50% = 10
Step 5: DDI Talent outputs net of leakage and displacement converted into GVA – total over 15 years- (PhDs only)		
Net GVA uplift	Displacement numbers multiply by the GVA uplift per graduate (lifetime, discounted) as follows: Easter Bush: • £597,344 for CD Region • £91,165 for Rest of Scotland • £255,428 for Rest of UK	Easter Bush: • CD region: 25 * £597,344 = £3.2m • Rest of Scotland = 8 * £91,165 = £0.2m • Rest of UK: 10 * £255,428 = £0.5m
Step 6: GVA from Net DDI Talent with discount factor applied over 15 years (PhDs only)		
Net Teaching Impact NPV	Net GVA uplift multiplied by the discount factor of 3.5% per region per year.	Easter Bush: • CD region: £2.2m • Rest of Scotland: £0.1m • Rest of UK: £0.4m
Step 7: Discounted GVA from Net DDI Talent including multiplier effects – total over 15 years (PhDs only)		
Net GVA after multiplier	Net Teaching impact NPV multiplied by the graduate GVA impact multiplier per region, as follows: • 1.27 for CD Region • 1.5 for Scotland (Rest of Scotland + CD Region) • 2.6 for UK (Rest of Scotland + CD region + Rest of UK)	Easter Bush: • CD Region: £2.2m * 1.27 = £2.8m • Scotland: (£2.2m + £0.1m) * 1.5 = £3.5m • UK: (£2.2m + £0.1m + £0.4m) * 2.6 = £7.0m
Step 8: Discounted GVA from net DDI Talent students (all DDI graduates) – total over 15 years		
Total GVA	Sum of the Net GVA after multiplier for each degree per region, minus the CPD Net GVA (which is allocated to Adoption)	• CD Region: £21.8m • Scotland: £27.2m • UK: £62.4m
Step 9: Discounted GVA from net DDI Talent graduates post allocation to Entrepreneurship – total over 15 years		
Graduate GVA Impact	88% of the Total Talent GVA (12% allocated to Entrepreneurship) per region	• CD Region: £21.8m * 88% = £19.1m • Scotland: £27.2m * 88% = £23.9m • UK: £62.4m * 88% = £54.9m
Total DDI Talent Graduate GVA (UK)		**£54.9m**

As a result of the above additionality adjustments, and as demonstrated in Table 27 below, net uplifts in GVA (over the lifetime of the Programme) from DDI trained talent at Easter Bush is estimated to be £54.9m (excluding student spending (of £2m) and teaching employment impacts (of £8.4m).

Table 27: DDI Talent related Net GVA (discounted)

Category	GVA
Talent Graduates	£54.9m
Talent Student Spending	£2.0m
Talent Employment	£8.4m
Total Talent	**£65.3m**

Research Outcome Analysis

This section presents the approach that has been undertaken to quantify DDI based research funding impacts. For the purposes of the economic case DDI Agri-Tech Easter Bush Research **impacts** have been based upon all direct public, private and third sector DDI research funding attracted to the UoE as a result of the Easter Bush Hub activities. Table 28 presents the split of DDI research funding by source e.g. public and private funds (including private leveraged funds of £50.3m). This data has also been used to calculate the potential return on investment that could be generated in GVA terms over the Programme period from the Easter Bush's anticipated research funding profile.

Table 28: DDI Research Funding Split by Funder

DDI Hub	Public funding	Third party (including private leveraged funds) Funding	Overseas Funding
Easter Bush	£49.1m	£59.6m	£7.0m

It is important to note that while the volume of overseas funding attracted is recognised in the commercial case as an **income flow** in the economic case the **impact** of these funds has **not been quantified** at this time due to the lack of certainty regarding whether any subsequent returns will be captured at a UK level.

In regard to **research outcomes** analysis has been based on existing evidence in relation to the likely GVA uplifts resulting from this research. The key assumptions drawn from this evidence are:

GVA:

- **Rates of return**: research from the University of Edinburgh[104], Russell Group Universities[105] and wider sources[106] have indicated the average rate of return from R&D investment to be between 20% to 30%. In order to be prudent a 20% rate of return p.a. until the end of the DDI Programme for public and private research funding has been assumed; and,

- **Time lags**: this research also indicated the need to take time lags into consideration when measuring the impact of R&D funding indicating a 4 year time lag for public and private sector

104 From: A Science and Innovation Audit Report for University of Edinburgh, 2016.

105 From: London Economics – The Economic Impact of Russell Group Universities, 2017.

106 Including (amongst other reports): Frontier Economics – Rates of Return to investment in Science and innovation, 2014 and Haskel et al - The Economic significance of the UK Science Base 2014.

R&D i.e. funding in year 1 will start generating impact in Year 5 for the remaining 10 years of the Programme.

Additionality Effects:

The key additionality assumptions applied to DDI research funding are:

- **Leakage**: a low level of leakage (of 10%) has been assumed on the basis the majority of the research funding will be retained within the University and hence City Deal Region boundary with 95% leakage assumed for the Rest of Scotland and Rest of UK (given the majority of impact is expected to occur and remain within the City Deal Region);
- **Displacement**: different displacement levels have been applied to the different types of research funding and geographical areas. For example, we have assumed no displacement for public and private funds at the City Deal Region level given the innovative nature of R&D the funding will be seeking to unlock and the lack of alternative Higher Education Institutions/competitor bodies likely to undertake similar activity within the City Region. Higher levels of displacement of between 20% to 30% have been assumed for the Rest of Scotland and UK levels; and,
- **Multipliers**: Type II multipliers have been applied for the SIC code 72 (R&D) 2014 for GVA and Employment impacts for the City Deal and Scotland levels based on Scottish Government data for the Scottish economy. The UK level multiplier has been based on PwC Analysis of UK level Type II GVA and Employment Multipliers.

Table 29 presents the steps taken (in terms of the additionality factors and economic metrics applied) to calculate the GVA generated as a result of DDI related research activities.

Table 29: Easter Bush Research Economic Outcome Analysis Process

Steps	Calculation	Worked Example
Step 1: Identification of gross Research outputs – total over 15 years		
Outputs	Provided by the UoE and summarised at Table 12	Easter Bush (reference case): • £212.6m from UK Research Councils • £47.2m from UK Government Departments • £2.7m from Industry & Commerce • £12.9m from Overseas (EU) • £24.3m from Overseas (outwith EU) • £29.3m from UK Charities • £17.3m from HEI Partners • £276.1m from Leveraged Private Funds Easter Bush (baseline case): • £172.4m from UK Research Councils • £38.3m from UK Government Departments • £2.2m from Industry & Commerce • £10.5m from Overseas (EU) • £19.7m from Overseas (outwith EU) • £23.8m from UK Charities • £14.0m from HEI Partners • £225.8m from Leveraged Private Funds
Step 2: Calculation of cumulative DDI uplift Research outputs – total over 15 years		

Steps	Calculation	Worked Example
Uplift numbers	• Reference case minus baseline outputs numbers	Easter Bush (uplift case): • £40.2m from UK Research Councils • £8.9m from UK Government Departments • £0.5m from Industry & Commerce • £2.4m from Overseas (EU) • £4.6m from Overseas (outwith EU) • £5.5m from UK Charities • £3.3m from HEI Partners • £50.3m from Leveraged Private Funds
Step 3: DDI Research outputs net of leakage (based on funding destination data from UoE) – total over 15 years		
Funding destination	Uplift numbers multiplied by Research funding ultimate destination factor per sectors as follows: • 90% City Deal Region • 5% Rest of Scotland • 5% Rest of UK	Easter Bush: • CD region: £115.8m * 90% = £104.2m • Rest of Scotland: £115.8m * 5% = £5.8m • Rest of UK: £115.8m * 5% = £5.8m
Step 4: DDI Research outputs net of leakage and displacement (based on secondary data sources) – total over 15 years		
Displacement	Funding destination number multiplied by 1 minus the Research displacement factor, minus the leveraged private funds, as follows: UK Research Councils • 0% City Deal Region • 20% Rest of Scotland • 30% Rest of UK UK Government Departments • 0% City Deal Region • 20% Rest of Scotland • 30% Rest of UK Industry & Commerce • 0% City Deal Region • 10% Rest of Scotland • 20% Rest of UK Overseas (EU) • 0% City Deal Region • 10% Rest of Scotland • 20% Rest of UK Overseas (outwith EU) • 0% City Deal Region • 10% Rest of Scotland • 20% Rest of UK UK Charities • 0% City Deal Region • 10% Rest of Scotland • 20% Rest of UK HEI Partners • 0% City Deal Region • 10% Rest of Scotland • 20% Rest of UK	Easter Bush: • CD region: £58.9m • Rest of Scotland: £2.7m • Rest of UK: £2.4m
Step 5: DDI Research outputs net of leakage and displacement converted into GVA – total over 15 years		
Net Research GVA Impact	For each year (1 to 15) • Sum of all regions Displacement numbers minus all regions Overseas numbers, multiplied by 20%, applying a 4 years delay	• Easter Bush: £35.1m

