CONTROLLED ENVIRONMENT AGRICULTURE PILOTS IMPACT REPORT

A report for Social Farms & Gardens

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Executive Summary

In February 2022, Social Farms & Gardens (SFG) commissioned a Social Return on Investment (SROI) report to collect evidence on the impacts/outcomes of SFG's Crop Cycle project.

Crop Cycle

Controlled Environment Agriculture (CEA) is about controlling the ecosystem within which a crop is grown. Using CEA methods, factors such as temperature, humidity, light, and nutrition, as well as complimentary factors such as carbon dioxide levels and air renewal can be controlled. The three most common CEA growing methods are aquaponics, aeroponics and hydroponics.

Crop Cycle has supported the creation of four CEA pilots; in Wrexham in north Wales, Newtown in mid Wales, and Cwmbran and Treherbert in south Wales. The four sites were intended to be test beds for CEA in a community-led setting. SFG and partners wanted to explore how CEA could help communities to deliver activities which educated and involved people in the food they eat, providing learning and business development opportunities, and increasing the sustainability of local food networks by giving people access to nutritious, locally grown food. It was expected that the sites would need three years to install CEA technologies, train staff in how to use the equipment and ramp up food production and identify and develop routes to market.

Crop Cycle received just over £400,000 in a grant from the Welsh Government's Foundational Economy Challenge Fund. Each pilot site received revenue and capital funding to set up their CEA pilot, with capital infrastructure costs generally accounting for 75%-80% of a pilot site's budget.

What is social value and how can it be measured?

In Wales, the Wellbeing of Future Generations Act 2015 requires public bodies in Wales to think about the long-term impact of their decisions, to work better with people, communities, and each other and to prevent persistent problems such as poverty, health inequalities and climate change. The Wellbeing Act puts in place 7 Wellbeing Goals for Wales to achieve. The goals are:

- A Prosperous Wales
- A Globally Responsible Wales
- A Resilient Wales
- A Healthier Wales
- A More Equal Wales
- A Wales of Cohesive Communities
- A Wales of Vibrant Shared Culture and Thriving Welsh Language

The National TOMs Wales[1] are an agreed set of measurements that enable projects to demonstrate how they are delivering against the 7 goals. For each goal the TOMs identify a set of outcomes, units of measurement, and the proxy value of one unit of the outcome. Using these metrics and values, projects can evidence and calculate their total local economic and social value.

The total local economic and social value a project creates is not money within the project's bank account. Rather, the total figure represents the value realised, or costs avoided, elsewhere in the system, and the hypothetical value people place on social outcomes.

This research has used the TOMs to calculate the economic and social value of Crop Cycle.

Financial impact of the pilot sites

SFG commissioned a separate piece of research on the pilots' financial return on investment. The research[1] has found that, even when producing at full capacity, produce sales alone are unlikely to cover the costs involved in growing. This forecast is after having discounted each site's initial capital expenditure. The four sites do not appear to be financially viable in a commercial food production sense because:

- Ongoing energy, maintenance and distribution costs associated with producing and selling CEA grown food are too high.
- Revenue streams are too low – each site could produce a modest amount of produce based on the CEA capacity they have installed but there is limited demand locally for this (relatively) low value produce – e.g., micro-greens are a high value crop but the restaurant and hospitality trade in Wales has limited demand for micro-greens.

Given these findings relating to the financial viability of the four pilots, it will be the wider monetised and non-monetised impacts the CEA pilots deliver which have greatest bearing on the overall value for money of the pilots. It should be noted that the barriers to financial viability are not particular to their being based in community settings but rather general constraints of CEA systems.

Social and economic impacts of the pilot sites

The research has uncovered a range of examples of how the four pilots are making a beneficial impact in their local areas over and above their financial return. Many of these impacts map to the seven themes (TOMs) of the National Social Value Measurement Framework for Wales.

Figure 1: Crop Cycle's impact mapped to the 7 TOMs themes

[1] *Community Enterprise Business Planning Consultation Report*, f3 consulting, May 2022

Many of these impacts have been achieved because Crop Cycle has prioritised community involvement in the CEA pilots - for instance, all four pilot sites are supporting local employment and are led by third sector organisation who have been funded and supported to develop their skills and capacity.

Where data allows, the research has used the TOMs framework to value these wider impacts. The valuation exercise suggests that, together, the four pilot sites have created over £70,000 in economic and social value for Wales.

Table 1: Estimated economic and social value of the four pilot sites

Type of impact	Metric	Value
Employment created	1.8 FTEs	£49,500
Training of pilot staff	58.5 days	£2,820
Delivering CEA workshops for children and adults	622.5 hours	£9,340
Supply chain employment created	0.25 FTEs	£6,875
Apprenticeships created	10 weeks training	£2,300
Total		**£70,835**

Source: Little Lion Research calculations, using TOMs

Lessons learnt from pilot activity to date

Crop Cycle has supported the creation of four CEA pilot sites, spread throughout Wales and involving a range of audiences (primary school children, college students, the public) in a range of ways (workshops, exhibitions, produce sales). These sites have installed and operated a range of CEA technologies. Whilst the pilot sites are not the first CEA installations in Wales, by helping to create four new CEA sites Crop Cycle has made a significant contribution to the scale and breadth of CEA activity in Wales. Programme performance has been impressive given the restrictions all sites faced during the COVID-19 pandemic.

The pilot sites have faced challenges in terms of sourcing and installing CEA technologies, training staff in how to use and demonstrate the CEA technologies, operating multiple CEA technologies, and engaging the public in large scale/meaningful ways (exacerbated by the Covid lockdown). Via Crop Cycle network meetings, pilot teams have received support to overcome some of these challenges. Other challenges have been harder to overcome, pointing to a need to give pilots a longer timeframe over which to set up equipment, train staff and engage local communities.

Recommendations

We make several recommendations to SF&G and local and national government in Wales. Implementing these recommendations will help to sustain the four pilots as they move towards financial viability.

We recommend that SF&G continues to support the four pilot sites, by making revenue grants of up to £5,000 per year for the next three years available to the pilots, and maintaining the Crop Cycle network through which pilot teams can be supported with issues such as reducing production costs. Sites should be encouraged to specialise in one or two CEA technologies, and data should be collected from the pilots in a consistent manner.

We recommend that local and national government in Wales supports the Crop Cycle programme by leveraging public procurement to increase demand for Crop Cycle produce, ensuring curriculums are delivering the skilled workers needed to operate CEA technologies, developing the business support

offer for CEA producers, and linking the pilot sites and CEA grown Welsh produce to Wales food and drink sector marketing and branding.

Introduction

In February 2022, Social Farms & Gardens (SFG) commissioned a Social Return on Investment (SROI) report to collect evidence on the impacts/outcomes of SFG's Crop Cycle project. Crop Cycle has helped to create four Controlled Environment Agriculture (CEA) pilots. The SROI was to go beyond stating the financial return of each pilot to evaluate wider gains from the investment in the four CEA pilots.

This report presents the findings from the SROI exercise.

What is Controlled Environment Agriculture?

CEA is about controlling the ecosystem within which a crop is grown.

Using CEA methods, factors such as temperature, humidity, light, and nutrition, as well as complimentary factors such as carbon dioxide levels and air renewal can be controlled.

These factors are often controlled using automated techniques which can be controlled by sensors and timers, and even remotely through different software. To efficiently operate a CEA system requires not only horticultural knowledge but also a technical knowledge of using the equipment. Generally, developing this technical knowledge requires formal training.

CEA usually takes place in an indoor environment (e.g., shipping containers, factories, converted warehouses). In these purpose-built indoor grow spaces, it is easier to control the growing ecosystem than outdoors, for instance in a tunnel house. In outdoor grow spaces, you can control and automate some aspects of the nutrition and light, but other factors (e.g., temperature and humidity) can be harder to manage.

While CEA can be carried out in conventional horizontal agriculture methods, the fine control it offers over production inputs mean that vertical grow methods can be used. By placing grow areas on top of each other, such as racks in a hydroponic system, a grow area can operate within a reduced area, which in turn reduces rent and running costs.

The three most common CEA growing methods are aquaponics, aeroponics and hydroponics. More detail on these growing methods is provided in Figure 1 on the next page.

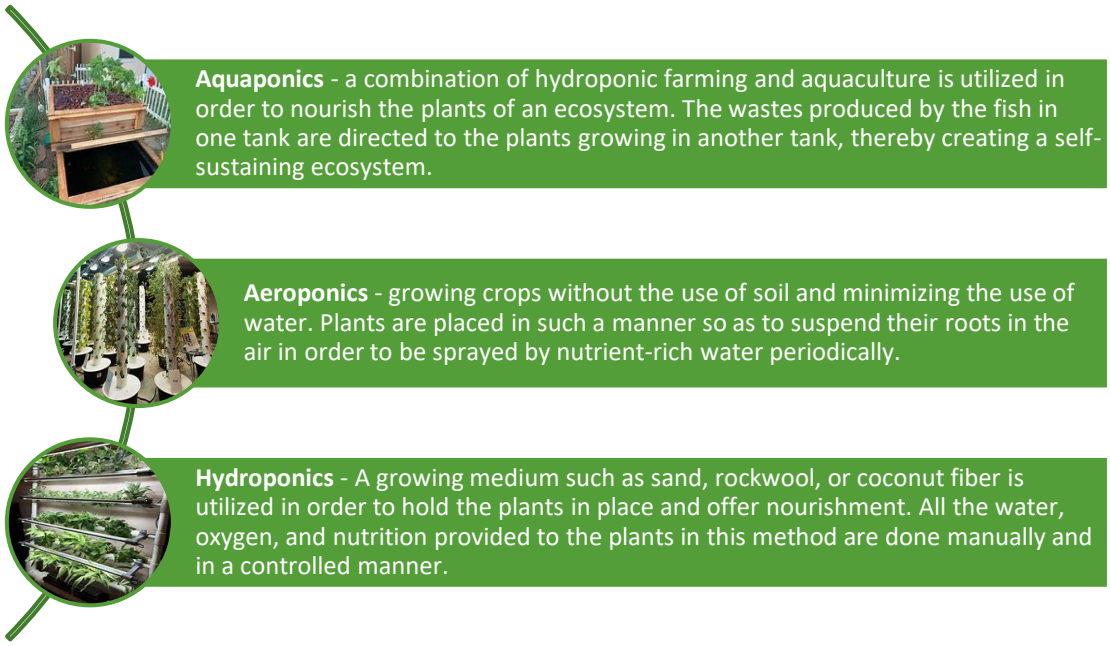
CEA can deliver several benefits in comparison to traditional agricultural growing methods. CEA can deliver greater outputs (i.e., produce) for fewer inputs - most obviously, less water and lower fertiliser costs. It has been estimated that large-scale CEA has 70-90% lower water and other input costs compared to 'traditional' agriculture[2]. The greater ability to protect plants from pests and diseases means that CEA systems have lower wastage rates.

