



Crop Guide

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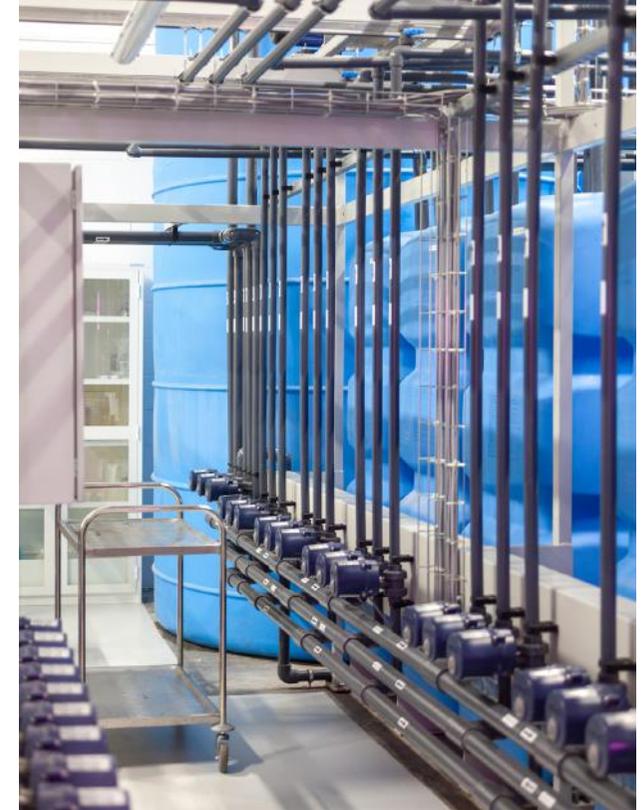
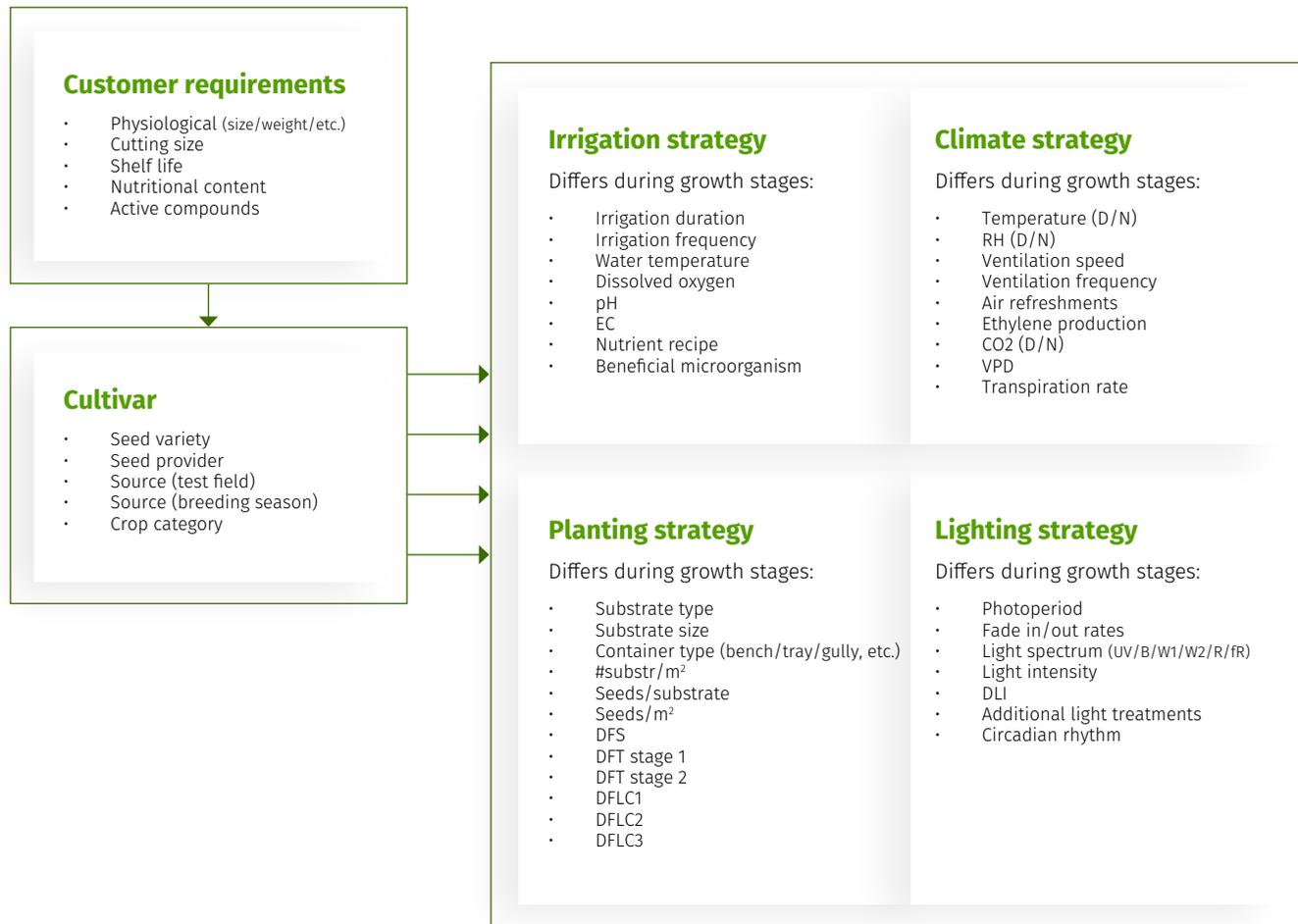
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What is a Plant Growth Recipe?