Steps	Calculation	Worked Example
Step 6: Discounted GVA from Net Research GVA including multiplier effects – total over 15 years		
Multiplier	Net GVA Impact number multiplied by the Research impact multiplier of 2.6 for UK	• Easter Bush: £35.1m * 2.6 = £91.3m
Step 7: GVA from Net Research GVA discount factor applied over 15 years		
Net Impact NPV	Multiplier number multiplied by the discount factor of 3.5% per year.	• Easter Bush: £59.4m
Step 8: Discounted GVA from net impact NPV – total over 15 years		
Total Research GVA	Net Impact NPV number split per region at hub level as follows: • CD region: 4% • Scotland: 8% • Rest of UK: 92%	Easter Bush: • CD region: £2.4m • Scotland: £4.8m • Rest of UK: £59.4m
Total DDI Research Funding GVA (UK)		**£59.4m**

As a result of the above additionality adjustments, and as demonstrated in Table 30 below, net uplifts in GVA (over the lifetime of the Programme) from research are estimated to be £59.4m (excluding - as mentioned previously - research employment impacts of an additional £54.2m). In order to demonstrate the geographical split of Research impacts the current regional split of DDI sector GVA (comprising the Education and Human Health, ICT, Professional and Technical, Construction and Arts and Entertainment and Financial Services sectors) has been used as a proxy, namely: City Deal Region 2%, Scotland 6% and UK 94% (based on data from Scottish Government and ONS 2015).

Table 30: Net Discounted GVA Impact for DDI Research Funding (excluding Overseas Research Funding)

DDI Hub	Net Additional DDI Research GVA – City Deal Region	Net Additional DDI Research GVA – Scotland	Net Additional DDI Research GVA – UK
Easter Bush	£2.4m	£4.8m	£59.4m

Based on data from UoE, 2018 and PwC analysis of Net DDI Research Outputs and Impacts over 15 years.

Adoption Outcome Analysis

This section presents the approach undertaken to quantify DDI based adoption funding impacts in GVA terms. The analysis of **net adoption outputs** has involved assessing likely levels of adoption funding attributable to Easter Bush with and without the DDI Programme. This is based on the leveraged private sector investment of £50.3m (based on the public sector funding identified under Research above) and the near to market activities undertaken as a result of the direct DDI Adoption funding of £2.6m that will be made available by UoE to the Easter Bush Hub as part of the DDI Programme.

Analysis of adoption impacts has been undertaken of the projected levels of such adoption funds over the next 15 years with and without the DDI Programme to isolate **net adoption leverage outputs** attributable to Easter Bush of £52.9m (as presented in Table 31 below).

Table 31: DDI Adoption Uplifts

DDI Hub	Private Leveraged DDI Adoption Funding	UoE DDI Adoption Funding	Total Gross DDI Adoption Funding
Easter Bush	£50.3m	£2.6m	£52.9m

In quantifying the type and level of impacts that might be created from Adoption activities consideration has also been given to the uptake of CPD DDI modules. The projected levels of CPD uptake have been estimated over the next 15 years with and without the DDI Programme to isolate the **net CPD outputs** attributable to Easter Bush (of £3.9m).

In regard to **Adoption outcomes** the key assumptions drawn are:

GVA:

- **Private sector leverage**: this has been estimated by applying a level of £1.25 (discounted) (equating to £1.36 undiscounted) over 8 years for every £1 of public sector research funding based on research commissioned by BIS on the crowding in effects of university public sector research funding in the UK[107] that indicates "*£1 of publicly funded research that is conducted within HEI results in private sector funding an additional £0.29 of research that is conducted within HEIs, and an additional £1.07 that is conducted outside of HEIs*";

- **Rates of return:** per the Research section above a 20% rate of return p.a. is applied until the end of the DDI Programme for direct DDI Adoption funding and the leveraged private funds from public sector research; and,

- **Time lags:** a reduced time lag of 2 years has been applied to adoption funding to reflect the nearer to market nature of such private funded research.

Additionality Effects: in the absence of alternative information, and based on discussions with the University of Edinburgh, the additionality assumptions as outlined under the research section above have also been applied to DDI Adoption funding with the exception of displacement where - given the innovative and bespoke nature of close to market research undertaken as a result of DDI Adoption funds - it is assumed that displacement levels are likely to be zero.

In order to demonstrate the geographical split of adoption impacts the current regional split of DDI sector GVA (comprising the Education and Human Health, ICT, Professional and Technical, Construction and Arts and Entertainment and Financial Services sectors) is used as a proxy, namely: City Deal Region 2%, Scotland 6% and UK 94% (based on data from Scottish Government and ONS 2015) and applied these proportions to the Adoption GVA impact of the Easter Bush Hub.

Table 32 presents the steps taken (in terms of the additionality factors and economic metrics applied) to calculate the GVA generated as a result of DDI related adoption activities.

[107] From: BIS – Research and development: What is the relationship between public and private investment in science innovation and research? 2015.

Table 32: Easter Bush Adoption Economic Outcome Analysis Process

Steps	Calculation	Worked Example
Step 1: Identification of gross Adoption outputs – total over 15 years		
Outputs	Provided by the UoE	• DDI Adoption Funding- n/a – all outputs are incremental Easter Bush Private leveraged funds: • £225.8m (baseline case) • £276.1m (reference case)
Step 2: Calculation of cumulative DDI uplift Adoption outputs – total over 15 years		
Uplift numbers	Provided by the UoE	Easter Bush (uplift case): • DDI Adoption Funding £2.6m • Private leveraged funds £50.3m
Step 3: DDI Adoption outputs net of leakage (based on funding destination data from UoE) – total over 15 years		
Funding destination	Uplift numbers multiplied by Adoption funding ultimate destination factor as follows: • 90% City Deal Region • 5% Rest of Scotland • 5% Rest of UK	Easter Bush – Adoption funding: • CD region: £2.6m * 90% = £2.3m • Rest of Scotland: £2.6m * 5% = £0.1m • Rest of UK: £2.6m * 5% = £0.1m Easter Bush – Private Leveraged Funds • CD region: £50.3m * 90% = £45.3m • Rest of Scotland: £50.3m * 5% = £2.5m • Rest of UK: £50.3m * 5% = £2.5m
Step 4: DDI Adoption outputs net of leakage and displacement (based on secondary data sources) – total over 15 years		
Displacement	Funding destination number multiplied by 1 minus the Adoption displacement factor, as follows: DDI Adoption Funds: • 0% City Deal Region • 0% Rest of Scotland • 0% Rest of UK Private leveraged Funds • 0% City Deal Region • 0% Rest of Scotland • 0% Rest of UK	Easter Bush – Adoption funding: • CD region: £2.3m • Rest of Scotland: £0.1m • Rest of UK: £0.1m Easter Bush – Private Leveraged Funds • CD region: £45.3m • Rest of Scotland: £2.5m • Rest of UK: £2.5m
Step 5: DDI Adoption outputs net of leakage and displacement converted into GVA – total over 15 years		
Net Adoption GVA Impact	For each year (1 to 15): Sum of all regions Displacement numbers - multiplied by 20%, applying a 2 years delay	Easter Bush – Adoption Funding: £1.9m Easter Bush – Private Leveraged Funds: £26.7m
Step 6: Discounted GVA from Net Adoption GVA including multiplier effects – total over 15 years		
Multiplier	Net GVA Impact number multiplied by the Adoption impact multiplier of 2.6 for UK	• Easter Bush – Adoption Funding: £1.9m * 2.6 = £5.0m • Easter Bush – Private Leveraged Funds: £26.7m * 2.6 = £69.3m
Step 7: GVA from Net Adoption GVA discount factor applied over 15 years		
Net Impact NPV	Multiplier number multiplied by the discount factor of 3.5% per year.	• Easter Bush – Adoption Funding: £3.4m • Easter Bush – Private Leveraged Funds: £45.0m

Steps	Calculation	Worked Example
Step 8: Discounted GVA from net impact NPV – total over 15 years		
Total Adoption GVA	Net Impact NPV number split per region at hub level as follows (for Adoption Funding only): • CD region: 4% • Scotland: 8% • Rest of UK: 92%	Easter Bush – Adoption Funding: • CD region: £0.1m • Scotland: £0.3m • UK: £3.4m Easter Bush – Private Leveraged Funds: • CD region: £1.8m • Scotland: £3.6m • UK: £45.0m
Total DDI Adoption Funding GVA (UK)		**£48.3m**

As a result of the above additionality adjustments, and as demonstrated in Table 33 below, net uplifts in GVA (over the lifetime of the Programme) from adoption funds are estimated to be £48.3m (excluding - as mentioned previously – adoption employment impacts of an additional £4.2m and CPD impacts of £3.9m[108]).