In an environment where there is growing competition for land and water resources, and with climate change making outdoor growing harder/less predictable, CEA's ability to reduce demand for such inputs is valuable. CEA can enable produce to be grown in regions where the outdoor climate is not conducive to the produce, helping to reduce 'food miles'. For instance, using CEA methods crops such as micro greens, peppers, tomatoes, strawberries can be grown all year round in northern European climates.

[2] What is a Controlled Environment Agriculture (CEA)? (pinduoduo-global.com); Controlled Environment Agriculture - from glasshouse to vertical farm - Agri-TechE (agri-tech-e.co.uk)

Not all agricultural input costs are reduced under CEA approaches. CEA approaches consume more electricity than traditional horticultural methods. Setting up CEA systems requires greater capital investment upfront and creates ongoing monitoring and delivery costs. It also requires staff training in how to use CEA technologies.

Figure 2: Three common CEA growing methods



Crop Cycle

During late 2020 / early 2021 through support from the Welsh Government's Foundational Economy Team, Food Division & Valleys Regional Park Officers, SFG (with the support of the Nutri Wales Cluster group lead) established the Crop Cycle project to pilot CEA units in community settings and under community management.

Four CEA pilot sites were established; in Wrexham in north Wales, Newtown in mid Wales, and Cwmbran and Treherbert in south Wales. Figure 2 on the following page gives a summary of each site.

The four sites were intended to be test beds for CEA in a community-led setting. SFG and partners wanted to explore how CEA could help communities to deliver activities which educated and involved people in the food they eat, providing learning and business development opportunities, and increasing the sustainability of local food networks by giving people access to nutritious, locally grown food. It was expected that the sites would need three years to install CEA technologies, train staff in how to use the equipment and ramp up food production and sales.

There was a desire for government investment in the pilot sites to benefit Welsh businesses. Sites were encouraged to use Welsh-based CEA and technology businesses where feasible to design and help install the infrastructure, ensuring it was suitable for each site's conditions and requirements. As part of the tender process the brief included the requirement for the successful businesses to provide a level of on-going support to the projects as the technology is installed, trialled, and moved into production.

Figure 3: Location of the Crop Cycle CEA pilots

Xplore! is a science centre in Wrexham. Farm Urban has installed two living walls that visitors to the centre can view. The Xplore! team is running CEA workshops for schools and community groups.

Cultivate is a cooperative linking food and the local community. The SFG pilot site is on the outskirts of Newtown, next to the FE college campus. There is a deli in the town centre which makes use of the produce from the grow site.

Greenmeadow Community Farm is a working farm based in Cwmbran, managed by Torfaen Council. The SFG pilot involves a CEA grow container on the site plus a Farm Urban Living Wall in the café.

The Treherbert SFG CEA pilot is part of the wider Welcome to our Woods community partnership that aims to address socio-economic challenges within the Valleys.

Crop Cycle received just over £400,000 in a grant from the Welsh Government's Foundational Economy Challenge Fund. Each site received a mix of revenue and capital funding to set up their CEA pilot.

Table 2: Revenue and capital budgets for each pilot site

Project	Revenue (£)	Capital (£)
Welcome to our Woods	37,500	112,500
Greenmeadow Community Farm	18,000	98,000
Xplore!	10,000	16,500
Cultivate	22,500	90,500

Source: SFG budget data, 2021/22, rounded to the nearest £500.

Three of the four pilot sites invested in aeroponic/hydroponic growing equipment sourced from UK manufacturers. This required large scale capital investment. The remaining site, Xplore!, did not install such equipment and hence had a lower capital budget.

Other pilot site capital costs included:

- Site preparation
- Solar panels
- CEA software subscriptions
- Costs of seeds/plants
- Other growing equipment, e.g., polytunnels
- Packing for produce grown for sale/distribution

Pilot sites used their revenue funding to pay for:

- Staffing costs associated with setting up and managing the CEA installations
- Staff training costs
- Educational activities associated with the CEA installations
- Community engagement
- Marketing and communications costs

What is social value?

The value of a project is often assessed by comparing the cost of setting up and running the project with the income that the project will subsequently generate. If a project's projected or actual income exceeds its costs, it is deemed financially viable.

Financial assessments do not consider the value that a project delivers for individuals (for example, the learning of a new skill), businesses (for example, a more resilient local business base), or communities (for example, increased pride in the local area). These benefits are categorised as economic and social.

There is no single way of measuring economic and social value. In Wales, the Wellbeing of Future Generations Act 2015 requires public bodies in Wales to think about the long-term impact of their decisions, to work better with people, communities, and each other and to prevent persistent problems such as poverty, health inequalities and climate change. The Wellbeing Act puts in place 7 Wellbeing Goals for Wales to achieve. The National TOMs Wales[3] are an agreed set of measurements that enable projects to demonstrate how they are delivering against the 7 goals. For each goal (or

[3] Welsh National TOMs guidance - Social Value Portal

theme) – for example, a more prosperous Wales – the TOMs identify a set of outcomes – for instance, more people in employment – units of measurement – for example, number of local residents employed by the project – and the proxy value of one outcome – in this example, one job is worth £27,500 per year. Using these metrics and values, projects can evidence and calculate their total local economic and social value.

The total local economic and social value a project creates is not money in the project's bank account. Rather, the total figure represents the value realised, or costs avoided, elsewhere in the system – for example, the reduction in universal credit payments as local people secure jobs – and the hypothetical value people place on social outcomes such as feeling more connected to the neighbours.

Research methodology

The research has involved a 3-stage methodology, with various tasks carried out at each stage:

Stage 1 – scoping the intended outcomes for the four pilots

- An inception meeting was held with SFG staff who have been involved with the pilots.
- Following the inception meeting, we reviewed background information on each pilot.
- Initial phone/online consultations were arranged with the four pilot teams to learn more about their activities and to plan our site visits.
- The research team also joined an online network meeting of the four pilot teams.
- We undertook a literature and policy review to summarise the wider context for the pilots and the possible impacts of the pilots' activities.

Stage 2 – primary research to gather evidence of the pilots' impacts

- The research team arranged visits to each pilot site to speak with pilot teams, volunteers, and representatives of partner organisations to learn more about the wider context and narrative that their pilot fits into and contributes towards. Each visit lasted 2-3 hours and provided an opportunity to gather multimedia evidence for this final report.
- Following the visits, we requested further data and evidence on impact from each pilot team.
- We also had telephone/online consultations with Welsh Government officers and other pilot partners about how the impact of the pilots should be considered and measured, and the extent to which pilots are delivering specific outcomes.

Stage 3 – analysis and reporting on the net value of these outcomes

- We have collated evidence to identify the outcomes of each pilot.
- Where possible, we have placed values on outcomes using the values and proxies set out in the National TOMs Wales guidance.
- Consulted with a separate team of consultants who are reviewing the pilots' financial impact to ensure we capture the totality of each site's impacts.[4]
- Consulted with SF&G on how the evidence and findings translate into making the case for

[4] More detailed analysis of the financial viability of the four CEA pilot sites is provided in *Community Enterprise Business Planning Consultation Report*, f3 consulting, May 2022. Using data provided by the pilot sites and SFG, checked against CEA industry estimates, the report sets out the income generation potential of each pilot site for the next three years, and sets this against the fixed and variable costs likely to be incurred by each pilot site to produce a profit/loss calculation.

community-led agriculture projects in Wales.

All primary research took place in February and March 2022, with the collation and analysis of research evidence taking place in April 2022.

Assumptions and caveats made by the research

The impact modelling has assumed zero deadweight for each pilot site, i.e., in the absence of Crop Cycle funding none of the pilot teams would have had the funding or capacity to purchase and install CEA equipment. In discussions with pilot teams, we asked about how sites had previously been used, in all cases pilot teams told us that the sites had been vacant and/or partners had not had the funds necessary to prepare sites for food production.

Regarding the attribution of impacts, some of the impacts related to the pilots, such as visits to the site by the public and educational activities, are not solely due to the pilots. For example, Xplore! is a science centre open to the public and with an educational programme; not all Xplore! visitors and educational sessions are due solely to the CEA installation the venue now possesses.

The four pilots have had to contend with several challenges, not least several periods of lockdown in response to the Covid-19 pandemic. Pilot sites have not made as much progress as they anticipated in relation to growing produce, training staff in how to operate CEA equipment, and demonstrating CEA technologies to students and the public. This has meant the impact modelling has had to rely on partial/forecast data. In each chapter, we note the robustness of pilot data. We also include qualitative discussions of the wider benefits that the pilots are delivering for their local area.

Structure of the report

This report includes a chapter on each Crop Cycle CEA pilot site.