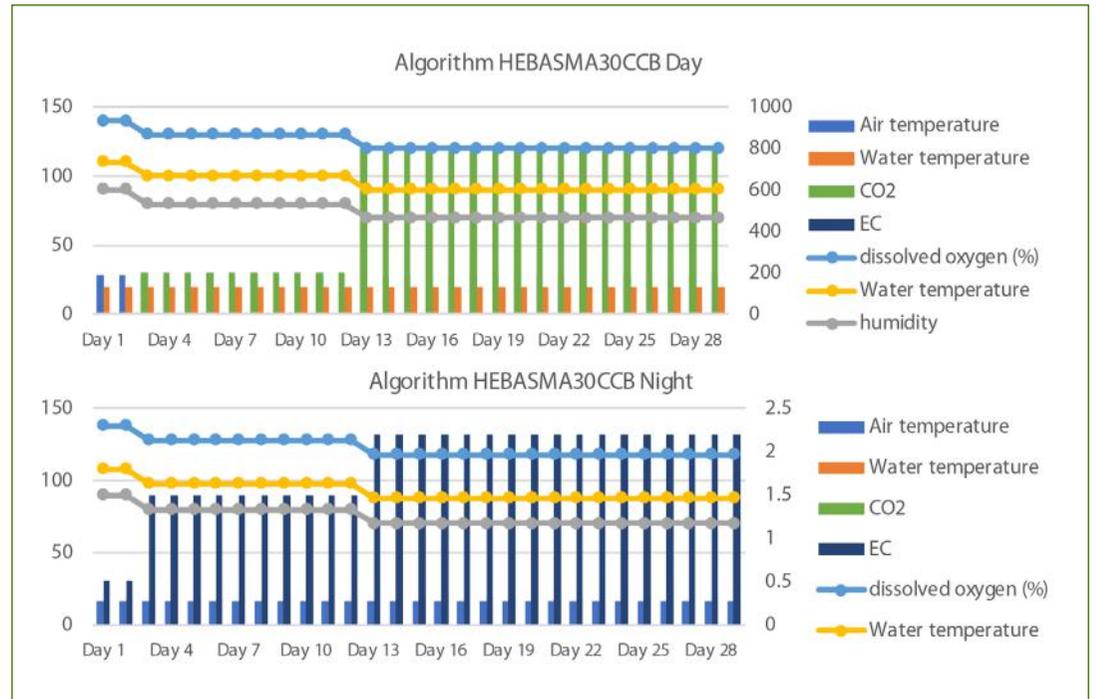
A recipe is a predefined set of operating procedures (seed planting, germination time, transplanting method, etc.) and approximately 45 parameter settings (LED intensity and spectrum, daylight hours, temperature, humidity, irrigation on/off timing, nutrient mix, substrate composition, etc.)

UCS growth recipe (between 39-100 parameters)



The plant will grow in controlled environmental conditions for it to achieve the desired morphological and sensory properties.