Table 33: Net Discounted GVA Impact for DDI Adoption Funding

Source of Impact	Net Additional DDI Adoption GVA
DDI Adoption Employment	£4.2m
DDI Adoption Funds	£48.3m
DDI CPD Training	£3.9m
DDI Adoption Total	£56.4m

Entrepreneurship Outcome Analysis

This section presents the approach undertaken to quantify DDI based entrepreneurship impacts based on the:

- Increase in DDI start-ups likely to be generated by Easter Bush activities projected to be approximately 30 over 15 years; and,

- Number of undergraduates likely to engage in setting up or joining DDI micro/SMEs.

In the case of DDI start-ups it has been assumed that - in the absence of the Programme – no such DDI start-ups will occur (and therefore all such start-ups may be attributed to the Programme). The profile of DDI start-ups for Easter Bush has been provided in Appendix G and indicates a steadily rising level of DDI start-ups over the 15 year period profiled.

[108] A breakdown of the GVA and additionality assumptions underpinning the calculation of CPD impacts for Easter Bush, has been provided in Appendix J of this business case.

In regard to the **GVA outcomes,** associated with this level of start-ups, analysis has been based on existing evidence in relation to the estimated (direct) investment levels likely to be provided through various funding rounds via the DDI Entrepreneurship Programme.

This is based on data from the UoE indicating the vast majority (up to 90%) of start-up companies are based within the City Deal Region. For displacement, low levels (10%) have again been assumed at the City Deal and Scotland level, as it is assumed that the DDI start-up companies will attract new and different investment streams into the region that will seek to embed benefits locally by partnering with Easter Bush start-ups. In the absence of evidence, and given the presence of a larger pool of alternative funders and investors, it is assumed these funds would be fully displaced at the UK level.

The additionality assumptions, as outlined under the Research and Adoption sections above, have also been applied to DDI Entrepreneurship funding in relation to leakage (i.e. low leakage of 10% at City Deal level) and multiplier effects.

Table 34 below presents the steps taken (in terms of additionality factors and economic metrics applied) to calculate the GVA generated as a result of DDI related entrepreneurship activities.

Table 34: Easter Bush Entrepreneurship Economic Outcome Analysis Process

Steps	Calculation	Worked Example
Step 1: Identification of gross Entrepreneurship Funds – total over 15 years		
Entrepreneurship Funds	Provided by the UoE	n/a – all outputs are incremental
Step 2: Calculation of cumulative DDI uplift Entrepreneurship Funds – total over 15 years		
Uplift numbers	Provided by the UoE	Easter Bush (uplift case): Venture Capital funding from new companies formed of: £3.9m
Step 3: DDI Entrepreneurship Funds net of leakage (based on funding destination data from UoE) – total over 15 years		
Funding destination	Uplift numbers multiplied by Entrepreneurship funding ultimate destination factor as follows: • 90% City Deal Region • 5% Rest of Scotland • 5% Rest of UK	Easter Bush: • CD region: £3.9m * 90% = £3.5m • Rest of Scotland: £3.9m * 5% = £0.2m • Rest of UK: £3.9m * 5% = £0.2m
Step 4: DDI Entrepreneurship Funds net of leakage and displacement (based on secondary data sources) – total over 15 years		
Displacement	Funding destination number multiplied by 1 minus the Entrepreneurship displacement factor, as follows: • 10% City Deal Region • 10% Rest of Scotland • 100% Rest of UK	Easter Bush: • CD region: £3.5m * 90% = £3.2m • Rest of Scotland: £0.2m * 90% = £0.2m • Rest of UK: £0.2m * 0% = £0
Step 5: Discounted GVA from Net Entrepreneurship GVA including multiplier effects – total over 15 years		
Multiplier	Net GVA Impact number multiplied by the Entrepreneurship impact multiplier per region, as follows: • 1.40 for CD Region • 1.7 for Scotland (Rest of Scotland + CD Region)	Easter Bush: • CD region: £3.2m * 1.40 = £4.4m • Scotland = (£3.2m + £0.2m) * 1.7 = £5.7m • UK: (£3.2m + £0.2m + £0) * 2.2 = £7.3m

Steps	Calculation	Worked Example
	• 2.2 for UK (Rest of Scotland + CD region + Rest of UK)	
Step 7: GVA from Net Entrepreneurship GVA discount factor applied over 15 years		
Net Impact NPV	Multiplier number multiplied by the discount factor of 3.5% per year.	Easter Bush: • CD region: £2.9m • Scotland: £3.8m • UK: £4.9m
Total DDI Entrepreneurship GVA (UK)		**£4.9m**

As a result of the above additionality adjustments, and as demonstrated in Table 35 below, net uplifts in GVA (over the lifetime of the Programme) from such DDI start-up investment is likely to be £4.9m (excluding graduate impacts of £7.5m[109]).

Table 35: Net Discounted GVA Impact for DDI Entrepreneurship

Source of Impact	Net Additional DDI Entrepreneurship GVA
DDI Entrepreneurship Employment	£0.3m
DDI Entrepreneurship Funds	£4.9m
DDI Entrepreneurship Graduates	£7.5m
DDI Entrepreneurship Total	£12.6m

Benefit Cost Ratios

In this section the analysis above (of net impacts and estimated net costs) is used to provide a basis upon which to draw conclusions concerning the "value for money" of the DDI Agri-Tech Uplift option. Value for money has been considered in terms of efficiency i.e. the ratio of outputs and impacts to the public sector costs of obtaining such effects.

Table 36 compares the net public sector funding requirement of £44.3 million[110] to the estimated net GVA impacts at the City Region, Scotland and UK wide levels. This analysis demonstrates a return to public sector funding of:

- £66.7m at the Edinburgh City Region level;
- £93.7m at a Scotland level; and,
- £248.0m at the UK wide level.

Table 36: Easter Bush Benefit Cost Ratio

	Public Sector Funding	Expected net benefit (NPV)	Ratio
Edinburgh City Region	£44.3m	£66.7m	1.51

[109] This is based on existing evidence from the UoE that on average 12% of graduates are employed in small and micro businesses.

[110] i.e. £28.3 million City Region Deal, £10 million BBSRC and £6 million EIDF.

Scotland	£44.3m	£93.7m	2.11
UK	£44.3m	£248.0m	5.59

Sensitivity Analysis

Optimism Bias: Capital Costs

In regard to capital costs - given the experience over the last decade of the Universities Estate department in successfully managing and delivering a wide range of new build projects on time and to budget - any risk of Easter Bush capital cost overruns is likely to be both minimal and, if manifest, will be borne by the University. Consequently, from a public sector funding perspective, there is no requirement to model optimism bias in regard to capital cost variations[111].

Optimism Bias: Time Delays

There may be the potential for **unexpected time delays** in completing the development of the new building or associated road infrastructure upon which development is predicated. Table 37 below outlines the impact upon the Easter Bush Cost Benefit ratios of 1, 2 and 3 year time delays. As illustrated, these suggest that while CB ratios will fall, they will remain positive at levels of 1: 3.37 even after a 3 year delay.

Table 37: Net GVA and Cost Benefit Ratios including development time delays

	City Region	Rest of Scotland	Rest of UK	UK	Cost Benefit Ratio
Current Estimates	£66.7m	£27.0m	£154.3m	£248.0m	5.59
1 year delay	£40.9m	£15.8m	£128.7m	£185.4m	4.18
2 year delay	£36.9m	£14.3m	£115.1m	£166.4m	3.76
3 year delay	£33.0m	£12.9m	£103.5m	£149.4m	3.37

Optimism Bias: Operational costs and benefits

In this context HM Treasury Supplementary Guidance on Optimism Bias[112] states: *"due to a lack of available data, Mott MacDonald was unable to recommend sound upper and lower bound optimism bias levels for operating expenditure (except for outsourcing projects) or benefits shortfall. Optimism bias should still be considered for these parameters. If there is no other evidence to support adjustments to operating costs or benefits, appraisers should use sensitivity analysis to check switching values. This should help to answer key questions such as:*

- *By how much can we allow benefits to fall short of expectations, if the proposal is to remain worthwhile? How likely is this?*

[111] Recognising, however, that any such cost overruns represent an unanticipated use of (scarce) resources and consequent opportunity cost to the University and benefit realisation.

