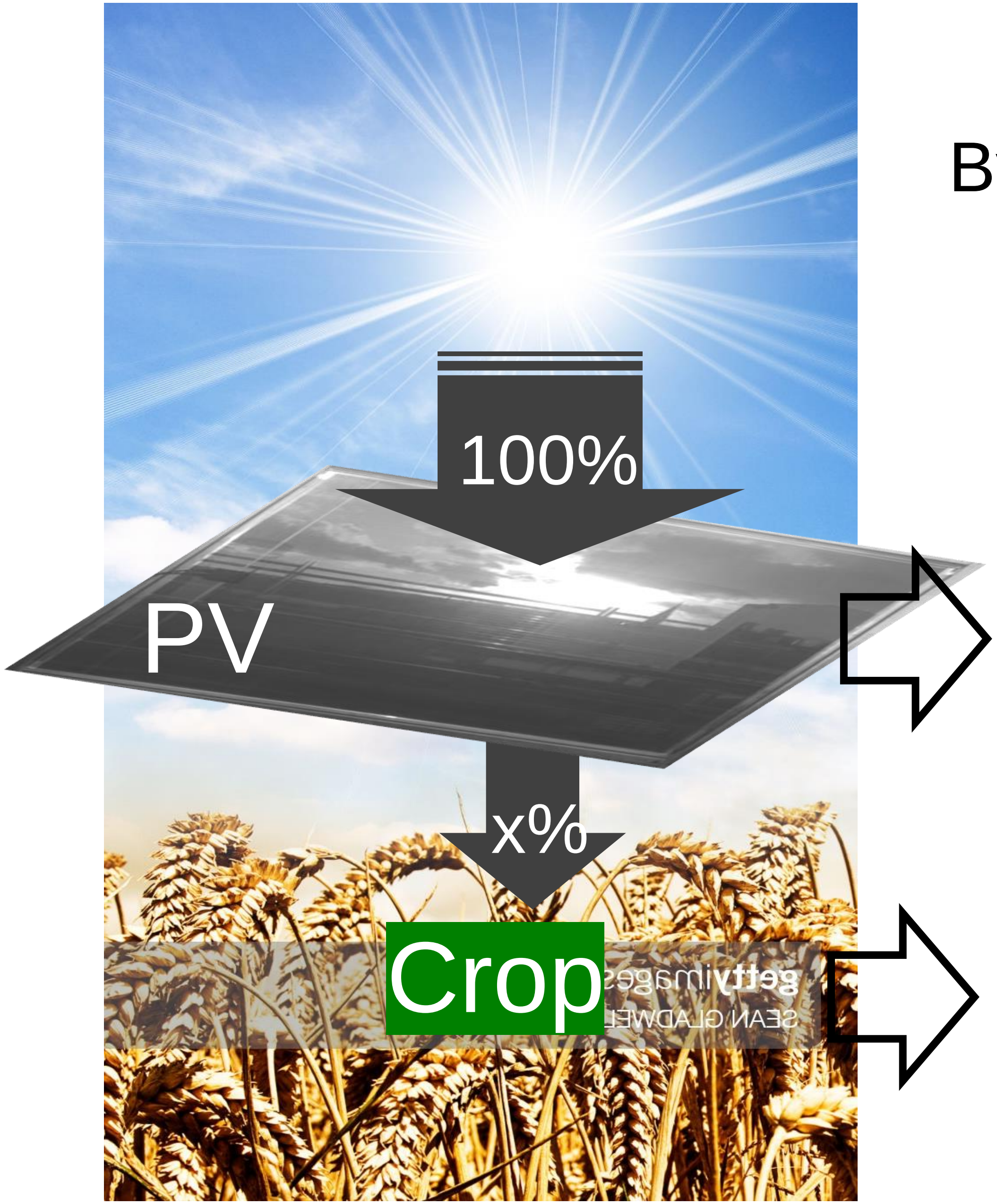
# The energy that our food eats

(Paolo Bombelli, pb346@cam.ac.uk)

