Agrivoltaic: Concept and benefits

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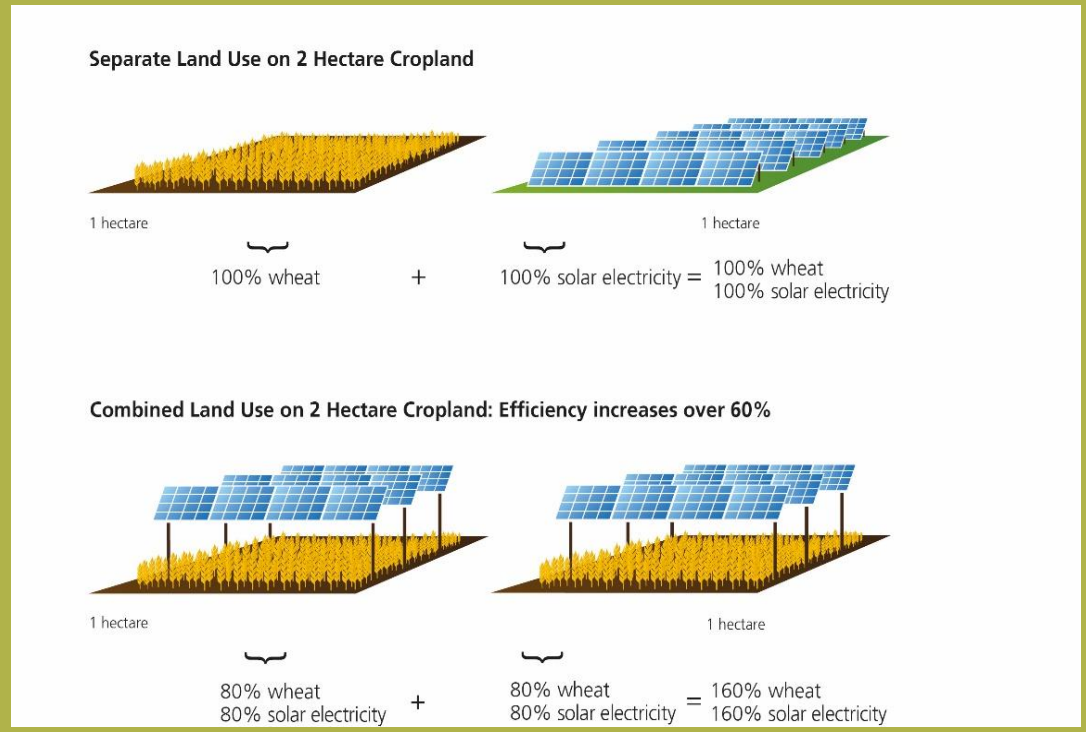
01- What is agrivoltaic?

- Combination between solar energy production and agriculture on a same land
- Evolution the agro forestry
- 1981: Adolf Goetzberger and Armin Zastrow were the pioneers of this technique
  → On the coexistence of solar-energy conversion and plant cultivation (1982)
- 2004: Akira Nagashima improved the idea by introducing the notion of using the light saturation point to optimize production

02- Why this is interesting?

- Space optimisation: one area for two utilisations
- Provides a solution for the conflict of interests between agriculture and solar energy
- Great potential



03- How does it work?

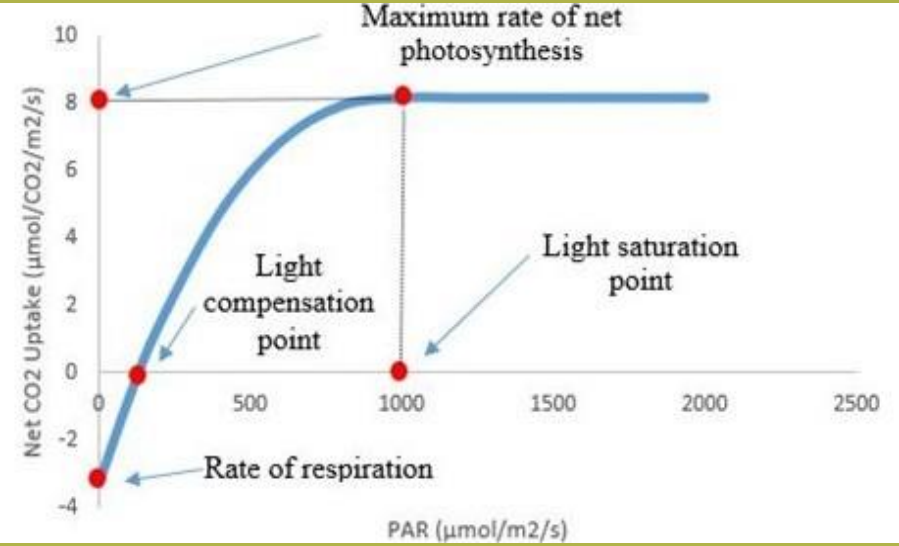
- On the ground: crops (cereals, vegetables, fruits, grapes, berries…)
- Above the crops: solar panels mounted on pillars
- Process: Solar panels will get a part of luminosity and leave the remaining part for the crops

