

THIS IS FOOD & DRINK
Food & Drink Manufacturing



Controlled Environment Agriculture



Cymru
Wales

CEA Cymru

CEA Wales

Excellence in Controlled
Environment Agriculture

2021

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The Vision for CEA Wales

The Well Being of Future Generations (Wales) Act 2015 sets the agenda for the pursuit of emerging opportunities that can promote the long term future prosperity and security of communities across Wales.

The Welsh Government champions the development and growth of Controlled Environment Agriculture (CEA) in Wales; combining the goals of targeted support for leading edge technology enterprises with the advancement of new solutions for food production.

The pace of change in the world is getting ever faster and we must prepare the Welsh Food and Drink industry for a future shaped by new product development and high-tech industry.

Long term concerns for climate change, declining natural resources and population growth demand a more resilient and diversified food supply chain that can help alleviate the pressure on traditional systems.

CEA is an innovative growing model that has the potential to revolutionise the food supply chain. Through CEA we can help improve food security, satisfy demanding consumer expectations, diminish import dependency, whilst also lowering the carbon footprint of producing food.

Our VISION for CEA Wales is to be the premier location in the United Kingdom for CEA enterprises to locate, develop and succeed. Wales is outward-facing and forward-looking, providing a first class environment and infrastructure where investment in CEA can be fully nurtured and realised. Drawing upon a truly exceptional research base, supply chain strength in new technologies, targeted account management, and unrivalled trade programmes, our goal is to achieve international recognition for Wales as a CEA Centre of Excellence.

Our MISSION: Through our unparalleled network of close collaboration between industry, academia and government, we have listened to the needs of the CEA sector to ensure that locating to Wales is a 'lessons learned' approach.

- We will demonstrate to the CEA Sector our passion and commitment to promoting commercial success in the Welsh food and drink industry.
- We will prove the ambition in Wales to help realise the investment of UK based enterprises and Foreign Direct Investment.

- We will show there is a clear route to locating CEA to Wales, where we are creating the best conditions for fostering sustained CEA viability and growth.

PART 1: Our Commitment to CEA Wales

Prosperity for All: Commercial success in the Welsh food sector

The Welsh Government's Economic Action Plan, 'Prosperity for All', highlights the central importance of prioritising support to the food sector in Wales, towards achieving sustained economic growth whilst reducing regional inequality.

Because food supply is a part of the infrastructure of everyday life, the sector in Wales is significant in scale. The entire food and drink supply chain, including primary production, food and drink processing, wholesale, retail and foodservice, accounts for one in five business units and 18% of the Welsh workforce

The Welsh food sector has the ability to cover economic opportunities across the country, even in the most remote rural areas. The sector carries a presence in the traditional strongholds of the Welsh language where there are some 40% or more Welsh speakers.

The Welsh food industry is important because it produces the goods that are central to the quality of life and security of people in Wales.

Spend on food represents an unavoidable commitment of household expenditure across low and high income groups, on average accounting for 11.3% of weekly family expenditure by UK households¹.

Our achievements so far:

Towards Sustainable Growth: An Action Plan for the Food and Drink Industry 2014 – 2020 set out the ambition to grow the food and drink sector by 30% turnover to £7 billion by 2020. We have directly supported the sector to exceed this by achieving £7.473bn by 2019.

The Food & Drink Wales Industry Board has been created to act as the voice of the sector, helping Welsh Government raise the profile of Welsh food and drink, attract investment, and encourage industry led training and career development.

¹ **Manifesto for the Foundation Economy** – Centre for Research on Socio-Cultural Change, November 2013.

Sustained multi-million pound public investment in the Welsh food and drink sector has been delivered through the Food Business Investment Scheme (FBIS), providing match funded support under the Rural Development Programme to allow business creation and expansion. The pro-business approach under FBIS has seen the delivery of nearly £111.7 million in new capital projects.

Project Helix represents a £21m investment to establish a network of food centres across Wales, providing direct support and guidance to business start-ups and promoting entrepreneurship by catalysing new product development. Survival rates for new start-ups for the sector in Wales are among the highest in the UK, with the 5 year survival rate in Wales being 56% in 2016 compared to a UK rate of 45%.

Welsh Government research provides industry with a vital source of market intelligence and consumer insight, whilst a range of trade and 'meet the buyer' events, including the 'London: Route to Market' programme and Taste Wales event, directly assist market penetration. International Trade Programmes have supported an increase in the value of Welsh food and drink exports by 34% since 2014.

CEA: Shaping the future of food supply in Wales

The **Well Being of Future Generations (Wales) Act 2015** is the strength of our commitment to developing and promoting CEA in Wales.

The act is unique to Wales, and creates a duty in law for public bodies to deliver 'sustainable development'; to improve the economic, social, environmental and cultural well-being of Wales. This means taking action aimed at achieving the 'Well-being goals' - a shared vision of the Wales we want to see and live in.

The diverse and long term benefits of CEA as a food system can directly contribute to all seven 'Well-being goals'. This creates an imperative to target support for CEA businesses and provide the infrastructure in Wales that will cause those businesses to succeed.



A Prosperous Wales: Compound Annual Growth Rate (CAGR) expected to be 21.3% to 33% from 2018-19 to 2024-25. The Economy Futures Fund targets enterprises where innovation, entrepreneurship, technological change and new business practices can be developed.

A resilient Wales: The largest food sector trade gap in ‘Fruit and vegetables’ at £9.8 bn. The UK climate does not support all types of horticultural production. Artificially controlled climates for import substitution opportunity.

A healthier Wales: Studies show 70% of UK shoppers consider diet to be important to them. The ability to manipulate our food production with precision, towards maximising nutritional value is the central opportunity of CEA.

A more equal Wales: The Employability Plan, published in March 2018, recognises the need to cater for the 'work of tomorrow'. This highly technological farming technique can help drive the need for higher skilled, higher value jobs within the Welsh food sector.

A Wales of more cohesive communities: CEA is independent of location, providing an avenue for investment and regeneration, together with the promotion of good food choices, across Welsh regions.

A Wales of vibrant culture and thriving Welsh language: UK consumers consider the main attributes of top Welsh brands to be natural (59%), great quality (75%) and having fantastic taste (73%). 81% of consumers say they are more likely to buy from a brand with positive sustainability.

A globally responsible Wales: Global forecasts show by 2050 there will be 9 billion mouths to feed, generating a 60% increase in food demand. Using traditional methods could increase global temperatures by 2°C. CEA presents key opportunities to incorporate the three 'R's of reduce, reuse and recycle for greater circularity.

PART 2: Wales, the Centre of Excellence

Excellence in Supporting Food Business Investment

In Wales there is a clear network of interventions designed to promote sustained growth in food businesses, which taken together, present a compelling argument for CEA enterprises to locate and invest in Wales.