REAP 2020

# Sunlight can be shared




Electricity

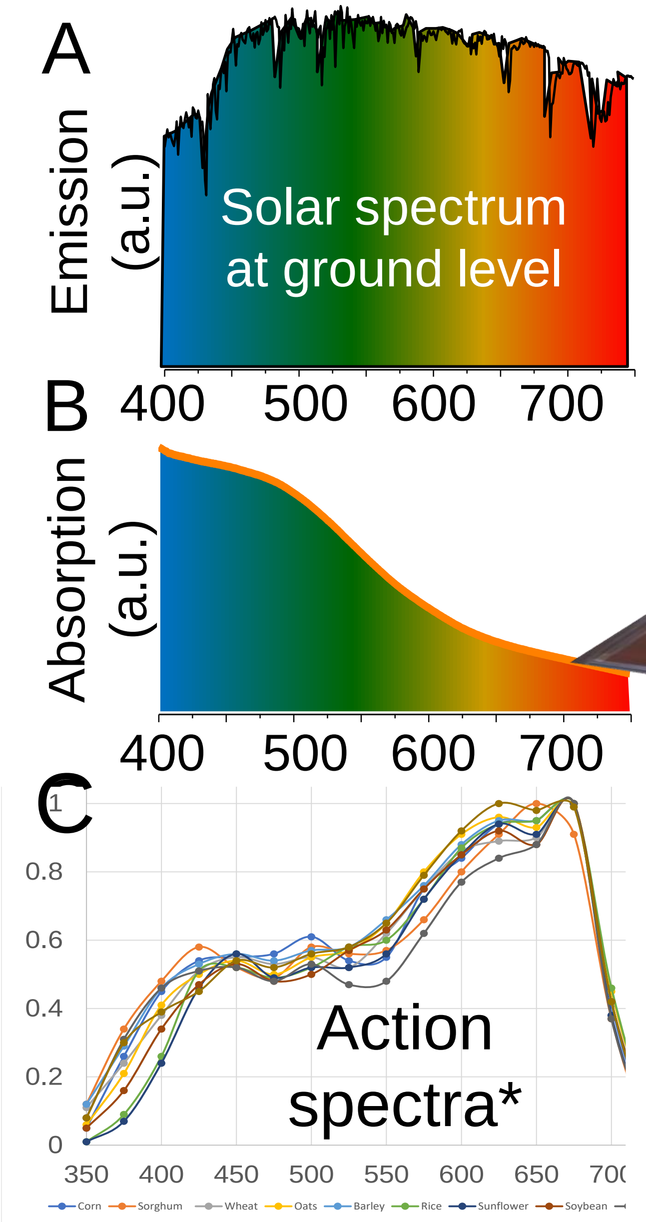
Food

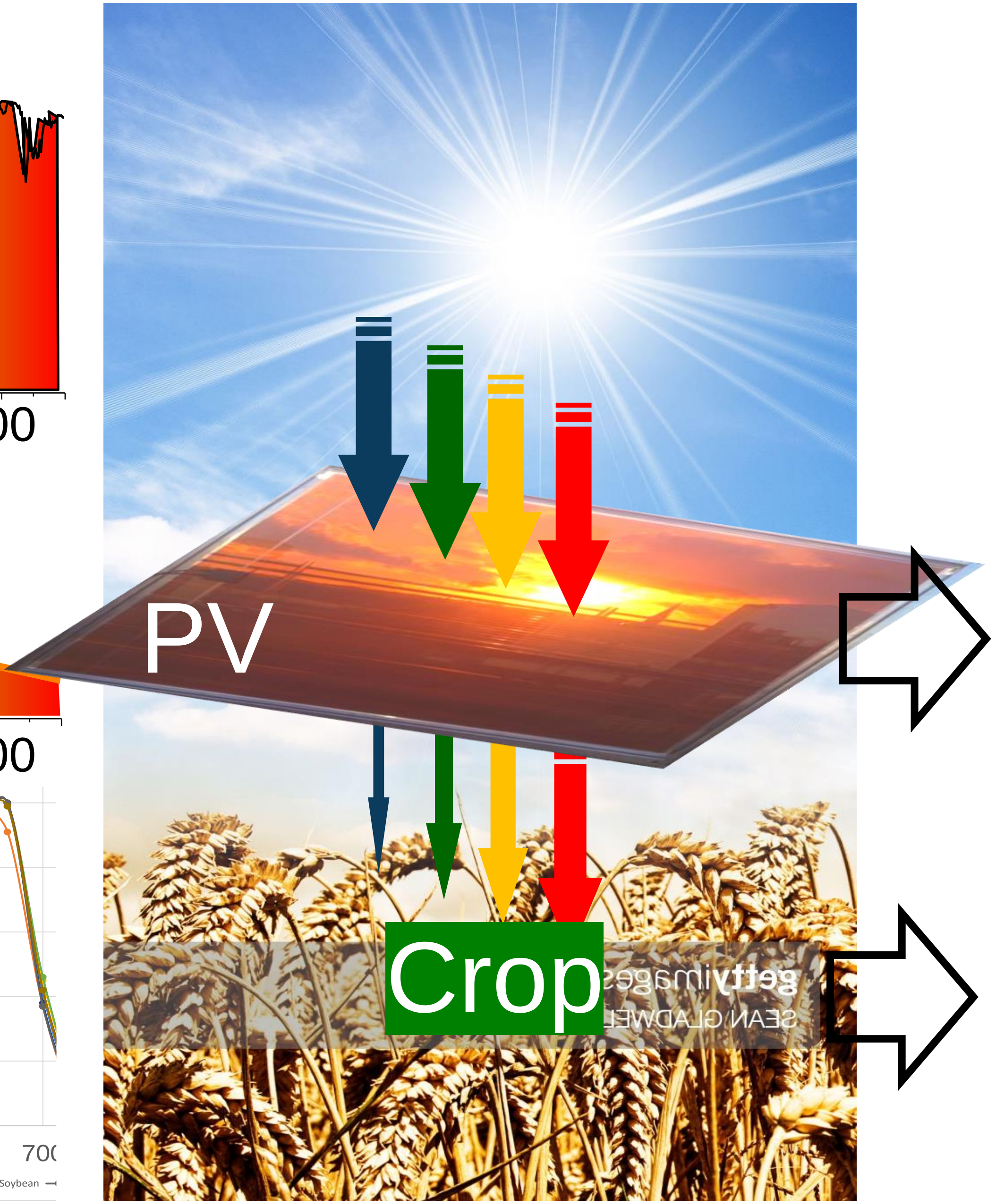
## Agrivoltaics

By using semi-transparent solar panel

GOETZBERGER, A.; ZASTROW, A. (1982-01-01). "On the Coexistence of Solar-Energy Conversion and Plant Cultivation". *International Journal of Solar Energy*. **1** (1): 55–69. Bibcode:1982IJSE....1...55G. doi:10.1080/01425918208909875. ISSN 0142-5919.

# Sunlight can be shared… or redistributed




Electricity

Food

## Agrivoltaics

By using tinted semi-transparent solar panel

*photosynthetic action spectra for common crop plants (corn, sorghum, wheat, oats, barley, rice, sunflower, soybean, lettuce, tomato).

THE ACTION SPECTRUM, ABSORPTANCE AND QUANTUM YIELD OF PHOTOSYNTHESIS IN CROP PLANTS
K. J. McCREE
*Agric. Meteorol.*, 9 (1971/1972) 191-216

# We have tested the following hypothesis

"Can sunlight be redistributed by using tinted semi-transparent solar panel to allow concurrent production of crops and electricity on the same cropland?"

ADVANCED ENERGY MATERIALS

[Tinted Semi-Transparent Solar Panels Allow Concurrent Production of Crops and Electricity on the Same Cropland](https://doi.org/10.1002/aenm.202001189)

