world horti center
growing the future

Centre for Sustainability
Leiden-Delft-Erasmus Universities

Sustainable Horticulture

Assignment 1

Application of daylight in closed cultivation systems

Problem statement

Production of plants within closed cultivation systems (vertical or indoor farming) is completely dependent on the application of artificial lighting. This takes a lot of energy. Is it possible to use daylight to reduce energy consumption in order to make growing in closed environments more sustainable?

Research question

Is it possible to capture daylight and bring it into the closed cultivation environment in a concentrated way via fiberglass or could this be done in other ways?

Organization involved

Artechno
www.artechno.nl

Suggested academic backgrounds

- Sustainable Energy Technology (TUD)
- Robotics (TUD)

Expected type of work

Technical study

Assignment 2

Speed up the access to fair and honest food, by using robots, AI, sensors, substrates and VR/AR

Problem statement

Society is making increasingly strict demands on the way in which food is produced. The development and application of new techniques is essential in this regard. Can you help speed up access to fair and honest food?

We as Logiqs dream of these techniques:

- **Robots**, which do the cultivation operations and thus ensure uniformity and accurate measurements of plants, so that we have very good data about the growth of plants.
- **AI**, which uses data from nurseries around the world to create increasingly better growing recipes, using those recipes all over the world
- **Sensors** that very accurately measure everything in and around the plants
- **Substrates** on which the plants grow that are sustainable and uniform. Share data safely and fairly, so that the purpose of "accelerate access to honest food" works
- Supporting customers around the world with **VR/AR** with the minor problems that arise.

We now have this knowledge:

- By growing vegetables and fruit in a greenhouse, production is more predictable, water consumption is less and few fertilizers and pesticides are released into the environment
- By growing fruit and vegetables in a vertical farm, production is predictable, water consumption is minimal and no fertilizers and pesticides are released into the environment
- Greenhouses often require heating or cooling and vertical farms require a lot of electricity and cooling, which can contribute to extra CO_2 in the atmosphere
- Plants adapt to the circumstances and how plants react to the circumstances also depends on their history.
- Plants grow better if the air moves from bottom to top along the leaves
- Red light is the most energy efficient, but plants also need blue, far red and green to get the right shape.
- When growing in a greenhouse or hall, large temperature differences often occur. As a result, the RH is sometimes 100%, resulting in fungi and diseases, or in other places much lower, so that the plant keeps the stomata closed and no CO_2 is available for photosynthesis

But soon we will need:

- Accurate measurement of PH, temperature and RH, leaf temperature for leaves on all levels and Ion content measurements of all fertilizers
- Models of the plant
- Ways to get high levels of vitamins
- Grow recipes that adapt to different market demands from day to day Robots for sowing, transplanting, packaging harvesting
- Set up a production line for something that has never been produced on that scale
- Set up distribution and support worldwide

Research question(s)

Can you help speed up access to fair food? What's your dream? What do you want to investigate? We are looking for master thesis researchers on:

- AI
- Software development
- Industrialization of all our products
- Mechatronics for internal transport machines, robots, cleaning
- Controls for these machines
- Set up a secure data structure that helps every player in the chain without having to share sensitive data
- Knowledge of plants and irrigation
- Sensor technology, both optical, as well as air and water characteristics

Organization involved

Logiqs
www.logiqs.nl

Suggested academic backgrounds

- Robotics (TUD)
- Biology (Leiden)
- Management of Technology (TUD)
- Computer Engineering (TUD)
- Systems and Control (TUD)

