CARBON FERTILIZED & CONTROLLED ATMOSPHERE, AQUAPONICS

GREENHOUSE

THE CLIMATE CHANGES

The climate changes,

it does not matter if it changes:

- due to a bad management of natural resources by man,
- due to the eruption of a volcano,
- because the power of the Sun varies in intensity
- or because the Earth's axis moves, promoting an alternation of temperate and cold periods,

the climate changes.

Cultivating in a controlled environment means being able **to guarantee the production** of nutritional products **in spite of changing of the climatic conditions.**

GREENHOUSE vs OPEN FIELD

Conventional agricultural practices can cause a wide range of negative impacts on the environment. “Conventional” agriculture” has been historically defined as the practice of growing crops in soil, in the open air, with irrigation, and the active application of nutrients, pesticides, and herbicides.

Some of the negative impacts of conventional agriculture include the high and inefficient use of water, large land requirements, high concentrations of nutrients and pesticides in runoff, and soil degradation accompanied by erosion.

As the world population continues to grow at a rapid rate, so too must the food production. However, approximately 38.6% of the ice-free land and 70% of withdrawn freshwater is already devoted to agriculture. To sustainably feed the world’s growing population, methods for growing food have to evolve.

The benefits of high tech greenhouse agriculture are numerous. In addition to higher yields and water efficiency, when practiced in a controlled environment, it can be designed to support continuous production throughout the year.

Various commercial and specialty crops can be grown using high tech greenhouse including tomatoes, cucumbers, peppers, eggplants, strawberries, and many more.

GROWTH – Limiting Factors

There are several limiting factor for a plant to grow, the most important are:

- Temperature
- Light
- Humidity
- CO_2 availability
- Fertilizer availability
- Water availability

The limiting factors are different for the different culture and an high tech greenhouse must be able to recreate the best environmental parameter for the plant that we need to grow.

The open field environment falls within the limits of plant growth for restricted periods of the year only.

Variety	Min Temp. (°C)	Max Temp. (°C)	CO_2 (ppm)	Humidity (%)	Light (lux)
Tomato	13	26	1'200	60	30'000
Cucumber	18	28	3'000	80	30'000
Aubergine	15	26	2'500	70	20'000
Strawberry	10	22	2'000	70	15'000
Rose	14	25	1'500	70	40'000

GROWTH – Limiting Factors

LIGHT

The most limitation factor in an open field is the light, if it is too low or too high (like at noon with 100'000 lux), the plant do not grows.

The open field available PAR (photosynthetically active radiation) is usually less than 20% of the total radiation that can provide an high tech greenhouse.

TEMPERATURE

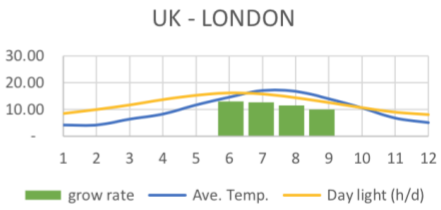
The plant grow just in close range of temperature, if it is to cold or to hot the plant stop growing.

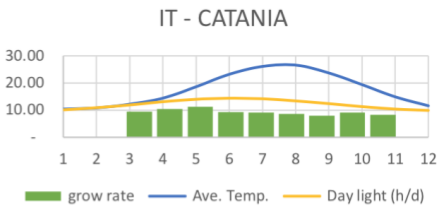
Inside an high tech greenhouse the temperature is maintained at the optimal level for each kind of cultivation.

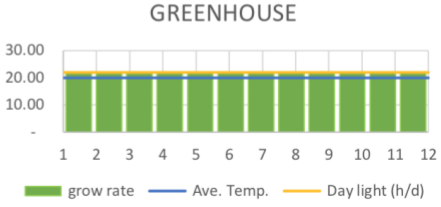
CO_2

The plant require an high level of CO_2 to grow, usually in the range 1'000 – 3'000 ppm, far higher than the 400 ppm today available in the atmosphere. A right level of CO_2 allow the plant to grow up to 40% faster than in an open field.

It is important to notice that the minimum level for a plant to develop the photosynthesis process is 150 ppm.







GREENHOUSE - THE ENERGY PROBLEM

A carbon-fertilized greenhouses capture the CO_2 to produce high quality nutritional products.

A controlled atmosphere greenhouse, can grow nutritional product with a yield >10 times the traditional open field avoiding any problem related to the external climate conditions.

The most relevant problem related to the greenhouse cultivation is the large amount of energy (electric and thermal) and CO_2 required to control the environmental condition inside a closed habitat.

Energy availability is the major factor in assessing the sustainability of high tech greenhouses.

A sustainable solution to solve the problem is to use organic based waste materials to produce the greenhouse energy requirements.

A waste valorisation plants can offer to the greenhouse,100% of the electricity, heat, CO_2 and water required, **for free**.

LETTUCE PRODUCTION (data provided by: Arizona State University)				
	UNIT	GREENHOUSE	OPEN FIELD	GH/OF
PRODUCTION YIELD	Kg/m^2/year	41.0	3.9	10.5
WATER REQUIREMENT	Litre/kg/year	20	250	0.08
ENERGY REQUIREMENT	MJ/kg/year	90	1.1	82

WASTE TO ENERGY VALORISATION PLANT

A waste valorisation plants can offer to the greenhouse:

- 100% of the electricity
- 100% of the heat
- 100% of the CO_2
- 100% of water

for free.

A waste valorisation plant manging:

10'000 ton/year of municipal solid waste

can manage 10'000 m^2 of greenhouse,

Providing:

- 24 hours of artificial light (> 5'000 MWh/year)
- 25 °C air conditioning (> 12'000 MWh/year)
- 2000 ppm of CO_2 (> 700 m^3/h)
- 75% of stable humidity.