



VertiFarm 2019

International workshop on vertical
farming

13-15 October 2019

Wageningen, The Netherlands



A new vision on plant production

The world population is rapidly growing from about 7 today to 9.5 billion people in 2050 and eating habits are changing. The demand for high quality fresh vegetables that are safe, healthy, tasty, and sustainably produced within or near urban areas is strongly increasing. This requires a new vision on food production and distribution. Vertical farming offers a new route that could fit future urban food systems. Vertical farming is a rapidly developing technology where plants are grown under fully controlled conditions in buildings in many stacked layers without solar light. Other terms used for this type of vertical farms are city farms, indoor farms, or plant factory with artificial light (PFAL). Vertical farming is a next level production system, which allows production of plants at any place including the most urbanised regions of the world. The use of LED light and the full control of both the aboveground and belowground conditions in combination with the right cultivar, enables growers to produce products with extra added value, which appeal to the demand of consumers for safe, reliable, and tasty, nutritious food.



VertiFarm2019: Workshop on vertical farming
13-15 October 2019
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The Workshop

It is now time for the first international workshop on Vertical Farming, organised under the auspices of the International Society for Horticultural Science.

The workshop combines a number of oral presentations of world leading horticultural researchers, panel discussions with renowned companies, short oral and poster presentations on the latest research results on vertical farming. The workshop welcomes scientific presentations on all aspects of vertical farming, ranging from plant physiology, breeding, climate control, engineering, systems design, urban planning, economics, consumer demands and business development. Although at this moment vertical farming largely deals with vegetables, there are also opportunities for production of ornamental (young) plants. Therefore, the workshop also welcomes presentations on ornamentals in vertical farms.

You are most welcome to attend the workshop from 13 to 15 October on the Campus of Wageningen University the Netherlands. If you want to be sure to have a place at the workshop, register now.



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Keynote speakers

Eri Hayashi, Japan Plant Factory Association (Japan)

Global R&D and business trends of plant factories toward inclusive and sustainable societies

Murat Kacira, University of Arizona (USA):

Climate control

Luuk Graamans, Wageningen UR & TU Delft (the Netherlands)

Greenhouses or vertical farms? Future perspectives for cities in the light of resource use efficiency

Erik Runkle, Michigan State University (USA)

Spectral manipulations to elicit desired plant quality attributes

Qichang Yang, CAAS, Institute for urban agriculture (China)

Current status of vertical farming and its development of energy saving technologies in China

Bruce Bugbee, Utah State University (USA)

Turning photons into food: Modelling the potential of indoor agriculture

Marie-Christine Van Labeke, Ghent University (Belgium)

Multilayer production of ornamentals: light on young plants

Danny Geelen, Ghent University (Belgium)

Plant health in a controlled environment and the impact of organic nutrition

Emiel Wubben, Wageningen UR (the Netherlands)

Vertical Farming: Where is the business? A study into its business types and business models

Francesco Orsini, Bologna University (Italy)

Sustainable use of resources in indoor farms with artificial lighting

Invited speakers

Dorthe Larsen, Wageningen UR (the Netherlands)

Improving quality and secondary metabolite content in basil with LED light

Qianxixi Min, Wageningen UR (the Netherlands)

Producing lettuce with longer shelf life by short-term pre-harvest lighting

Sharath Kumar Malleshaiah, Wageningen UR (the Netherlands):

Control of flowering in vertical farms: case study on Chrysanthemum

Wenqing Jin, Wageningen UR (the Netherlands)

Effects of farred light on growth and development of lettuce

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Speakers from companies during panel discussions

- David Hu, Sananbio, China
- Katashi Kai, 808Factory, Japan
- David Proenza, Urban Farms Global, Panama
- Pavlos Kalaitzoglou, Infarm, Germany
- John Bijl, OwnGreens & VitroPlus, The Netherlands
- Céline Nicole, Philips lighting (Signify), The Netherlands
- Johan Lindqvist, Heliospectra, Sweden
- Theo Tekstra, Fluence Bioengineering/Osram, The Netherlands
- Jan Westra, Priva, The Netherlands
- Pim Molenaars, Rockwool Grodan, The Netherlands
- Martin Veenstra, Certhon, The Netherlands
- Peter Visser, Basf, (Nunhems), The Netherlands

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Registration fee

	Early bird (before 1 Aug)	Regular (after 1 Aug)
ISHS member	265	315
Non-ISHS Member	330	380
Dinner (14 Oct)	50	50

The fee for Non-ISHS members includes the fee for a one year membership of ISHS (International Society for Horticultural Science; www.ishs.org). Hence you can benefit for one year from ISHS membership.