Within each pilot site chapter, the report:

- Explains the specifics of the pilot at the site, in terms of the delivery team and partner organisations, and the wider context for the pilot.
- Includes photos of the pilot site and the CEA infrastructure that has been developed on site.
- Sets out intended impacts, and impacts to date of each pilot site in terms of:
    - Financial impact – summarising the associated but separate piece of research on the sales income and running costs of each pilot.
    - The economic, social, and environmental impacts of the pilot sites, where possible monetising these impacts using the Wales TOMs framework methodology.
- Notes the challenges and lessons learned from each CEA pilot site.

The final chapter sets out conclusions and policy recommendations.

Greenmeadow Community Farm

Greenmeadow Community Farm is a working farm based in Cwmbran, managed by Torfaen Council. The Community Farm in its current form was opened in 1991 by a group of local people. The primary role of the site is as a tourist attraction, which aims to teach visitors about the environment, farming, and where food comes from.

Greenmeadow hosts school visits from its well-established school network. This is often for Primary age children, although there is a lot on offer for older students too. The farm offers alternative provision placements and volunteering opportunities; many staff have been recruited via the Kickstart scheme which provides government funding to create new jobs for 16 to 24 year olds on Universal Credit who are at risk of long term unemployment.

In the farmhouse, visitors will find a reception and gift shop as well as the 'Café Cwtch', where visitors can purchase snacks and drink, as well site-prepared meals, and buy the farm's own produce, including pork, fresh eggs, and sheep fleeces.

The pilot

Using the Crop Cycle funding, Greenmeadow Community Farm has been able to install two CEA units:

- A CEA grow container set within the animal paddocks and play areas on the site; and
- A Farm Urban Living Wall set up in the café area which shows customers how food can be grown using vertical CEA technologies and processes.

Grow container

The grow container is found behind the main building housing the reception, café, and gift shop, towards where the tractor ride starts from. The container currently has a vertical wall on the outside with plants growing outdoors, as well as solar panels on the roof to help provide power.

The primary objective of this site is to grow all greens used in the café. Microgreens are also grown, which are used sparingly as garnish in the café, with the intention that these will be sold locally as small salad boxes as production increases.

Figure 4: Greenmeadow CEA grow container with vertical wall

Source: LLR site visit, March 2022

The technology within the grow container was purchased from Digital Farming, a CEA company based in Pencoed, 30 miles from Greenmeadow.

As the grow area of the container must be kept off limits to the public (to prevent contamination of the clean room where the plants are growing), it is difficult for members of the public to learn about what is happening inside the container. To help bring this project to the public, Greenmeadow plan to install a live-feed camera system in the container, and a television screen in the window of the cleaning room so that visitors outside can see what is happening in real-time. The fact that the area in front of the container is used as a waiting area for the popular tractor ride will mean that many people will be around the screen.

Figure 5: Interior of Greenmeadow CEA grow container

Source: LLR site visit, March 2022

Hydroponic living wall

The Living Wall has been installed behind the bar in the seating area of the café. A trough at the bottom holds all the plant feed mix with water, which is pulled up vertically through tubes and dripped down to feed the plants. Having the Living Wall in a visible place allows café customers to see how food can be grown in alternative ways to standard soil methods.

Figure 6: Greenmeadow Farm Urban living wall

Source: LLR site visit, March 2022

Farm Urban have also supplied Greenmeadow with a kit to deliver aquaponic workshops in primary schools (years 5 & 6). This includes a kit that pupils can put together and learn how aquaponics can be used in a limited space to grow leafy greens indoors.

At the time of our visit, aquaponics workshop had been delivered to one school. The farm has a well-established network of local schools who send pupils on visits to the farm and/or host workshops and lessons about the farm. It is expected that 10-20 CEA workshops could be run each year.

Figure 7: Greenmeadow hydroponics kit

Source: LLR site visit, March 2022

Staffing

Five Greenmeadow staff are involved with the pilot. All were previously employed at the farm.

Most of these individuals are involved with the pilot for 1-2 hours per week. One member of staff works in the grow container one day a week alongside their other roles at the farm.

CEA farming methods are new to Greenmeadow staff. When Greenmeadow learned their CEA pilot project was going ahead, five staff volunteered to be trained in how to operate and maintain the CEA equipment.

To date, Greemeadow staff have spent 10 hours delivering CEA workshops for local schoolchildren. This figure will increase as the farm rolls out its CEA school workshops.

Greenmeadow management plans to advertise volunteering roles specific to the pilot. It is expected that these roles will secure a minimum 10 – 20 hours per week of volunteer input for the farm.

Financial impact

The Greenmeadow pilot has the potential to grow almost 1 tonne of produce per year using its various CEA installations, the majority of this being grown in the grow container installed at the farm. Allowing for 15% wastage and assuming this produce is sold at £2 per bag, it is estimated that income from sales of CEA grown produce could exceed £1,000 per month by year 3 of the pilot.

Greenmeadow will incur fixed and variable costs from operating the CEA installations. Staffing costs associated with one member of staff working 1-2 days per week on CEA grow activities represent the largest of these costs. The CEA installations will also require light/heat/power which will increase the farm's utility bills, and cost will be incurred around preparing/packaging produce. The total monthly cost to Greenmeadow of running the CEA installations is forecast to be £900-£1,100 per month.

Table 3: Greenmeadow CEA pilot – headline profit and loss analysis

	Year 1	Year 2	Year 3
Sales income	£4,169	£6,692	£10,650
Fixed costs	£6,490	£7,990	£9,490
Cost of sales	£1,163	£1,728	£2,220
Profit (loss)	-£3,484	-£3,026	-£1,060

Source: *Community Enterprise Business Planning Consultation Report*, f3 consulting, May 2022
Note: Sales income forecasts assume CEA installations will be working at 33% capacity in year 1, 55% in year 2 and 100% in year 3 to allow time for Greenmeadow staff to be trained in how to use the equipment. Sales figures include income the farm will get from non-food sales (e.g., plug plants) and running educational sessions. Initial pilot capital costs are not included in the financial appraisal.

The financial modelling suggests that the Greenmeadow CEA pilot will struggle to break even on a purely commercial basis. Therefore, it is the wider monetised and non-monetised impacts the CEA pilot delivers which have greatest bearing on the overall value for money of the pilot.

Wider impacts

The primary objective for Greenmeadow of hosting a CEA pilot was to provide produce to be used by the site's café, fitting in with the ethos the farm has of growing and promoting fresh produce for the benefit of the local community. This objective has been achieved. The café has been regularly supplied with produce from the CEA grow container. The team plans to change the café's menu to let customers know about the origin of the food they are eating to raise awareness of the range of quality of local produce.

Greenmeadow's CEA facilities are not yet fully operational, some growing space remains empty. The vertical living wall installed against the grow container is not being regularly harvested. If the pilot team can exploit the full growing capacity they now have, they could generate more produce to consume on site or sell/distribute locally. Greenmeadow have spoken with local care homes about providing them with leafy greens and are looking at options to market CEA produce directly to customers.

The Greenmeadow pilot has supported local businesses; pilot equipment was bought from a company based nearby and the farm regularly purchases supplies from a local garden centre.

Greenmeadow is owned by Torfaen County Borough Council. Under the Well-being of Future Generations Act 2015 the council is legally required to follow sustainable development by creating a prosperous, cohesive, resilient, more equal locality. The Council is committed to reducing carbon emissions as part of its declaration of a climate emergency. The Council's Corporate Plan and Recovery Plan for 2021-'23 commits the Council to *'Work in a sustainable way to ensure the local environment*

is valued and maintained for future generations' and to *'Support and promote the local economy'.* The CEA pilot makes a major contribution to these Council objectives.

The Greenmeadow CEA pilot has created employment and training opportunities:

- One staff member works one day per week on the CEA pilot, and four other staff members spend a few hours each working on the pilot (e.g., 0.25 FTEs).
- All these staff live locally.
- It is intended that this staff member will be supported by a young person recruited via the Kickstart scheme that funds jobs for young people who are at risk of long-term unemployment.
- Other teams within the farm's workforce, e.g., the café and shop, have recruited Kickstart funded employees who are indirectly benefiting from the CEA pilot bringing visitors to the site and providing produce for the café.

Greenmeadow pilot activity is contributing to a more prosperous Wales by sustaining local employment. The TOMs guidance recommends such contributions be valued at £27,500 per FTE[5]. The Greenmeadow pilot has created £6,875 in economic value (£27,500 x 0.25) by sustaining local jobs.

Five Greenmeadow staff have benefits from 12.5 days training trained in how to use and demonstrate the CEA technologies. The TOMs framework values staff training/upskilling at £285 per week[6]. This value relates to accredited training (e.g., BTEC, NVQ) rather than non-accredited training such as that being accessed by Greenmeadow staff. If we conservatively value the training received by Greenmeadow staff at £200 per week, the CEA pilot has delivered £500 in economic value by upskilling Greenmeadow staff (2.5 weeks of training X £200 per week).

The Greenmeadow team have been trained to deliver aquaponics sessions for primary school age children. Via Greenmeadow's existing school outreach activity, there is the potential to scale this to reach 10-20 schools each year. Assuming 30 school pupils per session (which is in line with school workshop numbers recorded by other CEA pilots), this would mean 300-600 local schoolchildren learning about CEA technologies each year. The TOMs guidance recommends such contributions be valued at £15 per hour of student training[7]. Assuming each workshop is delivered by two staff and takes half a day, we calculate the Greenmeadow CEA pilot could create £1,800 (15 workshops x 8 hours staff time per workshop = 120 hours x £15 per hour) of economic value per year through the delivery of workshops for local schoolchildren

Farm Urban has evaluated the impact of delivering these workshops to school children in Liverpool and Manchester. They found the sessions inspire pupils to learn new things about big topics such as climate change and to realise the difference they can make through their food and lifestyle choices[8]. The Greenmeadow pilot is giving students practical experience of new technology and helping them to explore cross-disciplinary approaches to work and business.

