Controlled Environment Agriculture (CEA)

In CEA, environmental factors such as temperature and humidity are controlled. The most common example of CEA is a greenhouse. Inside a basic greenhouse, temperature and humidity will increase, CO_2 concentration will vary, and some sunlight will be blocked.

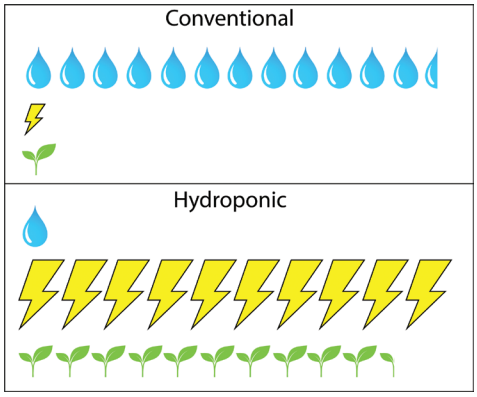
Initial effect of basic greenhouse enclosure.

Temperature	Humidity	CO_2 Concentration	Light Intensity
↑	↑	↑ or ↓	↓

Adding technology and automation allows these and other factors to be precisely controlled, and the use of water recycling technology makes CEA extremely water efficient.

Hydroponic greenhouses are a popular form of CEA. In Yuma, for example, hydroponic greenhouses

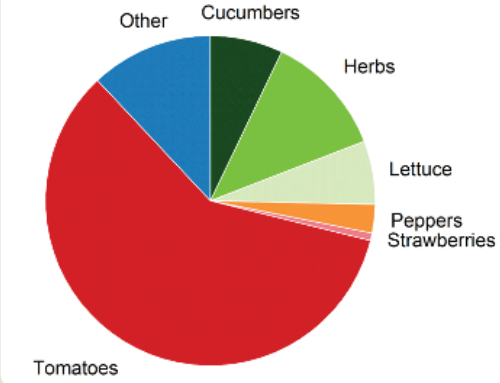
- use about 13 times less water than conventional agriculture for the same lettuce yield.
- can yield 11 times more than conventional agriculture from the same land area.
- **BUT** require 82 times more energy to produce the same yield.



Relative resource use and yield for hydroponics v conventional lettuce production

Adoption of CEA depends on specific benefit-cost calculations.

- CEA's high capital and operational costs limit its use to high-value crops.
- **BUT** its relatively small water and land area demands make CEA well suited for areas with water or land scarcity while minimizing waste and transportation costs.

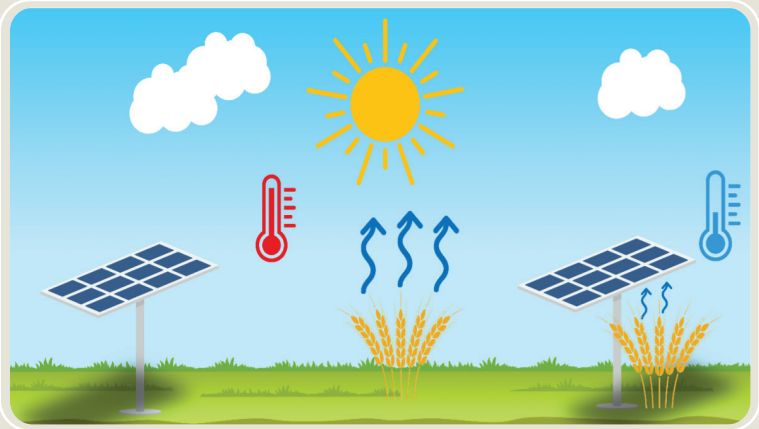


Crops produced in CEA greenhouses in the United States

Agrivoltaics

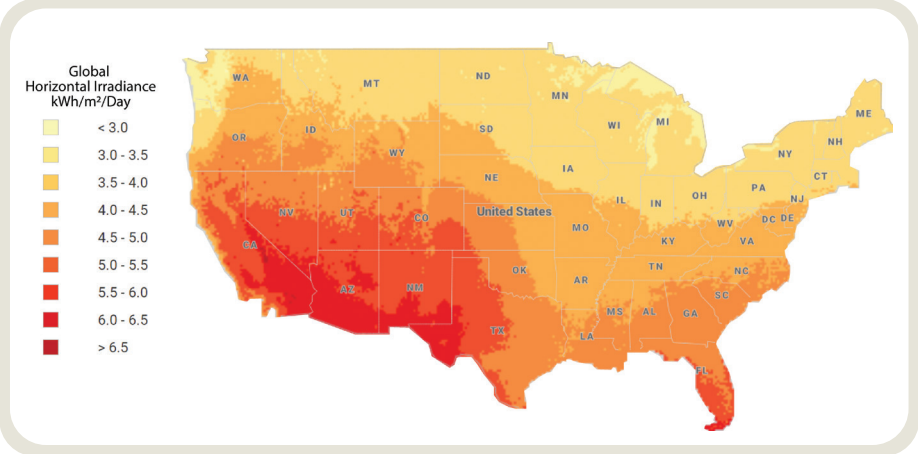
Agrivoltaics can combine solar energy production with agricultural production. Placing solar energy panels on agricultural land promises to produce energy while reducing water use and maintaining or slightly improving crop yields over time.

- Shade from photovoltaic panels moderates the temperature near the crop, decreasing evaporative water loss.
- Evapotranspiration from the crop cools the photovoltaic panels, increasing their efficiency.



Arizona's climate is particularly well suited for adopting agrivoltaics

- The state receives a lot of solar radiation with little cloud cover
- Arizona has very high global horizontal irradiance (GHI)
- GHI is the total solar radiation experienced on a horizontal surface and is one of the most important factors in predicting solar panel output.



Limits on water supplies and high water and energy costs may force some farmers to fallow land and potentially abandon farming.

- Agrivoltaic energy production augments income and makes farms resilient to costs and price volatility.
- Temporary fallowing and investments in water efficiency are more politically and economically viable with a more resilient agriculture industry.