Guiding sustained growth in food businesses:

Dedicated key account management for large scale food businesses and Foreign Direct Investment (FDI), delivers a collaborative approach for the alignment of available Welsh Government and UK support measures. Start-ups and SMEs benefit from a broad range of targeted financial and technical services.

Our Food Business Development Managers can provide advice on accessing support through schemes such as the **Economy Futures Fund**, **SMART Cymru** or the **Food Business Investment Scheme (FBIS)**, which target competitiveness in food businesses, growth in future technologies, and help commercialise new products, processes and services.

Food Innovation and Investment for Growth conferences provide businesses with direction on investment options. Further information can be obtained through the [Directory of Fund Providers and Investors](#).

The **CEA Special Interest Group**, delivered by BIC Innovation, can support applications to available UK programmes, such as **Innovate UK**.

A unique lender to micro and SME businesses, the **Development Bank of Wales** makes it easier to get the finance needed to start up, strengthen and grow.

The Investor Ready Programme, delivered by BIC Innovation, has been designed to assist SMEs in the food sector to prepare for inward investment, through improved management information, business planning, financial modelling and introduction to potential fund providers.

Project Helix:

Food Centres at Zero2Five - Cardiff Metropolitan University, the **Food Technology Centre** – Coleg Menai, and **Food Centre Wales** – Horeb, can support new product development from concept, design, and manufacture through to the consumer's shopping basket. This includes guidance on technical information, UK food legislation, SALSA and BRC accreditation, and industry intelligence.

Project HELIX works with Welsh food and drink companies to forensically identifying ways of introducing efficiencies across process controls, site design, packaging and systems development.

Cywain:

Delivered by Menter a Business, Cywain aims to make Welsh food and drink businesses competitive, strengthen supply chain links, provide advice on how to scale up profitably, and strengthen Wales' reputation for producing high quality food and drink. The project offers consultation and mentoring through a network of Regional Managers.

Locating to Wales:

Wales benefits from a highly cost-competitive commercial property market. We can help you find the property that is right for your CEA enterprise in the location that best suits you and provides excellent access to your markets.

Welsh Government has established eight [Enterprise Zones](#) in designated areas across Wales, creating the best possible conditions for businesses to succeed. The [Business Wales Property Database](#) provides a central location for details on commercial properties and land across Wales.

Excellence in Future Energies

'Energy Generation in Wales', produced by Regen for the Welsh Government, highlights the commitment for renewables to generate electricity equal to 70% of Wales' consumption by 2030, and a net zero target in GHG emissions by 2050.

This has driven the focus in Wales to embed a wide range of technologies into the mainstream including on and off-shore wind, small and large scale hydro projects plus exploring the opportunities available from our marine resource.

In 2018, Wales had 68,700 renewable energy projects in operation², and by 2019 achieved 50% of electricity consumption generated by renewable energy - an increase of over 500% since 2005.

² [The Energy Generation in Wales 2018 report](#)

The Welsh Government targets at least 1 GW of renewable energy capacity should be locally owned by 2030. In 2018, there were 335 local business and 775 farms and estates generating energy from renewable sources. In 2019, Wales was 78% towards achieving the 1 GW target.

Hydro: Hydro-related companies in Wales, range from utility providers such as Dŵr Cymru Welsh Water to large hydro energy scheme operators including RWE Innogy and Statkraft Energy. Projects range from the largest pump storage project in the UK operated by First Hydro Company, through to small-scale hydro of 5 MW or less operated by companies including Dulas, North Wales Hydro and TGV Hydro.

Solar: Wales has a mature solar energy sector, with expertise in solar photovoltaic (PV) energy. Dulas designs, manufactures and installs a range of solar PV systems including solar refrigeration. BIPVco, based in north Wales, designs and manufactures an integrated solar PV roof. Sure Chill's technology is used in over 35 countries, including a breakthrough refrigeration system and sustainable energy storage.

Marine: Wales has the potential to generate around 10 GW from marine energy, including the Severn Estuary resource. The Welsh Government is working in tandem with Welsh based device developers, including Minesto, Marine Power Systems and Wave-tricity. This includes the Deep Green project off the coast of Anglesey to develop the first low-velocity tidal energy project in the world at a commercial scale.

Wind: In 2016 there were 86 operational wind farms, including RWE Innogy's three offshore wind farms, with an additional 16 under construction and a further 58 consented to.

CEA Businesses in Wales can benefit from UK support, including the Non-Domestic Renewable Heat Incentive for small business projects, the Smart Export Guarantee (SEG), through to the Contract for Difference for 5 MW+ developments.

The Carbon Trust through the Energy Efficiency Loan Fund (Wales), provides interest free finance for new energy efficiency and renewable energy projects that will lower carbon emissions and provide cost savings.

Excellence in CEA Supply Chain and Infrastructure

There are a range of cross cutting technologies required to facilitate CEA. Wales is home to a diverse and innovative commercial industry base, with world class leading technology enterprises that can support CEA across the broad range of business needs.

CEA Supply Chain:

Complete CEA solutions are catered for by **Phytoponics** and **Hydrogarden** in hydroponics. Solutions in soilless commercial agriculture are provided by **Saturn Bioponice**, whilst **Pontus Research Ltd** offers a fully independent R&D service in aquaculture and aquatics. Suppliers to the CEA sector include **Merlin Hydroponics** and **Plantwell Hydroponics**. Across the UK, **Cambridge HOK** are specialists in glasshouse manufacturing and enclosed vertical farming.

EFT Consult, Swansea is an industry leader in the circular economy, designing innovative solutions for CEA, including energy use and storage, waste to energy conversion.

Strength in wider supply chain infrastructure includes **IQE**, a leading global supplier of advanced semiconductor materials.

Expertise in interior lighting and LEDs is delivered by enterprises such as **LUX-TSI** and the **Trulux Group**. Also in the UK, **Phytolux** and **Philips Lighting** are key LED providers for horticulture.

Agxio, is an AI, data science and machine learning company that has developed and implemented an expert AI application for use in CEA systems.

Specialism in high quality sensors and systems for the commercial horticulture industry is provided by **Skye Instruments**, whilst across the UK, **Priva** is an industry leader in complete monitoring and control options for larger facilities.

Variable frequency drives and motor control technology is designed, manufactured and supplied in Wales by leading businesses such as **Invertek Drives**, **Nidec Control Techniques** and the **Motor Control Warehouse**.

Supply chain diversity in Wales includes solutions for horticultural product lifecycle tracking through **RFID Direct**, the provision of integrated pest management technologies through **Russell IPM**, and organic biopesticides for increased crop yields through **Bionema**.

More widely, with offices in the UK, **Enza Zaden** is a leading seed specialist, with wide varieties specially bred for vertical farming. **Rijk Zwaan** is also industry leading, particularly with tomato and salad crops.

Crops requiring substrates are provided for across the UK by suppliers such as **Grodan** and **ICL**.