The CEA pilot will be linked to the Level 1&2 Animal Care vocational qualifications that young people and adult learners can undertake at Greenmeadow. Exposure to CEA technologies within these courses will make the training more engaging and appealing to older learners.

[5] National TOMs Wales, NTW1
[6] National TOMs Wales, NTW7
[7] National TOMs Wales, NTW6
[8] Farm Urban in-house monitoring and evaluation of aquaponics workshops run in Liverpool and Manchester in 2018/19.

Xplore!

Xplore! is a science discovery centre in Wrexham, North Wales. The site has over 65 interactive science exhibits/items. Xplore! has a strong focus on education, with the site regularly hosting school-trips and team members delivering workshops in schools further afield than Wrexham that may not be able to bring a whole cohort of pupils into the centre.

Xplore! was previously called 'Techniquest' and was based on the Wrexham University campus outside the town centre. Techniquest had a long history of education/outreach work but there was felt to be limited public/wider awareness of Techniquest due to its location on campus, out if sight of the public.

With funding from the Wellcome Trust, a decision was taken to move Techniquest into Wrexham town centre and to rebrand the centre as Xplore! A lease was taken on an empty department store in Wrexham. Xplore!'s new town centre site was due to open in May 2020, but the Covid-19 lockdown period meant the opening was delayed.

Now fully open, from Monday to Thursday, Xplore! hosts school/home schooling groups, either at the Wrexham site, or remotely with staff visiting schools. The Xplore! team offer schools a 'menu' of 40 different workshops, many of which are hands-on and interactive. In a typical month, Xplore! will engage 600-900 schoolchildren and 50-70 teachers. School visitor numbers are split between primary and secondary schools, and English and Welsh schools.

From Friday – Sunday the centre is open to the public. The centre is popular with parents who bring their children to learn more about science and to try hands-on activities. Xplore! welcomes around 180 visitors per day at the weekend, rising to about 300 per day during half-term weeks.

The pilot

Xplore! was introduced to SFG through their work with Farm Urban. While still based at their previous site, preparations were made with Farm Urban to create two Living Walls on site and to develop workshops for schools and community groups. Farm Urban provided Xplore! with the living wall equipment and training in how to use/maintain the walls.

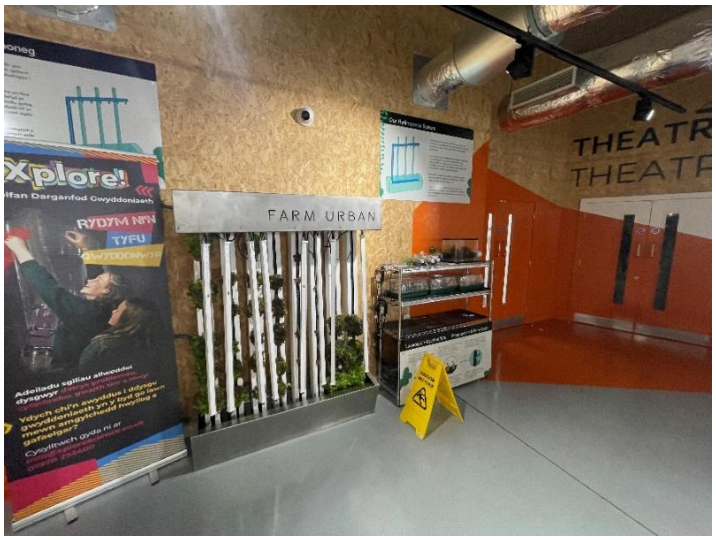
Xplore! has worked with Farm Urban to deliver two forms of CEA activity:

- Two Farm Urban Living Walls located within the centre, one by the main entrance and one within the main exhibition space; and
- Feed our Future educational workshops – Through its network of school contacts and reputation in the region as a source of STEM activities for schools, Xplore! has been able to deliver two Feed our Future workshops, with another seven workshops booked for the coming month.

Living Walls

There are two Farm Urban Living Walls at Xplore!. The first Living Wall is in the entrance to the site, while the second is within the main activity floor.

Figure 8: Living Wall installation at Xplore!



Xplore! hosts 'Harvest Days', where members of the public can interact with the Living Walls, harvesting plants to take home, as well as helping with the planting of new seeds to replace the plants that have been removed.

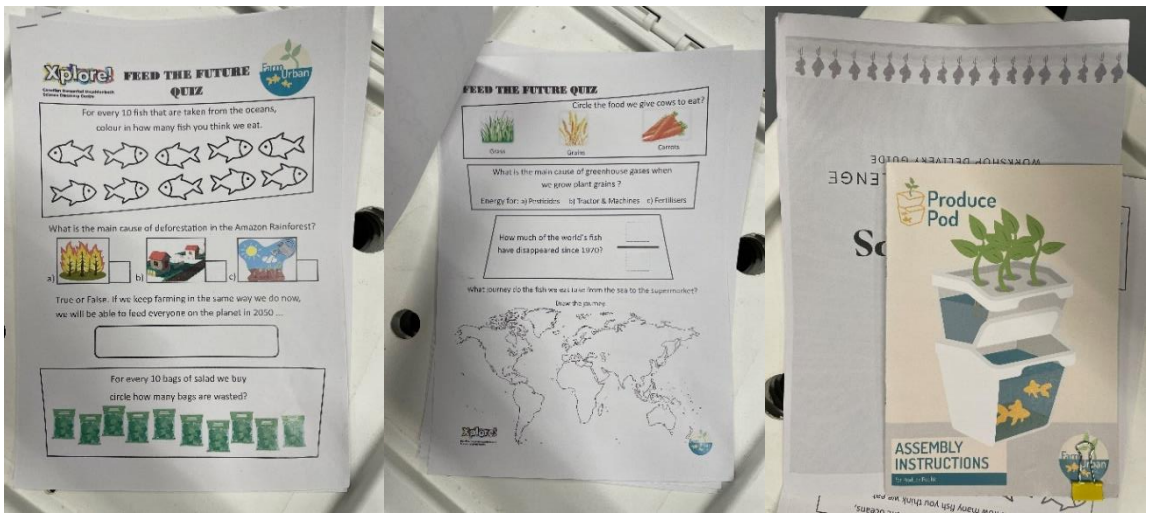
Feed Our Future workshops

Farm Urban have delivered training to six Xplore! staff on the delivery of the 'Feed Our Future' workshops. The staff shadowed the Farm Urban team as they delivered a workshop for school children.

Source: LLR site visit, March 2022

The Feed our Future workshop involves a short presentation to teach children about where their food comes from, and how it can be produced, as well as an interactive aspect where groups put together an aquaponic grow-kit.

Figure 9: Feed our Future worksheets



Source: Farm Urban

To date, 298 students from local schools have attended/are booked to attend in the coming weeks a Feed our Future workshop. Each workshop has involved an average of 33 students. The Xplore! team has a target of engaging 840 students with the workshop. To hit this target, will require the delivery of another 16 workshops this year.

Unlike other Xplore! workshops that schools must pay to attend, the Feed our Future workshops are fully funded by the Crop Cycle grant. Xplore! have therefore used the Feed our Future workshops as a way of reaching out to schools who haven't engaged with the centre (for some time) with the hope that they will enjoy the workshop and potentially book a subsequent paid-for session.

The Crop Cycle funding has enabled Xplore! to enhance its educational offer. Previously, they did not run any workshops that introduced plant-based and sustainability content and concepts. The funding has also contributed to the administration costs associated with the booking of the workshops, thereby contributing more generally to the core operating costs of Xplore! to enable the centre to become more financially sustainable.

Staffing

One Xplore! member of staff spends half a day a week working on pilot coordination activities.

Six Xplore! staff each recevied three days training (on and offsite) in how to operate and demonstate the living walls, and how to run the Feed our Future workshops. Some of these staff have since left Xplore! but the centre has recently undertaken a recruitment drive and have recruited four new staff. Xplore! management would like all members of staff to be trained in the upkeep of the Living Walls and the delivery of the Feed our Future workshops.

Xplore! management estimates that staff will spend 60 days per year delivering workshops associated with the CEA pilot.

All Xplore! staff live locally. All are paid, none are volunteers

Financial impact

The Xplore! team is not using their CEA equipment to grow produce for commercial sale; therefore, the pilot will not have the same income generation potential as the three other CEA pilot sites delivered under Crop Cycle. A profit/loss model for the Xplore! CEA pilot has been created to consider the additional income the centre could see from delivering more educational workshops set against the cost of maintaining the CEA equipment.

Table 4: Xplore! CEA pilot – headline profit and loss analysis

	Year 1	Year 2	Year 3
Sales income	£1,200	£1,400	£1,600
Fixed costs	£1,990	£1,990	£1,990
Cost of sales	£300	£350	£400
Profit (loss)	£1,090	£940	£790

Source: *Community Enterprise Business Planning Consultation Report*, f3 consulting, May 2022
Note: Sales income forecasts based on Xplore! running 6-8 CEA educational workshops per year, generating income of £200 per workshop.

The financial modelling suggests that the Xplore! CEA pilot will not make a positive financial contribution to the centre due to the small number of CEA educational workshops the centre could run. Again, it is the wider monetised and non-monetised impacts the CEA pilot delivers which have greatest bearing on the overall value for money of the pilot.

Wider impacts

The primary purpose of Xplore! hosting a CEA pilot is to expand its educational offer. To date, two schools have participated in the Feed our Future workshops, with another seven schools due to attend the workshop in the coming month. The Xplore! team hopes to deliver another 16 school workshops before the end of the year. Through these workshops, it is expected that 840 students will learn more about CEA technologies.