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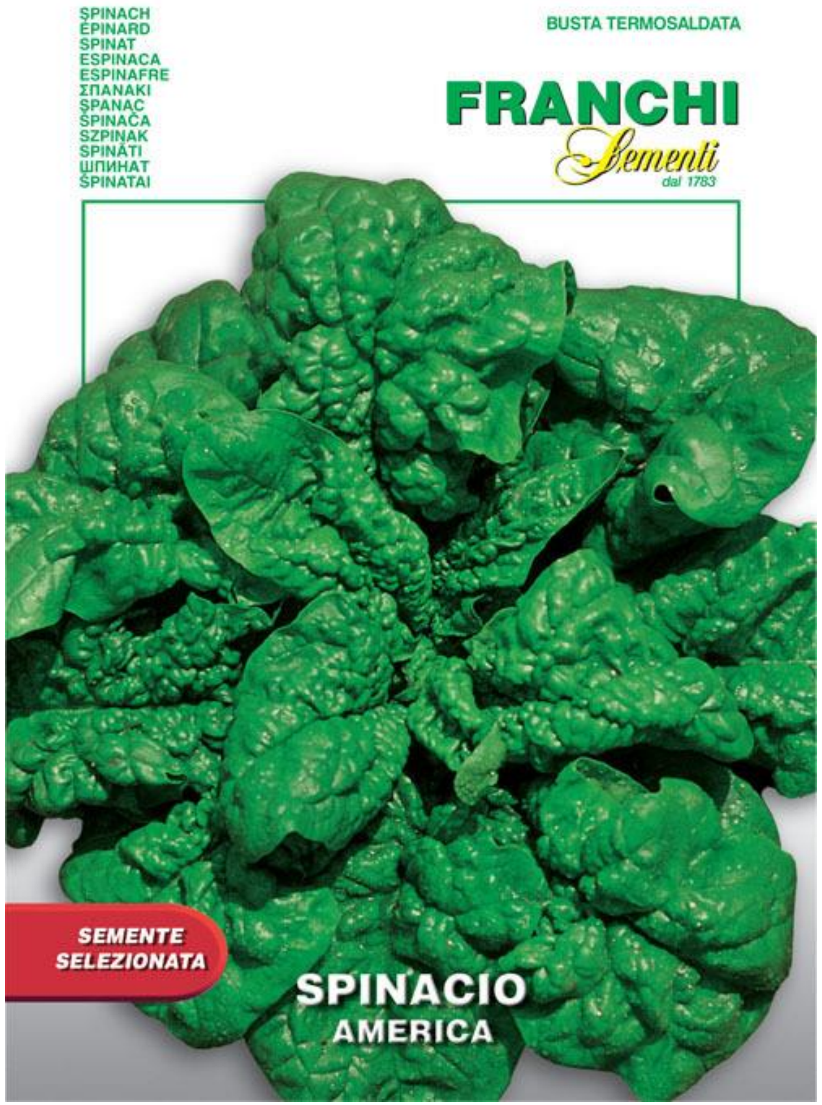
First published: 02 August 2020 https://doi.org/10.1002/aenm.202001189