The registration fee includes the welcome reception, coffee/tea, lunches, bites & drinks.

Registration closes 6 October.



Poster Presentations

There is ample time for poster presentations and discussions. Poster presenters can apply for presenting also a poster pitch (3 minutes oral talk). Titles for poster pitches must be submitted before 1 July (no abstract needed)

Notification of poster acceptance will be 15 July.

Postersize: A0 format, portrait

Sponsoring

There are several options for sponsoring, including small booths.

Practical Information

Info on accommodation and travel can be found at www.wur.eu/vertifarm2019

Registration and further information

For registration, sponsorship and further information see the website of the workshop: www.wur.eu/vertifarm2019

Contact

Questions about registration:

Niek Botden,

Niek.Botden@hortilink.nl

All other questions (programme, sponsorship):

Leo Marcelis,

Leo.Marcelis@wur.nl

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Programme

Sunday 13 October

Location: WICC, Lawickse Allee 9, Wageningen

5:00-8:00 PM Registration

6:00-9:00 PM Welcome reception

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Programme

Monday 14 October

Location: Orion, Bronland 1, Wageningen

8:00 Registration (Ground floor), mounting posters (Floor 3)

Room: 'Waaierzaal', Floor 1

9:00 Opening (*Leo Marcelis, Murat Kacira, Francesco Orsini*)

9:10 Eri Hayashi

Global R&D and business trends of plant factories toward inclusive and sustainable societies

9:45 Murat Kacira

Climate control

10:20 Break (Ground floor)

10:50 Luuk Graamans

Greenhouses or vertical farms? Future perspectives for cities in the light of resource use efficiency

11:25 Panel Discussion with companies (*Sananbio, 808Factory, Urban Farms Global*)

11:55 Poster pitches (parallel sessions; 'Waaierzaal' and 'Noordzaal')

12:30 Lunch (Ground Floor)

13:30 Poster presentations (Floor 3)

13:30-16:30 What is necessary to take vertical farming to the next level?

Interactive session organised by Association for Vertical farming ('Noordzaal')

14:30 Dorthe Larsen ('Waaierzaal')

Improving quality and secondary metabolite content in basil with LED light

14:50 Wenqing Jin

Effects of farred light on growth and development of lettuce

15:10 Francesco Orsini

Sustainable use of resources in indoor farms with artificial lighting

15:45 Break (Ground floor)

16:15 Danny Geelen

Plant health in a controlled environment and the impact of organic nutrition

16:50 Panel Discussion with companies (*Priva, Grodan, Certhon*)

17:20 Closure

19.00 Workshop dinner (*Location: WICC, Lawickse Allee 9, Wageningen*)

VertiFarm2019: Workshop on vertical farming



Programme

Tuesday 15 October

Location: Orion, Bronland 1, Wageningen

Room: 'Waaierzaal', Floor 1

9:00 Qichang Yang

Current status of vertical farming and its development of energy saving technologies in China

9:35 Erik Runkle

Spectral manipulations to elicit desired plant quality attributes

10:20 Break (Ground floor)

10:40 Bruce Bugbee

Turning photons into food: Modelling the potential of indoor agriculture

11:15 Panel Discussion with companies (Own Greens, Infarm, Basf)

11:45 Poster pitches

12:20 Lunch (Ground floor)

13:20 Poster presentations (Floor 3)

13:20 Successful business models for vertical farming

interactive session organised by Gus van der Feltz, the Farm Tech Society)

14:20 Qianxixi Min

Producing lettuce with longer shelf life by short-term pre-harvest lighting

14:40 Sharath Kumar Malleshaiah

Control of flowering in vertical farms: case study on Chrysanthemum

15:00 Marie-Christine Van Labeke

Multilayer production of ornamentals: light on young plants

15:35 Break (Ground floor)