[112] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/191507/Optimism_bias.pdf

• *How much can operating costs increase, if the proposal is to remain worthwhile? How likely is this to happen?*

• *What will be the impact on benefits if operating costs are constrained?*

In order to account for these risks and therefore **optimism bias** (such as **overestimating** the number of students trained and their subsequent employment destinations or **future cost increases reducing the delivery of benefits**) - the percentage reduction in benefits required (under the 2013 Green Book scenario) was also stress tested ("switched").

As indicated in Table 38 below benefits would need to reduce significantly – by as much as 82% - before this 'threshold' is breached.

Table 38: Easter Bush Benefit Cost Ratio – Optimism Bias Sensitivity Analysis

Easter Bush	DDI Programme Benefit	DDI Programme BCR	Reduction in DDI Programme Benefit	BCR Threshold	Reduction in DDI Benefit level
UK level	£248.0m	5.59	£44.3m	1	82%

Specific Assumption changes and 2018 Green Book guidance

In relation to the above four scenarios have been considered:

i. Green Book (2013) assumptions – with talent benefits reduced by 50% to stress test the possibility that not all projected graduates receive DDI training over the 15 year programme period and/or of those trained only 50% may seek or gain employment in DDI related sectors;

ii. Green Book (2013) assumptions – with return on investment from research being achieved with a 6 year time lag (to reflect findings from BIES studies indicating a time lag of up to 6-7 years for research funding);

iii. Green Book (2018) assumptions for direct employment – with GVA uplift considered (net of counterfactual GVA) for direct TRADE related employment; and,

iv. Green Book (2018) assumptions – with 100% displacement at the UK level and Type I multipliers at the City Deal and Scotland levels.

As presented, in Table 39, when applying the above sensitivities to the Easter Bush Hub impacts, against the total undiscounted DDI Easter Bush costs of £44.3 million the UK BCR is:

i. 2013 Green Book 50% Talent impact: 4.46;

ii. 2013 Green Book 6 year time lag for Research impacts: 5.03;

iii. 2018 Green Book GVA uplift for direct employment: 1.66; and,

iv. 2018 Green Book: 2.13.

In all four scenarios the DDI Programme impacts comfortably exceeds the minimum BCR 'threshold' of over 1:1 at the UK level.

Table 39: Easter Bush Benefit Cost Ratio – Additional Sensitivity Analysis

Cost Benefit reduction	Easter Bush – 100% scenario	50% Talent	6 year lag for Research	2018 Green Book GVA uplift for direct employment	2018 Green Book
City Deal Region	1.51	1.23	1.48	0.77	1.21
Scotland	2.12	1.76	2.07	1.99	1.64
UK	5.60	4.86	5.03	1.66	2.13

Overall Summary

Table 40 presents a summary of Easter Bush benefits over 15 years (based on the approach described above for each element of TRADE). As illustrated this suggests that the Agri-Tech Hub will generate an overall discounted net GVA of £179.6m over the Programme lifetime.

Table 40: Summary of DDI TRADE Outcomes and Consequent Net GVA Impacts Summary (discounted)

DDI Target Outcomes	Projected DDI Uplifts in Easter Bush Activity	Read Across to Appendix I
Talent		**All the numbers presented in this table relate to the DDI uplift tables at Appendix G (namely Tables 3, 6, 7, 8 & 9).**
Total number of additional students and others engaged with DDI	141.284	• *Equals the sum of all the DDI Talent uplifts in Table 9 (namely all credit bearing/non-credit bearing DDI participants and pathway courses, CPDs, MOOCs and other forms of interaction with Easter Bush Institute (i.e. 80 + 490 + 80 + 24,036 + 115,939 + 659 = 141,284).*
Total number of additional DDI data-certificated students	1,084	• *UG/PGT/PGR totals (as above)* ***BUT*** *for the purposes of identifying subsequent GVA impacts the first total of Table 3 Appendix G has been converted to "UG FTE"[113] [i.e. 80 pathway courses is converted to 3 UGs "equivalents"]. This level (of 3) has then been added to UG/PGT/PGR/ODL total levels (of 0, 490, 80 and 659) and 12% of this total amount removed and recognised under* ***Entrepreneurship****. (i.e. (3 + 490 + 80 + 659) x 88.0% = 1,084). Also note that CPDs (of 24,036) are excluded and allocated to* ***Adoption*** *and the 115,939 non-credit bearing and other interactions are* ***excluded*** *on the grounds that - for the purposes of the Easter Bush economic impact analysis - these interactions are not assumed to generate any substantive economic impact.*
Additional uplift in GVA	£65.3m	• *This is based on the discounted lifetime earning impacts of the FTE DDI certificated students identified above, on campus student spending while attending courses in Edinburgh (in Table 9 of 490 Masters and 80 PhDs) and the direct income and expenditure related to the additional 9 academic staff employed by Easter Bush as identified at Table 7 (by 2031/32).*

[113] In order to subsequently estimate the GVA impact of those students in receipt of DDI Pathway Courses compared to those undertaking a full DDI undergraduate degree the former students proportion of their degree spent on a DDI Pathway Course has been captured by assuming each student would take one Pathway Course p.a. over a four year undergraduate degree programme worth 20 points (this has been adjusted to 10 points for Public Sector Pathway Courses) out of 480 for a full degree programme. Consequently 4% (or 2% for Public Sector Pathway Courses) of any future uplifts in GVA compared to their peers that take a "full" DDI programme course.

Research		
Total additional research income	£65.5m	• *All funding streams excluding inflation and leveraged private R&D funds identified in the total column of Table 9 (i.e. UK Research Councils (40.2), UK Government Depts. (8.9), Industry (0.5), EU and non-EU Overseas (7.0) UK Charities (5.6) & HEI Partners (3.3)).*
Additional uplift in GVA	£113.6m	• *Based on a net present value of the assumed return on investment of 20% per annum after 4 years to the wider economy[114] from this research funding over the lifetime of the City Deal programme and the GVA uplift from additional DDI related Easter Bush research staff employed of 42 (as identified at Appendix G by 2031/32).*
Adoption		
Total additional private sector investment leveraged (including DDI Adoption funding)	£52.9m	• *Comprising the assumed (off campus and uninflated) £50.3m leveraged private R&D spend (identified at Table 27) stimulated by University research[115] and the £2.6m direct adoption income (on campus and uninflated) identified at Table 28.*
Additional CPD modules	24,036	• *As identified (previously) at Table 9.*
Additional uplift in GVA	£56.4m	• *Based on the net present value of the assumed return on investment of 20% per annum after 2 years[116] to the wider economy from private leveraged funding (of £50.4 million at Table 28), assumed DDI adoption funding (of £2.6 million in Table 9) the GVA uplift from credit bearing CPDs (derived from BiGGAR Economics analysis) and the 3 adoption staff supported by Easter Bush activity (as per Appendix G by 2031/32).*
Datasets		
Number of new TRADE data sets utilised	~100 new data sets	• *This is a "target level" which in the absence of any other information was assigned to each Hub based on allocated capital spend by UK government as % of total spend on innovation which in the cases of Easter Bush is 10%. Note that no economic impacts are assigned to these data sets (except as a potential facilitator of other Talent, Research, Adoption and Entrepreneurial activities).*
Entrepreneurship		
Number of DDI companies formed on campus	30	• *As identified at Table 9 and is based on data supplied by academic sector leads in relation to the likely number of teams entering incubation programmes as supplied by these leads.*
Number of degree holding graduates likely to engage in DDI micro/SMEs	148	• *Assumes that 12% of DDI undergraduates are likely to engage in setting up or joining DDI micro/SMEs upon graduating based on student destination data provided by the Careers Service (i.e. (3 + 490 + 80 + 659) x 12.0% = 148).*
Investment leveraged	£3.9m	• *As identified at Table 9 (i.e. 30 start-ups) and based on past EI average funding of £129,750 per start-up based on the likelihood of securing successive support over each funding round from seed corn to series A-C funding.*
Additional uplift in GVA	£12.6m	• *This is based on the discounted lifetime earning impacts of the 148 FTE DDI certificated students and direct company investment of £3.9 million in DDI start-ups.*
Total GVA	**£248.0m**	

[114] See in particular: http://www.rsc.org/globalassets/04-campaigning-outreach/policy/research-innovation/economic-significance-uk-science-base-2014.pdf and https://londoneconomics.co.uk/wp-content/uploads/2017/11/LE-Economic-impact-of-Russell-Group-universities-19-10-2017-FINAL.pdf

[115] See: https://www.gov.uk/government/publications/research-and-development-relationship-between-public-and-private-investment

[116] A reduced time lag of 2 years has been applied to adoption funding to reflect the nearer to market nature of such private funded research.

