

# Indoor Vertical Farming of Strawberries: What Have We Learned?

Jane Richter, Communications Manager, Berries Australia & Helen Newman, Berry Industry Development Officer, Agricultural Produce Commission WA

- Indoor vertical farming of strawberries can work commercially, but primarily as a premium product, not as a replacement for field or protected cropping at scale
- Energy costs are the dominant economic and environmental constraint, making location and power source critical
- Automation and management capability matter as much as technology, with labour efficiency gains often coming from systems integration rather than robotics alone
- Strawberries are significantly more complex than leafy greens, increasing capital, operational risk and learning curves

Indoor vertical farming has attracted significant global investment over the past decade, promising year-round production, consistent quality and reduced reliance on labour, land and chemicals. While leafy greens have dominated early commercial success, strawberries have increasingly been identified as a potential high-value crop suited to vertical systems. A growing body of published research, commercial case studies, and industry reports now allows a clearer assessment of whether indoor vertical farming of strawberries is commercially viable and under what conditions it may work.

## Where is vertical strawberry farming most advanced?

While interest is global, commercial maturity is concentrated in a small number of countries with specific structural advantages.

### Japan

Japan is widely regarded as the most advanced market for indoor strawberry farming. High domestic strawberry prices, strong consumer demand for premium fruit, and

limited arable land have driven adoption of controlled-environment systems. Several Japanese operations successfully produce strawberries indoors at commercial scale, often supplying gift, hospitality and specialty retail markets. A key success driver is that Japanese consumers are willing to pay for quality, flavour and appearance.

### United States

The US hosts the most visible venture-backed vertical strawberry projects, particularly in urban and peri-urban areas. Companies such as Oishii (spanning more than 237,500 square feet in Phillipsburg, New Jersey, their largest farm is located adjacent to an expansive solar field, utilising solar energy to help power operations) and Plenty® (opened its first strawberry farm in 2024 in Virginia) have demonstrated that indoor strawberries can reach commercial markets, albeit at premium price points.

Partnerships with major berry marketers have focused on year-round consistency and proximity to consumers. The key success drivers are access to capital, branding capability, and proximity to large metropolitan markets.

## Europe (Netherlands and Nordic countries):

The Netherlands and the Nordic countries have strong expertise in controlled-environment systems, particularly in greenhouse systems. Fully indoor vertical strawberry farming exists but remains limited, often integrated with renewable energy or district heating systems to manage costs. The key success drivers are energy efficiency innovation and advanced horticultural engineering.

## Middle East

The Middle East has invested heavily in vertical farming due to water scarcity and dependence on imports. While strawberries are produced indoors, most operations remain in early commercial stages and rely on subsidised energy or strategic food-security investment rather than pure market economics. The key success driver in this market is food security rather than short-term profitability.

## What are the pros and cons of strawberries in vertical farming systems?

Strawberries sit at the upper end of complexity for indoor vertical farming. Lessons from global experience highlight clear advantages and equally clear constraints.

### Advantages

#### Premium yield per square metre:

Strawberries offer far higher revenue potential than leafy greens, making them one of the few fruit crops capable of supporting indoor production costs

#### Year-round, climate-independent supply:

Vertical systems remove seasonal variability, allowing consistent production regardless of weather, pests or extreme climate events

#### Exceptional fruit quality control:

Precise control over light, temperature, humidity and nutrition enables uniform size, appearance and flavour which are all attributes valued in premium markets

#### Reduced water use and chemical inputs:

Recirculating hydroponic systems significantly reduce water use and largely eliminate the need for conventional pesticides

### Constraints

#### High energy demand:

Lighting and climate control account for most operating costs. In most regions, electricity price and carbon intensity determine both profitability and sustainability outcomes

#### Biological complexity:

Strawberries require pollination, careful fruit set management and longer crop cycles than leafy greens, increasing management intensity and failure risk

#### Capital and operational intensity:

Initial capital expenditure is high, and returns depend on consistent execution, skilled staff and continuous optimisation

#### Limited scalability at commodity prices:

Current evidence shows indoor strawberries struggle to compete with field or protected cropping on price, particularly during peak seasonal supply

## Is vertical strawberry farming a good fit for Australia?

Australia presents a mixed but nuanced case for indoor vertical strawberry farming.