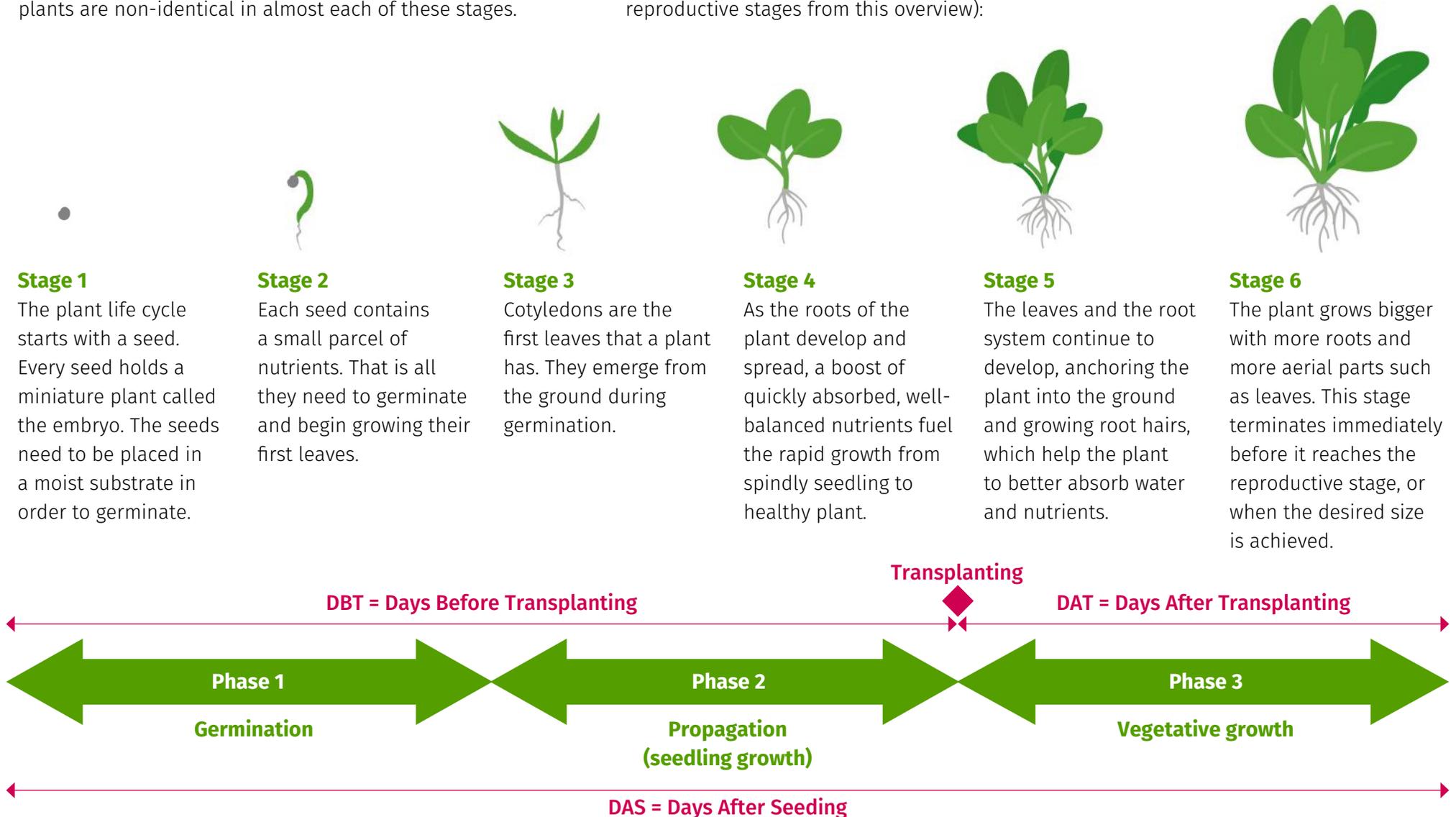
If executed correctly during the entire growth cycle of the plant, the plant will conform to the required quality specifications and result in the prescribed net yield, in a predefined number of days.



What Are the 3 Phases of Plant Growth?

During their lifetime, plants go through different stages of plant growth and have a distinctly different appearance in each of these stages. Furthermore, the demands of the plants are non-identical in almost each of these stages.

The differences can be related to temperature, nutrient recipe, planting density, light settings, etc. The different stages of plant growth are (we excluded the flowering and reproductive stages from this overview):



Gross vs Net Yield



1. Living yield (gross yield plus roots and substrate)

The total weight of the crop includes the roots, substrate, outer leaves, and bottom leaves



2. Gross yield* (without roots)

This yield reflects the weight of the plant excluding substrate and roots and including all leaves (bottom leaves and yellow leaves), where the crop has been cut right above the substrate.