04- Constraints – Crop sunlight needs

- Photosynthesis:

$$\underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} \xrightarrow{\text{Light}} \underset{\text{Sugar}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2}$$

- Light saturation point: maximum amount of light a plant can use for photosynthesis. Above this point, the photosynthesis rate will not be increased



→ The solar panels must, at least, let pass a light intensity equal to this saturation point. All above can be converted into electric energy

05- Constraints – Agricultural exploitation

- The installation must not impact the agricultural exploitation of the area
  → The panels must be high enough to allow farm vehicles to go beneath
  → The space between two pillars must be wide enough for the same reason
- Safety constraint: prevention of panels falling due to the wind (people could be working below)

06- Static configuration

- Solar panels inclination cannot be changed

Static configuration		
	Upsides	**Downsides**
	Simplicity	Limitation of plant varieties
	The most affordable	No control on the shadow created
	The most reliable	

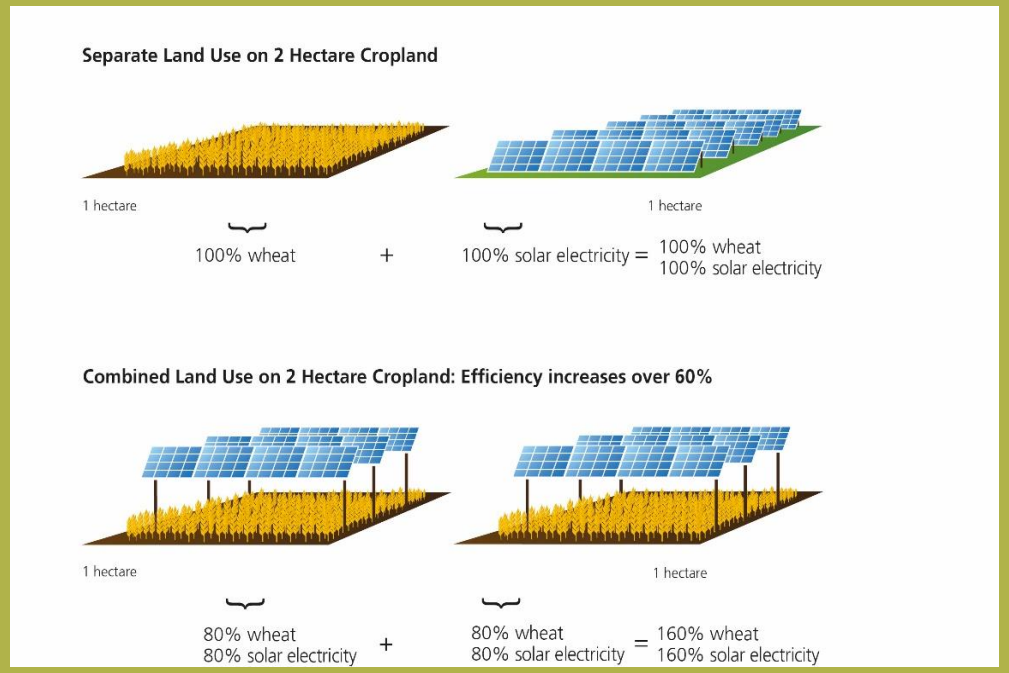
07- Dynamic configuration

- Solar panels inclination can be changed

Dynamic configuration		
	Upsides	**Downsides**
	Possibility to regulate the shade	More expensive and complicated than the static one
	Horizontal inclination protects against hail and freezing temperatures during the night	Panels inclination depends of the needs of the crops, so the energy production is less predictable
		Less reliable

08- Upsides (theorical) of agrivoltaic

- Better optimisation of land
- Protection of the crops against extreme weather
- Improvement of agricultural yield



09- Downsides (theorical) of agrivoltaic

- Harmful for the crop if it provides too much shadow (more applicable for static configuration)
- Costs of the installation
- Increased humidity due to the evaporation reduction → can bring diseases or parasites
- More visible because of the height of the installation

10- Notable projects

- Japan: 2 x 2 KW plants with mushrooms crop → 40 tons/year
- Port of Augusta (Australia): Concentrated solar thermal plant used to desalinate water from the sea. The water steam is used to produce electricity and for irrigation of a 20 Ha greenhouse.

Thank you for your attention !