



# Growing crops in Vertical Farms: challenges and opportunities

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## What is a Vertical Farm?

Vertical Farms are indoor cultivation system in which all light is provide by artificial sources, commonly LED lights, and environmental factors (e.g., climate, water and nutrients) are controlled. At the Business Unit Greenhouse Horticulture and Flower Bulbs we use our state-of-the-art Vertical Farm facility for multi-disciplinary research.

## Vertical Farm facility of the Businesses Unit Greenhouse Horticulture

In 2021 our Vertical Farm facility opened in Bleiswijk.

It features:

- 4 airtight climate cells: multilayer cultivation system and high wire cultivation system
- 20 m<sup>2</sup> cultivation area per cell
- Adjustable photoperiod (daylength), light spectrum and intensity (up to 1000  $\mu\text{mol}/\text{m}^2/\text{s}$  light, provided by B, W, R and FR LEDs)
- Climate regulation (e.g., temperature and humidity)
- CO<sub>2</sub> dosing and CO<sub>2</sub> uptake by the crop
- Resource use efficiency calculations
- Active ethylene removal (when desired)
- Water and nutrient recirculation
- Different irrigation systems

## Research in the Vertical Farm soybean and strawberry

### Trials with soybean and strawberry

Among the research that has been conducted in the Vertical Farm, trials with different varieties of soybean and with strawberry were performed. We followed a multi-disciplinary approach and the goal of these trials was to develop knowledge on:

- Cultivating these crops indoor (e.g., climate strategy, light spectrum, daylength)
- Regulation of (molecular) plant processes by environmental factors such as growth, flowering and gene expression.
- Controlling plant processes using specific light (spectrum) or temperature treatments in order to steer:
  - Crop development
  - Plant architecture
  - Production
  - Product quality