60 Xplore! staff days will be dedicated to delivering these free workshops. The TOMs guidance recommends such contributions be valued at £15 per hour of student training[9]. We calculate the Xplore! CEA pilot has created £6,750 (60 days x 7.5 hours per day = 450 hours x £15 per hour) of economic value through the delivery of workshops for local schoolchildren.

As noted in the Greenmeadow CEA pilot chapter, there is evidence of the wider benefits that the workshops deliver in terms of making pupils more aware of topics such as climate change, the difference they can make through their food and lifestyle choices, and cross-disciplinary approaches to problem-solving.

One Xplore! staff member spends 0.5 days per week (equivalent to 0.1 FTEs) working on pilot activity. This contributes to a more prosperous Wales by sustaining Welsh employment. The TOMs guidance recommends such contributions be valued at £27,500 per FTE[10], The Xplore! CEA pilot has created £2,750 in economic value by helping to sustain local employment.

Xplore! staff have participated in 18 days of training in how to use and demonstrate the CEA technologies. A further round of training, totalling 12 days is planned for four new recruits. The TOMs framework values staff training/upskilling at £285 per week[11]. This value relates to accredited training (e.g. BTEC, NVQ) rather than non-accredited training such as that being accessed by Xplore! staff. If we conservatively value the training received by Xplore! staff at £200 per week, the CEA pilot has delivered £1,200 in economic value by upskilling Xplore! staff (30 days/5 = 6 weeks of training X £200 per week).

Whilst Xplore! Is open to the public from Friday-Sunday, the two living walls funded through the CEA pilot form a very small part of the centre's appeal to visitors and Xplore! staff recognise that whilst the living walls are *"visually very interesting"* they not hands-on as is the case for other Xplore! installations. Also, for much of the time the living walls have been in situ, Xplore! has not been open to the public. For those reasons, we have assumed no boost to Xplore! visitor numbers from hosting the CEA pilot and no associated increase in ticket sales income.

The Xplore! CEA pilot team wants to include CEA within its adult community learning sessions on topics such as basic skills, digital skills, and carbon literacy. Improving the knowledge and skills of residents in relation to these topics is a priority for Wrexham County Borough Council. Like Greenmeadow in Torfaen, the council is legally required to follow sustainable development by creating a prosperous, cohesive, resilient, more equal locality. The Xplore! CEA pilot makes a major contribution to these Council objectives.

[9] National TOMs Wales, NTW6
[10] National TOMs Wales, NTW1
[11] National TOMs Wales, NTW7

Cultivate

Cultivate is a cooperative, run by volunteers and employees, based in Newtown in Powys, mid Wales.

The aim of the cooperative is to address issues within the modern food system, and work towards sustainable local food solutions. Cultivate has three 'themes': grow – via community gardens and allotments; eat – through its shop, deli, café, and kitchens; and share – via courses, projects, and volunteering opportunities.

The Cultivate main site is on the outskirts of Newtown, at the Neath Port Talbot Further Education college Newtown campus. The cooperative also runs a deli in the town centre which makes use of the produce from the grow site.

Cultivate have a track record of delivering food and drink projects. They have established a community orchard which resulted in the planting of 1,800 fruit and nut trees around town. They also run a 'Food Surplus' initiative where residents can collect free, locally grown food that would otherwise go to waste.

Cultivate's track record in successfully running food and drink projects, as well as their interest in innovative ways to introduce different methods of farming to their community meant when another site had to withdraw their CEA proposal, Cultivate were approached to take part in the CEA pilots.

Figure 10: Cultivate grow site

Source: LLR site visit, March 2022

The pilot

In December 2020, Cultivate were approached to take part in Crop Cycle. Cultivate prepared a site and installed a grow container. They started to train staff in how to use the grow contained equipment. Farm Urban supplied a Living Wall, which is currently installed at the college campus.

Horticulture training

Cultivate has a Level 2 training offer based around practical horticulture, which makes use of the polytunnels and growing beds in Cultivate's community garden. This is a new training offer for mid-Wales. The FE college has a food and catering specialism and plans to involve its Horticulture Level 2 students with the Living wall and on the Cultivate site. Cultivate and the FE college plan to include CEA training and knowledge within this training offer.

Cultivate is also in conversation with two of the College's faculties to explore how the CEA equipment could be used in research:

- The sports department of the College are looking at using microgreens and food processing to create a sports drink that can be marketed.
- The business school is exploring how medicinal herbs grown using the CEA equipment can be certified for public use.

Grow container

Cultivate make use of the aeroponic section of the grow container to grow microgreens which are sold to two customers:

- Sales of salad boxes, twice a week to the Cultivate deli in Newtown Centre. This contains a mixture of microgreens to be used in the deli's salads.
- Sales of salad boxes, twice a week to Health Loaded, a restaurant in Newtown that prepares and delivers *"healthy and tasty food locally to everyone who needs healthier options and cares about their nutrition."*

Any extra produce goes to Cultivate's 'Food Surplus' initiative to reduce food waste.

The solar (PV) panels on the roof of the grow container are not yet operational.

Figure 11: Aeroponic growing equipment at Cultivate

Source: LLR site visit, March 2022

Figure 12: A salad box grown in Cultivate's grow container and sold to a local restaurant

Living wall

A living wall has been installed at the College. At the time of our site visit the wall was not planted up and operational.

Aquaponic kit

Farm Urban have supplied Cultivate with an aquaponic kit that will be used to grow crops for commercial sale. No Cultivate staff have been trained in how to use or demonstrate the aquaponic kit. There is the intention that a member of staff will receive training and then deliver a workshop in a school where they are a governor.

Source: LLR site visit, March 2022

Supplying produce to schools

Cultivate have been selected to deliver leafy greens to two local primary schools as part of the Sustainable Food Places movement. This national scheme allows an area to sign up to six key themes to work towards:

- Taking a strategic and collaborative approach to good food governance and action.
- Building public awareness, active food citizenship and a local good food movement.
- Tackling food poverty, diet related ill-health and access to affordable healthy food.
- Creating a vibrant, prosperous, and diverse sustainable food economy.
- Transforming catering and procurement and revitalizing local supply chains.
- Tackling the climate and nature emergency through sustainable food and farming and an end to food waste.

Cultivate will make up part of the group of organisations working towards delivering these themes in Newtown.

Cultivate would like to scale up this primary school offer to reach more of the 93 primary schools within Powys. However, the rise in fuel costs, along with the rural layout of Powys means it is not currently cost effective for Cultivate to supply leafy greens to more of the county's primary schools.

Staffing

Cultivate has 10 members of staff, three Board members (who are not employees) and 40 volunteers.

Two members of staff were trained in using the grow container. One of these has since left Cultivate. The remaining trained member of Cultivate's staff works 11 hours per week in the grow container. Their role is to oversee the aeroponics installation, so it produces enough microgreens to meet demand from Cultivate 'eat' venues.

The member of staff in charge of the grow container is yet to receive formal training in how to use the aeroponic equipment. They have been trained by a colleague who was previously in the role and have been learning to use the digital app that is linked to the equipment. By using the app, the grow container systems can be controlled remotely (pH modifier, nutrients, automated feeding and flushing of grow areas), and the staff member can input harvest figures and track this over time.

Financial impact

The Cultivate pilot has the potential to grow 600kg of produce per year using its CEA installations. Allowing for 15% wastage and assuming this produce is sold at £2 per bag, it is estimated that income from sales of CEA grown produce could exceed £1,600 per month by summer of year 3 of the pilot, and £13,000 of sales per year. Micro-greens sales comprise the bulk of this income.

Cultivate will incur fixed and variable costs from operating the CEA installations. Staffing costs associated with one member of staff working 1-2 days per week on CEA grow activities represent the largest of these costs. The CEA installations will also require light/heat/power which will increase the farm's utility bills, and cost will be incurred around preparing/packaging produce. The total monthly cost to Cultivate of running the CEA installations is forecast to be £800-£1,000 per month by year 3.

Table 5: Cultivate CEA pilot – headline profit and loss analysis

	Year 1	Year 2	Year 3
Sales income	£4,391	£9,137	£13,069
Fixed costs	£5,490	£6,740	£7,990
Cost of sales	£948	£1,800	£2,527
Profit (loss)	**-£2,047**	**£597**	**£2,552**

Source: *Community Enterprise Business Planning Consultation Report*, f3 consulting, May 2022

Note: Sales income forecasts assume CEA installations will be working at 25% capacity in year 1, 40% in year 2 and 100% in year 3 to allow time for Cultivate staff to be trained in how to use the equipment. Sales figures include income Cultivate will receive from other sales and running educational sessions. Initial pilot capital costs are not included in the financial appraisal.

The financial modelling suggests that the Cultivate CEA pilot may, under optimal conditions, generate enough income from the sale of CEA grown produce to cover its running costs and leave a small annual profit. Issues with production capacity and/or increased running costs would likely eliminate this small profit. Therefore, it is the wider monetised and non-monetised impacts the CEA pilot delivers which have greatest bearing on the overall value for money of the pilot.

Wider impacts

The Crop Cycle CEA pilot has contributed to Cultivate's three aims of grow, eat and share.

The CEA pilot has allowed Cultivate to increase the range of food it grows. Cultivate now grows/plans to grow microgreens and leafy greens including peashoots, mustard leaves, micro radish, micro red cabbage, kale, and watercress. This complements the fruit and nuts that are harvested in Cultivate's community orchards, and the more mainstream vegetables that Cultivate grows in its polytunnels.

Cultivate has used CEA equipment to provide locally grown, healthy food in a range of venues – their own Deli, a local restaurant, local schools and via the community food surplus project. Each of these venues serves a different section of the community and charges varying amounts, helping to ensure that as many residents, workers, and visitors to the town as possible can eat the food grown using the CEA pilot equipment.