SMART Objectives

The goal of the Data Driven Innovation (DDI) Programme is to establish the Edinburgh and South East Scotland City Region (City Region) as the **Data Capital of Europe**. In realising this ambition – as detailed below - the DDI Programme has a series of SMART objectives.

Specific

As illustrated, in Table 41 overleaf the Easter Bush Agri-Tech Hub will deliver a range of ("net additional") Programme outcomes:

- **Talent:** through net uplifts in FTE certified student participation levels of 1,084 across a range of online and on campus DDI courses;
- **Research:** in terms of attracting additional on and off campus research funding of around £65.5 million;
- **Adoption:** research effects which represent uplifts in industry focused research of around £52.9 million and 24,036 CPDs;
- **Data:** of around 100 new data sets (from, for example, the pooling of public and private sector Agri data to deliver new high impact insights) that will ensure the generation of the economic benefits from the other activities; and,
- **Entrepreneurship:** outcomes of around 30 new DDI Agri-Tech start-up companies (and around 150 graduates likely to be attracted to start up or join DDI micro and SME businesses).

Table 41: Summary of DDI objectives

DDI Target Outcomes	the Easter Bush Net Additional Fifteen –year uplift over Baseline position
Talent	
• **Total number of DDI "FTE" data-certificated students**	1,084
Research	
• **Total research income**	£65.5m
Adoption	
• **Investment leveraged**[117] • **CPD modules**[118]	£52.9m 24,036
Datasets	
• **Number of TRADE data sets utilised**	~100 new data sets
Entrepreneurship	

[117] This includes the DDI Adoption funding.

[118] **Only** credit bearing CPD courses.

DDI Target Outcomes	the Easter Bush Net Additional Fifteen –year uplift over Baseline position
• **Number of DDI companies formed on campus**	30
• **Number of undergraduates likely to engage in micro/SMEs** [119]	148

Measurable

As reflected in each of the Hub Business Cases these specific outcomes have been modelled annually over the 15 year time period of the City Deal Programme. Progress against each target TRADE outcome will therefore be compared to each Hub Target and progress measured accordingly.

Achievable

City Region partners (local business leaders, 6 local councils, 5 universities and 5 further education institutes) concluded Heads of Terms with the UK and Scottish Governments for an overall City Deal in July 2017. While agreement on the profile of funding is still to be finalised these Terms provided clear financial parameters within which the development of the innovation element of this Deal - namely the DDI Programme - could be progressed in terms of:

- **A Network of five DDI Innovation Hubs (Bayes Centre, Easter Bush Campus, Edinburgh Futures Institute, National Robotarium and Usher Institute):** that will enhance and accelerate the City Region's existing DDI capabilities (in ***talent*** development and ***research, adoption*** and ***data*** analysis);

- **The EIDF**[120]**:** to ensure international competitiveness by transforming the City Region's ***data, research, adoption*** and ***talent*** capacity through sustained capital investment in underpinning data capability, computing and data storage infrastructure; and,

- **The DDI Programme Delivery Office**: to engage with key industry sectors and drive cross-sectoral innovation through a range of ***adoption*** and ***entrepreneurship*** activities and inward investment and inclusive growth programmes.

A range of public, private and third sector partners have been engaged in developing the DDI Programme and projected outputs. All have expressed support for participation in the TRADE activities proposed. As a result the Programme has a strong pipeline of industry and public sector collaboration opportunities.

In addition the DDI Programme, and associated risk profile, is affordable and capable of being self-sustaining over the longer term. Both the capital investment and Programme activities proposed can

[119] As above footnote

[120] The EIDF infrastructure includes the provision of a regional IoT innovation platform covering an area of approximately 7,780 square kilometres. The network will provide the ability to generate dynamic data at scale to support the activities of EIDF and the Innovation Hubs and will provide a pre-commercial platform to support IoT-based data development in Scotland.

be accommodated within the Universities current business procurement and estates management processes.

Finally, DDI Programme activities will be governed by a dedicated DDI City Deal Executive Governance Board that will report to the overall City Deal Joint Committee (the latter of which will assume responsibility for the monitoring and evaluation of DDI Programme outcomes at the regional level).

In addition – and prior to setting up a separate Easter Bush Advisory Board – the University in general and the Easter Bush team in particular will seek advice, guidance and support from the Regional Enterprise Council that has recently been set up to support the wider City Regional Deal programme[121].

Relevant

Public sector investment in digital infrastructure and innovation is a strategic priority for both Scottish and UK Governments. As highlighted by (and referenced in the market failure section) the House of Commons Science and Technology Committee Second Report of Session : *"the digital skills gap (estimated at levels of 750,000 in 2017) is approaching crisis levels and this not only has economic implications but also puts the quality and security of this data risk. This risks UK Business being unable to grow the big data sector at the rate it should. In the meantime this skills gap is due to grow exponentially as big data reaches further into the economy".*[122]

Consequently government intervention is predicated on:

- **Minimising risk**: as recognised in the Industrial Strategy addressing this skills gap requires Government intervention and investment: *"governments can make long-term investment that no single commercial or academic player can take alone. The modern nation state is the most powerful means we have of pooling risk".*[123] Adopting this investor of first resort role reflects the importance of Governments in supporting technological change – from the internet to bio-tech –and achieving public-private partnerships that are more symbiotic;[124]

- **Providing cornerstone funding:** this role is also recognised by the Heads of Terms. The Universities do not have access to sufficient levels of other funding sources (either internally or externally) to deploy the data infrastructure and physical Hubs necessary to create the sustainable system of TRADE innovation activities - to the scale and timescales - that will support the Scottish and UK economies address the critical skills gaps identified above and, by extension, the industrial growth both Governments seek; and,

[121] The overarching purpose of the group is to provide the voice of the business and third sector to guide the implementation of the Deal and support the other City Region deal partners towards a shared ambition for achieving sustainable and inclusive economic growth for the City Region. Government representatives are currently drawn from Skills Development Scotland and Scottish Enterprise.

[122] https://publications.parliament.uk/pa/cm201617/cmselect/cmsctech/270/270.pdf

[123] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf

[124] As indicated, for example, by Professor Mariana Mazzucato's: "*The Entrepreneurial State: debunking public vs. private sector myths."*

- **Maintaining and enhancing the City Regions and UK competitive advantage:** the BEIS-sponsored Science and Innovation Audit (SIA) - which identified the City Region's pre-eminent position, within the UK, to best respond to global DDI opportunities as well as competitive threats - concluded that: *"if* (public) *investment is deferred, we run the risk of losing both competitiveness and output to other* (global) *digital clusters that have the confidence to invest. We also risk losing jobs in myriad parts of the economy as a result of automation extending into knowledge-intensive services".*[125]

Time Bound

The specific target outcomes are all set within the 15-year funding profile defined by the Heads of Terms.

[125] SIA Summary

6 Commercial Case

6.1 Introduction

The Campus is in year 9 of an ambitious 20 year capital plan (with over £400m of funds being invested in the campus over the past 9 years[126]).

The plan aims to provide a dynamic and vibrant working environment with world-class facilities equipped with the latest technologies in order to:

- Continue to attract research scientists and clinicians of the highest quality;
- Foster and enhance collaborative Agri-Tech research; and,
- Provide an educational environment which sustains and expands links with industry.

6.2 Output Based Specification

Facilities and Equipment

As illustrated in detail at section 4.2.4 to realise the full potential to develop data-driven agriculture and translation to products, City Region Deal activities (and investment) will be distributed across the Easter Bush campus through:

- **Data Science** to underpin research and development, creating capacity for curation and data analysis followed by adoption of evidence-based 'precision agriculture';
- Infrastructure for data curation, including the expansion of animal facilities underpinning **animal biotechnology and gene editing;**
- Increased capacity in **Aquaculture genetics and health;** and,
- **Emerging technology platforms** in order to underpin strategically supported research; including evolving phenotypic and genomic technologies, as well as **modernisation** of proteomic and bio-imaging technologies.