16:15 Emiel Wubben

Vertical Farming: Where is the business? A study into its business types and business models

16:40 Panel Discussion with lighting companies (Signify, Fluence, Heliospectra)

17:10 Drinks & Bites (Ground floor)

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Convenors



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Prof Dr Leo Marcelis

www.hpp.wur.nl

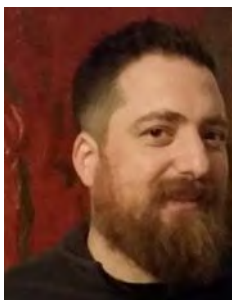


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Prof Dr Murat Kacira

<http://ceac.arizona.edu/>



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Dr Francesco Orsini

<https://site.unibo.it/rescue-ab/en>

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VertiFarm 2019 is sponsored by:



Light for Urban Farming



Poster pitches

Monday 11:55-12:30

Parallel session 1

Lecture room 'Waaierzaal'

Poster no	Presenter	Title	Authors
1	Celina Gomez	The Ultimate Plug	Celina Gómez, Paul Fisher, and Megha Poudel
3	Annemieke Roobeek	GrwNxt: International Data-driven Infrastructure for Feeding Megacities	Annemieke Roobeek
5	Tjerk Reijenga	Factory renovation to multi-functional building with urban farming	Tjerk Reijenga
7	Ying Liu	The effect of blue light on anthocyanin accumulation in pepper fruits	Ying Liu; Rob E. Schouten; Yury Tikunov; Arnaud Bovy; Richard G. F. Visser; Xinxuan Liu; Leo F.M. Marcelis
9	Aina Prinzenberg	LED vs. HPS light: effects on tomato greenhouse cultivation and breeding potentials	Aina E. Prinzenberg, Hanneke van der Schoot, Leo Marcelis, Richard Visser, Ep Heuvelink and Henk Schouten
11	Janina Gajc-Wolska	Effect of LED lighting on the yielding of tomato and cucumber grown on mineral wool	Janina Gajc-Wolska; Katarzyna Kowalczyk; Malgorzata Mirgos; Anna Geszprych
13	Katarzyna Kowalczyk	Effect of LED lighting on the quality of tomato fruit	Katarzyna Kowalczyk; Janina Gajc-Wolska; Malgorzata Mirgos; Anna Geszprych; Monika Maria Niedzinska; Jadwiga Radzanowska
15	Anna Geszprych	Effect of LED lighting on the yield and quality of lettuce grown in NFT system	Anna Geszprych; Katarzyna Kowalczyk; Malgorzata Mirgos; Jaroslaw Leon Przybyl; Monika Maria Niedzinska; Julita Grams; Janina Gajc-Wolska
17	Kun Li	Optimization of a New Technique for High-efficiency Microclimate Regulation and its Effects on Lettuce Growth in a Plant Factory	Zhirong Zou; Qichang Yang; Kun Li
19	Yuexiang Chen	A method of quantifying the Climate Distribution and Yield Prediction in a Vertical Farm	Yuexiang Chen; Simon van Mourik; Esteban Baeza Romero; Eldert van Henten

Poster pitches

Monday 11:55-12:30

Parallel session 2

Lecture room 'Noordzaal'