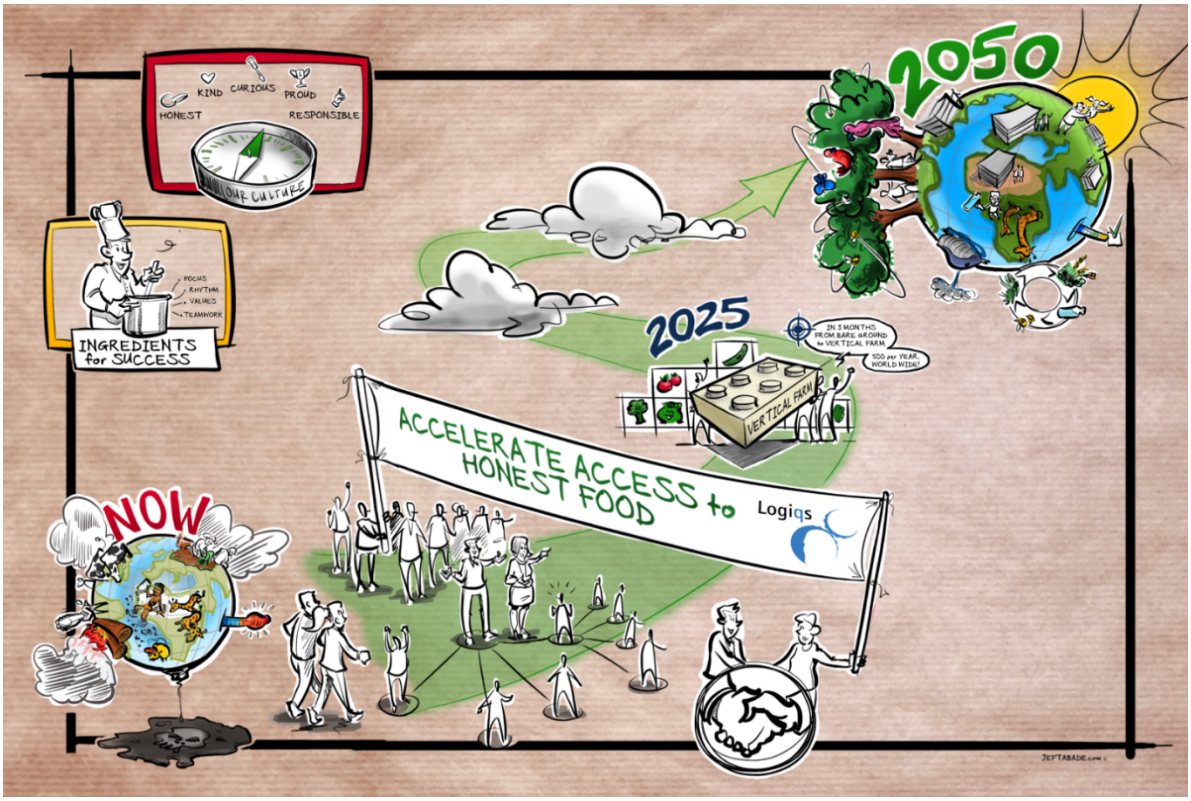
Background information

This is what the world looks like now:

- Supermarkets want cheap food on the shelves that has a long shelf life. Playing healthy and having fun does not count and public health suffers.
- Producers grow this and use manure, pesticides and lots of fresh water to grow it. Many of those fertilizers and pesticides end up in the environment
- There is a complicated chain to ensure that there is always food on the shelves, with a lot of waste and transport to make that happen The food that is there is distributed unfairly

But soon…

- Can you opt for tasty and healthy food that is sustainably grown
- Without waste and without negative effects on the earth.
- And available to everyone
- Share cultivation data and technology freely without restrictions, which does not benefit everyone



We now have these techniques:

- A combination of multi-layer growing and updraft
- Logistics hardware and software for multi-layer cultivation and processing in a central area, by moving 6 m^2 cultivation tables through the nursery with lifts and shuttles
- Climate control of air per unit of 6 m^2
- Control irrigation and feeding via fertilizers per unit of 6 m^2
- Bringing light very homogeneously to plants and regulate it per color per unit of 6 m^2

Assignment 3

How to transform and implement Dutch Greenhouse knowledge and technology into Sub Sahara Africa to feed the growing and urbanizing population?

Problem statement

The African continent and mainly Sub Sahara Africa is facing fast growth of population and urbanization, roughly meaning that African agriculture has to double its production taking care of environmental limitations and a changing both rural and urban society. The current African agricultural practices will be not be able to keep with this demand. To quote of the leading agro-entrepreneurs in Nigeria, Samson Ogbole: *"Food production should not be seasonal because hunger is not seasonal".*

Dutch protective cultivation methods in Greenhouse can be an example and technology base to transform this African production. But there's a knowledge gap. How to come across this gap. How can the technology and knowledge be adjusted so that it can be implemented in Sub Sahara Africa, so that's it relates to both the people, planet and profit aspects at hand.

Research question(s)

How to transform and implement Dutch Greenhouse knowledge and technology into Sub Sahara Africa to feed the growing and urbanizing population?

