How to be successful in vertical farming?

Tom Konisser / LED Horticulture
12th of June, 2019
Personal introduction

Me

Work

Life
Agenda

- Introduction
- Possibilities and challenges
- Benefits
- Applications
- Crops
Philips lighting? Signify!

Light sources

Luminares

Systems and Services

No. 1
Conventional. LED, Connected

€7bn
sales in 2017, ~ 75% professional

32,000
people in 70 countries

Top 10
World’s greenest companies

Information owned by Signify not to be shared without permission
Vegetables & fruits
- High wire vegetables
- Leafy vegetables
- Herbs
- Soft fruits

Floriculture
- Cut flowers
- Potted plants
- Perennials
- Annuals

City farming
- Leafy vegetables
- Herbs
- Soft fruits

Others
- Bio based compounds
- Tissue culture
- Research
Our approach

Plant specialist

Horti LED partners

Recipe partners

Application engineer

Account manager

Crop

Lighting

Climate

Control & data

Irrigation

Sensors

Logistics

Grower

Information owned by Signify not to be shared without permission
Possibilities and challenges

Production up:
• Breeding -> specific selections or genetics for indoor farming
• Improved growth recipes-> e.g. red coloring

Cost down:
• Integration of technologies
• Scalability (economies of scale)
• Initial investment down

Adjust solutions to location:
• Greenhouse without daylight when affordable land is available
• Hybrid solution in Western Europe or specialty (niche) markets in West-Europe
• Indoor farms in or near big cities

Educate the market:
• Create awareness with consumers and professional users
Benefits of Vertical farming

Improve Reliability
• Controlled production cycle > increase predictability
• No pressure from disease or climate
• Grow free of pesticides

Optimize Quality
• Improved plant quality and uniformity
• Optimized for taste, color, nutrient content
• Sustainable production

Increase Yield
• Much higher yield than other methods
• Shorter production cycles, year round
• Less waste in value chain, longer shelf life
Benefits of Vertical farming – young plants

**Improve Reliability**
- Fully controlled production cycle
- Year-round young plant availability (=no surprises)
- Year-round consistent young plants

**Optimize Quality**
- Better rooting =faster growth in field
- Improved young plant quality and uniformity
- Disease and pests-free young plants
- Sustainable production, less resources, re-use

**Increase Yield**
- Higher germination rate
- Less losses of plants =higher production
- Faster adaptation in the field
- Shorter propagation cycles
- Very efficient use of floor space
Improving reliability by being able to guarantee minimum residue limits year round

| MRL = Maximum Residue Limit |
| ARfD = Acute Reference Dosage |

| Evaluation NL according to Greenon- en Fruitportaal model |
|---|---|---|---|---|---|---|
| **Approved** | **MRL** | **Sum MRL** | **ARfD** | **Sum ARfD** | **Number of pesticides** | **Pesticide blacklist** |
| Alex NL | YES | ok | ok | --- | ok | ok |
| Lidi NL | YES | ok | --- | ok | ok | --- |
| Plus NL | YES | --- | --- | ok | --- | --- |
| C1000/JUMBO | YES | ok | --- | ok | --- | ok |
| AH | YES | ok | --- | --- | --- | --- |
| Superunië | YES | ok | --- | --- | --- | --- |

| Evaluation DE according to Greenon- en Fruitportaal model |
|---|---|---|---|---|---|---|
| **Approved** | **MRL** | **Sum MRL** | **ARfD** | **Sum ARfD** | **Number of pesticides** | **Pesticide blacklist** |
| Dohle | YES | --- | ok | --- | ok | --- |
| Tegut | YES | ok | --- | ok | --- | ok |
| Tengelmann | YES | ok | ok | ok | --- | --- |
| Plus DE | YES | ok | --- | --- | ok | --- |

| Evaluation DE according to UNIVeG model |
|---|---|---|---|---|---|---|
| **Approved** | **MRL** | **Sum MRL** | **ARfD** | **Sum ARfD** | **Number of pesticides** | **Pesticide blacklist** |
| Alex DE | YES | ok | ok | ok | ok | ok |
| Lidi DE | YES | ok | ok | ok | ok | ok |
| REWE | YES | ok | ok | ok | ok | ok |
| Kaufland | YES | ok | ok | ok | ok | ok |
| Metro | YES | ok | ok | ok | ok | ok |
| Globus | YES | ok | ok | ok | ok | ok |
| Norma | YES | ok | ok | ok | ok | ok |
| Edenka | YES | ok | ok | ok | ok | ok |
| Global 2000 | YES | ok | ok | ok | ok | ok |
**Improve reliability**