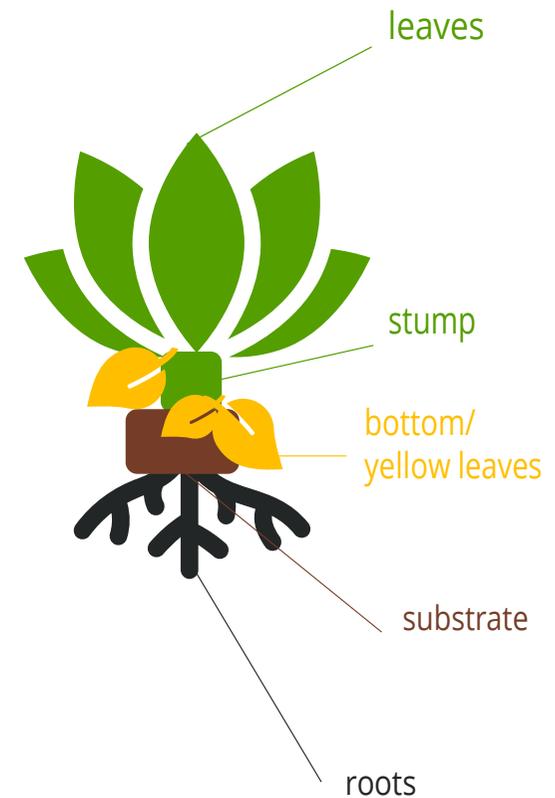


3. Net yield** (with the stump)

The net yield with the stump refers to a full crop ready for sale, without the yellow and bottom leaves.



4. Yield ready-to-eat (net yield without stump)



*This yield is reported in this Crop Guide

**This information is made available in the 'Crop Guide Plus' for your selection of cultivars

Bench Irrigation System

Ebb & Flow (also called Flood & Drain)

- It increases the root development during the early stages of vegetative plant growth. Water mixed with nutrients floods the bench and subsequently drains out and back into the reservoir until the next cycle starts. This drain period allows a high amount of oxygen to reach the root system.
- Used for: Lettuce, Herbs, Microgreens

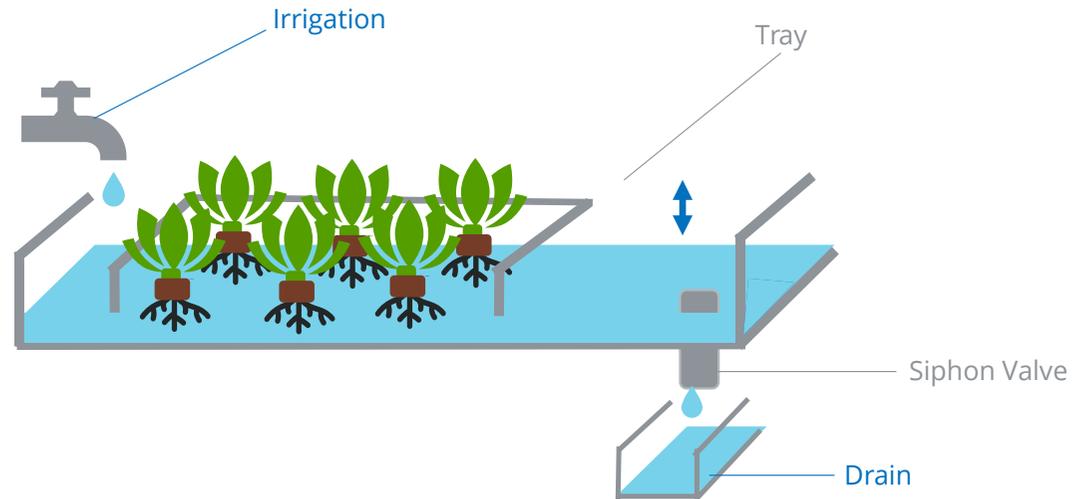
Shallow Water

- Some marsh plants like Salicornia prefer a very wet environment in the root zone. The irrigation system is set to leave a certain amount of water inside the bench.

Drip Irrigation

- Drip irrigation works just like the ebb and flow method, except that the nutrients are carried to and from the plants much slowly, through a drip irrigation ring.

Our benches are designed for ebb & flow, shallow water, and drip irrigation.



Gross Yield Data

With the ModuleX (bench irrigation)



Leafy Greens

Herbs

Microgreens

ModuleX Leafy Greens & Lettuce

Crop Type	Crop Name	Days Before Transfer	Days After Transfer	Approximate Gross Yield*		Yield calculated on date after sowing (DAS) or date after transfer (DAT)**
				kg/sqm/year	Lbs/sq.ft./year	
Baby Leaf						
	Crispy lettuce	2	22	79.2	16.2	DAT
	Crispy lettuce	2	22	72.6	14.9	DAS
	Lollo rosso	2	19	74.5	15.3	DAT
	Batavia red	2	21	51.3	10.5	DAT
	Oakleaf	2	21	38.4	7.9	DAT
	Oakleaf red	2	20	55.3	11.3	DAT
Lettuce						
	Batavia	2	40	68.9	14.1	DAT
	Salanova	2	34	59.8	12.3	DAT
	Oakleaf red	2	40	43.3	8.9	DAT
	Lollo	2	41	50.9	10.4	DAT
	Lollo red	2	40	45.4	9.3	DAT
Leafy Green						
	Lamb lettuce	2	23	7.9	1.6	DAT
Asian Leafy						
	Pak choi	3	32	27.4	5.6	DAT
	Chinese spinach	2	35	4.5	0.9	DAT
	Chinese broccoli	2	29	16.1	3.3	DAT



*Gross Yield = for more information on 'Gross vs Net Yield', see Annex 1, and for 'Approximate vs Validated Test Data', see Annex 2. Yields are per m² (sq. ft.) of harvest surface after transplanting.