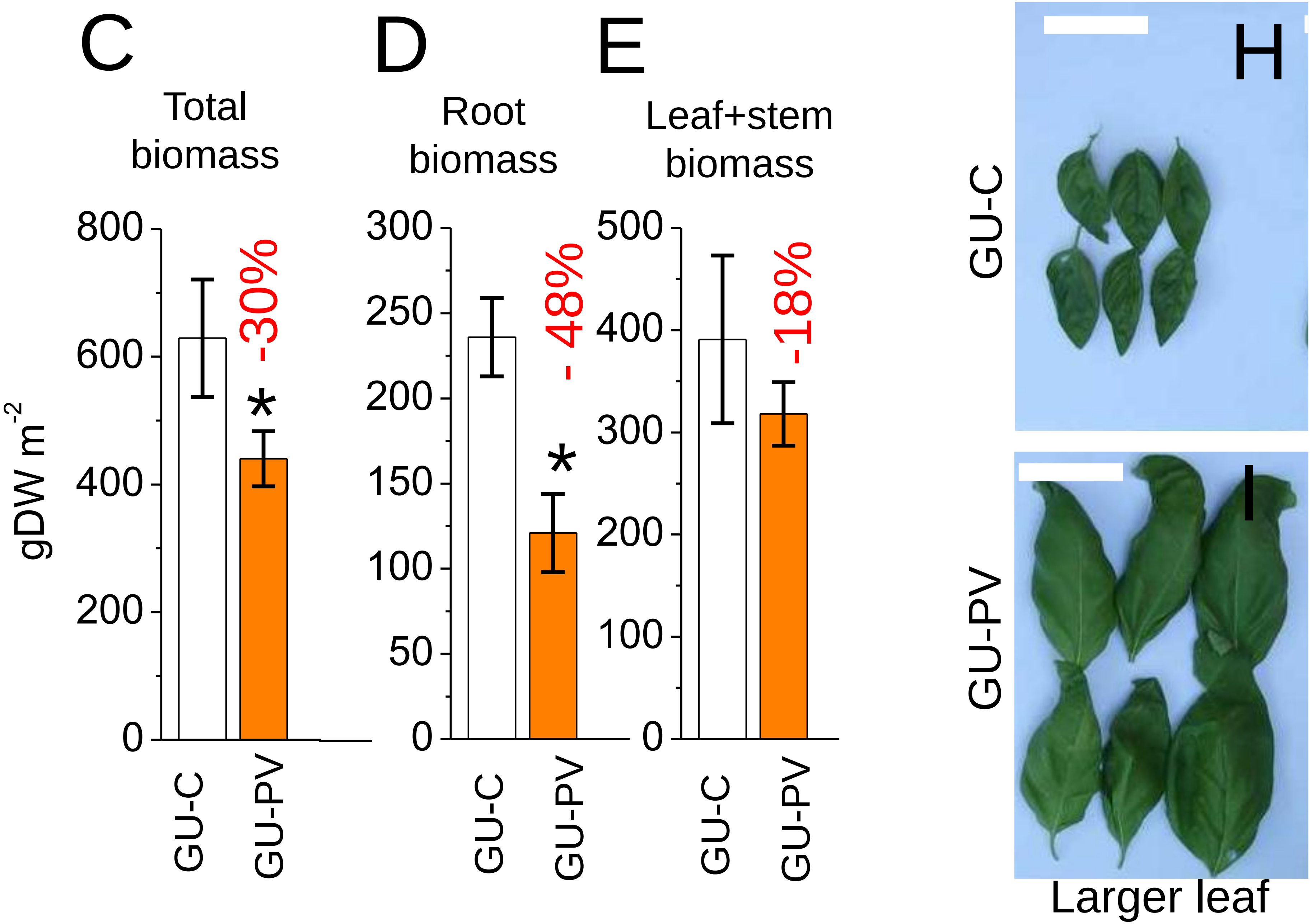
# The crops tested (Basil and Spinach)


