Institution: Aberystwyth and Bangor Universities: Biosciences, Environment and Agriculture Alliance (BEAA)
Unit of Assessment: UoA6 (Agriculture, Veterinary and Food Science)
a. Context

Our vision is to convert the 21st century's grand challenges of food, water and energy security into opportunities for sustainable wealth creation for society. To realise this vision we aim to:

Enhance food and energy production by working with farmers, fishers and producer associations, to provide the tools to promote efficient sustainable production systems in the UK and worldwide. Furthermore, we extend this work into production supply chains by working with retailers and their suppliers through the Centre of Excellence for UK farming (CEUKF) to encourage uptake and application of new forage and grain varieties, and more efficient practices in agroforestry and animal nutrition.

Through our work on nutrient use efficiency in plants and animals, to develop innovative methods to **minimise the impact of food and energy production on the environment**, and to allow production of animals as well as food and energy crops to thrive in a world subject to climate change.

Realise the economic and commercial impact of our work on new plant varieties and its contribution to sustainable development, through a technology platform for plant breeding programmes unique within the UK University sector. New crop varieties can be rapidly developed to commercial product stage, allowing the benefits of genomics and biotechnology to be rapidly realised for the benefit of the economy and society. This activity provides a clear point of strategic differentiation that has been advanced by the establishment of the National Plant Phenomics Centre (NPCC) and genomics laboratory to support our mission to accelerate the translation of scientific research excellence to practical technological solutions to the needs of business and society.

Maximise the impact of our research on society via policy and by improving societal health and welfare by engaging with government and its agencies. We provide and communicate the underlying knowledge needed to improve rural and marine environmental policy-making and its implementation, e.g. by increasing understanding of the contribution and constraints to increasing production efficiency in pasture-based agriculture whilst decreasing environmental impact. Furthermore our work ultimately promotes human health and welfare both through the provision of animal and plant feeds with beneficial effects on human health and through improved monitoring and elimination of risk from both dietary and environmental sources.

Promote international development by working as partners within the recently established CGIAR research programmes**,** and through collaboration with national governments, NGOs and aid organisations. Our work is closely integrated with international research initiatives targeted at articulating and achieving sustainable development goals emerging from the UN post-2015 sustainable development agenda, in particular, increasing food security, improving nutrition, reducing poverty and protecting the environment.

b. Approach to impact

We recognise that, whilst fundamental research is essential to deliver high impact science, discovery on its own is not enough - it needs to have applied benefits. BEAA scientists work closely with many partners in the UK and throughout the world to ensure that our science serves their needs and to promote technology transfer and knowledge exchange, thus delivering practical economic and social impact. Specifically our approach to impact is based around the approaches of **partnership**, **collaboration** and **communication**.

1] By establishing long-term strategic **partnerships,** we aim to catalyse linkages between research, enterprise and innovation, ensuring that research is both informed by and, informs the needs of, key stakeholders**:**

We work with **plant breeding companies,** through our breeding programmes, enabling investment in basic plant science research to be translated into new products to deliver economic and social impact. Our unique collection of genetic variation, new mating designs, next generation sequencing and phenotyping capability provides opportunities to understand key biological phenomena such as heterosis, recombination, self-incompatibility and phenotypic and metabolic plasticity. All our major crop targets are commercialised through the identification of, and collaboration with, partner organisations with a proven track record of delivering improved varieties, e.g. Germinal Holdings Ltd (forage grasses and legumes), Senova (oats), Ceres (miscanthus), ICRISAT (pearl millet). Aberystwyth varieties account for circa 60% of all the oats grown in the UK and 20-30% of the forage grasses and clovers in the UK.

The BBSRC Advanced Training Partnerships in Sustainable and Efficient Food Production is an Aberystwyth-led partnership with Bangor and NIAB which develops and delivers research-led training to the **UK agri-food industry** through an innovative combination of workshops and flexible distance learning (www.atp-pasture.org.uk). Its stated aim is to "address the high-level skills needs of pasture-based agriculture, by providing training focused on using the latest research findings, to increase the efficiency and reduce the environmental impact of extensive beef, sheep and dairy farming". Content is developed in partnership with and driven by demand from Industry. The ATP both injects the results from our research directly into the UK Agri Food Industry and also informs us of current research needs and opportunities.