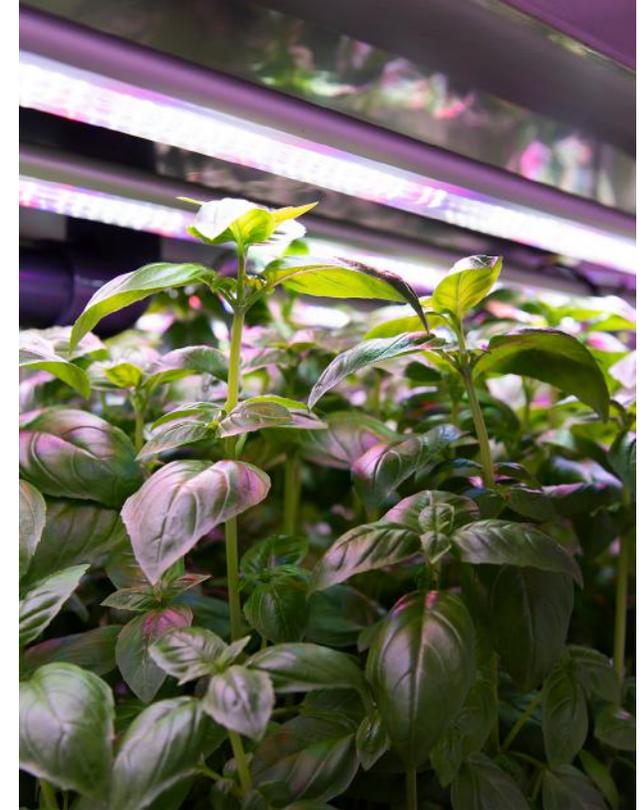
**DAS refers to the total yield calculated from the day of sowing. DAT refers to the total yield, calculated from the moment of transfer, which is more relevant if germination/propagation takes place in a separate area.

ModuleX Herbs

Crop Type	Crop Name	Days Before Transfer	Days After Transfer	Approximate Gross Yield*		Yield calculated on date after sowing (DAS) or date after transfer (DAT)**
				kg/sqm/year	Lbs/sq.ft./year	
Herb						
	Basil Genovese	17	12	88.7	18.2	DAT
	Parsley (flat leaf)	17	16	42.8	8.8	DAT
	Parsley (curly leaf)	17	22	28.3	5.8	DAT
	Lemon balm	17	21	31.6	6.5	DAT
	Dill	17	11	55.8	11.4	DAT
	Sage	17	18	37.2	7.6	DAT
	Marjoram	17	21	29.0	5.9	DAT
	Tarragon	17	18	9.2	1.9	DAT
	Savory	17	18	33.1	6.8	DAT
	Mint	17	18	27.2	5.6	DAT
	Thyme	17	23	23.7	4.9	DAT
	Coriander	17	14	63.4	13.0	DAT
	Chervil	17	11	31.5	6.5	DAT

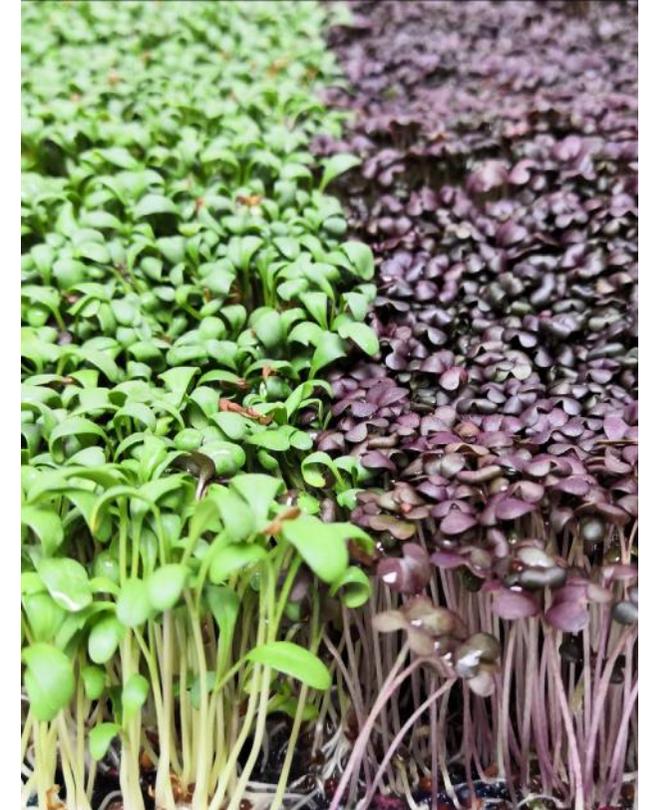
*Gross Yield = for more information on 'Gross vs Net Yield', see Annex 1, and for 'Approximate vs Validated Test Data', see Annex 2. Yields are per m2 (sq. ft.) of harvest surface after transplanting.