by being able to guarantee free of pesticides

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**Analysis report**

<table>
<thead>
<tr>
<th>Analysis report</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>In order of</strong></td>
</tr>
<tr>
<td><strong>Contact</strong></td>
</tr>
<tr>
<td><strong>Address</strong></td>
</tr>
<tr>
<td><strong>City</strong></td>
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<tr>
<td><strong>Sample number</strong></td>
</tr>
<tr>
<td><strong>Identification</strong></td>
</tr>
<tr>
<td><strong>Matrix</strong></td>
</tr>
<tr>
<td><strong>Variety</strong></td>
</tr>
<tr>
<td><strong>Country of origin</strong></td>
</tr>
<tr>
<td><strong>Grower</strong></td>
</tr>
</tbody>
</table>

The analyzed pesticides are documented on form DRF-133 version 11 valid from 02-01-15.

**Pesticide (GC-MSMS)**

- **No pesticides at a content above the limit of quantitation were detected.**

**Pesticide (LC-MSMS)**

- **No pesticides at a content above the limit of quantitation were detected.**

**Additional information concerning the sample:**

Clopyralid and Fosetyl-Aluminium cannot be detected.

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**MRL** = Maximum Residue Limit  
**ARfD** = Acute Reference Dosage
Optimize quality...
and guarantee the nutritional value of your produce

Proven results from research into nutrient content carried out at the Philips GrowWise Center:

- Pre-harvest LED lighting treatment to increase vitamin C content of rocket
- Pre-harvest LED lighting treatment increases flavonols in spinach and arugula
- Special light recipe to enhance red coloration in lettuce
- Brix in strawberries increased from an average of 6 in greenhouse production to 9.5 in vertical farm
- Volatiles in basil can be steered to improve flavor and essential oil content
- Special Philips Growth Recipes influence nitrate levels in rocket, lettuce and spinach
**Optimize quality...**
by increasing vitamin C with pre harvest light treatment

Vitamin C is a powerful antioxidant. It protects your body from the damage of free radicals, toxic chemicals and pollutants.

Eating 50g of ‘our’ rocket salad provides the dietary recommendation (RDA) of 75mg in vitamin C.
Optimize quality...
by increasing yield and coloration of red lettuce

Lollo rosso
Red Salanova
Red Oak
Increase yield... 
by managing and optimizing most of the variables 
that influence shelf life

Pre – and post harvest factors like:
- Light (spectrum, intensity)
- Climate (temperature, humidity)
- Irrigation
- Bacterial count
- Nutritional value
- Visual appearance

![Diagram showing shelf life and quality decay](chart.png)

- Traditional growth methods
- Vertical farming
- Vertical farming optimized to extend shelf life
# Applications of indoor farming

<table>
<thead>
<tr>
<th>LEVEL OF... PER APPLICATION</th>
<th>GREENHOUSE HYDROPONICS</th>
<th>GREENHOUSE WITHOUT DAYLIGHT (SINGLE &amp; MULTILAYER)</th>
<th>VERTICAL FARM</th>
<th>HYBRID (GREENHOUSE &amp; VERTICAL FARM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTOMATION &amp; TECHNOLOGY</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿</td>
</tr>
<tr>
<td>CONTROL OF PRODUCTION PROCESS</td>
<td>🌿🌿🌿🌿🌿 (daylight dependent)</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿 young plant phase</td>
</tr>
<tr>
<td>REDUCE IMPACT FROM OUTSIDE</td>
<td>🌿🌿🌿🌿🌿 semi closed, limited impact</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿 strong start</td>
</tr>
<tr>
<td>QUALITY</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿 Steering on nutrient content possible</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿 Fast start, stronger plant</td>
</tr>
<tr>
<td>YIELD</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿 low waste</td>
<td>🌿🌿🌿🌿🌿</td>
<td>🌿🌿🌿🌿🌿</td>
</tr>
</tbody>
</table>
Siberia (NL)

- **Background:** Building new greenhouse
- **Challenge:** Year round supply at consistent higher quality
- **Solution:** > 900,000 ft² with Greenpower LED Top Lighting
- **Sales channel:** Retail (EU)

“The lettuce is growing even faster than I had expected.”
80 Acres (US)