A comprehensive Welsh supplier directory can be seen at **Annex 1**.

Transport Links & Logistics:

Cardiff Airport provides a well-established cargo unit, computerised links with both the Border Agency and international airlines, and 40+ direct destinations worldwide.

High speed trains link Wales with most UK cities, with just 100 minutes journey time from Cardiff to London. On the doorstep of Wales, 60 million consumers in England provide a huge market for Welsh food and drink producers.

The geography of Wales lends itself to international trade, with major ports located all along the Welsh coasts. These include Milford Haven, the UK's largest energy port and Holyhead, the internationally strategic gateway port with routes to Ireland.

Case Study:

Digital Farming Ltd has been developing digitally integrated CEA farming solutions for 3 years. Initial focus on strawberry production has enabled low-cost production systems and identified the need for smart integration between the control and growing systems and the energy supply to enable a route to net-zero sustainable CEA. They have successfully introduced an end-end digital system from local (edge) sensors and controls to a cloud-based API able to communicate securely and intelligently with external systems including AI platforms and smart energy networks. Aligning these systems with complex recipes for the growing platforms ensures a focus on generating a roadmap to net zero CEA farming for high nutrition foods.



Dragon Microgreens are a CEA initiative producing fresh, local and fully sustainable food for restaurants and online sales. Through non-hydroponic media using low tech LED technologies, they focus on 11 varieties of micro greens selected for their nutrient dense profile and exceptional taste. In Wales, they have found local demand and a location that enables them to use fresh spring water. Key clients include Michelin starred restaurants who have previously imported micro greens.



Springfield Nursery South Wales, part of **S&A Produce**, have integrated LED lighting into their glasshouse system to extend dramatically the production season of British strawberries. By moving to a higher technology approach they have achieved near year-round production. S&A wanted an LED solution with high light levels, and a bee-friendly solution in line with their values. Trials resulted in higher yields, accelerated the growth phase, and increased sugar levels by 25%.



Excellence in Research & Development

Commercial success in CEA requires the support of a nucleus of academic and technical expertise to support development and enable innovation. Wales has an excellent research base to support a growing CEA industry.

The Institute of Biological, Environmental and Rural Sciences (IBERS) is based at Aberystwyth University in Mid Wales, and has been a world leader for 100 years in Plant Science and complementary areas related to CEA including materials science, engineering, system design, robotics, computer science and bio-refining.



- IBERS hosts the **National Plant Phenomics Centre**, the UK's most advanced research greenhouse – one of only seven such facilities in the world. IBERS have developed extensive automated climatically-controlled growing systems and instrumented fields where sensors, fixed or drone based, can track crops throughout their life cycle and even post-harvest. This enables novel research into longitudinal traits that impact on plant health, quality and consumer acceptability.
- Computational scientists have exploited AI (i.e. deep learning and other approaches) to probe the complex interactions between genetics, environment, development and management, to produce predictive models that will accelerate research and breeding, with the ultimate aim of enhancing agricultural profitability and sustainability. The developed technology has extended beyond crops and is being applied in food factories.

- IBERS researchers have the strategic goal of understanding the basis of individual human and animal nutritional ‘metabotypes’ to meet the challenges of linking dietary exposure to health outcomes. Associated with this is the use of high-resolution metabolomics technology and high content plant phenotyping to facilitate the design of ‘smart’ crop varieties able to deliver desirable dietary chemistry which will impact on health and well-being.
- IBERS is a world leader in the development of ‘global’ screening technology that is used to screen new varieties (both traditionally bred and GM) and processed food raw materials for a desirable chemical composition. There is accordingly a specific involvement in the development of software and database resources for identifying the chemical constituents of biological samples.

AberInnovation, based at Aberystwyth University, provides world-leading facilities and expertise within the biotechnology, agri-tech, and food and drink sectors. The £40.5m campus support business growth by de-risking R&D activities, facilitating new product and process development, and routes to market.



- The Seed Biobank and Processing Facility provides world leading plant breeding programmes, with a controlled environment facility for the secure cataloguing of plant genetic resources.
- The Biorefining Centre, including the Industrial Biotechnology Acceleration Suite (IBAS), is a pilot scale facility for extracting, analyzing and optimizing chemicals from biomass and waste stream materials with integral industrial biotechnology.
- The ‘Future Food Centre’ provides a food grade environment for the testing, validation and improvement of existing and novel materials as foods including

nutritional content, advanced compositional analysis, shelf life and consumer preferences.

- The Advanced Analytical Science Centre offers the analytical capability to identify food functionality, nutritional content and health benefits, interacting with the Well-being and Health Assessment Research Unit (WARU) for food intervention studies.

Case Study:

The Advanced Manufacturing Research Centre (AMRC) Cymru



The team behind the University of Sheffield AMRC Cymru is a powerful partnership between the Welsh Government, local authorities, growth and enterprise agencies and a world-leading R&D centre in advanced manufacturing.

As a cutting edge R&D facility, AMRC Cymru will be driven by industry, for industry. It will provide an open innovation platform accessible to all manufacturers for the whole of Wales. Our mission is to:

- De-risk R&D investment in innovation to drive step-change improvements in productivity, quality and sustainability
- Accelerate the adoption of Industry 4.0 technologies including:
 - Robotics and automation
 - Artificial intelligence and machine learning
 - Augmented and virtual reality
 - Digital twins, simulation and modelling
 - Additive manufacture
 - Connected smart factories and supply chains
 - Stimulate inward investment from high-value added manufacturing brands

- Attract and inspire research talent from across Wales and the wider world
- Support the expansion of a high-value added skills base, widening opportunity for all and acting as a magnet for inward investors and fast growing scale-ups.

“AMRC Cymru is a game-changer. It will ensure a thriving industry base that will be a catalyst for economic growth across the supply chain, increasing productivity and supporting the competitiveness of Welsh industry at home and around the world.”

Ken Skates MS (Former Minister for Economy and Transport)

Excellence in Skills & Training

CEA growing requires a mix of skills from agronomy to photonics. Within Wales we have a wealth of relevant skills provision bolstered by Welsh Government support for training.

Through the Welsh Government Learning Grant and Financial Contingency Fund, Wales directly funds individuals to continue their education post age 16 via the Education Maintenance Allowance.

Undergraduate and Post Graduate skills are financed through Student Finance Wales, and robust apprenticeship schemes allow employers to save on costs of securing the best new talent.

Further Education:

Access to specialised horticulture apprenticeships is provided by **Coleg Sir Gar**, in close collaboration with the National Botanic Garden of Wales, and by **Coleg Cambria**, offering Level 2 and Level 3 apprenticeships in work based horticulture.

Pembrokeshire College delivers a City & Guilds Level 3 Diploma in Food and Drink Engineering Maintenance designed to ensure the supply of highly skilled engineers to the food and drink processing sectors.