Organization involved

Seed2Feed Foundation
www.seed2feed.net

Suggested academic backgrounds

- Management of Technology (TUD)
- African Studies (Leiden)
- Innovation Management (Erasmus)

Assignment 4

How to create a plant watering system based on the latest technology insights, that's optimizes plant growth and minimizes water and nutrients use?

Problem statement

The water-system of a plant is like the bloodstream of the Human, it's supplying nutrients and removing waste. Like the condition of blood, the water condition of the water in a Greenhouse is an indicator of the crops health. With the right measurement in place the production of crop can be measured and steered, early warning mechanism can act as prevention.
But also water is scarce resource an efficient and effective water supply can minimise the need for water and nutrients, which are ideally reused within a closed system.

Research question(s)

How to create a plant watering system based on the latest technology insights, that's optimizes plant growth and minimizes water and nutrients use?

Organization involved

Priva
www.priva.com

Suggested academic backgrounds

- Robotics (TUD)
- Management of Technology (TUD)

Assignment 5

How to integrate (greenhouse) horticulture symbiotically into the circular megacities of the future (2040-2050)?

Problem statement

Dutch horticulture is faced with the challenge of fulfilling the social demand for circularity. However, if there is one sector where this can lead to new opportunities and potential revenue models, it is horticulture. However, this requires new knowledge, in which the focus is not only aimed at optimizing current processes, but rather the connection with other entities within society offers perspective in order to arrive at solutions for the (future) challenges.

Research question(s)

The central issue of the Circular Metropolis transition program in the context of the strategy of the Greenport West-Holland: feeding & greening the megacities is: how to integrate (greenhouse) horticulture symbiotically into the circular megacities of the future (2040-2050)? Possible sub-issues are:

A. Value of circular residual flows and opportunities
B. An economic and social model for circularity of organic residual flows
C. Circular solution(s) for large-scale valorisation of residual flows for high-rise cultivation
D. Valuation and business models of products and residual flows: place-based circularity
E. Social: social integration of greenhouse horticulture

Organization involved

Greenport West-Holland – Program Circular Metropolis

Suggested academic backgrounds

- Industrial Ecology (TUD/Leiden)
- Governance of Sustainability (Leiden)
- Global Business and Sustainability (Erasmus)
- Social studies (psychology, sociology etc.) (Erasmus, Leiden)
- Philosophy (Erasmus, Leiden)
- Humanities (Leiden)

Explanation of the sub issues

A. Value of circular residual flows and opportunities

In addition to the main products (vegetables, fruit, plants, flowers), large quantities of organic residual flows are produced. For example, stems and leaves of tomatoes and peppers. Many innovative applications are possible for these residual flows: paper, cardboard, building materials, textiles. Also (medicinal) ingredients (chemistry) can be extracted from these residual flows. The residual flows are currently being composted, whereby plastic pollution (cultivation aids) is an issue

(pre-separation and other treatments are required). As a greenhouse horticulture sector, we are now faced with the choice to focus on large-scale valorisation. This requires knowledge.

B. An economic and social model for circularity of organic residual flows

How do we as greenhouse horticulture make the right decisions to implement innovative applications of the residual flows on a large scale? What are the best business models? What are the best crossovers (construction, health, packaging etc)? Where is the most value added in these new value chains? What new entrepreneurship does this require from current entrepreneurs and possibly new entrepreneurs/enterprises?

C. Circular solution(s) for large-scale valorisation of residual flows for high-rise cultivation

Currently, efforts are being made to replace plastic (often PP) with biobased and compostable variants. However, these also have drawbacks, both in terms of processing in the greenhouse and in the further processing of the residual flows (new applications). Replacing plastic (PP) to biobased and compostable is not always a solution. What is the solution for the greenhouse that makes high-quality value possible. Design a circular solution for high-rise cultivation that guarantees circularity of the residual flow. A solution that is easy to apply in the greenhouse, enables simple separation and which is also circular in itself.

D. Valuation and business models of products and residual flows: place-based circularity

In the context of the future, new entrepreneurship is being considered: selling the concept. Applying the knowledge and expertise for efficient food production in the megacities of the world, regardless of the local situation. In addition to regular crops (tomatoes, etc.), horti-footprint calculations show that growing crops such as papayas in greenhouse horticulture in the Netherlands also has a more favorable environmental impact. In the context of 'selling the concept', a model must be developed that answers the question, based on circular thoughts: 'When and where do you produce what?'. When do you export, when do you import? And when do you produce locally.