Basil-Spring/Summer

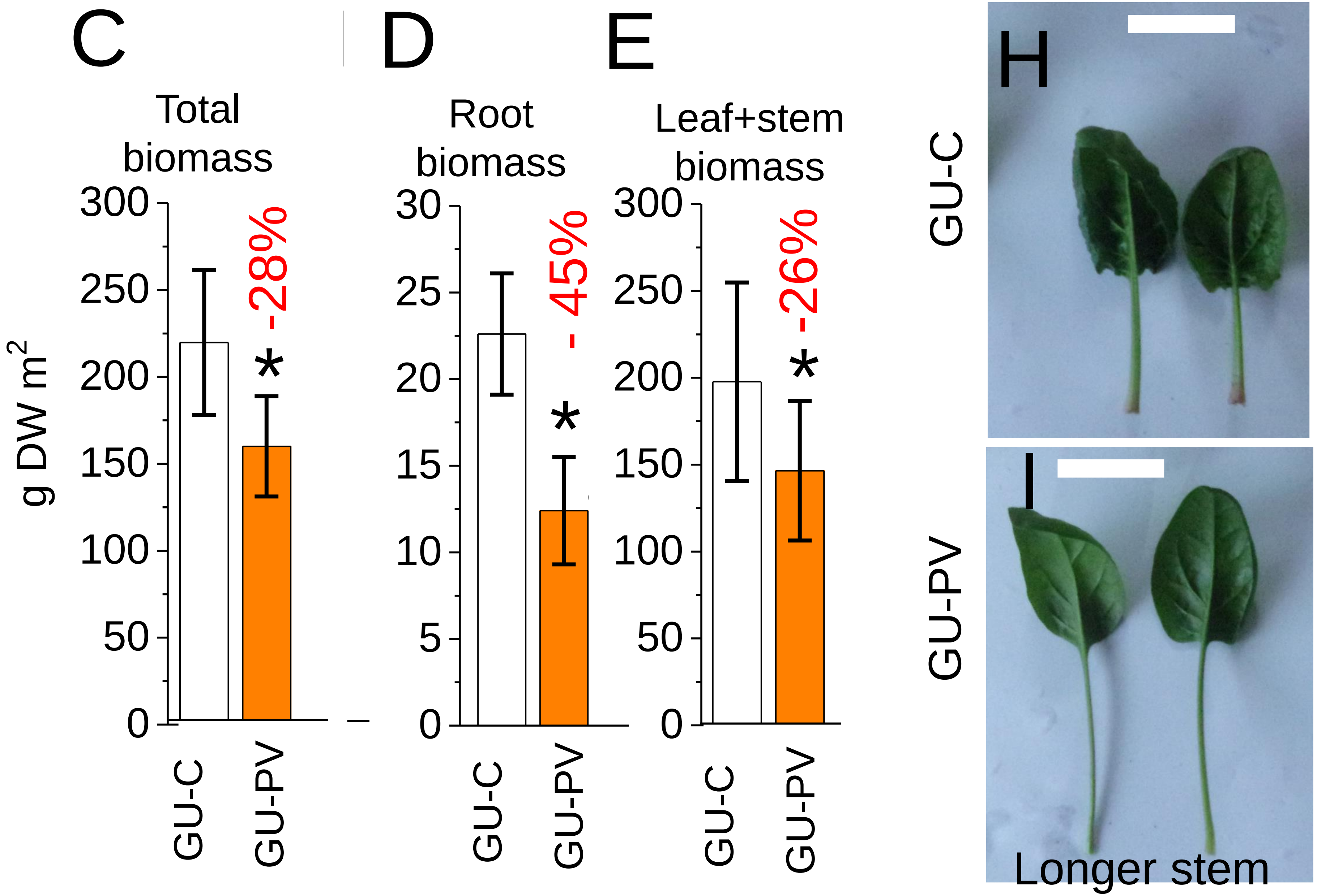



Spinach-Summer/Autumn