The **NPTC Group of Colleges**, in collaboration with **Cultivate Newtown**, have introduced a new ‘Growing through CEA Systems’ module for Level 1 & Level 2 Horticulture Courses being offered by the Newtown Campus. The Cultivate CEA Community site is also available to students as an option for farm diversification and future income streams.

Higher Education:

Aberystwyth University is one of the few universities in the UK delivering Plant Science degrees and IBERS are offering CEA modules as part of their degree courses.

Aberystwyth University has been named as one of 12 UK Institutions that will participate in the Food Bio Systems partnership which is the third phase of **BBSRC's Doctoral Training Partnerships (DTP)**. This will see 4 PHD level students a year focused on food research and will develop the next generation of bio scientists with in-depth knowledge and technical expertise of food systems and biological processes across the Agri-Food system.

Tyfu Cymru, Lantra Wales:

Delivered through Lantra (Wales), Tyfu Cymru seeks to provide the training and skills necessary to ensure commercial businesses are positioned to take advantage of opportunities within the horticulture sector.

Tyfu Cymru is fully engaged in the CEA Wales Strategy Group. Lantra is a leading award winning body providing quality training courses and industry recognised qualifications across a range of sectors.

Horticulture Wales:

Managed and delivered by Glyndwr University, the programme aims at shortening supply chains, reducing waste and promoting collaborative working through cluster groups.

The programme has been supporting the introduction of demonstration CEA systems into the Xplore! Science Discovery Centre in Wrexham, towards the vision for Wales being a leader in Urban Growing to regenerate town centres and create opportunities in the wake of COVID-19.

Case Study:

Food Skills Cymru has hit a major milestone, having supported 100 businesses with their training needs within its first year of delivery.



“I am delighted with the development of the programme in its first year, having assisted 100 Welsh food and drink businesses with their training needs.

The food and drink industry and the whole supply chain is very important to the Welsh economy. Almost 20% of all employment in Wales lies within the food and drink sector and it contributes approximately £6.9 billion in sales revenue.

When we did research back in 2015 we discovered that there was quite a lot of skills gaps and technical shortages not only within food technology and food safety legislation, but also in other areas like leadership and management, waste awareness and sales and marketing. However, with the funding available for these business we can help ensure their employees have the correct skills to thrive in an ever-changing industry.”

Sarah Lewis, Project Manager for Food Skills Cymru

Food Skills Cymru supports businesses within the Welsh food and drink processing and manufacturing industry to ensure employees have the right skills and training to strengthen the industry as a whole.

Working across all food sectors, the goal of the Programme is to help prepare employees across Wales to adapt to future and environmental challenges and position them to capitalize on opportunities for business development.

Eligible businesses can benefit from up to €200,000 funding across the duration of the programme.

The service includes a full Skills Diagnostic of the business to identify skills gaps and implement a bespoke training plan. Businesses are able to submit funding applications to help support with the cost of completing any training courses.

The programme works collaboratively with other Welsh Government funded projects such as Project Helix and Cywain to ensure businesses are receiving the right support tailored to their specific needs.

Excellence in Promoting Welsh Food & Drink

CEA businesses in Wales can benefit from dedicated support designed to raise the profile of Welsh food and drink and to promote our Welsh based producers in UK and international markets. We have well-established connections with UK retail chains, wholesalers and international buyers.

Trade Development Programme:

The Trade Development Programme specifically manages the relationship between the Welsh Government and the top 10 retailers.

Meet the Buyer events bring in the major food and drink retailers, wholesalers and independents. The aim is to strengthen the supply chain, provide insight into buyer purchasing requirements, and to provide unique opportunities to boost sales.

The Trade Lounge Showcase at the Royal Welsh Agricultural Show is a 4 day event and one of the largest displays of Welsh food and drink.

Support to individual food businesses includes preparation for meetings with buyers, joint events with retailers such as the Co-op Local Supplier Awards, insight into the needs of retail buyers and their current projects, and advice on how to defend and expand listings.

International Trade Programme:

A bespoke three step programme is designed to overcome barriers to trading outside of the UK. Support includes 1-to-1 consultancy to identify target markets, lead generation with in-market buyers, and assistance for overseas business visits.

Trade Development Visits offer tailored missions of food businesses to potentially high value international markets. These purposefully link businesses to overseas buyers to maximise leads and sales. In 2019, visits included Japan, Ireland, Qatar and major international food shows, such as SIAL – Paris, Anuga – Cologne and Gulfood – Dubai.

The Export Club facilitates collaboration, drawing together our successful food and drink exporters, and providing the forum for knowledge sharing and networking for improved export performance.

Market Insight:

The Welsh Government supports the food sector with research projects covering retail trends and market intelligence, making available an extensive library of industry reports through the Kantar World Panel and thefoodpeople.

A leading market research provider, Ipsos MORI, was recently commissioned to carry out a study on consumer perceptions for CEA produce:

- 35% of consumers in the UK have heard of CEA
- 69% of adults in the UK say they would probably or definitely try CEA food
- Consumers value taste and freshness above other considerations when buying food
- In order of priority price, nutrition, local production and environmental credentials are also important
- Consumers like the idea of CEA providing for the local community if it is not to the detriment of traditional agriculture
- Microgreens have strong appeal, driven by nutrition & taste benefits and lower water usage in production.

Case Study:



Excellence in CEA Industry Collaboration

CEA growing combines technologies and know-how from multiple fields of science and industry and requires collaboration within and across disciplines.

The Food & Drink Business Cluster Programme was first established as a pilot in 2015 and has since grown to include approximately 700 members across industry and academia. The programme has evolved to become a primary route for government support to the Welsh food and drink sector.

The clusters foster collaborative behaviour between businesses by providing a network of sophisticated, economically significant ecosystems in which people can meet, exchange ideas, develop innovations, and create business driven solutions to target business needs.

Wales has active Business Clusters and Special Interest Groups (SIG) across a range of areas that are essential for supporting CEA enterprises. These include:

- Manufacturing Cluster
- Cyber Security Cluster
- Compound Semiconductor Cluster
- Creative Industries Cluster
- Health Care Cluster

The Nutri-Wales Cluster:

Funded by Welsh Government, the Nutri-Wales Cluster connects food and drink producers, academia and government to focus on research and development, innovation, insight and intelligence, and growth in the market space where food, health, nutrition and well-being converge.

Through its Future Foods programme the Nutri Wales Cluster has established Special Interest Groups in 'CEA & Agri-Tech' and in 'Engineering & Processing'.

"The economic Cluster model in Wales has informed the establishment of the Closed Environment Agriculture SIG, a circular economy initiative, comprises companies and research organisations with complimentary skill-sets and technologies: LED Lighting, Hydroponics, Plant Science, Sensors and Data collection, Nutrition, Estates and re-generation, Renewables and Waste to energy, Water treatment and Algae, British Standards (BSI), Software, Cyber Security, Bio-Sciences, Strawberry growing, Aeroponics, Analytics, Data Science and IoT, Charities."

