



HEALTHY SOIL
HEALTHY FOOD
HEALTHY PEOPLE

Using low-energy hydroponic systems for food production close to cities

The H3 project (Healthy soil, Healthy food, Healthy people) seeks to transform food systems 'from the ground up'. This is one of a series of policy and practice briefs summarising the findings of the H3 project in accessible language and drawing out their implications for government, business, and civil society.

Our low-cost hydroponic horticulture

uses a nutrient solution rather than soil in unheated polytunnels without artificial light on existing farms and businesses close to urban areas to benefit from low costs, short supply chains, and local labour.



Lettuce yields are up to 10 times higher than field cultivation, and the hydroponics system was also able to successfully grow a range of herbs and leafy greens, with the polytunnels protecting the crops and workers from the weather.

Background

The UK food system has become over-reliant on imports, especially of fresh produce like salad crops, making it vulnerable to supply shocks. Rising energy, fertilizer, water, and labour costs make growing these crops uncompetitive compared to imports from countries with lower-wages and warmer climates, which provide more than half the lettuce we consume. Less than 1% of UK agricultural land is used for horticulture, with field-growing of lettuces declining by 42% since 2015 [1], only continuing on drained fen peatland, an unsustainable national hot-spot for greenhouse gas emissions [2]. Protected horticulture (glasshouses and polytunnels) shrank by 73% since 1990, to less than 0.002% of UK agricultural land area [1]. High-tech "vertical farms" have been uneconomic due to high set-up and electricity costs. To address these problems the H3 project has investigated an alternative new sustainable and low-cost model for lettuce production.

Lettuces grown hydroponically using nutrient solution without using supplementary heating or lighting achieved annual yields of 25–40 kg m² of polytunnel area, equivalent to 250–400 tonnes per hectare, with crops harvested from April to December.



Method

- We conducted trials on underused land close to farm buildings at Our Cow Molly dairy farm five miles from the centre of Sheffield and which has a shop on site and delivers directly to local shops, and at Wentworth Castle Gardens 3.5 miles from Barnsley and 13 miles from Sheffield on a derelict area of a historic walled garden, adjacent to a National-Trust cafe and The Northern College.
- Six replicate polytunnels were installed across the two sites, providing a total growing area of 160 m², with modular nutrient-film hydroponic growing systems constructed from modified roof guttering placed on scaffolding frames, and the nutrient solution pumped from universal bulk carrier tanks.
- We grew nine commercial lettuce varieties, three adapted for cool-season, three for warm season, and the remainder suitable for all-year growth. Seeds were germinated in propagators and transplanted into the hydroponic systems in staggered cycles of about 70 days from germination to harvest over a period of up to a year, with yields recorded at each harvest.
- Air temperatures and light inside and outside the polytunnels were monitored using automated sensors, with passive ventilation achieved by opening the side flaps and end doors in warmer periods. Lettuce growth rates were studied in relation to the seasonal variations in these conditions.



a



b

Unheated polytunnels without supplementary lighting (a) installed at Our Cow Molly Dairy Farm, at the edge of the Peak District, with Sheffield in the centre distance, and (b) used to grow lettuces hydroponically on scaffolding supports that are a comfortable height for workers.

Key findings

- The three best performing lettuce varieties achieved yields ranging from 25–40 kg m² of polytunnel area per year. This is 4.5 – 10 times more than UK field grown lettuce productivity, which ranges from 3.9 and 5.0 kg m² per year depending upon rotations and weather conditions ^[1], and is similar to or higher than the 29 kg m² achieved by lettuces grown in soil in Dutch greenhouses with CO₂ concentrations increased to 800 ppm.
- By using cold-tolerant cultivars in winter and heat-tolerant varieties in summer, we achieved a 321-day growing window, with a harvest period from April to December, showing that systems avoiding heating and lighting costs can deliver locally produced lettuces in spite of the unpredictable UK climate and for much longer periods than field-growing.
- The polytunnels protect the crops and workers from rain and snow, raising the temperatures by up to 4 °C in the spring to increase growth rates and extend the productive growing season.
- The total land area of our model polytunnels that would be needed to supply the 128,000 tonnes of lettuces imported into the UK in 2024 would be only an additional 320 ha compared to the 407 ha of glasshouses or polytunnels currently used to produce lettuces in protected horticulture in the UK ^[1].
- This area is just over 1% of the 30,000 ha of brownfield sites, mainly in urban areas, which are prioritized for housing development ^[3].
- Near-urban locations offer more sustainable short supply chains ^[4] and the potential to integrate with existing chilled distribution transport used by local dairy farms, and access to a larger flexible workforce than in rural locations. There are further opportunities to develop training and qualifications in food-based horticulture linked to local further education colleges.