Through supplying local schools, the Cultivate CEA pilot is helping to improve young people's awareness of how the food they eat is grown and the importance of a healthy diet.

Maintaining the pilot site CEA equipment takes one member of staff 1-2 days per week (e.g., 0.25 FTEs). This contributes to a more prosperous Wales by sustaining Welsh employment. The TOMs guidance recommends such contributions be valued at £27,500 per FTE[12]. The Cultivate CEA pilot has created £6,875 in economic value per year by helping to sustain local employment

The CEA pilot has required two Cultivate members of staff to learn new skills. For the other CEA pilots, such as training usually took 2-3 days to complete. The TOMs framework values staff training/upskilling at £285 per week[13]. This value relates to accredited training (e.g., BTEC, NVQ) rather than
non-accredited training such as that being accessed by Cultivate staff. If we conservatively value the training received by Cultivate staff at £200 per week, the CEA pilot has delivered £160 in economic value by upskilling Cultivate staff (2 staff x 2 days training each = 0.8 weeks of training X £200 per week).

The CEA pilot will enable the local FE college to offer a broader range of practical horticultural training and skills development opportunities, aiding efforts to develop mid-Wales as a centre of horticultural expertise.

The educational impact of the Cultivate CEA pilot extends to research collaborations between Cultivate and the FE College. Both research projects are in the early stages. We cannot place a value on this activity at present. The research projects have the potential to show how community led activity and innovations can be linked with other local facilities and knowledge to create new, high value economic activity.

[12] National TOMs Wales, NTW1
[13] National TOMs Wales, NTW7

Welcome to our Woods

Treherbert is a village of 5,500 residents in the Upper Rhondda Valleys, 25 miles north west of Cardiff. Like many villages in the Rhondda, Treherbert is a former industrial coal mining village.

Welcome to our Woods (WtoW) is a community partnership based in Treherbert but with sites across the Rhondda Valley. WtoW was established in its current form in 2014. The Partnership is a blend of local private sector businesses and landowners, statutory government and agencies, voluntary sector organisations, local community groups and individuals who offer their time and skills.

WtoW's work is focused on finding solutions to local problems in relation to:

- Health and wellbeing – limited access to quality green space, poor mental health, and physical inactivity.
- Skills and jobs – the prevalence of low wage/low skills and few wage opportunities.
- Poverty – such as a lack/limited access to services and fuel poverty.

WtoW has partnered with Rhondda Housing Association, a social landlord, and other Community Interest Companies (CICs) to develop the Rhondda Skyline project. Rhondda Skyline aims to give residents control over the mountains and woodlands surrounding the Upper Rhondda through the founding of a Community Land Trust. This Trust will secure the rights to the land from National Resource Wales, the body that currently manages it, and allow local people to decide how it is used and what projects can be funded to benefit of the local community.

WtoW has also established a Limited Community Company that works with the community partnership to explore opportunities to deliver social impacts through the production of timber and non-timber products and other ecosystem services.

The pilot

The CEA pilot in Treherbert is located on the site of a former petrol station which had been transferred into WtoW from Rhondda Housing Association and which had been derelict for more than a decade. The site is located on the main road through the village and had become an eyesore due to littering and antisocial behaviour. The site is spread across two levels, with the upper level 35m by 15m, and vehicular access via the lower level. Due to the site's layout and previous use, it was deemed unsuitable for housing development.

Figure 13: Image of how the Treherbert CEA pilot site used to look

The WtoW partnership had been consulting with the community for several years on what to do with the site. Feedback from the community identified the site as somewhere the community could visit, enjoy, and grow food in raised beds and poly tunnels. Whilst the partnership awaited funding to develop the site, it used a small lottery grant to pay a contractor to clean up the site and make it flat and safe.

Source: www.seanjamescameron.com

Figure 14: Treherbert CEA site - under development

Source: LLR site visit, March 2022

The site has three structures, each serving a different purpose. On the right-hand side of site, when viewed from the road, there is a general amenity building with a kitchen, toilets, and an educational/community space. Welcome to our Woods is storing its Farm Urban hydroponic and aquaponic equipment (which will be used in workshops with school children) in the amenity space as they prepare to fully open the site.

On the left-hand side of the site is the CEA grow container. Within the grow container the pilot team has installed aeroponic growing equipment. Issues with the grow container mean the pilot team has not been able to grow any crops to date. The plan is to grow a selection of vegetables and fruit, with members of the community being able to suggest/request what is being grown.

Figure 15: CEA equipment at the Treherbert pilot site

Source: LLR site visit, March 2022

The middle of the site is clear and flat, with raised walkways making the site accessible to all. The pilot team plan to install raised beds, poly tunnels and seating areas so that staff, volunteers, and visitors can participate in growing produce and socialise in the space.

Another shipping container is located on the back, lower portion of the site. This offers storage space and is intended to be a location for mushroom cultivation in the longer-term.

Where possible, the materials used on site have been recycled/reclaimed from other uses.

Figure 16: Artist's impression of how the Treherbert pilot site will look

Source: Saskia Blake

Staffing

Two residents have been employed as builders/carpenters to create the pilot site. Woodworking tools and equipment in the partnership's Head Office space has been used to fabricate much of what has been installed at the pilot site.

Five WtoW staff are directly involved in running the CEA pilot: two operational staff spend two days per week working on the pilot; two managers spend 0.5 days per week working on the pilot; and an apprenticeship spends one day per week on the pilot. In total, six days of WtoW staff time is spent on the pilot each week.

Four of these staff members live within a mile of the site. One staff member was economically inactive before the pilot and is now employed to work, in part, on the pilot.

To use and demonstrate the CEA technologies, staff have participated in training. Six WtoW staff have spent three days being trained in the aquaponics workshops and the use of the hydroponics growing wall provided by Farm Urban. Two staff spent three days being fully trained in using the aeroponics growing system from Lettusgrow.

Welcome to our Woods has other sites and initiatives in the locality. Staff and volunteers working on these are also contributing to the development of the CEA pilot site.

Work with local schools

Two members of staff have been trained to deliver CEA workshops for school children. These staff have spent two days training 60 local primary school pupils to date. The pilot team plans to engage five more local primary and secondary schools via these workshops.

Financial impact

The Welcome to our Woods pilot has the potential to grow and sell 45 bags of microgreens per week using its aeroponics equipment. Allowing for 15% wastage and assuming this produce is sold at £2 per bag, production at this scale could generate nearly £6,000 in annual retail sales by year 3 of the pilot.

Welcome to our Woods will incur fixed and variable costs from operating its CEA installations. Staffing costs associated with one member of staff working 1-2 days per week on CEA grow activities represent the largest of these costs. The CEA installations will also require light/heat/power which will increase the farm's utility bills, and cost will be incurred around preparing/packaging produce. The total monthly cost to Welcome to our Woods of running the CEA installations is forecast to be £600-£800 per month.

*Table 6: **Welcome to our Woods** CEA pilot – headline profit and loss analysis*

	Year 1	Year 2	Year 3
Sales income	£2,574	£3,479	£5,801
Fixed costs	£4,490	£5,490	£6,490
Cost of sales	£636	£859	£1,422
Profit (loss)	**-£2,552**	**-£2,869**	**-£2,111**

Source: *Community Enterprise Business Planning Consultation Report*, f3 consulting, May 2022
Note: Sales income forecasts assume CEA installations will be working at 25% capacity in year 1, 40% in year 2 and 100% in year 3 to allow time for Welcome to our Woods staff to be trained in how to use the equipment. Sales figures includes income the pilot will generate from other sales and running educational sessions. Initial pilot capital costs are not included in the financial appraisal.

The financial modelling suggests that the Welcome to our Woods CEA pilot will struggle to break even on a purely commercial basis by 2023. For Welcome to our Woods to achieve their aim of the CEA pilot being self-sufficient by 2025, there will need to be an increase in crop production by circa 40%, without such an increase requiring significant extra staff; this will be challenging. Therefore, it is the wider monetised and non-monetised impacts the CEA pilot delivers which have greatest bearing on the overall value for money of the pilot.

Wider impacts

The Welcome to our Woods team views the CEA pilot as a live research programme which is helping them to:

- Learn about what impacts the pilot can deliver.
- Train staff and the community.
- Connect CEA with and into other local initiatives.

Some of the pilot's impacts will be clearly measurable/local in nature, such as:

- Contributing to the local food hub, which supplies healthy, local food to the community.
- Providing produce for a local 'pay as you feel' café.
- Making money from produce and plant sales.
- Making compost from waste produce/products.
- Providing education and training opportunities on a range of subjects for a range of age groups/skill levels.
- Hosting an annual calendar of community events.

Medium and longer-term goals around the pilot include:

- Using solar and biomass technologies to generate electricity for both the pilot site and other Welcome to our Woods sites.
- The pilot site acting as a test bed for larger agro-forestry/woodland farming sites on the hills surrounding the village – this will help to test how community involvement in/ownership of the land can help to create local economies that are no longer reliant on monocultures (e.g., conifer plantations).

In total, six days of WtoW staff time is spent on the pilot each week, equating to 1.2 FTEs. This contributes to a more prosperous Wales by sustaining local employment. The TOMs guidance recommends such contributions be valued at £27,500 per FTE[14]. The WtoW pilot is created £33,000 in economic value per year by helping to sustain local employment.

Two local tradespeople were employed to prepare and build the pilot site; we have assumed this represents 0.25 FTEs (two people working part-time for circa six months). The TOMs guidance recommends such supply chain employment be valued at £27,500 per FTE[15]. The WtoW pilot created £6,875 in economic value through supply chain employment.

The pilot is also helping an apprentice to develop their horticultural skills and knowledge by working with the CEA equipment one day per week, which equates to approximately 10 weeks of apprenticeship training per year. The TOMs guidance recommends apprenticeship trianing opportunities are valued at £231.45 per week. We calculate the WtoW pilot will create £2,300 in economic value this year from providing this apprenticeship training activity.

