

Greenhouse crops & solar power in Belgium, multisite and pluriannual study

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Introduction

The **Grewfarm project** is a **photovoltaic greenhouse** development initiative in the Walloon Region, supported by three competitiveness clusters (Wagralim, MecaTech, GreenWin) and led by a consortium bringing together academic research institutions (UMons, ULiège, HEPH Condorcet) and private companies (Green Energy 4 Seasons, DHK). ULiège and HEPH Condorcet are responsible for assessing the agronomic performance of these greenhouses, made of transparent polycarbonate, based on the shading rate generated by the installation of solar panels on the roof.

The main objectives are:

- (i) to develop an innovative range of photovoltaic greenhouses,
- (ii) to design production auxiliaries controlled by new software, and
- (iii) to develop services for the study and implementation of agrivoltaic projects.

Methods

The production of a **diversity of vegetable crops**, both summer and winter, as well as mid-season crops, will be monitored over **two years at two sites**: Ath (BE-7800) and Gembloux (BE-5030).

- ✓ A pilot photovoltaic greenhouse has been installed at each site, with **two levels of solar panel coverage (Figure 1.A)**:
 - 33%, or moderate coverage (« **GF33** »)
 - 50%, or high coverage (« **GF50** »)
 - Gembloux site includes an **open-field plot (OFP) (Figure 1.C)** ;
 - Ath site has a **conventional tunnel greenhouse (CTG)**.
- ✓ Moreover, light sensors were used to monitor photosynthetic active radiation (PAR) and daily light integral (DLI) at crop level under the different situations.



Figure 1: Grewfarm photovoltaic greenhouse and associated experimental installations at Ath and Gembloux sites. (A) Aerial view of the Grewfarm prototype Greenhouse as built in Ath and Gembloux showing the aera with 33% (upper part, or GF33) and 50% (lower part, or GF50) photovoltaic panel coverage, and on the right the open filed plots (OFP). (B) Inside view of the Grewfarm prototype greenhouse with summer vegetable crops. (C) Inside view of the conventional tunnel greenhouse (CTG) in Ath.

Results

- Results from the first year of monitoring indicate a **reduction in photosynthetically active radiation (PAR)**, measured as daily light integral (DLI), of approximately 32%, 49%, and 60% under the conventional tunnel greenhouse (CTG), and the zones with moderate (GF33) and high solar panel coverage (GF50), respectively, compared to an open-field plot (OFP) (results from Ath site – **Figure 1.B**).
- For the 12 summer and 10 winter vegetable crops tested between may 2024 and march 2025, **average yields were strongly impacted**, specifically with the high coverage of solar panel (GF50) compared to a conventionnal tunnel greenhouse (**Figure 2**).
- Individual analysis of the yield performance of the various vegetable crops indicates a degree of variability in both production outcomes and **crop-specific responses** to the level of solar panel coverage (**Figure 3**). Some crops clearly benefited from greenhouse cultivation, highlighting the potential of the Grewfarm concept (e.g., strawberries). Others exhibited substantial yield reductions under high photovoltaic coverage levels (e.g., celery, sweet peppers).

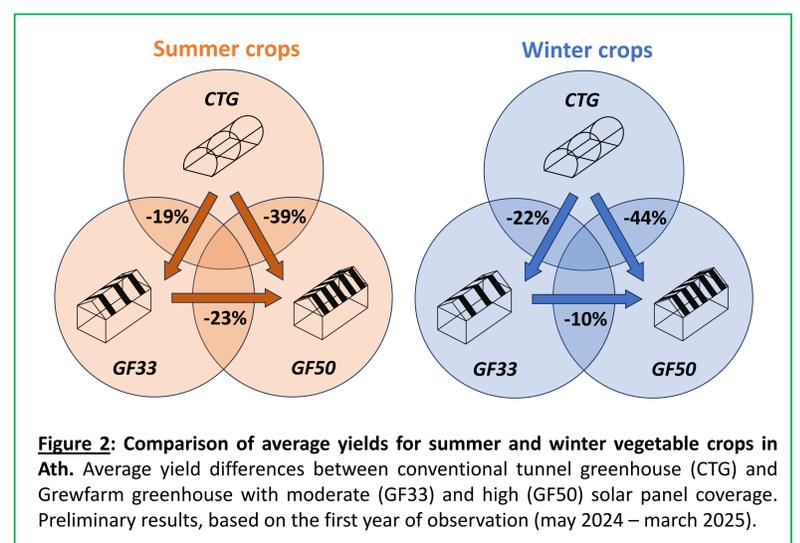


Figure 2: Comparison of average yields for summer and winter vegetable crops in Ath. Average yield differences between conventional tunnel greenhouse (CTG) and Grewfarm greenhouse with moderate (GF33) and high (GF50) solar panel coverage. Preliminary results, based on the first year of observation (may 2024 – march 2025).

Conclusions and perspectives

Although the cultivation of certain crops is feasible under the current prototype, the 50% PV coverage proves challenging under Belgian conditions due to excessive attenuation of photosynthetically active radiation (PAR), which in turn leads to yield reductions and growth delays. The continuation of the project will involve the assessment of additional crops to expand the range of tested species. Greenhouse climate control will be improved through a combination of forced and passive ventilation systems. These initial findings will require validation through the results of the 2025 season.

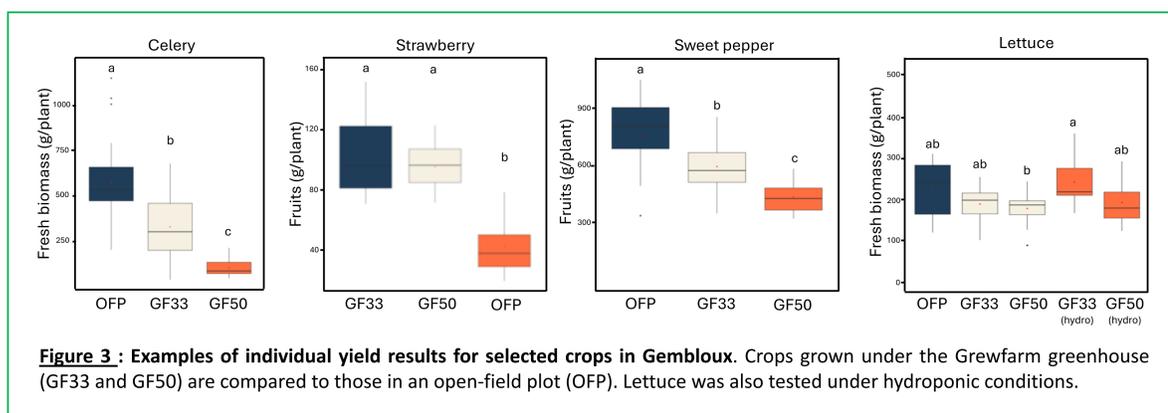


Figure 3: Examples of individual yield results for selected crops in Gembloux. Crops grown under the Grewfarm greenhouse (GF33 and GF50) are compared to those in an open-field plot (OFP). Lettuce was also tested under hydroponic conditions.

Partners & Acknowledgements :