Digital Farming Ltd

Plants & Architecture Cluster:

As part of the National Research Network for Low Carbon Energy and Environment, the Plants & Architecture Cluster is led by Professor Iain Donnison from Aberystwyth University and includes members from Aberystwyth, Bangor and Cardiff Universities.

One of the key aims of the cluster is to deliver research for improving the techniques for growing food in and around urban populations, including CEA, and to measure the effects of new growing environments on plants.

CEA in the Community:

Welsh Government has been supporting the introduction of CEA into local communities. A recent project, Crop Cycle, has supported four communities to enable foods and plants produced within CEA systems to be managed and sold locally, some of it by buyers within metres of where it is produced. The provision of small-scale CEA systems within the local community provides sustainable sources of nutritious crops for health and social benefits.

Case Study:

Tech Tyfu are currently recruiting growers to the first collaborative hydroponics scheme of its kind in North Wales. These pioneer growers will have their chance to experience hydroponics and will inspire them to develop the technology in their own direction.



The project seeks to maximise the significant potential for development in the region, where farmers can apply existing experience of supply chains and markets for selling food, and can adapt existing agricultural buildings to house vertical farming units.

North Wales also boasts many high-end restaurants, benefiting to a large extent from the tourism industry, and as such creates a demand for high-value fruit and veg, which can be easily and efficiently grown through hydroponics.

Tech Tyfu are exploring possibilities that will help Wales adapt to post-Brexit challenges, and are looking for innovative people to have a go at using this pivotal technology which will become increasingly important in the food production of the future.

The project will create a skill-sharing forum, with growers exchanging their learning experiences and collaborating on supply chains.

Tech Tyfu is run by **Menter Môn** and funded through the Welsh Government Rural Communities – Rural Development Programme 2014-2020, which is funded by the European Agricultural Fund for Rural Development and the Welsh Government.

PART 3: The CEA Wales Route Map

To deliver our vision for CEA Wales, we have outlined a clear route or pathway for businesses to invest and locate their CEA enterprise to Wales and receiving all of the support needed. Essentially, this route provides a local network of support in Wales that can account manage potential investment and provide for the full needs of CEA commercial viability.

Key Contact Points in Wales

Foreign Direct Investment (FDI) enquiries: Welsh Government Food Division.

UK based project enquiries: Welsh Government Food Division.

What to consider when setting up a CEA business and who can help:

- **Crop Selection:** Nutri-Wales Cluster - CEA SIG; Aberystwyth University
- **Growing System Selection:** Nutri-Wales Cluster - CEA SIG; Aberystwyth University
- **Site Selection:** Business Wales; Natural Resources Wales
- **Planning Permission:** Local Planning Authorities
- **Skills and Labour:** Business Wales; Lantra; Nutri-Wales Cluster - CEA SIG
- **Enabling Technologies:** AMRC Cymru; Local Engineering Consultants; Nutri-Wales Cluster - CEA SIG; Engineering SIG; Academia
- **Consumables:** Nutri-Wales Cluster - CEA SIG
- **Utilities:** Local Energy Consultants
- **Supply Chains:** Nutri-Wales Cluster - CEA SIG
- **Production Standards & Accreditation:** Food Standards Agency; Environmental Health Office; Sustainability Cluster (B Corp)

Crop Selection

Contact for additional support with crop selection and cost modelling:

Nutri-Wales Cluster: +44 (0) 1656 861 536 / bwyd-food@bic-innovation.com

Attention needs to be paid to the importance of a feasible business model for the specific crop and its suitability for commercial scale.

The business model should specifically consider the value of the crop and the biomass output, in conjunction with the growing technology used and its cost.

The ability to create differentiation through nutritional profile, appearance and consistency will support higher market prices, but ultimately CEA crops will compete on price point with field grown crops.

Vertical farms, where crops are grown in stacked systems, have the benefit of growing more crop in a defined area than conventional agriculture.

However, this tends to restrict the crops that can be grown due to the limited heights between the stacks. This can mean common CEA crops such as tomatoes and cucumbers are not grown in vertical farms.

To support new entrants to the sector and help them attract investment, the Welsh CEA Special Interest Group can develop detailed cost models, considering multiple factors including initial set up costs, labour, energy, heat, nutritional inputs, water, and land cost.

Crops currently suited to commercial scale CEA include herbs, microgreens, leafy greens, fungi, tomatoes, berries, flowers, cannabis, and animal fodder.



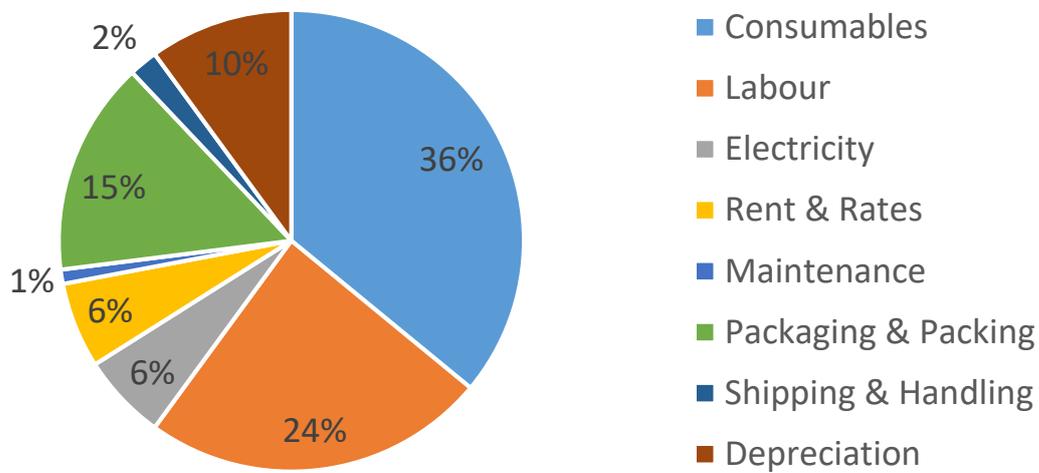
Cost Model 1 – 48m² (small scale) Vertical Farm Growing Microgreens:

Microgreens are very fast-growing baby herbs and greens which are packed with micro-nutrients. Of note is the amount of consumable cost, which is mainly due to the seed costs arising from the rapid growth of microgreens (within 8-12 days).