The Centre of Excellence for UK farming is a pioneering Aberystwyth-led **agri-food supply chain** partnership with many of the UK's **major food retailers**. CEUKF is an inclusive Food Supply Chains Knowledge Exchange collaboration between ourselves and the Scottish Rural University College, the National Institute of Agricultural Botany (NIAB), Harper Adams University and the Agri-Food and Biosciences Institute Northern Ireland, that exists to pool resources to deliver novel linkages between the providers and the users of research, knowledge and innovation throughout the Agri-Food supply chain industries. CEUKF manages and delivers the Farming Futures web site (www.farmingfutures.org.uk) which has been voted the number one site for information on climate change and agriculture in the Farmers Weekly and has a high degree of brand recognition with 47% of farmers in the UK aware of the site. In the last 12 months its Twitter feed has gained some 4000 new followers, up from 1000 in 2012. To date CEUKF has facilitated joint industry-academia research and knowledge exchange to a value of £8 million, greatly enhancing our collaborations with the major food retailers and their supply chains.

2] Through the **collaborations**, in part facilitated by our partnerships developed above, and described below, we aim to rapidly inject high-level research into policy and industry at UK and global levels.

Contract Research: Industry sponsored projects for specific applied research currently account for an income of around £700k annually and include projects for Germinal Holdings, Alltech, Genus, Innovis, DSM, ABVista, DairyCo, Carrs-Billington Unilever, The Sports Turf Research Institute, ADAS and Welsh Water amongst others, and ensure that our research is both informed by and impacts on UK Industry.

Large Collaborative Projects: Aberystwyth's Defra-LINK income has been in the region of £2.5 million annually, but with the demise of this programme, we have expanded our portfolio of TSB-funded projects to achieve a similar level of funding.

The **Welsh Institute for Sustainable Environments Network (WISE)** is a collaboration between Aberystwyth, Bangor and Swansea Universities supported by the European Regional Development Fund through the Welsh Government. The WISE Network aims to ensure that SMEs can take full advantage of the growth in the Green Economy by developing sustainable products, processes and services. To support this, the Network has established a framework that allows stakeholders and policy makers to plan for a sustainable future promoting the best use and development of natural resources and biodiversity. The **Biorefining Centre of Excellence** (**BEACON)** is a collaboration between Aberystwyth, Bangor and Swansea Universities supported from the European Regional Development Fund through the Welsh Government. BEACON builds on research already under way to produce fuels from energy crops such as miscanthus and high-

sugar grasses. It will also enable us to develop our expertise in using bacteria and fungi to digest, or ferment, plant matter within the bio-refining process and build on work to produce new materials from plants, which can be used to develop innovative products. Through WISE and BEACON we have collaborated with some 80 SMEs and larger enterprises in the last 2 years. Additional collaboration has been facilitated through a number of FP7 Marie Curie awards allowing us to interact with SMEs on a European scale.

The National Plant Phenomics Centre (NPPC) is a publically accessible BBSRC-funded resource that provides a step change in the way plant biology is implemented, providing robust and objective screening of plant populations based on state-of-the-art imaging platforms. It affords national capability for independent evaluation of new GMO products; and facilities for genome-wide association studies (GWAS) and systems-based genetics for complex traits.

Proof of Concept: Through the use of Welsh Government Academia for Business (A4B), Knowledge Economy Skills Scholarship (KESS), Knowledge Transfer Partnership and BBSRC Proof of Concept and Pathfinder grants we work with industrial partners to ensure that our science leads to commercially viable products and services. Over the last 5 years we have engaged in approximately 25 A4B projects worth £4 million, hosted 84 KESS PhD and MRes/MPhil students, led 7 Knowledge Transfer Partnerships and held 5 Proof of Concept and Pathfinder grants.

3] Through **communication,** we disseminate the outputs from our research and engage key stakeholders in dialogue, collaboration and partnership building.

Farmers and producers: We have engaged in participatory research with farmers within national and international-scale projects, produced fact sheets, run discussion groups, demonstration farms and open days as part of the Welsh Government Farming Connect Scheme, running the Centre for Alternative Land Use (CALU), Grassland Development Centre (GDC), Organic Centre Wales (OCW) and Wales Climate Centre (WCC). In this context we have operated some 15 demonstration farms and 30 farmer discussion groups. From 2011, Farming Connect has been delivered by the company Menter a Busnes, and our staff have continued to supply information and expertise into the scheme. We are regular attendees at a wide range of agriculture events (including the Livestock Event, Royal Welsh, Muck and Magic, Cereals) where we host stands to ensure transfer of research findings into practice. We are active collaborators with the Agriculture and Horticulture Development Board (AHDB) and Hybu Cig Cymru - Meat Promotion Wales (HCC) providing briefings on research progress and data plus support for the production of on farm resources (booklets, web pages, farm breifings etc).