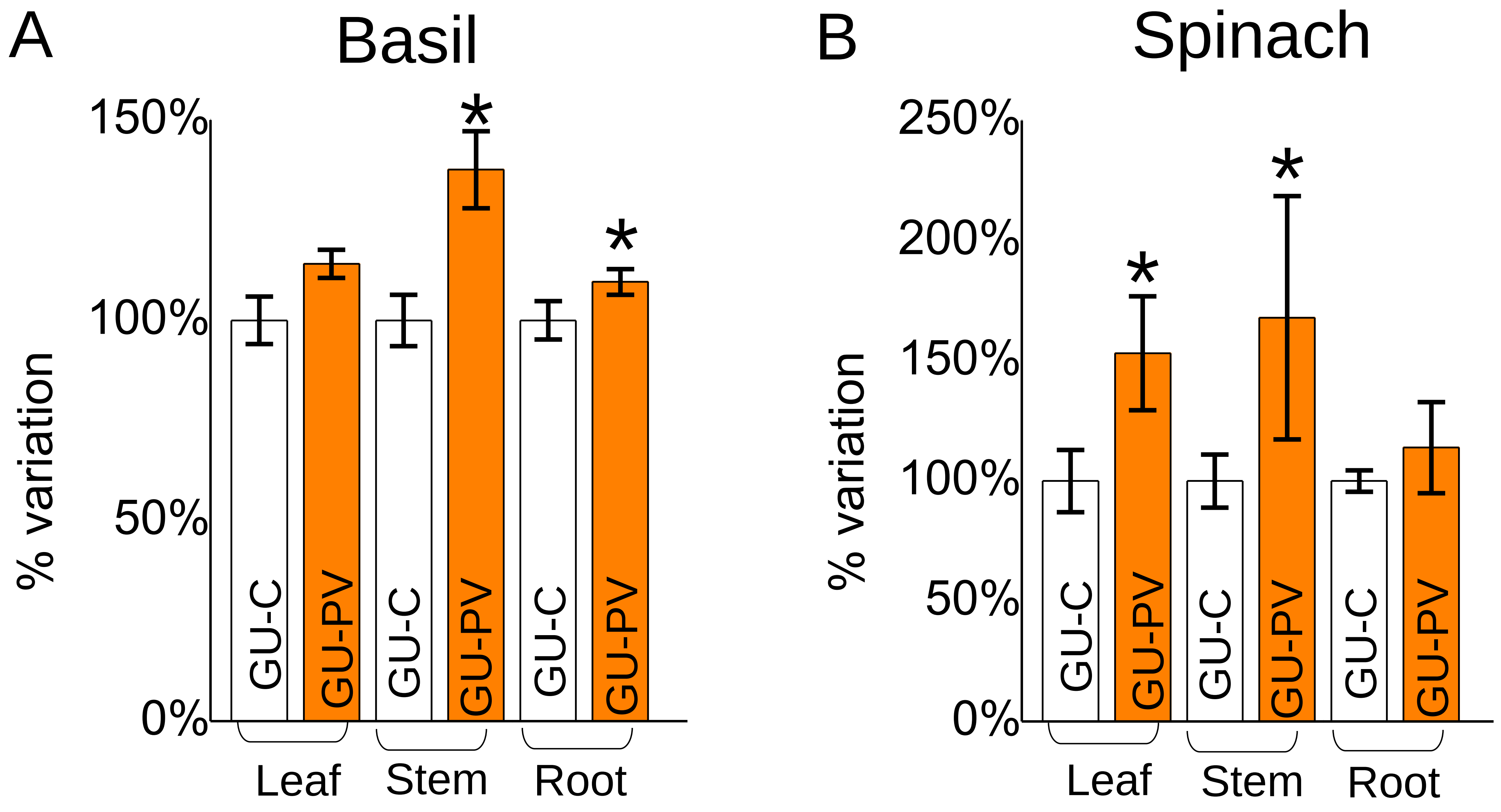
# Agrivoltaics (solar redistribution) on Basil