3+3 rack 4 level growing system	Unit
Physical floor area	48m ²
Usable growing area	165m ²
Capital required	£49,500
Annual crop yield	5.920 tonnes
Annual Revenue @ £25 per kg	£148,005

Cost Category	Cost £	Cost %
Consumables	45,655	36%
Labour	30,000	24%
Electricity (59357.76 KWhr / annum)	7,123	6%
Water & CO2	55	<1%
Rent & Rates @ £55 / m2 / annum	7,920	6%
Maintenance @ 2.5% per annum	1,238	1%
Packaging & Packing	18,888	15%
Shipping & Handling	2,960	2%
Depreciation	12,375	10%
Direct Costs	126,214	
Gross Profit per annum	21,791	15%

Cost Model 1 - Pie chart of percentage costs

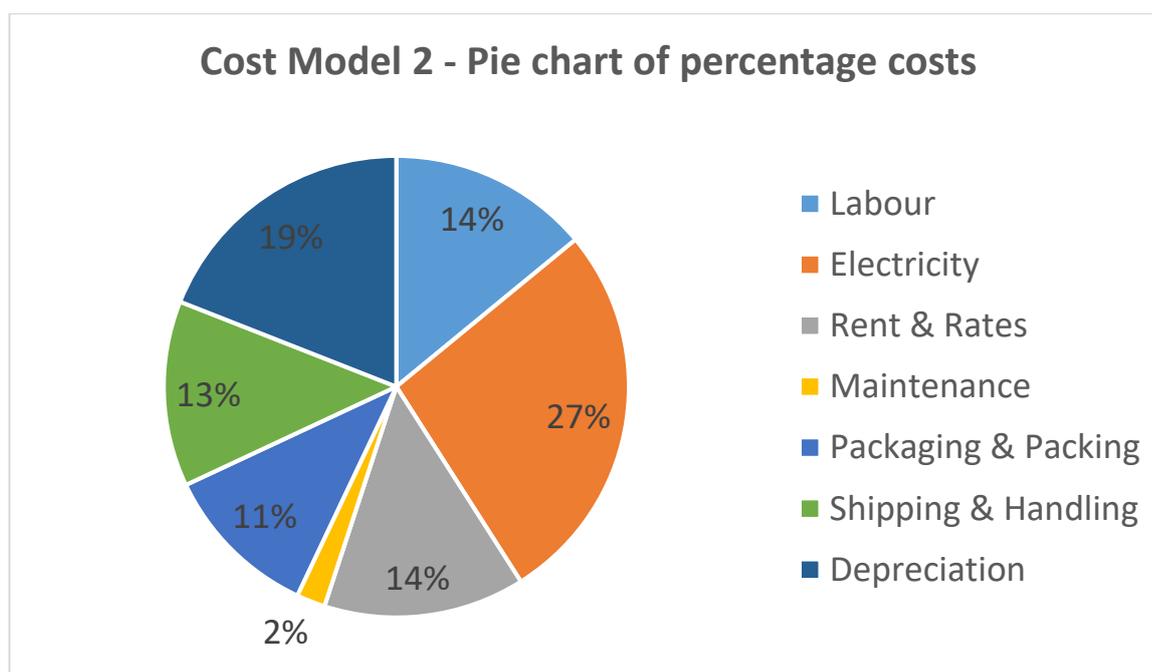


Cost Model 2 – 224m² (medium scale) Vertical Farm Growing Strawberries:

Strawberry production by hydroponics has been demonstrated in a number of countries. In this model electricity costs are substantial and profitability could be increased by incorporating a cheaper energy source.

3+3 rack 4 level growing system	Unit
Physical floor area	224m ²
Usable growing area	768m ²
Capital required	£192,000
Annual crop yield	65.618 tonnes
Annual Revenue @ £4.5 per kg	£295,281

Cost Category	Cost £	Cost %
Consumables	856	<1%
Labour	36,000	14%
Electricity (529244.16 KWhr / annum)	68,802	27%
Water & CO2	1,197	<1%
Rent & Rates @ £55 / m2 / annum	36,960	14%
Maintenance @ 2.5% per annum	4,800	2%
Packaging & Packing	27,843	11%
Shipping & Handling	32,809	13%
Depreciation	48,000	19%
Direct Costs	257,266	
Gross Profit per annum	38,014	13%



Growing Systems

Contact for additional information on growing systems and contact with existing growers:

Nutri-Wales Cluster: +44 (0) 1656 861 536 / bwyd-food@bic-innovation.com

There are three main types of CEA system:

- **Hydroponics:** growing without soil but instead using mineral nutrient solutions in a water solvent.
- **Aeroponics:** growing in an air or mist environment without the use of soil or an aggregate medium.
- **Aquaponics:** the waste produced by farmed fish or other aquatic creatures supplies the nutrients for plants grown hydroponically.

Commercial models include:

- **Large scale purpose-built units** are built for volume and tend toward higher levels of automation.
- **Small scale modular** focus on delivering “hyper-local” fresh produce, incorporating CEA into either urban or retail properties.
- **Hybrid CEA** units in combination with traditional units tend to be used for propagation and plant research, or as an area to grow specialist crops.

Site Selection

Support in identifying new properties and attending location visits:

Business Wales: +44 (0) 3000 603000 / [Business Wales](#)

Wales has many disused buildings in both urban and rural locations that could be repurposed for use as CEA growing facilities as well as an abundance of land suitable for new developments. One of the key advantages of Indoor farming is its ability to locate the crop production very near to the consumption or processing centres, providing improved shelf life and reduced food miles, thus reducing waste and environmental footprint.

Regenerating or repurposing an existing facility: Wales has a large supply of under-utilised building stock and CEA ventures can be developed in existing buildings. Advice on urban regeneration in Wales can be sought from the CALU.

Renting a facility: A 0.8ha facility will cost £1 – 1.5m per year and will require modification for indoor farming and to meet food certification standards. Container style modular units could be rented for less.

Constructing a new facility: Green belt land will cost between £17k/ha (NE Wales) to £28k/ha (SE Wales) depending on current land use, soil type and resource availability for new agricultural buildings.

Planning Permission

The relevant local planning authority: [Find your local planning authority](#)

The development of any project must be in accordance with the land use planning policies set out by the Welsh Government in the [Planning Policy \(Wales\)](#). Permission must be sought through the [Local Planning Authority](#) (LPA) through a process which may take 6 – 12 months to complete.

Identify a target site: Consider market access, resource availability and development costs.

Conduct a feasibility study:

- Check with LPA for development plans for the area. New projects must fit with such plans, or justify their exception.
- Check for any local challenges to development. These may be:
 - Impacts on the visual landscape, particularly in green belt land
 - Populations of creatures protected under the Wildlife and Countryside Act (1981) or EU regulations (e.g. bats or badgers)
 - Environmental health legislation for food production.

Pre-planning discussion with the LPA:

- Hold informal discussions with the LPA officer regarding the proposal. There may be a small charge, but use this as an opportunity to discuss:
 - Local planning requirements, and how these impact the project
 - Potential site problems such as utility access, flood zone risk, noise or traffic and what mitigation the LPA might require
 - Identify if there is a reasonable chance of getting permission.