Policy makers: We aim to influence policy at multiple levels. On the global stage, we work with the UN FAO on climate change adaptation and developing the evidence base for carbon sequestration and adaptation of agroecosystems. With funding from the Gates Foundation, we train GMO regulators from developing countries. Work with high profile international agencies, such as Africa Harvest (http://africaharvest.org) and the INDEPTH Network (http://www.indepth-network.org), ensures that our research has a direct route into policy at national and international level within developing countries. We are a key partner in CGIAR programmes on forests, trees and agroforestry; and integrated agricultural systems for dry areas and the humid tropics, respectively. We jointly coordinate the livestock group in the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE-JPI) Knowledge Hub “MASCUR” (http://www.macsur.eu) a consortium of 65 partners from 17 EU-countries which aims to provide efficient scientific support for strategic and political decision-making in the area of climate change and food production. On a national level our scientists serve on the Welsh and UK Government’s Climate Change Groups. We have an excellent record of helping to shape UK and EU Policy, e.g. through funding by the NERC-KT programme. Wayne Powell serves on the Secretary of State for Wales’ Business Advisory Group with particular responsibility for the rural economy, land-based sciences and the green economy. Aberystwyth delivers the Farm Business Survey which benchmarks 600 Welsh farms annually providing the UK’s most comprehensive and impartial source of comparative farm data and their reports are utilised in setting UK and EU policy and payment rates.

The food supply chain and the general public: Our close linkage with the supply chain allows us to introduce innovations in food safety directly into the retail sector; good examples of this are research on the lipid composition of milk and meat from ruminant production which led to the introduction of new branded products on the shop floor (Celtic Pride marketed by Castell Howell Foods Ltd) and the development of novel approaches to monitor and eliminate pathogen

contamination within slaughterhouses. We run regular public open days and attend a wide variety of public events annually including The Royal Welsh Show and Your Horse Live. We also maintain an active schools programme with a dedicated web presence and some 60 specialist lectures made available to local primary and secondary schools. We participate actively in National Science and Engineering Week (e.g. through the annual Aberystwyth and Bangor Science Festivals), Fascination of Plants Day and locally our staff contribute strongly to the Aberystwyth and Bangor Science Cafés. We also run the Welsh branch of FACE (Farm and Countryside Education) which supports educational school visits to farms.

c. Strategy and plans

Impact within the Aberystwyth-Bangor Biosciences, Environment and Agriculture Alliance (BEAA) is led by the respective heads of Institute and College (Powell and Jago) supported by the Directors of Research (Newbold and Healey), a dedicated Director of Enterprise (Marshall) and a Director of Outreach (Scollan), supported by a team of three business development managers, 5 project development officers and approximately 20 outreach staff. Our goal is to bring benefit to the economy and society, from the local to the global, by harnessing Aberystwyth and Bangor's locations, considerable human resources and interdisciplinary capabilities. We recognise that innovation in agriculture, the environment and natural resources will play a critical role in fostering a knowledge based bio-economy. Our strategy to achieve this goal is to continue to build and strengthen our **collaborations** and **partnerships** with relevant stakeholders including the Agri-Food industry, food retailers and their supply chains and both national and international policy makers. To advance this aim we will create a vibrant, world-leading (£35M) Innovation Campus at Aberystwyth and closely linked Science Park at Bangor which together will be a destination for existing and new companies, investors and entrepreneurs, designed to drive and capture new economic opportunities based on integrating inter-disciplinary research for impact. We will build on the principle of the EU *Smart Specialisation* regional approach to innovation, where Aberystwyth and Bangor have a record of excellence and scientific expertise, long-term strategic funding, unique facilities, biological resources, capability and commercial acumen.