WtoW staff have participated in 24 days of training in how to use and demonstrate the CEA technologies. The TOMs framework values staff training/upskilling at £285 per week[16]. This value relates to accredited training (e.g., BTEC, NVQ) rather than non-accredited training such as that being accessed by Xplore! staff. If we conservatively value the training received by Xplore! staff at £200 per week, the pilot has delivered £960 in economic value by upskilling WtoW staff (24 days/5 = 4.8 weeks of training X £200 per week.

Seven WtoW staff days have been/will be dedicated to delivering CEA training events for local schoolchildren. The TOMs guidance recommends such contributions be valued at £15 per hour of student training[17]. We calculate the WtoW pilot will create £790 (7 days x 7.5 hours per day = 52.5 hours x £15 per hour) of economic value this year through the delivery of educational workshops.

The Welcome to our Woods team would like the CEA pilot site to act as demonstrator for how communities can take control of land and have a say in how that land is used. They took a conscious decision to site the CEA pilot on the village high street and not at Welcome to our Woods' ex-brewery site near the train station. Having a large high street frontage shows to the community that positive change can be delivered and raises the likelihood of residents visiting the site and asking questions about what is going on.

[14] National TOMs Wales, NTW1
[15] National TOMs Wales, NTW1c
[16] National TOMs Wales, NTW7
[17] National TOMs Wales, NTW6

Community engagement

Welcome to our Woods, of which the CEA pilot is a part, aims to demonstrate that community involvement in and ownership of local resources can deliver positive socio-economic changes. The WtoW team consults the community on its planned activiites and involves them through the creation of employment and volunteering opportunities, and the running of events.

There is a growing evidence base which shows how participating in community-based activities can improve people's health and wellbeing. In 2010, the Marmot Review[18] established that social networks and social capital are important factors in supporting people's health and wellbeing. This was reiterated in the 2020 follow-up research[19] which emphasised that participation helps people feel a greater sense of control, and this has potential knock-on benefits for wellbeing and in turn other health outcomes.

Community-based activiites deliver these benefits because of how they are structured[20]. Community spaces are open to all and are less hierarchical than public or private sector space. Community spaces are places where people can learn practical skills from another person. Community spaces are connected by being sited in a specific locality and through regular programmes of events and activities where people can come together.

The positive impacts of community gardens have been demonstrated in research from the UK and the United States. For example:

- A project in Birmingham which included the creation of community gardens has generated evidence from case-studies and a resident survey that participants have improved their social connections. There has also been growing evidence of activities to influence change through engagement with local services and democratic processes[21].
- The Big Local programme was designed to support residents in 150 areas in England in making their area a better place to live (the evaluation focussed on 10 of the areas). The programme supported several community gardening projects to increase physical activity and enhance the urban environment. In-depth analysis revealed improvements to social relations as residents and partner organisations came together to develop a shared vision for their areas[22].
- A high-quality ethnographic study of a community garden in a vacated area of land in a poor, rural area of Illinois USA, found evidence that the intervention which was initially designed to improve food availability, affordability, and security, subsequently led to a wide range of wellbeing-related benefits. In addition to environmental improvements, increases in food security, and increases in use of greenspace, the community garden increased social activity and social connectedness[23].

The WtoW CEA pilot is a community space that will be open to all, providing practical learning opportunities and community events. The site is similar in design and purpose to the community

[18] Marmot, M. Fair society, healthy lives: the Marmot Review: strategic review of health inequalities in England post-2010. (2010)
[19] Marmot, M. et al (2020). Health equity in England: The Marmot Review 10 years on. London: Institute of Health Equity
[20] Participation | Communities in Control
[21] Community-Power-The-Evidence-FINAL.pdf (localtrust.org.uk)
[22] Pennington A, Watkins M, Bagnall A-M, South J, Corcoran R (2018) A systematic review of evidence on the impacts of joint decision-making on community wellbeing. London: What Works Centre for Wellbeing. p.41
[23] Ibid. p.40.

garden examples above. As the pilot develops it could be expected to deliver similar benefits for residents and the wider community.

Conclusions and recommendations

Programme performance

Crop Cycle has supported the creation of four CEA pilot sites. These sites have installed and operated a range of CEA technologies. Whilst the pilot sites are not the first CEA installations in Wales, by helping to create four new CEA sites Crop Cycle has made a significant contribution to the scale and breadth of CEA activity in Wales.

Crop Cycle has been inclusive in its design. The four sites are spread throughout Wales. They have engaged a range of audiences (primary school children, college students, the public) in a range of ways (workshops, exhibitions, produce sales).

The four pilot teams have come together via online network meetings. These have provided a forum for pilot teams to talk about the progress they have made and the challenges they have faced. Pilot teams mentioned the value they have taken from these meetings and how they plan to make in-person visits to other pilot sites as COVID-19 pandemic restrictions are lifted and as pilot site activities develop.

The COVID-19 pandemic led to the Welsh government imposing restrictions on social and economic activity. For much of their existence, the pilot sites have been unable to welcome the public/visitors/schoolchildren, nor have staff been able to take the technologies off-site for workshops and demonstrations. The restrictions slowed construction work at the pilot sites and delayed the training of staff in how to use the CEA equipment. Given these restrictions, it is impressive that three of the four sites are now operating their CEA equipment and welcoming visitors/students on site. The remaining Crop Cycle pilot site will reach this stage soon.

In addition to the COVID-19 related restrictions, the pilot sites have faced challenges in terms of:

- Sourcing and installing CEA technologies – the programme team have had difficulties dealing with CEA technology suppliers. Some equipment was delivered later than promised, other equipment was not received, and purchases had to be cancelled. This has slowed pilot site progress and had knock on effects in terms of sites being able to train staff and engage the public. For example, the Welcome to our Woods pilot site is yet to become fully operational as the team has had issues with the grow container. Defects relating to the container's doors and windows mean it is not at present health and safety compliant. Therefore, any produce grown in the container is at higher risk of contracting diseases and cannot be sold to the public, it can only be donated.
- Using Wales-based suppliers – the programme had an ambition to support Wales-based suppliers of CEA technologies by spending funding with Welsh businesses and by working with various special interest and cluster groups in Wales. Two of the four pilot sites (Greenmeadow and Cultivate) sourced its CEA technology from Welsh businesses; the other two pilot sites have used suppliers based outside of Wales.
- Training staff in how to use and demonstrate the CEA technologies – training sessions had to be cancelled due to COVID-19 restrictions. At some pilot sites, staff who were trained in the technologies have left and new recruits are yet to be trained.

- Operating multiple CEA technologies at three of the four pilot sites – operating hydroponic, aquaponic and aeroponic systems requires different skills. Pilot teams have learnt how to operate one or two CEA technologies, but other sets of CEA 'kit' has been unused.
- Maintaining the CEA equipment – staff at the pilot sites work on other activities beside the CEA installations. This has meant that they have limited time to maintain the CEA installations and, in some instances, CEA equipment such as the living walls and the aquaponics systems have not been set up or have not been maintained after being set up for the first time.
- Engaging the public in large scale/meaningful ways – those pilot sites that have been able to welcome the public onsite are still working out how to engage the public with the CEA technologies. At Xplore! the living wall installations are part of a much wider set of science exhibitions and the pilot team recognises that the living walls are less hands on than other exhibitions. At Greenmeadow, the grow container is sited in a well-used area of the farm, but the lack of windows means that visitors cannot see the CEA technologies inside the container, they can only read about them via the information boards next to the grow container.

The Crop Cycle programme has used LinkedIn, Twitter, Facebook, and Instagram to share information about CEA technologies and to provide updates on the development of pilot sites. Hundreds and in some cases thousands of people see these posts. Crop Cycle has also been featured in the mainstream media[24].

Social and mainstream media coverage is helping the programme to reach a wider audience. For example, the programme has fielded enquiries from farmers, agri-tech start-up businesses and institutions wishing to collaborate on funding bids.

Financial impact

An initial evaluation of the four-pilots estimated that the sites could grow £50,000 of produce per year on average and deliver £16,000 profit per year per site. Based on the amount of produce grown by the sites to date, these estimates appear to be too optimistic. Financial modelling[25] shows that even when producing at full capacity, produce sales alone are unlikely to cover the costs involved in growing. This forecast is after having discounted each site's initial capital expenditure.

Barriers to the pilot sites' financial viability are not particular to their being based in community settings but rather general constraints of CEA systems. The four sites do not appear to be financially viable in a commercial food production sense because:

- Ongoing energy, maintenance and distribution costs associated with producing and selling CEA grown food are too high.
- Revenue streams are too low – each site could produce a modest amount of produce based on the CEA capacity they have installed but there is limited demand locally for this (relatively) low value produce – e.g., micro-greens are a high value crop but the restaurant and hospitality trade in Wales has limited demand for micro-greens.

Given these findings relating to the financial viability of the four pilots, it will be the wider monetised and non-monetised impacts the CEA pilots deliver which have greatest bearing on the overall value for money of the pilots.

[24] Welsh Government funding to root food production project in communities as Foundational Delivery Plan is published | GOV.WALES ; Greenmeadow Community Farm Becomes A Test Bed For Exciting New Crop Cycle Project - NEWS.WALES ; Welsh Government Funding to Root Food Production Project - Business News Wales

[25] *Community Enterprise Business Planning Consultation Report*, f3 consulting, May 2022

Socio-economic impacts

The research has uncovered a range of examples of how the four pilots are make a beneficial impact in their local areas over and above their financial return. Many of these impacts map to the seven themes (TOMs) of the National Social Value Measurement Framework for Wales.