Make a formal application:

- Applications can be made by post to the LPA, or the online Planning Portal.
- Applications must include full project details and mandatory documentation that fulfils both local and national criteria. This will include:
 - Site maps and topography

- Archaeological and environmental reports, including any Environmental Impact Assessments
- Visual Impact Assessments for green belt land.

Application outcomes:

- If permission is granted, construction must begin within a fixed timescale and include any revisions requested during planning application.
- If unsuccessful, the proposal can be modified and resubmitted, or the decision appealed.

Skills & Labour

Support in sourcing skills:

Lantra Wales: [Lantra](#)

Business Wales: +44 (0) 3000 603000 / [Business Wales](#)

CEA growing can be labour intensive ranging from 8% to 45% of costs. Labour intensity varies between crop types and farm types. Depending on the technical complexity of the growing operation, skills needs can cover agronomists, horticulturists, agricultural engineers, and software engineers.

Enabling Technologies

Specialists in sensors and control solutions applicable to CEA:

Skye Instruments: [Skye Instruments](#)

EFT Consult: [EFT Consult](#)

CEA farming provides precision control over the growing environment. This ability is enabled by sensors and control systems which measure:

- 'Daylight' hours and 'Resting' hours
- Intensity of light
- Wavelength of light
- Nutrient solution delivered to the roots
- Humidity
- Temperature – around roots and shoots/leaves

- Air flow
- Concentration of CO₂
- pH

Support in with smart automation and robotic picking for CEA:

AMRC Cymru: [AMRC Cymru](#)

Advances in robotics and automated picking technologies will be beneficial in vertical farm designs where growing racks can reach 30ft in height. However, these technologies require significant capital investment and consideration should be given to CEA farm design that minimise both labour and capital investment costs.

Expertise in lighting applications for CEA:

EFT Consult: [EFT Consult](#)

Truelux: [Truelux Group](#)

Phytoponics: [Phytoponics](#)

LUX TSI: [LUX TSI](#)

For CEA growers, lighting is critical to achieving consistent yield and product quality for year-round production. All horticultural fixtures focus on photosynthetically active radiation (PAR), or light in the 400-700 nm range. Different types of fixture provide different qualities of light. LED lighting is becoming the preferred mode as it offers greater control over the narrow spectrum and gives out less heat.

CEA Consumables

Details on optimal seed varieties:

Aberinnovation (The Seed Biobank): [Aber Innovation](#)

Seed selection is an important consideration for CEA as some varieties perform better than others under indoor growing conditions. Selecting the correct variety can impact yield, nutritional profile and appearance. Seeds must be purchased and sent to propagators 3 – 6 weeks before planting if not being germinated in house. This can be grown on a pre-agreed schedule with propagators such as Cae Melwr, Llanrwst and Seiont Nurseries, Caernarfon.

CO2 Details:

CO2 concentration impacts photosynthetic rates, growth and yield of crops. In sealed environments like CEA growing rooms CO2 concentration can dip below desirable levels and it is not uncommon to supplement ambient CO2 levels. Pure food grade CO2 costs £125/kg/tonne (roughly 3 tonnes of CO2 will be required a day to enrich 0.8ha up to 900ppm for 12 hours).

Energy Details:

Before deciding on a building, the power requirements should be well known to support the growing equipment, lighting, pumps, HVAC, automation equipment, dehumidifiers, fans, computers, etc. Growers serious about scaling up should also consider any increases in power requirements for future expansions.

Delivering the light to the crops in the most efficient manner is the most important parameter in the consideration of energy in CEA.

A rapidly emerging opportunity for larger farms is to set up partnerships with energy companies and adjust the electrical load to suit off peak times where the electricity generators have surplus capacity and will offer reduced pricing. Further savings can be made by integrating the farm operation more closely with adjustment of load on an hourly basis depending on the grid demand. These dynamic smart integrations are a way in which a CEA business could creatively reduce its cost of electricity.

An emerging renewable energy alternative is that of hydroelectricity enabled through lower cost micro turbines. Water flow is still subject to seasonal variation but could be useful as a consideration in rural areas where there is plenty of access to free-flowing water, such as farms in mid-Wales.

Water source details:

Natural Resources Wales: [Natural Resources Wales](#)

Mains water can be utilised, but this will require additional holding tank infrastructure, and is provided at additional cost. Bore holes can be sunk if a permit is obtained from Natural Resources Wales and this may wish to be considered at the planning stage. Reliance on abstracted water can be reduced by harvesting rainwater: roof harvesting can yield up to 60L/month per m² of roof, with storage costs of £20-35/m³ in covered tank systems. Recirculated water will require a system for filtration, sterilisation and nutrient rebalancing, and clean water will be required for produce washing.

Production Standards & Accreditation

Accreditation:

Growers will also require accreditation with assurance schemes to ensure good environmental, ethical and safe food production. There are vast numbers of schemes and membership of these schemes will be subject to auditing and common assurance schemes are summarised below. The requirements of these schemes should be included from the point of inception for a new food production facility.

The **Kitemark** is a UK product and service quality trademark which is owned and operated by The [British Standards Institution \(BSI Group\)](#). To obtain Kitemark certification, products and services are assessed by BSI Product Services to ensure that they meet the requirements of the relevant British, European, trade association or international specification or standard. In addition, delivery of the product or service is audited against an accredited quality management system. Once a Kitemark licence is issued, licensees are regularly audited and are subject to surveillance visits to ensure continuing compliance. The Kitemark is not a legal requirement but is often used as a point of differentiation in competitive markets and is widely trusted.



Red Tractor Farm Assurance Scheme certification shows that a grower has adhered to a specified standard of food safety, hygiene and environmental protection.



British Retail Consortium (BRC) standards is a food safety and quality certification program that ensures growers meet their legal obligations and is typically required for marketing to supermarkets.



Like BRC standards, **SALSA** certification is designed for growers that wish to supply into local markets.



Accreditation with **LEAF** highlights sustainable agriculture and food production and can be used when marketing produce to customers.



The **Soil Association** sets criteria for organic food production, and accreditation will be necessary if organic mushrooms are to be marketed.



B Corporation certification measures a company's social and environmental performance. From supply chain and input materials to charitable giving and employee benefits, B Corp Certification proves your business is meeting the highest standards of verified performance.



Food Security:

Fresh produce must be grown to a high standard of quality: produce will be judged against specifications of size, shape, flavour and shelf-life that will be agreed with the customer in advance. Produce will also have to meet a range of food biosecurity standards defined in [Food Hygiene \(Wales\) Regulations \(2006\)](#) as overseen by the [Food Standards Agency](#) to ensure produce is not contaminated with pathogens such as Salmonella and E. coli or harmful residues during production.

Food production facilities must register with the local authority Environmental Health Officer within 4 weeks of operation, and will be regularly inspected according to [FSA](#) regulations.