### Where it may fit

**Premium urban markets:** Large metropolitan centres with affluent consumers may support premium indoor strawberries, particularly where freshness, flavour and local provenance are valued.

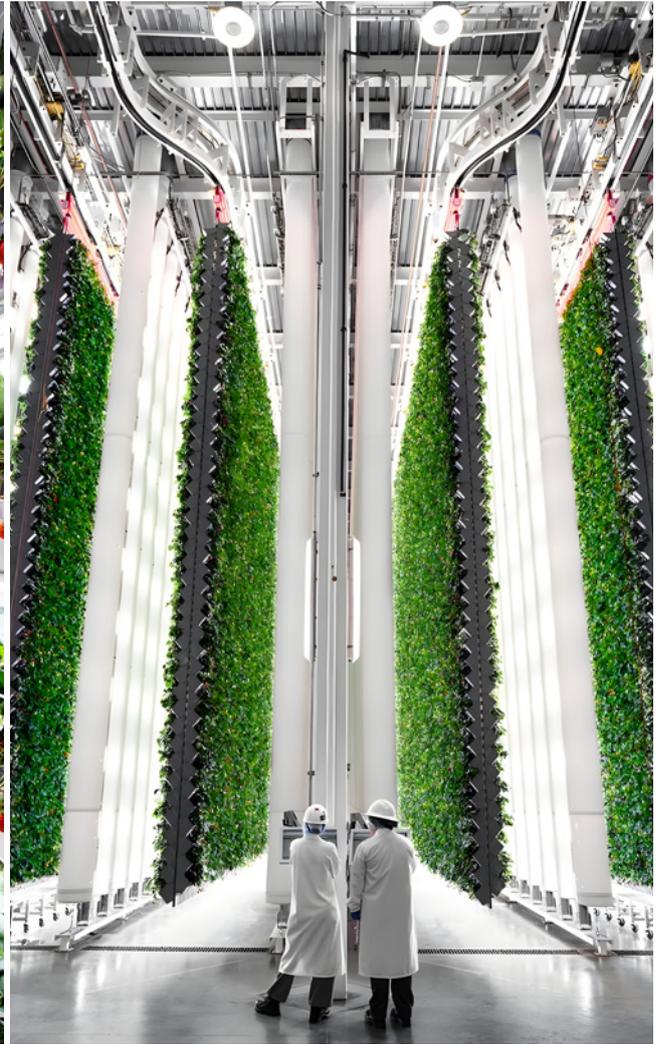
**Supply-gap periods:** Vertical systems may complement existing production by supplying strawberries during shoulder seasons or periods of climatic disruption, but is this sufficient to justify the capital required to build the infrastructure?

**Regions with access to low-cost or renewable energy:** Sites with on-site solar, renewable power agreements or waste-heat integration improve both economic and environmental performance.



**Oishii grows strawberries at two sites in New Jersey, USA and has an R&D centre in Japan**

Photo credit: Oishii



**Plenty® opened its first strawberry farm in 2024 in the heart of Virginia, USA**

Photo credit: Plenty

## Where caution is warranted

### Competing with open-field and protected cropping:

Australia's established strawberry industry benefits from efficient field and tunnel systems with far lower energy costs.

**High electricity prices:** Without structural energy advantages, operating costs can quickly outweigh revenue gains.

**Labour and technical capability:** Indoor farms require different skill sets, blending horticulture, engineering and data management, all capabilities which must be built and retained.