### Results: Soybean

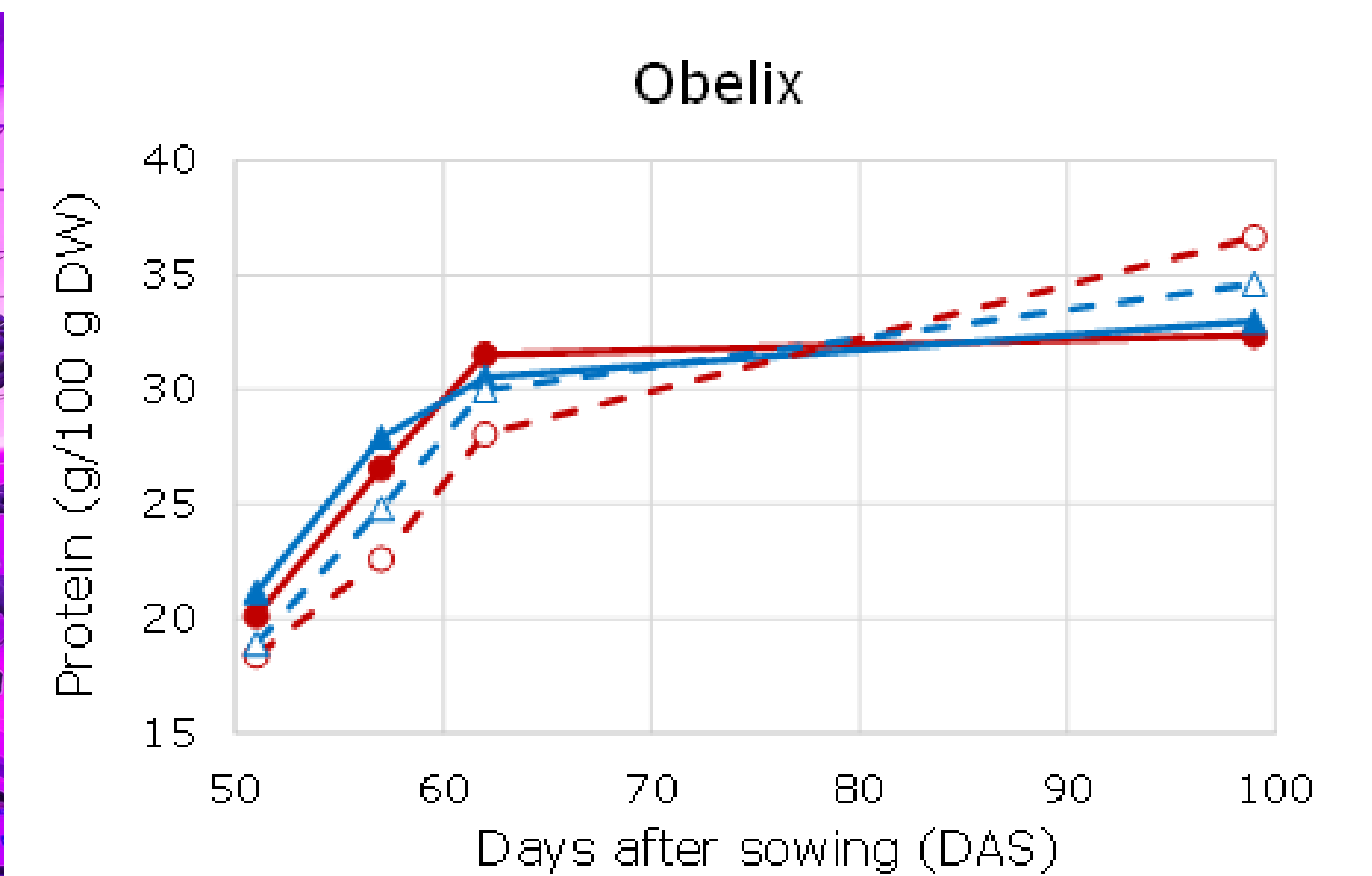
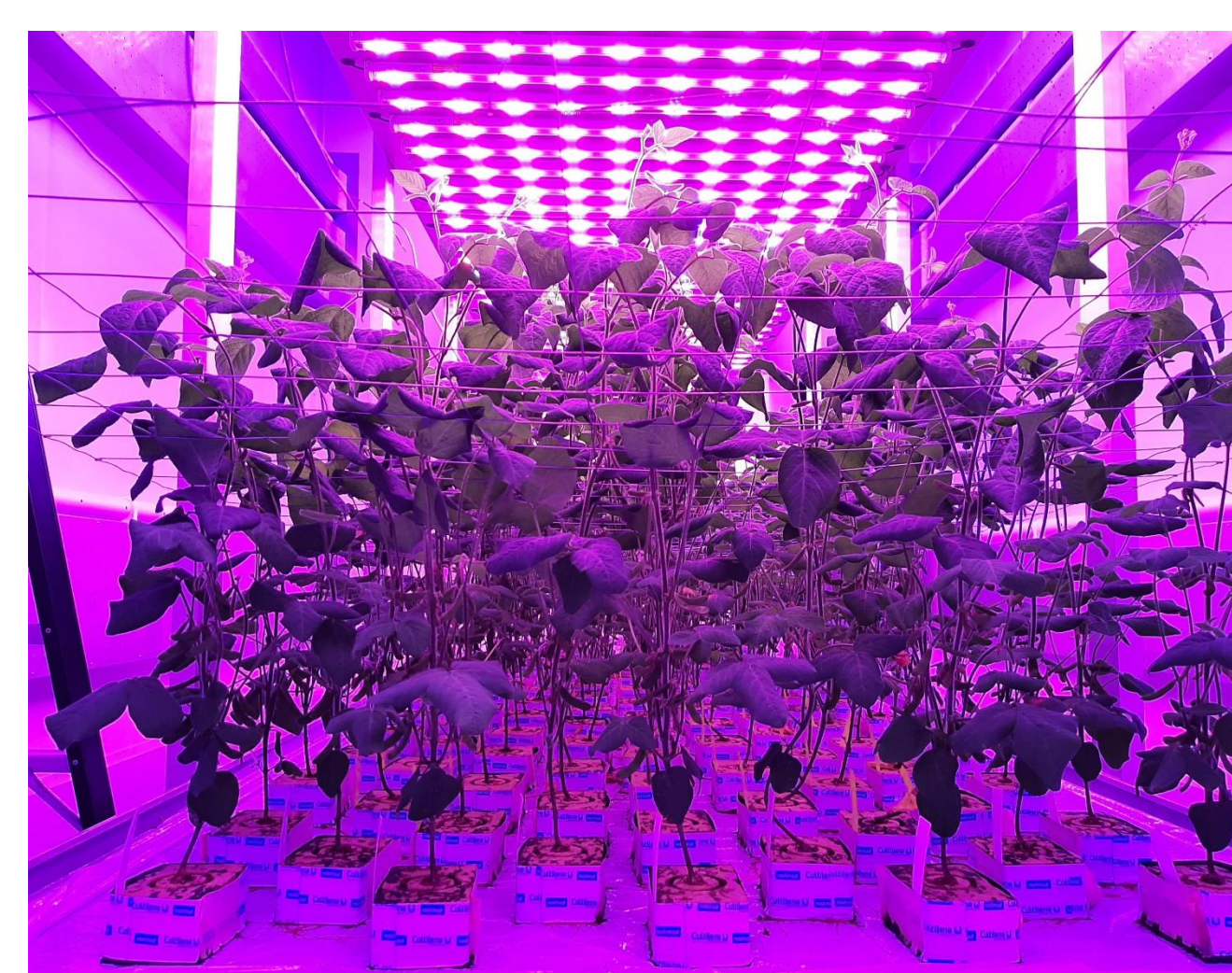
We were able to grow soybean in the multilayer cells of our Vertical Farm facility under different light spectra and temperature regimes. Adjusting the light spectrum (increasing B light) resulted in a more compact crop. In some cases, lowering the temperature during the seed filling stage increased protein content of the seed.

### Results: Strawberry

Preliminary results show that fluctuations in light intensity and temperature may have a negative impact on production of strawberries (Cv. Favori) and that Vitamin C content of the fruit may be increased by the light spectrum (increasing B light).



**Figure 1.** Strawberry cultivation in multilayer cells (picture on the **left**) and cucumber cultivation in the high-wire cells (picture on the **right**) of the Vertical Farm facility of the Business Unit Greenhouse Horticulture.



**Figure 2.** Soybean cultivation in multilayer cells (picture on the **left**) and seed protein content of soybean (Cv. Obelix) (graph on the **right**) that received a high % of blue light (blue lines) or not (red lines) and lower temperatures during the seed filling stage (dotted lines) or not (solid lines).

## Speed breeding in Vertical Farm cells: accelerate breeding programs?

A long crop generation time (the time it takes from seed to seed) can be a bottleneck for breeding programs. Vertical Farms allow for full control of environmental factors that control the crop generation time directly or indirectly such as daylength or light intensity. Therefore these facilities can be used as a tool to develop treatments or protocols that accelerate crop generation time and speed up breeding programs, als referred to as 'speed breeding'.

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