Risk and Control Measures:

Crop Pathogens: Routine monitoring of crop for E. coli, Salmonella and other food-borne pathogens must occur, including irrigation water and growing media.

Food Handling: Food industry standard HACCP precautions must be followed, including staff training and facilities to prevent food contamination.

Crop Residues: Maximum levels of crop protection product residues on products, including compost and pots of fresh-grown herbs.

Nitrate Content: Maximum leaf nitrate content values in salads and leafy crops can be controlled through monitoring of nutrient use.

ANNEX 1: Supplier Directory

Wales has a growing network of suppliers to the CEA sector covering the full spectrum of activities from room design, and energy system scoping to lighting specification, nutrients and consumables.

Company information:

Merlin Hydroponics: [Merlin Hydroponics](#)

Stock a wide variety of hydroponic equipment. They can supply Hydroponic Nutrients and Boosters, Lighting, Fans and Filters, as well as full Hydroponic Systems and Starter Kits.



Plantwell Hydroponics: [Plantwell Hydroponics](#)

Suppliers of a full range of hydroponics equipment from complete starter kits, grow tents and pot systems, to lighting, ventilation, propagation and irrigation equipment specifically designed for the hydroponic grower.



Hydrogarden: [Hydrogarden](#)

Hydrogarden offer a range of hydroponic solutions for commercial crop production and Vydrofarm vertical farming concept.



Saturn Bioponics: [Saturn Bioponics](#)

Suppliers of soilless crop production solutions for commercial agriculture.



Cambridge HOK: [Cambridge HOK](#)

Cambridge HOK design and construct custom glasshouse projects for the horticulture and can assist in the development of new sites.



Priva: [Priva](#)

Glasshouse environmental control systems.



P3P Partners: [P3P Partners](#)

P3P has worked in partnership with many UK growers on the installation of CHP units to provide heat and CO₂ for horticulture.



Orthios: [Orthios Eco Parks](#)

Specialists in the development of combined electricity generation from biomass and food production.



System Services: [System Services](#)

Service, Repair, Maintenance, Calibration, Retrofits & Upgrades on Environmental Test Chambers and Systems.



Skye Instruments: [Skye Instruments](#)

Supplier of horticultural products including light sensors & systems, weather monitoring sensors, automatic weather stations, plant research systems.



EFT Consult: [EFT Consult](#)

EFT specialises in building services consultancy, delivering electrical, mechanical and environmental engineering for new buildings and existing stock. EFT have an interest in waste to energy systems and circular energy.



IQE: [IQE](#)

IQE is a global leader in the design and manufacture of advanced semiconductor epiwafer products driving connected 5G technologies.



Agxio: [Agxio](#)

Agxio is an AI, data science and machine learning company that specialises in the biotech, life sciences and agricultural science industries. Founded in 2018 by a world-class team of award-winning technologists, scientists, entrepreneurs and practitioners, Agxio has developed and implemented an expert AI application for use in CEA systems.



Truelux: [Truelux Group](#)

Truelux provide interior and lighting products and services across multiple sectors from lighting consultancy and manufacturing, to FF&E procurement and installation.



Phytoponics: [Phytoponics](#)

Phytoponics offers a smart controllable growing platform which enhances fresh produce quality and yields for commercial growers.



PhytoLux: [Phytolux](#)

LED lighting specialists for the UK horticulture industry.



Philips: [Philips](#)

Suppliers of horticultural lighting solutions.



Pontus Research: [Pontus Research](#)

Pontus Research Ltd. is a fully independent Research and Development (R&D) service provider, offering high quality professional in-vivo R&D services to the aquaculture, marine and aquatics sectors.



LUX-TSI: [LUX-TSI](#)

LED Lighting Testing and Certification Experts.



RFID Direct: - [RFID Direct](#)

Provider of RFID tracking solutions to the Horticultural sectors.



Russell IPM: [Russell IPM](#)

Russell IPM is a developer of Integrated Pest Management technologies, they sell pheromones, traps, biopesticides and Pest Management Supply.



Bionema: [Bionema](#)

Bionema is a leading biopesticide product testing and technology development company, specialising in chemical-free, organic crop protection.



Invertek Drives: [Invertek Drives](#)

Designs, manufactures and markets highly innovative, easy to use variable frequency drives for the control of electric motors in industrial automation applications.



Nidec Control Techniques: [Nidec Control Techniques](#)

Nidec Control Techniques designs and manufactures electric motor control technology for industry.



Motor Control Warehouse: [Motor Control Warehouse](#)

MCW is one of the UK's leading suppliers of motor speed control products specialising in variable speed drives.



Bord na Mona: [Bord na Mona](#)

Suppliers of growing media.



ICL: [ICL](#)

Suppliers of precision fertilisers and growing media.



Bulrush: [Bulrush](#)

Suppliers of growing media.



Sinclair: [Sinclair](#)

Suppliers of compost and growing media.



Grodan: [Grodan](#)

Precision growing and hydroponics specialists, supplying equipment and growing media.



Solufeed: [Solufeed](#)

Speciality water soluble fertilisers.



ANNEX 2: CEA Associations & Trade Bodies

The following associations, organisations and trade bodies provide support to the CEA and horticulture sectors across the UK.

Company Information:

UK Urban Agritech: [UK Urban AgriTech](#)

A newly formed cross-industry body bringing together the UK's key players in modern agricultural technologies. They promote urban agri-tech as a solution for food and environmental crises. They aim to influence policy by sharing information, educating, and communicating practitioner needs as one.



UK Controlled Environment Users Group: [UK Controlled Environment Users Group](#)

The group is made up of managers of controlled environment facilities and other users of controlled environments from university departments, research institutes and companies concerned with plant research. It includes representatives of manufacturers of controlled environment cabinets, rooms and glasshouses and meets annually.



Commercial Horticulture Association: [Commercial Horticulture Association](#)

UK-based CHA is the representative body for manufacturers and suppliers of plants, products and services to commercial horticulture worldwide. They have members who are interested in CEA and companies who supply some of the infrastructure needed.



British Herbs: [British Herbs](#)

Trade association for UK herb growers.



British Leafy Salads Association: [BLSA](#)

The British Leafy Salads Association acts as a trade association for UK salad growers.



AHDB Horticulture: [AHDB](#)

AHDB Horticulture is a levy-funded, not-for-profit organisation that aims to provide advice and sector-specific R&D.



ADAS: [ADAS](#)

A leading provider of impartial expert consultancy for hydroponics, fresh produce agronomy and the wider UK Horticulture industry.



Tyfu Cymru: [Tyfu Cymru](#)

Delivering support to commercial horticulture through specialist training and grower networks.



Horticulture Wales: [Horticulture Wales](#)

Supporting the Welsh horticulture to adopt innovation and collaborative working.