Energy Centre (Combined heat and Power – CHP)

The University of Edinburgh Climate Action Plan sets out carbon reduction targets to the year 2020. To help address these targets large scale carbon emission reductions are required through investments in engineering infrastructure across the whole University Estate. In response to these targets and in support of the wider objectives of the Easter Bush Campus Masterplan 2025, the Easter

[126] For further information on the capital building completed within the current development plan, which will be utilised by the Agri-Tech Programme, please see the campus development website: https://www.ed.ac.uk/easter-bush-campus/where-people-thrive/campus-development/campus-buildings

Bush Energy Centre and associated infrastructure were proposed. The Energy Centre is an essential component of the next phase of development for the Easter Bush Campus.

Other Infrastructure

Alongside the Energy Centre, the other infrastructure works are fundamental to further developing the Easter Bush Campus and individual buildings. Roads, pathways and public realm works connect the buildings and allow ease of access for campus users. Low and high voltage electrical works provide supplies to current and future developments. Sustainable Drainage Systems (SuDS) allow surface rain water to soak away in a natural manner, with minimal impact to the surrounding environment and have no impact on the existing drainage network.

Roads

The local road network (and junctions) which support access to the Midlothian Science Zone and Easter Bush Campus are currently operating at or over capacity and are a constraint on development. Planned future investment at the Easter Bush Campus will generate increased traffic movements. To address these issues this business case includes the construction of the A701 Relief Road, Bush Loan Junction, the connecting A702 Link road and Straiton Junction, which together will allow traffic to access the Easter Bush Campus from the A702 and A720 Edinburgh City Bypass, reducing the impact of congestion, particularly at Bush Loan.

The A701 Relief Road and A702 Link road will have various features:

- 7.3-metre-wide single carriageway (plus additional land for future dualing) ;
- 3-metre-wide shared path separated from the carriageway by a maintained verge strip between the carriageway and shared path;
- Four post and rail timber fences to be provided to both sides of road reserve; and,
- Street lighting throughout.

As indicated previously proposals to re-prioritise road space along the bypassed section of the A701 (Straiton to Gowkley Moss) to promote sustainable travel choices (walking, cycling and bus based public transport) will be developed in partnership with SEStran. This will also enhance the accessibility of the Easter Bush Campus for staff, students and visitors travelling from City centre campuses and from further afield.

6.3 Sourcing Approach

The future build and management of Campus developments building has been and will be undertaken by the Estates Department of the University of Edinburgh. Similarly, procurement of services and equipment for Agri-Tech related matters will be undertaken in accordance with the University's own internal procurement policies and procedures, via the procurement team. More details on the build and procurement approach is set out in Appendix I.

The build and management of the enabling roads infrastructure (A701Relief Road, A702 Link Road, A702/Bush Loan junction and A701/A720 Straiton junction) will be undertaken by Midlothian Council

in line with their 2018 – 2030 Procurement Strategy[127] (and the Find a Tender Service or FTS, the successor to the OEJEU process) using a standard design and build approach.

[127] With full details at: https://www.midlothian.gov.uk/downloads/file/3055/procurement_strategy_2018-2023.

7.0 Management Case

7.1 Project Roles

The University and the Council will respectively oversee the Agri-Tech developments and transport improvements identified in this case. They are currently in the process of agreeing a concordat to ensure complimentary development timescales, adherence to joint project management protocols and common methods of progress reporting to the City Region Deal Joint Committee (that is responsible for delivering value for money from the Edinburgh and South East Scotland City Region deal and wider regional collaboration).

In the rest of this section consideration is given firstly to the University management case and then subsequently the Councils approach to project delivery.

7.2 University of Edinburgh

The DDI Programme Board is responsible for commissioning Agri-Tech investment at Easter Bush, working with the Easter Bush Senior Executive to establish and support the Agri-Tech Delivery Team and Agri-Tech Delivery Advisory Group (as detailed at Section 3.7, Figure 5).

The Agri-Tech Delivery Team will be responsible for the overall direction and management of Easter Bush data-related activities. Activities developed by the Agri-Tech Delivery Team will be presented to the School Senior Management Group for in-Campus approval before progressing to the DDI Programme Board.

The School Senior Management Group is ultimately accountable for the success of Easter Bush data investments and providing unified direction. The duties of the School Senior Management Group will include:

- Facilitating integration of the Easter Bush management team with the functional units of the DDI Programme, other DDI hubs and participating external organisations;
- Approval of major plans and resources and authorising any significant plan deviations;
- Approval of the initiation and completion of agreed DDI activities;
- Providing resources and authorising the funds necessary for completion of DDI activities;
- Ensuring effective communication within the Easter Bush team and with other stakeholders including periodic progress and KPI reporting to the DDI Programme Delivery Board;
- Providing strategic and operational advice to wider City Region Deal and University of Edinburgh governance as required; and,
- Advising on the resolution of disputes as they arise.

The **Agri-Tech SRO** Professor Bruce Whitelaw will report to the Head of School and SRO of the University **DDI Programme Delivery Board**, and chair the Agri-Tech Delivery Team**.**

The role of the **SRO** in the wider DDI Programme Board will be to ensure that the Easter Bush City Deal Programme is focused, throughout its life, on achieving and delivering outputs that will contribute to achievement of the KPI's and forecast benefits for the Easter Bush Campus and the wider DDI Programme.

The **Agri-Tech Delivery Team** are the principal owners of the Operational Delivery Plan delivering the TRADE themes, representing the interests of those designing, developing, facilitating, procuring and implementing the activities of Easter Bush. In this role the representatives are accountable for the quality of Easter Bush DDI activities and outputs. The role includes provision of necessary resources and ensuring that proposals for activities to be undertaken are feasible and realistic.

Agri-Tech Delivery Team

Details of the remit and membership of the Agri-Tech Delivery Team are detailed at section 3.6.2. This team will work alongside the SRO to ensure the day-to-day management is within the parameters set out in the remit above.

The Agri-Tech Delivery Team will report to and inform the DDI Programme Board. The SRO is responsible for the appointment and on-going appraisal of the staff for the DDI Programme. The prime responsibility of Agri-Tech Delivery Team is to ensure that Easter Bush produces required Agri-Tech outputs in accordance with identified time, cost, quality, scope, risk and benefit performance objectives.

7.3 Procurement Strategy

Please refer to Section 6.

7.4 Project Plan

The Easter Bush offering is based on:

- Diversifying the teaching portfolio in Agri-Tech data skills especially in postgraduate and CPD activity;

- Enhancing the research capabilities for data acquisition (e.g. enhanced genotyping by DNA sequencing combined with innovative deep-phenotyping through enabled animal and research facilities);

- Improving the acquisition, curation and analysis of data through the creation of an Agri-Tech Data Innovation Hub which will be home to several specialist Hubs – to enhance research, adoption and entrepreneurship activity accordingly; and,

- Sharing knowledge with the public by disseminating the Agri-Tech data skills into outreach activities for areas with low science capital and in rural communities.

The above will facilitate appropriate long-term partnerships and collaborations with academic and private sector data owners, provide the environment to nurture and up-skill the needed talent pool, and act as a powerful attractor with which to build commercial partnerships and private sector investment.

Appendix J presents a summary project plan that describes the Agri-Tech proposition which underpins the themes of Talent, Research, Adoption, Data and Entrepreneurship at Easter Bush. Each theme has component activities that are designed to support the deliverables expected of Easter Bush. Enabling resources are also considered.

The formal points at which progress will be monitored, controlled and reviewed are annually, with gateway reviews undertaken at years 3, 5 and 10.

7.5 Contract Management

Not applicable.

7.6 Risk Management Strategy

Appendix K sets out the approach to Risk Management for the Project. This approach conforms to existing risk management protocols[128]. Risks that could impact Easter Bush's ability to deliver its target outputs have been identified. The most pressing risks are presented in Table 43 overleaf.

7.7 Benefits Realisation Plan

Please refer to the Programme M&E plan for further details.

7.8 PIR/s and PER

A well-established Post Implementation Review (PIR) process is in place, comprising both non-financial and financial evaluations. The first Easter Bush PIR should occur within 12 months of operation. A number of follow up reviews can be initiated as required to ensure the project remains on track to meet financial and non-financial targets.