Poster no	Presenter	Title	Authors
21	Mahya Tavan	Optimised photoperiod, fertilization, and growing substrate influences yield and nutritional quality of hydroponically grown microgreens	MAHYA TAVAN, ALEXIS PANG, SIGFREDO FUENTES; DORIN GUPTA
23	Annie Drottberger	Adoption of technical innovations in production of greenhouse vegetables in Sweden	Annie Drottberger; Sara Spendrup; Lena Ekelund Axelson
25	Katsumi Ohyama	A trial of sustainable lettuce production in a large-scale vertical farm at Osaka Prefecture University	Katsumi Ohyama
27	David Katzin	A model for predicting energy use in controlled environment agriculture	David Katzin, Simon van Mourik, Anja Dieleman, Eldert van Henten
29	Dafni Avgoustaki	Optimization of energy consumption cost in vertical farms under different photoperiods	Avgoustaki Dafni D.
31	Gang Wu	Photothermal/day lighting performance analysis of a multifunctional solid compound parabolic concentrator for an active solar greenhouse roof	Gang Wu
33	Most Tahera Naznin	Indoor vertical farming in Sweden	Most Tahera Naznin and Beatrix Alsanius
35	Shumin Wang	vertical aquaponics	shumin wang; Zhenyan xu
37	Felix Thoma	Effects of Light on Secondary Metabolites in Consumable Leafy Greens	Felix Thoma; Annette Somborn-Schulz; Dennis Schlehüser; Volkmar Keuter
39	Yoshiaki Kitaya	Plant and fish growth and nitrogen flow in aquaponics integrated with lettuce hydroponics and loach aquaculture in vertical farming	Yoshiaki Kitay; Yotsuba Shimakawa; Teruo Wada; Toshio Shibuya; Ryosuke Endo; Masumi Kikuchi; Kenji Nakamura

Poster pitches

Tuesday 11:45-12:20

Lecture room 'Waaierzaal'

Poster no	Presenter	Title	Authors
2	Yongran Ji	FR stimulated fruit growth in tomato.	Yongran Ji
4	Cecilia Stanghellini	Growing recipes for lettuce in vertical farms and lighted greenhouses	C. Stanghellini; M. Butturini; L. Carotti; F. Pukic; L. Graamans
6	Thomas Bartzanas	Design and optimization of a controlled environment food production unit for space applications	Thomas Bartzanas, Avgoustos Pantazidis, Maria Kontogianni, George Profitiliotis
8	Yuqi Zhang	UVA Radiation Stimulates Production and Quality of Indoor Cultivated Lettuce	Yongcheng Chen; Jie Zou; Yating Zhang; Yuqi Zhang; Qichang Yang; Tao li
10	Ivan Tarakanov	Playing with light in a plant factory: Lifehacks from Nature	Ivan Tarakanov; Nikolay Sleptsov; Alina Ivanitskikh
12	Sissel Torre	Light quality as a tool to prevent tipburn in lettuce	Sissel Torre; Martin C Knoop; William C Rudolph-Lund; Ida K Hagen
14	Vanessa Lau	Increasing Organically Fertilized Hydroponic Yield	Vanessa Lau; Neil Mattson
16	Hayriye Yildiz Dasgan	Effects of Bio-Fertiliser Microalgae <i>Chlorella Vulgaris</i> on Hydroponically Grown Lettuce	H. Yildiz Dasgan, Onur Ergün
18	Emmy Dhooghe	Promoting plant quality in a multilayer growing system: focus on LED light and growing media	Emmy Dhooghe; Ellen De Keyser; Bart Vandecasteele; Johan Van Huylenbroeck
20	Martina Lazzarin	Does the diurnal variation in light quantity contribute to an efficient? photoprotection?	Martina Lazzarin - Wim van Ieperen - Leo Marcelis

Monday 13:30-14:25 Posters presentations (Floor 3)

On Monday all posters with uneven number will be presented.