Implications for policy incentives and practice

For national government:

Capital grants and low interest loans are urgently needed to support setting up low-energy hydroponic systems and apprentice worker training for growing salad crops close to cities, with 320 ha (just over 1% of the total brownfield) of this system enabling the UK to be self-sufficient in lettuce. This would help address skilled labour shortages, reduce reliance on unsustainable fenland peat cultivation ^[2] and imports from regions, such as southern Spain that face increasing water scarcity and other pressures ^[5]. The UK horticulture sector needs better support as one in three businesses are not profitable, and 58% made less than £25K in 2024/5 ^[6].

For business:

Our research highlights new opportunities for farms near urban areas and for owners of derelict urban spaces to deploy low-cost hydroponic horticulture on under-used land. This could cost-effectively produce substantial amounts of fresh salad crops and distribute them efficiently through vegetable box schemes or alongside milk deliveries by co-locating with dairy farms. Due to the very tight margins, most of the produce grown would need to be sold at retail rather than wholesale prices.

For civil society:

Commitments to local food purchasing by local authorities, the National Health Service, and large employers such as universities via long-term supplier contracts would help facilitate the uptake and economic success of low-cost hydroponic horticulture. This would reduce soil cultivation and transport greenhouse gas emissions, and increase the supply of fresh, local produce, which is important to dietary health.



Acknowledgements

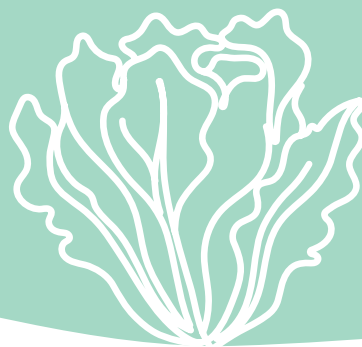
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Key references

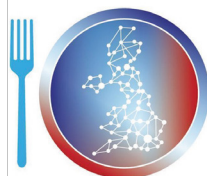
- [1] UK Horticultural Statistics 2025.
[See website >>](#)
- [2] Matysek, M., Leake, J., Banwart, S., Johnson, I., Page, S., Kaduk, J., Smalley, A., Cumming, A. and Zona, D. 2022. Optimizing fen peatland water table depth for romaine lettuce growth to reduce peat wastage under future climate warming. *Soil use and management*, 38, pp.341-354.
- [3] CPRE 2025.
[See website >>](#)
- [4] Ali, M., Koh, L., Acquaye, A., Leake, J., Nickles, J., Evans, T.P., Roberts, G. and Kemp, D. 2024. Sustainability assessment of peri-urban organic horticulture – A case study in the United Kingdom. *The International Journal of Life Cycle Assessment* 29, 456–468.
[See website >>](#)
- [5] Castro, A.J., López-Rodríguez, M.D., Giagnocavo, C., Gimenez, M., Céspedes, L., La Calle, A., Gallardo, M., Pumares, P., Cabello, J., Rodríguez, E., Uclés, D., Parra, S., Casas, J., Rodríguez, F., Fernandez-Prados, J.S., Alba-Patiño, D., Expósito-Granados, M., Murillo-López, B.E., Vasquez, L.M., Valera, D.L. 2024. Six collective challenges for sustainability of Almeria greenhouse horticulture. *International Journal of Environmental Health and Public Health* 16 4097.
[See website >>](#)
- [6] Defra 2026. Farm Business Income by farm type in England 2024/25
[See website >>](#)

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