7.9 Contingency Plan

The Easter Bush Campus undertakes annual reviews of its risk registers across all aspects of the teaching, clinical, science and operational activity. These registers rank the risks in line with the University's policies and procedures then, dependent upon the risk level, sets policies, procedures and action plans to mitigate the risk, and contingency plans where risks are difficult to mitigate. These risk registers inform the annual review of both Business Contingency Plans and Disaster Recovery Plans for the overall Campus. As a consequence, if any specific aspect of the Programme is not performing as per expectations, then there are clear mitigation and contingency plans in place to address this.

[128] Further information can be found at http://www.ed.ac.uk/internal-audit/associated-processes/risk-management.

Table 43: Easter Bush key risks and mitigation actions

Type	Description	Probability	Impact	Rank	Proximity	Response	Mitigation
External							
	Delivery of road component of the EB Programme – due to delivery being dependant on external parties to the University increases scope and cost.	3	5	15	Medium	Treat and Monitor	Strategic influence at the highest level to move the project on to the correct trajectory - pursue close working relationship with Midlothian Council to deliver designs
	New Courses (PGT/CPD/MOOCs etc.) are not developed in time to produce the planned outputs	3	3	9	Medium	Treat and Monitor	Appointments of CPD Director and Talent Lead to activity, workshops to promote the development of courses and organise resources
	Infrastructure costs (Computer/utilities) and timescales exceed plan	2	5	10	Medium	Treat and Monitor	Build in adequate contingencies and ensure that regular project comms take place with EPCC, Procurement, Estates and Scottish Power
	Damage to reputation/scientific credibility especially in commercial sector	1	3	3	Low	Mitigate	Allocate specific responsibilities to senior management for strategic partnerships. Work with EI to ensure maintenance of confidentiality between companies Monitor and re-enforce adherence to appropriate policies and procedures
	Easter Bush campus facility destroyed by e.g. flood, fire etc. losing significant equipment and halting all projects	1	3	3	Low	Mitigate	Adopt leading practice building protection approaches Maintain disaster recovery plan Ensure H&S compliance and regular building maintenance to mitigate likelihood of accidental damage
	Changes in UK Funding Environment impacts on availability of research funding available	3	3	9	Medium	Mitigate	Promote awareness of new initiatives and mentor academics. Develop a close partnership relationship with key strategic funding bodies.
	Unable to secure the Data Agreements required with external partners	3	4	23	High	Treat and Monitor	Ensure that EI & Legal are actively involved with negotiations with partners, work with programme and

Type	Description	Probability	Impact	Rank	Proximity	Response	Mitigation
							project leads to ensure the strategic partnership lead is involved at early stage Ensure data agreements have flexibility for the linked-up analysis research
	Major objections result in stakeholder disagreement and withdrawal of support	1	2	2	Low	Mitigate	Conduct thorough stakeholder engagement to assure buy-in
Operational							
	Unable to recruit staff in niche skill areas (e.g. bioinformatics, quantitative genetics etc.)	2	2	4	Low	Mitigate	Promote the additional benefits of working on Campus (work/life balance support, training, pensions etc.) Have a focussed succession and recruitment plan, and a highly evolved staff training and rewards plan Make sure of market retention supplement mechanism is in place, where required.
	Inadequate data protection policies and A(SP)A controls	1	3	3	Low	Mitigate	Ensure policy compliance to both data protection and security and Home Office A(SP)A
	IT and data infrastructure is inadequate for demands	2	3	6	Medium	Mitigate	Ensure on-going EIDF group dialogue and shared agreement of IT/data requirements
	Demand from other Estates projects affects ability to deliver Easter Bush required infrastructure	2	3	6	Medium	Mitigate	Maintain Estates focus on project
	Insufficient engagement and adoption (both internally and externally) impacts reputation and demand	2	3	6	Medium	Mitigate	Develop and enact engagement plan – with EI and Outreach and Public engagement team
	Innovation Centre tenants not recruited as per plan	1	2	2	Low	Mitigate	CEO maintains dialogue with current tenants and management recruitment of new tenants
	Global Academy recruitment (undergrad, postgrad & online) does not happen as per plan	2	3	6	High	Mitigate	Effective leadership via new Chair Maintain strong focus on recruitment against plan – with marketing involved in recruitment strategy

Type	Description	Probability	Impact	Rank	Proximity	Response	Mitigation
	Scientific requirements and technology assumptions prove to be incorrect	2	2	4	Low	Mitigate	Ensure good awareness of technology demands and technology solutions – undertake horizon scanning and market analysis at regular intervals
	Inability to reach agreement with delivery partners	2	3	6	Medium	Mitigate	Maintain strategic partnerships and activities through leadership in both programme and with EI
Change							
	User requirements assumptions prove to be incorrect	2	2	4	Low	Mitigate	Establish action groups. Undertake market analysis and public surveys at regular intervals to test assumptions
	Loss of ability to influence regulatory fora that guide and constrain Easter Bush activity	2	2	4	Low	Mitigate	Identify gaps in spheres of influence, involve wider University and its partners where appropriate to assist with influence
	Change in core systems make it difficult to secure data for evidencing DDI deliverables	2	2	4	Low	Mitigate	Establish contingency plan – have clear links to other ways of securing data if core system does not deliver.

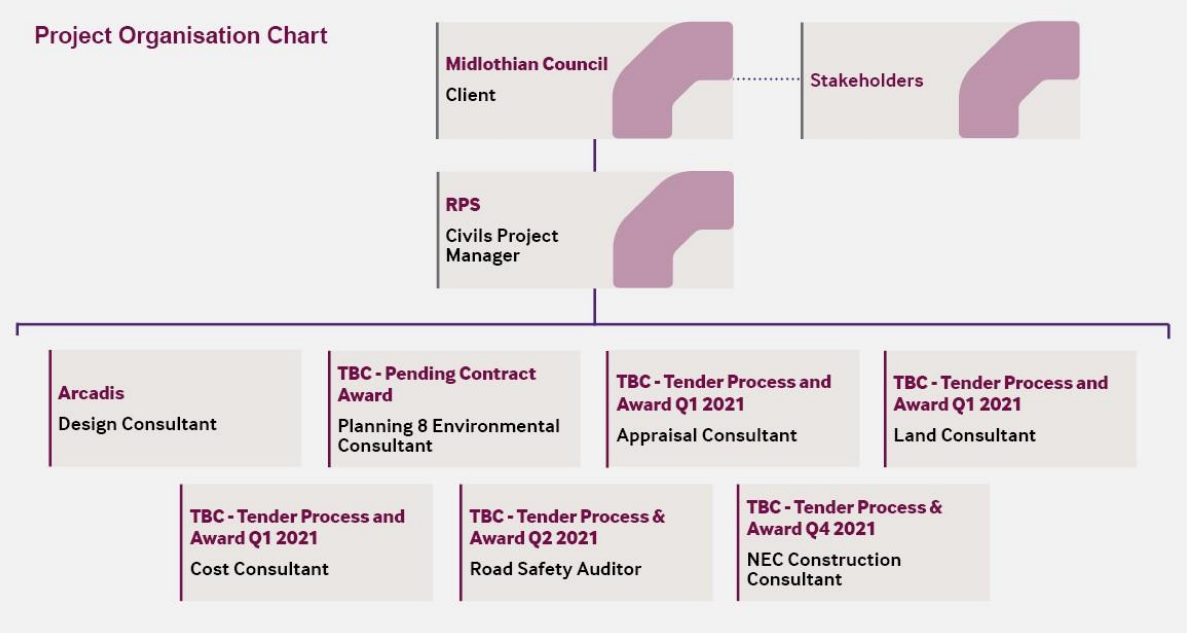
7.10 Midlothian Council

Midlothian Council (MLC) is engaging a team of Project Delivery Partners (PDPs) to deliver the A701 Relief Road and A702 Link Project. The management structure of the PDPs is set out in Figure 9 overleaf and their roles are:

- Civils Project Manager (CPM) - manage the delivery of the project;
- Design Consultant (Designer) - design and technical specifications for the scheme;
- Planning and Environmental Consultant (PEC) - managing the planning application and related environmental matters;
- Lands Consultant (PC) – consult and manage all landowners;
- Cost Consultant/ Quantity Surveyor (QS) - cost management and estimating;
- Appraisal Consultant - traffic and transportation modelling and appraisal services;

- Road Safety Auditor – undertake road safety audits; and,
- NEC Construction Consultant: supervise and administer the construction works for the project.