**DAS refers to the total yield calculated from the day of sowing. DAT refers to the total yield, calculated from the moment of transfer, which is more relevant if germination/propagation takes place in a separate area.



ModuleX Microgreens

Crop Type	Crop Name	Days Before Transfer	Days After Transfer	Approximate Gross Yield* kg/sqm/year	Lbs/sq.ft./year	Yield calculated on date after sowing (DAS) or date after transfer (DAT)**
Microgreens						
	Radish	6	0	134.5	27.5	DAS
		5	1	806.9	165.3	DAT
	Peas	12	0	48.9	10.0	DAS
		6	6	97.8	20.0	DAT
	Sunflower	12	0	102.4	21.0	DAS
		6	6	204.8	41.9	DAT
	Red cabbage	12	0	43.7	9.0	DAS
		6	6	87.4	17.9	DAT
	Sage	12	0	11.3	2.3	DAS
		6	6	21.4	4.4	DAT
	Shiso	14	0	55.0	11.3	DAS
		6	8	96.3	19.7	DAT
	Red mustard	7	0	110.0	22.5	DAS
		6	1	770.2	157.8	DAT
	Chards	14	0	21.0	4.3	DAS
		6	8	36.7	7.5	DAT
	Fenugreek	14	0	25.3	5.2	DAS
		6	8	44.2	9.1	DAT
	Cress	11	0	76.4	15.6	DAS
		6	5	168.0	34.4	DAT
	Broccoli	8	0	61.9	12.7	DAS
		6	2	247.6	50.7	DAT
	Rucola	11	0	41.7	8.5	DAS
		5	6	76.4	15.7	DAT
	Coriander	11	0	38.3	7.9	DAS
		6	5	84.4	17.3	DAT
	Basil	13	0	49.4	10.1	DAS
		6	7	91.7	18.8	DAT
	Wheatgrass	7	0	38.3	7.8	DAS
		5	2	137.5	28.2	DAT
	Mint	27	0	9.7	2.0	DAS
		6	21	12.5	2.6	DAT



*Gross Yield = for more information on 'Gross vs Net Yield', see Annex 1, and for 'Approximate vs Validated Test Data', see Annex 2. Yields are per m2 (sq. ft.) of harvest surface after transplanting.

**DAS refers to the total yield calculated from the day of sowing. DAT refers to the total yield, calculated from the moment of transfer, which is more relevant if germination/propagation takes place in a separate area.

Biological Trials

What if your desired crop is not in our crop guide?

Our Research Center in Belgium contains 13 state-of-the-art growth chambers, which can mimic any climate on earth. This allows our in-house team of plants scientists to research and validate your crop of choice.



To develop your own recipe:

Contact our sales support team



Annex

Annex 1: Gross vs Net Yield

Annex 2: Approximate Yield vs Validated Tests

Annex 3: The Diversity of Plants - “Basil is Not Basil”

Annex 4: Crop Pictures



Annex 1: Gross vs Net Yield

When harvesting a crop, not all of the biomass is used as a final product. The ratio of what the exact net yield is, related to the gross yield, depends on several quality parameters. It also might be different depending on the crop, application (end-use), or industry. As a rule of thumb, we have noted this ratio to lie between 5 and up to 30%.

- **For example:** when we only need a part of the herb, 30% will go to waste. As a first approximation, one can use 10%.



A non-exhaustive list of parameters which influence this ratio:

- Leaf size
- Leaf thickness
- Coloration of the leaves
- Taste
- Crispiness
- Shelf life

During a 'crop mix optimisation' study, our team maps these parameters and includes the impact assumptions on gross and net yield. In later stages, biological trials can validate these assumptions.

Example: Romaine Lettuce

- **Application:** Mixed salads for high-end restaurants
- **Quality specifications:** Lettuce delivered in plastic bags, ready to be served directly on the plate (no yellow leaves accepted)
- **Harvesting process:**
 1. Roots and substrate are removed from the crop
 2. Low hanging yellow leaves (see red arrows) are not accepted as per the quality specification of the customer
 3. Low hanging yellow leaves need to be removed during harvest
 4. The yellow leaves are discarded as scrap, the weight is part of the difference between the gross and net yield

Annex 2: Approximate Yield vs Validated Tests

Over the years, Urban Crop Solutions has developed over 290 plant growth recipes in the Urban Crop Solutions Research Centre.