# Agrivoltaics (solar redistribution) on Spinach



# Agrivoltaics (solar redistribution) and protein content



# Agrivoltaics (solar redistribution) economical impact

| Crop (cultivar) | Growth condition | Mean of the accumulated marketable biomass | | Value of the marketable biomass | Expected electrical output | Value of the expected electrical output | Total gross value (biomass + electrical output) |
|---|---|---|---|---|---|---|---|
| | | $gDW\ m^{-2}$ | $kgFW\ m^{-2}$ | $USD\ m^{-2}$ | $kWh\ m^{-2}$ | $USD\ m^{-2}$ | $USD\ m^{-2}$ |
| Basil (Italiano Classico) | GU-C | 245 | 3.43 | 22.8 | - | - | 22.8 |
| | GU-PV | 208 | 2.91 | 19.4 | 27.8 | 4.03 | 23.4 |
| Spinach (Spinacio America) | GU-C | 196 | 3.32 | 4.18 | - | - | 4.18 |
| | GU-PV | 145 | 2.47 | 3.11 | 17.6 | 2.55 | 5.66 |

+2.5%

+35%

The table shows the biomass production, the electrical output and their equivalent value in USD for conventional agriculture (GU-C) and agrivoltaic (GU-PV, orange shadowed) for basil and spinach

# In conclusions : agrivoltaics (solar redistribution)

I. Loss in the yield of marketable biomass for both basil (18%) and spinach (26%).

II. The phenotype of plant was different from the control plants (e.g., longer stems for spinach).

III. The amount of protein per unit of dry biomass in both plants was increase.

IV. Even with a loss in the yield of marketable biomass for both plants, projection of our experimental data has shown that agrivoltaics could give a substantial overall financial gain calculated to be +2.5% for the basil and +35% for the spinach compared with classical agriculture.

IV. Agrivoltaics can enrich the portfolio of farmers (food + electrical energy)

V. Vastly enhance global photovoltaics capacity without compromising agricultural production.

# Agrivoltaic open questions

Can we actually implement agrivoltaics in large scale?

i) Total benefits and costs of operation? (cost cycle and life cycle analysis)

ii) Optimal crops? And, can we develop “Agrivoltaics crops”?

iii) Optimal solar radiation? (geographical location)

iv) Additional benefit of Agrivoltaics? (e.g., plant phenotype, nutrient content, soil bio activity, etc.)

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ROYAL ACADEMY OF ENGINEERING

EnAlgae collaborate innovate communicate

# Thank for visiting!