E. Social: social integration of greenhouse horticulture

To ensure circular symbiotic integration of glasshouse horticulture in the megacities of the future, acceptance and even embrace of glasshouse horticulture on the edge of urban areas is a must. Greenhouse horticulture would like to fulfill its socially relevant function in an open connection with society. In practice, greenhouse horticulture is unfamiliar territory for many inhabitants of the city. What effort can be made to show the residents the social relevance, the circular innovations, the high-quality technology and the beautiful and healthy products. This issue has a communicative as well as a social component (behaviour, connections, listening, social infrastructures, etc.)

Assignment 6

What options are available to increase biodiversity around greenhouses?

Problem statement

For a controlled production of crops inside greenhouses, outside influences are reduced as much as possible. However, this does not mean that there is no impact of the greenhouses on the environment and vice versa; they are part of the same ecosystem. The challenge is to see how both worlds can intertwine.

Research question(s)

What options are available to increase biodiversity around greenhouses? Is it possible to have a richer biodiversity outside the greenhouse make a positive contribution to life in the greenhouse? What conditions must be met for this and what are the challenges involved?

Organization involved

Greenport West-Holland – Biodiversity Program

Suggested academic backgrounds

- Biology (Leiden)
- Biodiversity and Sustainability (Leiden)
- Governance of Sustainability (Leiden)

Assignment 7

A. What are the values for the future that are essential for the (Dutch) horticultural sector?
B. How can the values for the future be integrated into its (future) business model?

Problem statement

The social demand for sufficient, healthy and sustainably produced food is evident. Opinions within society differ widely about the way in which this can be implemented. On the one hand, efforts are being made to increasingly techno logicalize production (think of indoor farming, without daylight and from the ground); on the other hand, there are numerous social initiatives around the conservation of biodiversity, food forests, pixel farming, etc.

Research question(s)

The current greenhouse horticulture sector mainly focuses on further scaling up and technologicalization of its production methods. However, this is at odds with other developments in society (an example to which this can lead is the strongly changing attitude of society towards farmers). The question that arises from this is how these divergent developments can be brought together. What are the values for the future that are essential for the (Dutch) horticultural sector and how can they be integrated into its (future) business model?

Organization involved

NetWork Foundation in collaboration with Wageningen UR (dr. Ir. Clemens Driessen)

Suggested academic backgrounds

- Philosophy (Erasmus, Leiden)
- Social studies (Erasmus, Leiden)
- Global Business and Sustainability (Erasmus)

Assignment 8

Application of hydrogen as an energy source in the horticulture sector: technical challenges, sustainable business case and societal values

Problem statement

Energy is one of the major challenges for Dutch greenhouse horticulture. The use of natural gas is finite and alternatives are being sought. An interesting option here is the use of hydrogen. This poses challenges for the medium and long term. Optimal use of the existing energy infrastructure of CHPs for the application of hydrogen is an example of the first; an example of the longer term is the development of a future perspective for the use of hydrogen as a transition fuel on the way to a new interpretation of the energy supply for the greenhouse horticulture sector.

Research question(s)

Technical challenges play a role in this, but also the development of a sustainable business case for the application of hydrogen in the sector. In addition, it is important to take into account the changing demands from society; social values play an important role in this process.

Organization involved

Topsector Tuinbouw & Uitgangsmaterialen
www.topsectortu.nl

Suggested academic backgrounds

- Sustainable Energy Technology (TUD)
- Global Business and Sustainability (Erasmus)
- Management of Technology (TUD)
- Innovation Management (Erasmus)

Assignment 9

Systems interventions to bring the company's energy policy to a higher level

Problem statement

Floricultura is faced with the challenge of making energy-saving adjustments (innovations) within the organization, without negatively influencing the production quality. On the basis of an energy efficiency audit (EED energy audit), Floricultura searches for investment proposals to reduce energy consumption.

Research question(s)

The main focus here is on system interventions (across the various branches and departments) that bring the company's energy policy to a higher level. In practice, this concerns a broad spectrum of business activities (from tissue culture lab to greenhouses for the cultivation of tropical plants).

Organization involved

Floricultura
www.floricultura.com

Suggested academic backgrounds

- Global Business and Sustainability (Erasmus)
- Innovation Management (Erasmus)
- Management of Technology (TUD)