The global experience with indoor vertical strawberry farming shows measured success rather than transformation. The model works best where:

- retailers and consumers will pay for quality and consistency
- energy costs are controlled
- automation and management are well integrated
- production complements, rather than replaces, conventional systems

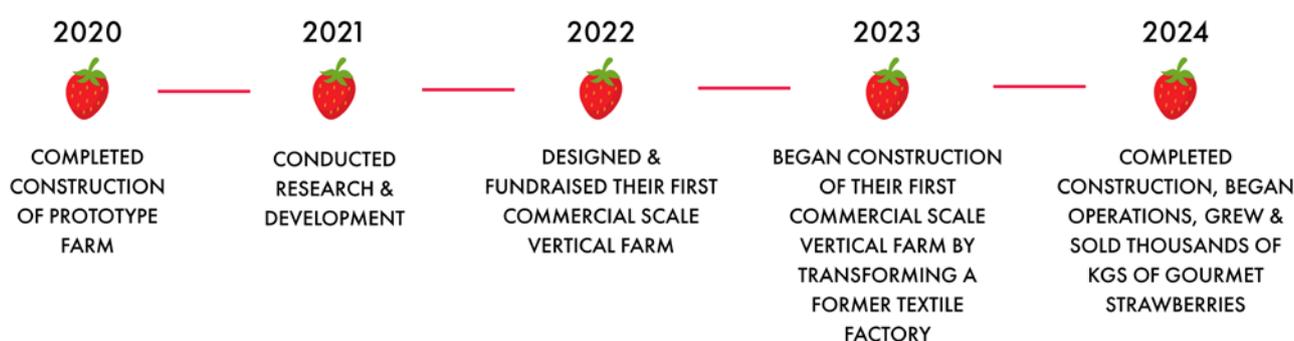
For Australia, vertical strawberry farming is unlikely to become a mainstream production model in the near term. However, targeted applications – premium supply, risk management and innovation – may offer value, particularly when aligned with existing industry strengths. As with all emerging systems, the strongest lesson is clear: technology alone does not guarantee success; commercial discipline, market alignment and cost control matter most.

## CASE STUDY: GUSH, Canada

Ophelia Sarakinis, founder of GUSH, shared insights from her indoor vertical strawberry farm in Montreal, Canada, during the February edition of 'Strawberry Café', the monthly forum of information exchange from the Ohio Controlled Environment Agriculture Centre in the USA.

After years of research and development, GUSH recently finished the transformation of a former textile factory into a state-of-the-art vertical farm capable of sustainably producing delicious, pesticide-free strawberries, 365 days a year.

### GUSH timeline from prototype farm to commercial fruit production



GUSH has a footprint of 8000 square foot (743m<sup>2</sup>), with three separate growing rooms housing around 15,000 plants (total) in an 8-tier, recirculating Nutrient Film Technique (NFT) growing system.

June-bearer cultivars with 90 day cropping cycles are used to maintain year round production, with plantings staggered across the three growing rooms. Current yields average 250–350 g per plant. June-bearers were selected for their predictable, single-cycle yield curve, which simplifies supply chain planning compared with the variable flushes of day neutrals. Shorter crop cycles and the use of separate growing rooms reduce operational risk and streamlines pest and disease management, as each room can be disinfected between cycles.

### General operating parameters currently used at GUSH:

**Power cost:** 5-8c per kilowatt hour (subsidised for food production)

**Lighting (PPFD):** up to 350–400  $\mu\text{mol}/\text{m}^2/\text{s}$

**Daily Light Integral (DLI):** 21  $\text{mol}/\text{m}^2/\text{d}$  (but can't have too much in an indoor setting)

**Light spectrum:** 16% blue, 43% green, 38% red, and 3–5% far-red (6% is too much). There was discussion around the potential of adding UV

**CO<sub>2</sub>:** enriched but rate not specified

**Temperature strategy:** starts cycle cooler (16 °C) with dim light; ends cycle warmer (21 °C) with full light intensity; if pushing long photoperiod (22 hours), keeps temperature around 19 °C and drop to 10 °C at night