The TOMs framework recognises that innovation is central to achieving the seven themes. Innovation creates products and processes that benefit individuals, communities, businesses, and the environment. The Crop Cycle programme is highly innovative. It has given community groups access to cutting edge technology so they can grow produce that is not traditionally grown in Wales. It has encouraged partners to consider how they work and what they could produce using such technology, e.g., the Cultivate project is working with the local FE College on two research projects.

Where data allows, the research has used the TOMs framework to value these wider impacts. The valuation exercise suggests that each pilot site has the potential to deliver socio-economic benefits equal to or greater than what they could generate from produce sales alone.

The valuation exercise suggests that, together, the four pilot sites have created over £70,000 in economic and social value for Wales. 80% of this value relates to the job creation impacts of the pilots, within the pilot delivery teams and, at one pilot site, within a supplier company. The remaining 20% is derived from various training and skills development activities facilitated by the pilot sites.

Table 7: Estimated economic and social value of the four pilot sites

Type of impact	Metric	Value
Employment created	1.8 FTEs	£49,500
Training of pilot staff	58.5 days	£2,820
Delivering CEA workshops for children and adults	622.5 hours	£9,340
Supply chain employment created	0.25 FTEs	£6,875
Apprenticeships created	10 weeks training	£2,300
Total		**£70,835**

Source: Little Lion Research calculations, using TOMs

These impacts are not monetisable. They cannot be used to repay each pilot's initial capital investment or cover ongoing revenue costs. The point of the TOMs framework, however, and the community initiatives for which it is designed, is *'to identify and attribute value within the spirit the Wellbeing of Future Generations Act'* from which the FECF funding is derived. It is clear the Crop Cycle programme is within the spirit of the Act.

Many of these impacts have been achieved because Crop Cycle has prioritised community involvement in the CEA pilots. For example:

- All four pilot sites are supporting local employment and are led by third sector organisation who have been funded and supported to develop their skills and capacity.
- Several sites plan to involve volunteers in CEA activities.
- The pilot teams were already part of school and other networks; this has meant they have been able to set up workshops for local schoolchildren and, in Cultivate's case, introduce new elements to the FE college curriculum.
- The pilots are protecting local nature and biodiversity and making cultural/visitor venues more sustainable.

- The Welcome to our Woods and Cultivate pilots are part of locality efforts to involve residents in decisions about how land should be used and to give practical learning opportunities. Evaluations of community garden schemes shows the positive impacts this approach can bring.
- The CEA technologies the pilots have used are not new to Wales but previously this technology has been confined to places of (higher) education or business premises and not open to the community. As the Xplore! pilot demonstrates, if equipment and technology is not easily accessible to the public, the public is unlikely to seek it out or to learn how to use it. All four pilot sites are prominent within their locality, they have been advertised, and they are associated with other activities which attract the public.

If the pilots had been led by private sector businesses, their focus would have been on maximising revenue (i.e., crop production) and minimising costs. Many of the impacts above are non-monetisable and/or sub-optimal in terms of crop production, e.g., locating the pilots in out-of-town industrial units would have been more efficient from a cost, energy and produce distribution perspective but would not have resulted in the same levels of community involvement in the pilots. Thus, the community-led ethos of Crop Cycle has been central to achieving these impacts.

Figure 17: Mapping Crop Cycle's impacts to TOMs

Prosperous

- Created and sustained local employment.
- Skills development opportunities for children and adults.
- Boosted apprenticeships.
- Early-stage R&D activities.

Resilient

- Environmental conservation and management volunteering opportunities created.
- Materials and equipment have been donated, recycled, repurposed and reused.

Healthier

- Some pilot sites plan to run health and wellbeing activities and link to the wider social prescribing agenda.

More equal

- Recruitment of local residents who were previously unemployed or NEET.
- Sites provide advice and training for young people.
- Delivery of workshops in/to schools which contribute to STEM agenda.

Cohesive communities

- Pilots are led by third sector organisations.
- These organisations have received business advice via the network meetings.
- Volunteering opportunities created.
- Activities for all ages planned.

Vibrant culture

- Programme helping to preserve native wildlife, biodiversity and heritage sites.
- Local residents have been involved in pilot activities.

Globally responsible

- Sites helping to reduce food miles.
- The sites plan to generate electricity and power from renewable energy sources linked to the CEA equipment.

Recommendations

Using the research findings, we make several recommendations to SFG and local and national government in Wales. Implementing these recommendations will help to sustain the four pilots as they move towards financial viability. As the pilots become established, more individuals will be exposed to and learn about CEA technologies and new research, business and employment opportunities will result. It is these medium to longer-term impacts, leveraged from the initial Future Economy Challenge Fund investment, which have the potential to deliver larger socio-economic benefits.

Below we present the recommendations, split between SFG and government:

Recommendations to SF&G:

- **Continue to support the four pilot sites** – the pilots were intended to run for three years. It was felt this amount of time would be needed for CEA equipment to be installed, staff to be trained, and local communities engaged. Due to funding timescales, the pilots have had 18 months to get up and running; more time is needed for them to become fully operational.
- **Continue to make small revenue grants available to the pilots** – only one of the four pilot sites has the potential to 'break-even' in the next few years and the very small profit forecast for this site could easily be swallowed by rising energy costs or production issues. All four sites are run by third sector organisations. If these organisations are having to subsidise CEA pilot activity, this means they will have less funds available for their other socially beneficial activities. We recommend that SFG provides each site with a revenue grant of up to £5,000 per year for the next three years. This will cover projected losses over the period, provide a small surplus for running free community and other pilot events, and give the sites the time to learn more about the CEA technology and to build income streams linked to the technology.
- **Promote specialisation at each pilot site** – trialling several CEA technologies at three pilot sites has been a mixed success. Some technology is not being used, for example Welcome to our Woods' aeroponics kit and Cultivate's aquaponics kit. SFG should support sites to swap unused kit so that each pilot team become experts in one technology. This will reduce staff training needs and costs, and boost production and hence (potential) sales income. It will reduce the range of CEA technologies visitors/students can see but information sheets could be made available explaining the other technologies and describing their use at other pilot sites.
- **Maintain the Crop Cycle network** – pilot teams told us how much they gained from the online network meetings and how much they are looking forward to visiting other pilot sites. The network meetings provide an opportunity for teams to share ideas and discuss problems on small (how much to charge for a school workshop) and big (how to use a piece of CEA software) issues. Consistent best practice across the four sites will emerge as a result and all sites should be helped to maximise production and reduce costs within their local context.
- **Support and advise the pilots on the topic of energy** – this could be done directly by SFG or via a procured expert. Energy costs are a major part of the ongoing running costs for CEA technologies. The viability of the four CEA pilots is highly dependent on energy prices which, at present, are high and volatile. We recommend that network session be held and expert advice offered to help pilots to incorporate renewable energy generation solutions onsite.
- **Gather more data from the pilots in a consistent manner** – after 18 months of activity there is still relatively little data available on each pilot site. Feedback has not been collected (in a

consistent manner) from participants in CEA workshops, members of the public visiting the sites, or consumers eating the produce grown by the pilots. The lack of data is due in part to COVID-19 restrictions making it hard for the pilots to engage the public. As the economy and society 'reopens' the pilots will be having more engagement with schoolchildren and the public. We recommend that SFG works with the pilot teams to develop standard approaches to recording pilot costs and produce (using the templates developed by F3) and standard feedback forms that collect data relevant to the seven TOMs themes. This will aid any future evaluation of the Crop Cycle programme.

- **Stick with four pilot sites** – linked to the previous recommendation, the four CEA pilots have delivered wider benefits because they have been linked to existing community activities and partners. These ecosystems cannot be created from scratch. Introducing more pilot sites would require significant further capital investment and new sites would likely require significant support during their set up phases at a time when the existing four sites still require support from SFG and others.

Recommendations to government (local and national)

- **Leverage public procurement** to increase demand for Crop Cycle produce and thereby create distribution networks through which the pilots can transport their produce. The financial modelling assumes that pilot sites will progress to full production capacity within three years but there is little evidence that local demand for leafy and micro greens is great enough to support this. The Wellbeing of Future Generations Act introduces the concept of social value to all areas of Welsh public procurement. Local and national government and public agencies could use their own procurement decisions (e.g., the purchasing of school and hospital meals) to leverage and enhance the social value already created through the Crop Cycle programme.
- **Curriculum and skills development** – through their educational workshops, the pilots will be creating a cohort of young people with knowledge of and, it is hoped, hands on experience of CEA technology. If these pupils wish to pursue careers in horticulture/agriculture, they will need further study pathways available to them. All four pilot sites have formed links to secondary, further and/or higher education institutions. An audit should be undertaken of the curriculums taught by these institutions to ensure that study pathways exist.
- **Developing the business support offer for CEA producers** – as the pilots become established, it is likely that new business ideas will be generated, either in relation to a type of produce or the technology used to make the produce. These start up businesses will need access to advice and funding to grow. In our experience, businesses are most receptive to business advice when it comes from an individual who has worked in the sector the business operates in. Identifying business adviser(s) with CEA experience and making them known to pilot sites will support the aim of CEA pilots leading to business and job creation.
- **Marketing and branding around Welsh produce** – the Welsh government has published a new strategic framework to promote Welsh food[26]. Government wants to *'create and communicate a global reputation for Wales as a Food Nation by showcasing our sector through Taste Wales, developing, and living our sustainable brand values'*. The CEA pilots contribute to this strategic mission through the production of high-quality produce that is not traditionally grown in Wales in ways that benefit people, communities, and the environment. Pilot site expertise in producing micro-greens and vegetables make them complementary to traditional Welsh strength in lamb and beef production. Through strategic initiatives, pilot sites could be helped to distribute their produce through local and national supply chains,

[26] 211126 FD Action Plan_Eng_Final.pdf (gov.wales)

including new routes to market such as direct to consumer sales, access business support, and promote the ‘Welshness’ of their produce to shoppers.