Authors are expected to be at their poster

For titles of Poster with uneven number 1-39 see list of poster pitches

Poster no	Presenter	Title	Authors
41	Evelien Van Tongerlo	Accelerating Phalaenopsis cultivation by vertical farming	E. van Tongerlo; W. van Ieperen; J.A. Dieleman; L.F.M. Marcelis
43	Hua Li	Effect of postharvest LED light on strawberry fruit quality	Hua Li, Ruimin Cao, Dorthe H. Larsen, Rob Schouten, Ernst Woltering, Leo Marcelis
45	Phoebe Sutton	Carotenoid and Tocopherol Synthesis Through LED Lighting Regimes in Hydroponically Produced Herbs	Phoebe Sutton, Dr Paul Challinor, Dr Martin McAinsh and Dr Gabriela Toldeo-Ortiz
47	Adam Friend	Beyond Leafy Greens: Indoor Production of Perennial Fruit Crops	Adam Friend; Robert Schaffer; David Chagné; Ed Morgan; Samantha Baldwin; Toshi Foster
49	Takashi Ikeda	Strawberry Production in Vertical Farm (Plant Factory)	Takashi Ikeda
51	Koichi Okayasu	Factors Required for Lettuce Production in Plant Factory Business - Case of Vitamin farm in Fukui, Japan -	Koichi Okayasu; Ryonetsu Kogyo Vitaminfarm Co., Ltd.
53	Gang Wu	Photothermal day lighting performance analysis of a multifunctional solid compound parabolic concentrator for an active solar greenhouse	Gang Wu; Qichang Yang
55	Isabela Scavacini De Freitas	Indoor and greenhouse growth of basil in Southeastern Brazil: a comparison study	Isabela Scavacini de Freitas; Nathalie de Jail; Fernando Silveira; Alessandro Sabino; Simone da Costa Mello
57	Victor Takazi Katayama	SUSKULT - A platform for the sustainable integration of vertical farming and resource recovery from wastewaters	Victor Takazi Katayama; Volkmar Keuter
59	Alex Humberto Calori	Effect of light-emitting diodes (LED) spectra on lettuce grown aeroponically	Alex Humberto Calori; Thiago Leandro Factor; Luis Felipe Villani Purquerio
61	Luis Felipe Villani Purquerio	Basil plant growth and quality in function of light-emitting diodes (LED) spectra	Luis Felipe Villani Purquerio; Alex Humberto Calori; Thiago Leandro Factor
63	Priscilla Malcolm Matamoros	Vulnerability to cavitation acclimates to changes in R:FR-ratio in tomato plants	Priscila Malcolm Matamoros; Leo Marcelis, Wim van Ieperen
65	Dorthe Larsen	Preharvest light for postharvest quality of basil	Dorthe H. Larsen; Julian Verdonk; Celine Nicole; Leo Marcelis; Ernst Woltering
67	Patricia Silva	Some experiences in vertical farming in Brazil	Nascimento,W.M; Silva, P.P.

Tuesday 13:20-14:15 Posters presentations (Floor 3)

On Tuesday all posters with even number will be presented.

Authors are expected to be at their poster

For titles of Poster with even number 2-20 see list of poster pitches

Poster no	Presenter	Title	Authors
22	Benjamin Barnes	Efficiency savings for commercial vegetable production	Ben Barnes
24	Lena Ekelund Axelson	Adoption of technical innovations in production of greenhouse vegetables in Sweden	Annie Drottberger; Sara Spendrup; Lena Ekelund Axelson
26	Marina Arias-Royo	The Air Project (Aerial Inulin and Rubber).	Marina Arias-Royo; Jelle Geurts; Anker Sørensen; Rolf Mank; Peter van Dijk.
28	Annie Drottberger	Adoption of technical innovations in production of greenhouse vegetables in Sweden	Annie Drottberger; Sara Spendrup; Lena Ekelund Axelson; Fredrik Fernqvist; Karl-Johan Bergstrand
30	Sander Van Delden	PlasmaPonics- Precision Horticulture with Locally Plasma-Produced Nitrogen Fertilizers	Sander.H. van Delden; Marc Escribà Gelonch; Sirui Li; Hamid.R. Godini; Volker Hessel; Fausto Gallucci; and Leo F.M. Marcelis
32	Javier Lomas	Kentia's root climate discovery and improvement.	Guanyi Chen, Javier Lomas
34	Dianfan Zhou	Water and nitrogen use efficiencies of field and greenhouse production	Dianfan Zhou; Matthew Wilson; Leo Marcelis; Ep Heuvelink; Holger Meinke
36	Graham Taylor	Hy4Dense: Developing hydroponic systems for vegetables sown at high density	Graham Taylor; Lydia Smith
38	Angela Pedroso Tonon	LEDs lighting as an alternative to increase production: Analysis of environmental impact in buildings plants cultivation systems.	Angela Pedroso Tonon; Gara Villalba; Joan Liesa; Xavier Gabarrell Durany
40	Nikolay Sleptsov	Correlation between changes in far-red light intensity and leaf nyctinastic movements in Phaseolus vulgaris plants	Nikolay Sleptsov, Ivan Tarakanov

Tuesday 13:20-14:15 Posters presentations (Floor 3)

On Tuesday all posters with even number will be presented.