It is important to note that the design of the growing system can have differences in yield. In this crop guide, we make a distinction between ebb & flow, shallow water, and drip irrigation systems. However, other parameters can also have an influence:

- Distance between the crop canopy and the LED lights, which can limit the maximum heights the crop can grow
- The intensity & spectrum of the LED lights, which improves with each new generation (approx. every 2 years)



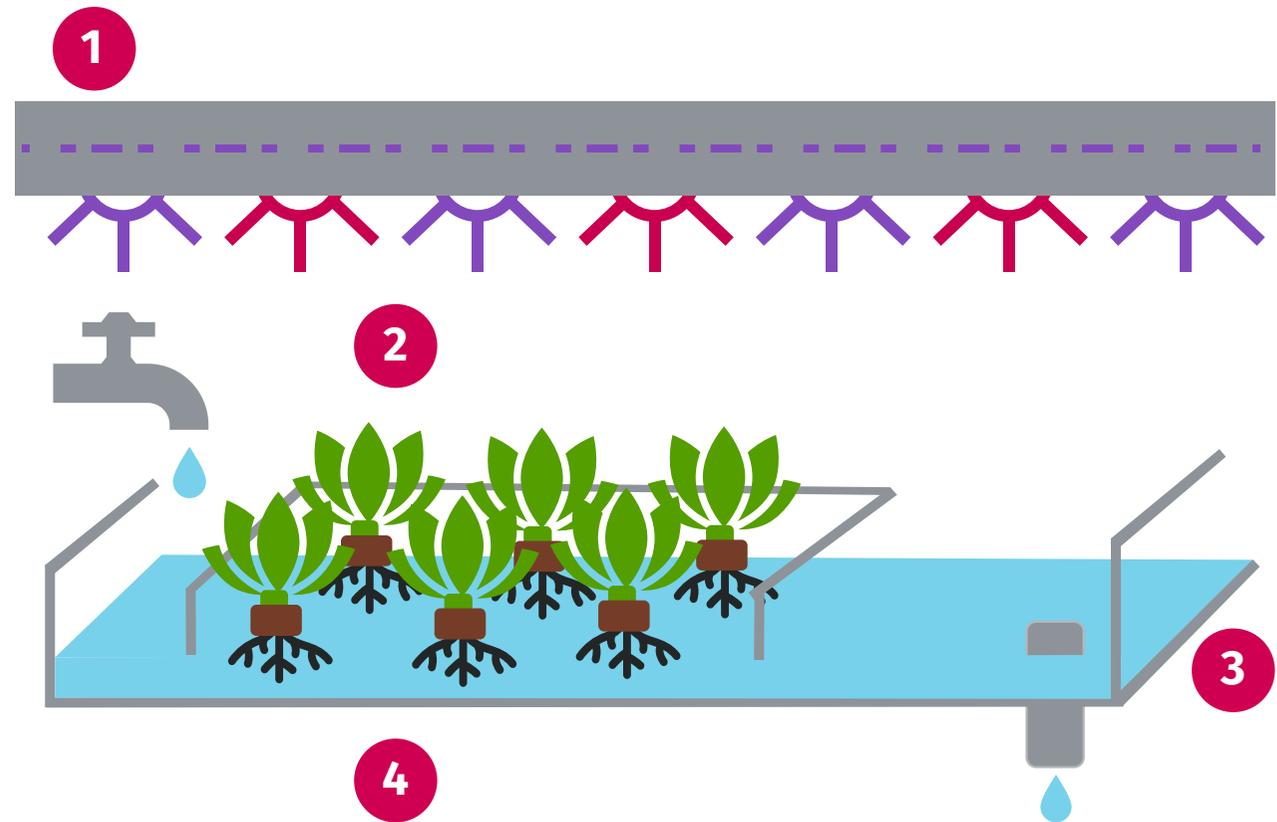
For practical reasons, it is impossible to physically test every single combination of these parameters. A simple calculation can make this clear: testing every seed of 220 cultivars under 3 different light intensities x 3 different “light-to-canopy” distances x 3 different irrigation setups x 2 types of plant positioning = 10,800 possible combinations. Performing trials for each of these combinations for an average of 40 days per trial, one would need 432,000 days of laboratory testing. For 10 labs, this would be the equivalent of 120 years of continuous testing in 10 labs concurrently.