- **Background:** Building new greenhouse without glass
- **Challenge:** Offer broad range of products to become category captain
- **Current solution:** 3500 ft² with 450 micromol/m²/sec Full LED
- **Sales channel:** US Retail

"Growing in a controlled environment enables us to focus on what really matters to our customers: quality and nutrition."
808Factory (JP)

- **Background:** Building new vertical farm
- **Challenge:** Consumer demand for safe and chemical-free vegetables
- **Solution:** 50000 square feet with Production Modules
- **Sales channel:** Retail (JP)

“
We have achieved cost-cutting and improved vegetable growth rates upon installation of Philips LED.”
Delissen (NL)

- **Background:** Building new greenhouse
- **Challenge:** Increase quality of and flexibility
- **Solution:** 50000 square feet with 152 micromol/m²/sec Production Module
- **Sales channel:** EU Retail

“"We have increased the quality of the plants due to a conditioned cultivation process.”"
Positive results achieved with diverse crops at Philips GrowWise Centre

- Lettuce (different types & varieties)
- Baby leaf (arugula, kale, lettuce, spinach, Asian greens and many others)
- Herbs (basil, cilantro, dill)
- Microgreens (various types)
- Soft fruits (strawberry, melon)
- Cucumber
- Tomato
- Brassicaceae
- And many more
Crops - Lettuce

- Butterhead
  - Aquino (RZ)
  - Cecilia (RZ)
  - Nuria (RZ)
  - Flandria (RZ)
  - Nuria (RZ)
- Salanova / frill type
  - Expertise (RZ)
  - Excite (RZ)
  - Extemp (RZ)
  - Exaudio (RZ)
  - Exfiles (RZ)
  - Exographie (RZ)
  - Expedition (RZ)
  - Experience (RZ)
  - Extender (RZ)
  - KNOX Exam (RZ)
  - Trinidad (RZ)
  - Vidotex (RZ)
  - Codex (RZ)
  - Haflex (RZ)
  - Blastex (RZ)
- Cos
  - Madelona (RZ)
  - Rafael (RZ)
  - Auvona (RZ)
  - Requena (RZ)
- Gem
  - Tudela
  - Bambi
  - Olita
  - Astorga
  - 41-655 (RZ)
  - 41-402 (RZ)
  - Requena (RZ)
  - Tarifa (RZ)
  - Thurinus (RZ)
  - Pazmanea (RZ)
Crops – Babyleafs

- Mustardleaf
  - Frizzy Lizzy
  - Frizzy joe
  - Pizzo
  - Red
- Arugula
  - Anastasia (Enza)
  - Belezia (Enza)
  - Grazia (Enza)
  - Leticia (Enza)
  - Coltivata (Enza)
  - Tricia (Enza)
  - Pronto (CN seeds)
  - Uber (CN seeds)
- Spinach
  - Ranchero (ENZA)
  - E03E (ENZA)
  - Chevelle (ENZA)
  - Shelby (ENZA)
  - Yabi (ENZA)
- Remex
  - sanguineus
  - Rumex
- Kale
  - Red Russian
  - Toscano
  - Scarlet
  - Dwarf (blue / green / curled)
- Mizuna
Crops - Brassicaceae

- Broccoli
- Bimi
- Kohlrabi
- Pakchoi
  - Regular
  - Dwarf
  - Arax
  - Mini
- Cauliflower
- Radish
  - Red
  - White
  - Rosa
- Kale
  - Red Russian
Crops – Young plants

✓ Iceberg lettuce
✓ Coss
✓ Frill lettuce
✓ Cabbage
  ✓ Chinese cabbage
  ✓ Pakchoy (different varieties)
✓ Broccoli
✓ Cauliflower
✓ Kohlrabi
✓ Tomato
✓ Strawberry young plants
  ✓ Portola
  ✓ Albion
  ✓ Harmony and more
✓ Floriculture
Conclusions

• Vertical farming offers many opportunities to improve fresh produce: reliability, quality, yield...
  • to reduce waste in the value chain
  • to produce local without use of pesticides

• And will become more mainstream as cost will go down and revenue will go up over time by...
  • integration and standardization of technologies
  • breeding of specific varieties for indoor cultivation

• Together with you we can develop the optimum solution for cultivation with LED lighting in a protected environment
Questions?

Please come and visit us at Greentech for more information:

- Hall 8 booth 561-563 Signify / CityFarming
- Hall 12 booth 101 Signify / Horticulture LED Solutions

or visit our websites at

www.philips.com/horti
www.philips.com/cityfarming