**Humidity:** generally maintained under 75%; lowered to 60% if needed

**Water temperature:** target 18–19 °C (this is very important in this system)

**pH:** maintained at around 5.5 – 5.8

**EC:** pushes higher for flavour; range 0.8 – 2.0; goes higher at the end of the crop cycle (found 2.5 was too harsh)

**Reservoir management:** 20% dumped daily to prevent nutrient/compound build-up in the recirculating system

**Irrigation:** continuous flow to reduce failure risk with on/off switching

**Nutrient management:** A/B solution with a stable recipe (after years of testing); previously did frequent foliar analysis to adjust

**Pollination:** bumblebees

## Ophelia's tips for other growers:

**Don't cut corners on lighting; light uniformity is critical.** Poor light uniformity in earlier setups (one light for two gutters) contributed to severe albinism (pale, dry, sour, unmarketable fruit) and major yield losses. Adding more top and side lighting doubled yields and improved quality, but it wasn't just "more light"; it was better distribution that mattered.

**Far-red needs a "sweet spot".** Too little far-red spectrum light caused stunting. Too much caused overly long trusses (snapping/kinking), tall plants shading lights, and more albinism. Best outcomes were seen at around 3–5% far-red which created shorter plants with good truss length.

**Long days can work.** Inspired by rumours of 24-hour photoperiods, 22-hour photoperiods were tested, and no negative effects were observed; plants grew faster, and fruit energy improved. Temperatures are kept slightly cooler (19°C) with the 22-hour photoperiods, so the plants aren't pushed too hard.

**Labour and tier-height reality.** Staff dislike working on ladders and lifts, so upper tiers were consistently neglected. Potential solutions might be reducing the height from 8 down to 4–5 tiers (like some other vertical farms) or adopt robotics.

**Even airflow is important.** A strong HVAC system helped avoid major humidity problems. Plenum air vents in the ceiling between each alley, with alternating alleys of air-supply air-return, keep air moving vertically. Inter-canopy fans between each tier move air horizontally, preventing stagnation in the canopy and evening out the airflow.

**IPM in indoor vertical is different.** Many greenhouse IPM approaches didn't translate well indoors. Insecticides and fungicides, including fungi and bacteria-based products, cannot be used in vertical farms in Canada, so there is a heavy reliance on biosecurity, biostimulants, and beneficial insects. Staff wear head-to-toe protective gear, but plant material (nursery stock) is still the biggest ingress risk. Insect pests haven't been a major issue, but aphids often show up, and ladybugs work surprisingly well for them. Other beneficials, such as lacewings, *Californicus*, and *Cucumberis*, are kept on standby.

**Plant supply: the recurring bottleneck.** Indoor vertical systems need a timely supply of very clean (disease-free) plant material with consistent chilling hours. Tray plants are commonly used because they are high-energy and have good flower initiation, but they come with disease and substrate recipes you can't control. Phytophthora, Pythium, and Fusarium can be managed with a cocktail of beneficial fungi, but there is no solution for Neopestalotiopsis apart from clean planting material. Some successful vertical farming companies do their own in-house propagation.

**System choices: Nutrient Film Technique (NFT) pros and cons.** NFT may not be optimal, but it is workable and optimisable. It was chosen instead of substrate to minimise weight in the suspended gutters and to facilitate easier filtration and recirculation of water. Substrate from tray plants created filtration headaches (disc filters don't handle substrate well) so plants are placed in 'nylon pantyhose' style containment bags.

## Interested in joining the Strawberry Café?

Dr. Chieri Kubota and Mark Kroggel have an online café series for Controlled Environment Agriculture strawberry enthusiasts: 'Strawberry Café'.

This monthly forum for information exchange is designed for those currently engaged in strawberry production.

**When:** Last Thursday of Month, starting at 11 AM US Eastern Time

**Where:** Zoom (registration required)

**Cost:** Free – Please sign up to be a member to receive more information at [bit.ly/BA-STR-Cafe](https://bit.ly/BA-STR-Cafe)