We will include the following 4 flagship initiatives: (i) an inter-disciplinary centre for the bio-economy building on the WISE project to provide not only technical solutions but also mechanisms to bring products and processes to market; (ii) an upland research platform for the UK built on the 2 universities' farm research centres at Henfaes and Pwllpeiran to capitalise on our strong basic science by translating it into innovative systems of land use and technologies that will improve UK and global uplands agriculture; (iii) an integrated platform for the development of capability for bioprospecting, and industrial biotechnology building on BEACON to develop a range of low carbon technologies as substitutes for fossil fuels; (iv) a Marine Innovation Centre scheduled for completion in 2014 designed as a hub to foster collaborative research with the commercial marine sector, providing business access to expertise, laboratory and ship facilities. We also seek to expand the National Plant Phenomics Centre (NPPC) through a Public-Private-Producers-Partnership for Food, Nutrition and Energy Security built around a business-facing breeding hotel incorporating national capability for the independent high-throughput phenotyping, and chemotyping. This will provide the focus whereby the plant breeding skills and underpinning genetic technologies and expertise within BEAA can be used by SMEs for pre-breeding of specific crops and by those industrial partners seeking to apply this technology within their breeding programmes. The NPPC expansion will also enable the rigorous and independent evaluation of new GM products that are anticipated to enter the EU market over the coming years. This outward-facing innovation campus will accelerate the translation of biosciences and other research for the benefit of the UK economy. In addition it will provide new opportunities for student training and employability and will catalyse the establishment of start-up companies. We will also continue to ensure that we **communicate** the output of our research and have recently appointed a Professor for Public Engagement (Scollan) and are supporting this through the creation of a small (3 person) support team for communication and engagement.

d. Relationship to case studies

By working in **partnership** with farmers, plant breeding companies and supply chains we have ensured that uptake of Aberystwyth- and Bangor-derived seed by the market is consistently high (as noted in the case studies for high sugar grasses, oats, rice, maize and pearl millet). It has led to Aberystwyth University being awarded both the Queens Anniversary Prize for Higher Education in 2010 for its work combining fundamental research on plant genetics with plant breeding techniques to develop new commercially viable plant varieties that are designed to tackle some of the pressing issues faced by communities across the world (food, water and energy security) and in 2011 the British Grassland Society's Innovation award for developing the Aber varieties of High Sugar Grasses (HSGs). Also as a result, Aberystwyth University was shortlisted for the Times Higher Education Awards 2013 for outstanding contribution to Innovation and Technology for its work on high sugar grasses with potential to transform pastoral-based livestock agriculture. Aber HSGs currently account for approximately 175,000 ha of UK grassland and 28% of UK perennial ryegrass seed sales (£5.5 million p.a.) and are increasingly being taken up elsewhere in Europe and the Southern Hemisphere. They represent multifunctional crops, comparing favourably with other plant-based feedstocks. Oat breeding programmes at IBERS account for approximately 65% of UK oats grown for human consumption, livestock feed and as a source of high value compounds for industry. The instant breakfast cereals market for oats in the UK is currently worth £120 million, with "Oats So Simple" alone worth £84.5 million, the 4th most valuable cereal in the UK, the majority (over 75%) of which is based on Aberystwyth varieties. The IBERS oat varieties also impact on other sectors: the ready to eat cereals, granolas and mueslis market is worth approximately £19 million and bars and biscuits nearly £10 million. The impact of our research on food security, with major international policy relevance, is well exemplified by our rice, pearl millet and maize case studies where the new hybrids bred for marginal lands in south Asia resulting from our research are being grown on over 1.4 million ha with over 8 million people benefiting by improved food security, during the REF period, as a direct result.

Through **collaboration**, Aber Instruments, a spinout from Aberystwyth University, has doubled its turnover since 2008 as a result of our research. This has been further strengthened by activity within BEACON which has led to a recent expansion of the fermentation market for the biomass probe, expanding from production of potable alcohol towards the efficient production of a wider range of biofuels and biorenewables. Collaboration with BioVelop on biomass fibre components and their utilization in the food industry has led to five novel nutritional products being released since 2010 (the most successful worth € 600,000 per year). In May 2013, the food-additive giant Tate & Lyle took over BioVelop, securing the success and lasting commercial impact of the BEAA technology. In addition to commercial impact for BioVelop, the underpinning research was also instrumental in demonstrating the potential of plant biomass to replace fossil fuel derived products and made an important contribution to the funding of new commercially-focused projects such as the £10 million investment by the Welsh European Funding Office in the BEACON Biorefining Centre of Excellence involving BEAA scientists.

Through **communication** of our research we are helping to shape policy at UK and international levels. Our work on collecting miscanthus genetic resources to breed novel energy crops for use in Europe has meant that we have had to pioneer the implementation of international policy on the fair and equitable use of natural resources. The experience and knowledge gained through this impact has provided an example for others to follow and is being used to support UK and EU legislation and policymaking. BEAA research on upland grazing management has provided government agencies and conservation bodies with an evidence base on which to develop policy and agri-enviroment schemes in both England and Wales. Furthermore our work on grassland fungi has both informed policy on Sites of Special Scientific Interest in relation to planning laws and has also stimulated public understanding of science through print media, radio, television and film.

In summary all our case studies have resulted from our strategy of partnership, collaboration and communication and provide a strong case for continuing this strategy into the future.