Figure 9: Proposed Project Management Structure Midlothian Council



RPS were commissioned in June 2020 by MLC as the "CPM" (for the A701 Relief Road and A702 Spur Road project) to:

- Provide technical advisers support to the Employer's Project Team to support the management, procurement and delivery of the project;
- Engage with key stakeholders and act as a point of contact for all stakeholder introduction meetings;
- Progress consultations with the various bodies required to ensure the project constraints, stakeholder requirements and project outcomes are fully understood; and,
- Manage regular Stakeholder Steering Group meetings.

Arcadis were appointed as the "Designer" in December 2020 following a tender process through Lot 1 of the Scotland Excel framework. The Designer role includes:

- Provision of all design services for the delivery of the scheme through the statutory procedures, up until handover to the Design and Build Contractor;
- Deliver a robust options case and final route option;
- Develop a planning stage scheme design that is accepted by all key stakeholders (including regulatory bodies);
- Design of all Accommodation Works;
- Obtaining all technical approvals;

- Preparation of a complete set of performance specifications, specimen designs and the like for inclusion in the Construction Contract Documents; and,
- Reviewing the Design Build Contractors design submissions and verification for compliance.

The tender process has concluded for the PEC, under Lot 3 of the Scotland Excel framework, and an award is pending. A detailed topographical and underground utility survey is currently being procured under Lot 4 of the Scotland Excel framework. Tender returns are scheduled for 22.01.21 and an award is anticipated mid-February. Finally, the Lands, Appraisal and Cost Consultants will be tendered during January 2021 with all awarded during Q1 2021.

The management of the transport improvements will involve seven specific work stages:

1. Options Generation/Appraisal;
2. Specimen Design;
3. Statutory Procedures (including Land Acquisition);
4. Tender Document Preparation;
5. Procurement Support of Contractor;
6. Construction/Site Supervision; and,
7. Post Construction, Defects Management and Maintenance.

The Scottish Transport Appraisal Guidance (STAG) principles and criteria are the overarching requirements applicable to the above and will be applied throughout all stages of the project.

7.11 Options Generation/Appraisal

This stage will involve the generation and evaluation of options for the works, to deliver the required project outcomes, and the refinement - through an appraisal process - to establish the most appropriate and cost-effective option.

Alternative route options, to those proposed routes identified in the Midlothian Local Development Plan, which have the potential to deliver the project objectives, will also be assessed in accordance with the principles of Stage 1 - Design Manual for Roads and Bridges (DMRB) Assessment, to identify the land use, environmental, engineering, economic and traffic advantages, disadvantages and constraints.

A Stage 2 assessment will be undertaken of short listed options identified at Stage 1. This will include analysing and presenting in more detail the advantages, disadvantages and constraints associated with the options, including the factors to be taken into consideration in choosing a preferred option. It will also include feedback from consultations with key stakeholders, statutory authorities and statutory consultees.

7.12 Specimen Design

This stage will cover:

- Preparation of an assessment in accordance with the principles of Stage 3 DMRB scheme assessment for a preferred option;
- Voluntary and statutory consultations, including organisation of, and attendance at, public exhibitions, meetings etc; and,
- Preparation of specimen designs (including relevant Road Safety Audits and works cost estimates) for the preferred option to a level of detail sufficient to permit the preparation of statutory consent applications.

7.13 Statutory Procedures (including Land Acquisition)

This stage covers the obligations in relation to delivering the statutory procedures and land acquisition for the scheme.

7.14 Tender Document Preparation

This stage covers the preparation and collation of tender documentation in sufficient detail to enable tenders to be obtained for the construction of the project.

7.15 Procurement Support of Contractor

This stage will cover assessing, evaluating and appointing a contractor to construct the scheme.

7.16 Construction/Site Supervision

This stage will cover the construction of the project by the appointed Design and Build contractor and supervision of the construction works.

7.17 Post Construction, Defects Management and Maintenance

This stage will cover the post construction administration, evaluation and monitoring of the project post-construction during the handover and defects period.

7.18 Identifying & Managing Risks & Potential Obstacles

The risk management process adopted throughout the project stages will be aligned with the STAG process for risk management and will incorporate value engineering and management. Current risks are outlined in Table 44.

Table 44: Identified risks and mitigation approaches

Identified Risk/Challenge	Probable.	Impact	Rating	Potential Impact	Mitigation and Management	Interactions, Risk Owner (Support)
Managing Stakeholder Expectations – Potential new developable commercial allocation identified in LDP (EC3)	H	M	6	Scheme considerations within LDP, including ensuring road access to development sites, new road openings, proposed road speed or access visibility requirements, pedestrian or cycling allowance or links with wider area is incorporated within the design	CPM to verify and confirm design requirements, to ensure they are reflected in Design Brief. Ensure pedestrian or cycling standards are allied. Ensure consistency with Design Consultant. Ensure that appraisal brief accounts for existing modelling and can be developed for full appraisal. Ensure developments within the LDP are included in the brief for appraisal. Continued engagement with MLC planning and economic development teams to confirm appraisal parameters and planning requirements. (CPM) CPM to ensure existing relationships (landowners and developers) are integrated into the consultant teams.	CPM, Design Consultant, Appraisal Consultant, Midlothian, Other Stakeholders
Managing Stakeholder Expectations – Potential residential area partners in central areas near A703 crossover junction, and west to A702	H	M	6	Third parties, such as housing developers influencing design, access, proposed road speed, pedestrian, cycling allowance or construction phases due to developer contribution payments		
Scheme route option changes, including junction type or routing – either to cater for objections or other planning conditions	L	H	3	Delay in carrying out redesign Requirement for further investigations (delay) due to revision of scheme	Planning and design consultants brief will highlight the need for a robust options report, to support the planning application route. CPM to understand the planning department requirements prior to developing the brief for consultants. Early agreement of junction needs and layout with Transport Scotland (Design Consultant)	Planning Consultant (CPM, Design, Environment, Midlothian Council)
Extents of the Environmental Statement not full defined – May be requirement for extended	M	H	6	Additional planning and environmental costs, delays	EIA Screening and Scoping to be incorporated into the brief for the Environmental Consultant. CPM will get an initial opinion (from	Initially: CPM After Inception: Environmental Consultant

monitoring and elements of a full EIAR				to programme delivery	Planners) prior to establishing the brief (during inception) Research and liaison with Planning Team and Council Planning Department Effective management of the Environmental Consultant to ensure that scope is fully realised (including statutory consultations)	
Difficult/ Objectionable landowners / community action groups and other stakeholders	M	H	6	May limit or delay access to specific areas of site for surveys and investigations. CPO process delayed by challenges to the schemes	Maintain good relationships created during the A701 GI phase. The connections made with landowners to be passed on to the design, environment and other consultants. Other consultant briefs to emphasise the importance of communications and agreement with landowners. Consideration to engaging Community Engagement specialist to help steer land acquisition/ access.	CPM, (Midlothian Council, Community Engagement, Environment and Planning Consultants)
Scheme Cost Benefit Analysis fails to demonstrate value for money	M	M	4	The scheme fails to justify construction, due to failure to properly consider wider benefits, traffic volume changes or high capital cost elements	Ensure the Appraisal Consultant brief specifies proper and detailed approach to capturing scheme benefits, such as Community Benefits Wider Safety Benefits Environmental Benefits Effective Traffic Modelling cordon (and benefits to other parts of the network) Working with QS and Design Consultant to maintain capital cost of the scheme, with enhancements being incorporated only when a tangible benefit can be identified. Manage land costs through efficient design.	CPM, Appraisal Consultant, Quantity Surveyor, design Consultant, Midlothian
Environmental Risk – ecology / protected species encountered	L	H	3	Delays or need to change route at a late stage in the project	CPM to provide early scoping brief, to include early identification, to Environmental Consultant (walkovers and consultation) Monitor outcome	CPM (Environmental Consultant)
Environmental Risk – Archaeology encountered	L	H	3	Delays or need to change route at a late stage in the project	CPM to provide early scoping brief, to include early identification, to Archaeological Consultant (desk study and field work). Monitor outcome	CPM (Archaeological Consultant)
Environmental Risk – ground contamination	L	H	3	Unforeseen contamination risk and large additional associated costs	CPM to provide early scoping brief, to include early identification, to Environmental Consultant (review GI and site history). Monitor outcome	CPM (Environment – Geocontam. Consultant)
Excessive scheme Cost or funding Risk				Project fails due to poor business case	Prepare thorough cost estimates at appropriate stages to avoid surprises.	

					Match scheme specification and costs to expected benefits.	