As a solution to this, we have developed the know-how to extrapolate yield numbers for different growth parameters. Yield numbers in this crop guide are either “extrapolations” or “validated trials”. A “validated trial” has been conducted with a 100% exact match of the parameters for a particular growing system. The ‘Crop Guide Plus’ contains all detailed information on validated trials versus extrapolations, and is accessible at the ‘business plan’ stage, and after signing an NDA.

Annex 2: Example

The picture shows a few of the many parameters impacting yield. To clarify the difference between validated and approximate yield, let us use the following example: the UCS Plant Scientists have grown a Romaine lettuce of 20cm (diameter) and 25cm (height) at 25 plants/m under $186 \mu\text{mol}/\text{m}^2/\text{s}$ using ebb & flow irrigation, yielding $70\text{kg}/\text{m}^2/\text{yr}$ with a vegetative growth duration (DAT) of 24 days (validated test).

A client is asking a plant of 15cm (height) and would like to know the yield. Based on the data our Plant Scientists have collected in the past, we can extrapolate that this would result in 51 plants/m having 40% of the weight, with a vegetative growth duration of 18 days and $76\text{kg}/\text{m}^2/\text{yr}$ of yield (approximate yield).



1. Light intensity & spectrum
2. Distance to light & plant height
3. Irrigation method & strategy
4. Planting density

Annex 3: The Diversity of Plants - “Basil is Not Basil”

Basil has multiple end-use applications and there is no such thing as a “universally perfect basil”. Every country, city, or chef can have their specifications on appearance, colour, odour, flavour, and consistency. The most common variety is the ‘Genovese’, which is typically sold in groceries in a transparent clamshell package. Other cultivars have different leaf sizes (XL leaf), aromas (lemon), colour (red), or are more suited for processing into pesto (XL Leaf). Some basil is sold with the roots as “living basil”, which increases shelf life to 3 weeks.

Conclusion 1

The end-use application dictates the customer requirements and product specifications, which can vary widely.

Basil for processing into pesto can yield 70 kg/m²/year (14 lbs/sqft/year) using cultivar “XL Leaf”. The Genovese cultivar is more suited for direct sales in a clamshell to a consumer, a grocery store, or the farmer’s market. For this application, only the tops of the plant can be used, resulting in a usable yield of only 20 kg/m²/year (4 lbs/sqft/year).

Conclusion 2

The growing costs of Genovese can be more than 300% higher than XL Leaf.

At Urban Crop Solutions we have tested 12 cultivars (varieties) of basil in multiple growing conditions. Below are the ones with the highest use in commercial applications. We can advise you on the ‘best fit’ for your region, for your end-use application, and your target customer. In the business planning phase, we can calculate your running costs and expected margins.



MINI



RED



THAI



GENOVESE



XL LEAF

	MINI	RED	THAI	GENOVESE	XL LEAF
Yield bench kg/m ² /yr	46	29	21	64	70
Yield bench lbs/sq.ft./yr	9	6	4	13	14

Annex 4: Crop Pictures

1. Leafy Greens



Batavia Lettuce



Butterhead Lettuce



Cai Dun



Chards



Chop Suey



Choy Sum



Eazyleaf Lettuce



Frisled Iceberg



Green Oakleaf Lettuce



Romaine Lettuce



Kale



Komatsuna



Little Gem Lettuce



Lollo Bionda Lettuce



Mache - Lamb's Lettuce



Mini Romaine Lettuce



Mizuna - Mustard Green



Multiseed - Tricolor



Oakleaf Lettuce Red



Ong Choi



Pak Choi



Red Mustard



Red Russian Kale



Sorrel



Rocket - Rucola - Arugula



Salanova Green - Lettuce



Salanova Red - Lettuce



Red Leaf Lettuce



Spinach



Water Spinach - Chinese



Tatsoi

2. Herbs



Basil - Lemon



Basil - Mini



Basil - Red



Basil - Thai



Basil - Genovese



Catmint



Chervil



Chives



Coriander



Dill



Fennel - Bulbing



Italian Parsley



Marjoram



Mint



Oregano



Pea Shoots



Rosemary



Sage



Shiso



Shiso - Red



Summer Savory



Tarragon



Thyme



Watercress



Artemisa



Astralagus



Eyebright



Lemon Balm



Peppermint



Stevia

3. Medicinal Herbs



St. John's Wort



Valeriana Officinalis

4. Root Crops



Radishes



Turnip

5. Baby Leafy



Baby Spinach



Baby Leaf Lettuce

6. Microgreens



Arugula Wasabi



Arugula



Basil Opal (Red)



Basil



Borage



Broccoli



Coriander



Kohlrabi



Microgreen Mix



Mizuna



Red Stem Radish



Lettuce stay in touch!

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