Authors are expected to be at their poster

For titles of Poster with even number 2-20 see list of poster pitches

Poster no	Presenter	Title	Authors
42	Warley Nascimento	Some experiences in vertical farming in Brazil	Nascimento,W.M; Silva, P.P.
44	Thijs Van Gerrewey	The relationship between substrate composition, lettuce yield and quality under different microbial treatments in indoor vertical farming	Thijs Van Gerrewey; Nele Ameloot; Oscar Navarrete; Maarten Vandecruys; Maaïke Perneel; Nico Boon; Danny Geelen
46	Maurice L Robinson	Using vertical farming and other hydroponic methods as part of an educational program for the community	M.L. Robinson, Angela O'Callaghan, Jeff Anderson, Trisha Braxton
48	Muhammad Umer Aslam	Properties and Appearance Analysis of Synthase Genes Involved in Floral-Scent Formation in Flowers: A Case Study	Muhammad Umer Aslam
50	Oula Ghannoum	Protected Cropping: use of Smart Glass to reduce energy cost in future climates	Oula Ghannoum; Sachin Chavan; Zhonghua Chen; Chris Cazzonelli; Chelsea Maier; Han Lin; Baohua Jia; David Tissue
52	Nikita Makhalin	Russian Vertical Farming	
54	Giuseppe Carlo Modarelli	LEDs photoperiodic lighting to promote flowering of two Ranunculus asiaticus L. hybrids	Giuseppe Carlo Modarelli; Carmen Arena, Emilia Dell'Aversana; Giovanna Marta Fusco; Stefania De Pascale; Roberta Paradiso
56	Ana Cristina Zepeda	Interacting Effects of Temperature Integration and Light Intensity on Growth and Development of Young Tomato Plants	Cristina Zepeda, Ep Heuvelink, Leo Marcelis
58	Alejandro Bustamante	Light stress in tomato plants grown under high humidity.	Alejandro J. Bustamante D.; Wim van Ieperen; Leo F.M. Marcelis
60	Christoph Carlen	Comparison of lettuce growth in hydroponic and in aeroponics under HPS-light	Christoph Carlen; Céline Gilli
62	Leo Marcelis	Green cucumbers in the red: Better yield under white than primarily red spectrum	Ep Heuvelink, Tijmen Kerstens, Joke Oosterkamp, Theoharis Ouzounis, Leo Marcelis
64	Leo Marcelis	Viability of broad-spectrum LED as a substitute for HPS in greenhouse tomato	Ep Heuvelink, Tijmen Kerstens, Joke Oosterkamp, Theoharis Ouzounis, Leo Marcelis
66	Kfar Vradim	TAPKIT Affordable hydroponics	Shay Zeltzer
68	Elias Kaiser	Should plants be woken up gently? Idea for modelling gas exchange dynamics	Elias Kaiser



Kick-off Urban Greenhouse Challenge'2

VertiFarm 2019 hosts the opening event of the second edition of the Urban Greenhouse Challenge, a cutting-edge, international student competition.

Multidisciplinary student teams are challenged to bring professional food production (back) into urban neighbourhoods integrating social, economic, environmental and technical aspects in one coherent concept. In the second edition of the Challenge they need to design an iconic and circular urban greenhouse for an exciting location in the Greater Bay Area in China. The design has to (1) produce safe and healthy food for the local neighbourhood and commercial markets, and (2) stimulate a healthy lifestyle and interactions with city dwellers.

The opening event will feature a speaker on the topic of urban farming (to be announced) as well as words of welcome from the organizers and a moment to look back at the first edition.

Visit the UCG'2-website for more information: <https://urbangreenhousechallenge.nl/>

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Venue of the workshop

Orion
Bronland 1 (Building 103)
Wageningen Campus
Wageningen
The Netherlands
[https://www.wur.nl/nl/locatie/
Orion-building-number-
103.htm](https://www.wur.nl/nl/locatie/Orion-building-number-103.htm)



Location for Welcome reception (Sunday) and Dinner (Monday)

WICC
Lawickse Allee 9
Wageningen
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www.wicc.nl



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