Studio aE Research Plan

Personal Information

Name: MICHAL SIUPIK
Student number 4709454
Address
Postal code
Place of residence
Telephone number
E-mail address

Studio

Name of the studio: Architectural Engineering
Teachers: Mo Smit, Gilbert Koskamp, Nick ten Caat

Argumentations of choice of the studio:

Two of my biggest fascinations in the broad scope of architectural design are adaptive reuse and implementation of farming practices in an urban environment. Those two topics have strong potential connections that can be explored and complement each other. Architecture Engineering studio offers "Harvest" and "Second Life" themes that initially caught my attention as they are compatible with my interests. Moreover, I prefer a technical and practical approach to design; therefore, I find the aE studio the most suitable for my work style. I believe the studio's choice will allow me to further investigate my fascinations and develop practical solutions for the building environment.

Graduation Project Title:

"Envisioning future food production in Sloterdijk: an urban farm in a repurposed office building"

1) Introduction

My project's problem statement splits into three most relevant aspects, which serve as foundation and starting point for my research and design.

1.1) The food scarcity and health aspect

The world's growing population will reach approximately 9.735 billion by 2050 (UN, Department of Economic and Social Affairs, Population Division et al., 2019). Accompanied by rising consumption per person due to wealth increase (Rohner, 2020), it will lead to significantly higher food, water and energy demand (Willett et al., 2019). Expanding cities consume land viable for farming. Even though the area of agricultural land worldwide expands, the pace does not match population growth. Between 1961-1999 the farmland area gained only 155 mln ha (from 1.351bln ha to 1.506 bln ha), while in the same period population doubled (3.1bln to 5.9bln) (Bruinsma & Harrison, 2003).

The extensive farming, growing emissions of CO_2, phosphates, and nitrates contribute to climate changes, followed by droughts, famines, and massive biodiversity loss. The EAT-Lancet committee predicts that this trend will continue if the current food production and nutrition approach will not change (Willett et al., 2019).

The committee thinks that one of the strongest levers to improve sustainability and condition of our planet's environment is a drastic change in the entire humankind's dietary

patterns, but primarily the diets of developed nations. The proposed answer for the future challenges is a concept of Planetary Health Diet (PHD) - balanced set of guidelines for the nutrition of individuals and larger international goals and interventions (Willett et al., 2019). It is designed to decrease the environmental impact of food consumption, production and other food-related actors while remaining affordable (Hirvonen et al., 2020)

1.2) Urbanisation & office vacancy

According to CBS and the World Bank, the urban population of the Netherlands rapidly grows. Almost 92% of the population lives in urban areas (UN Population Division, 2018). The country experiences rapid urbanisation and at the same time, a decrease in agricultural land (figure 1). Moreover, people's high concentration in cities extends the distance between consumer and food sources; therefore, the carbon footprint rises.

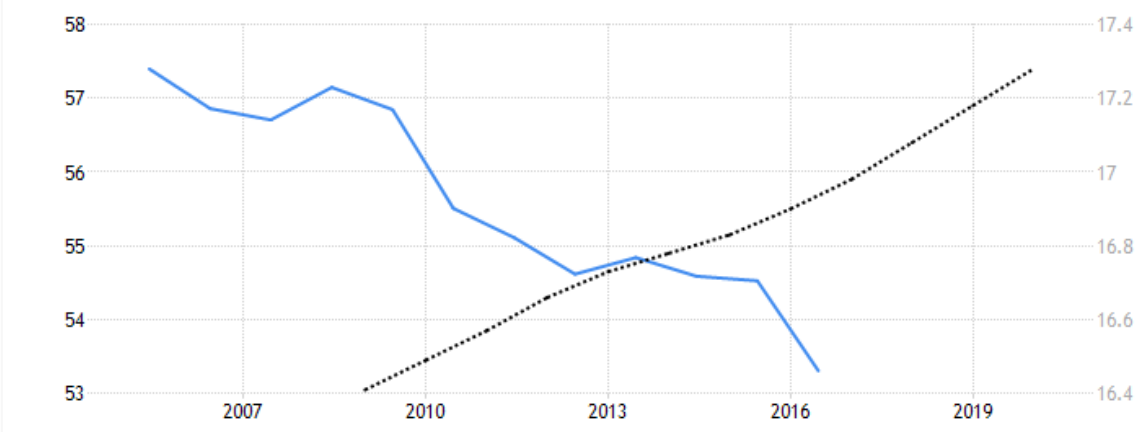


Figure 1. Agricultural land vs rban population of the Netherlands[1]

At the same time, the Netherlands experiences an office space oversupply. On average, 17% of the total office stock in the Netherlands is unoccupied. The highest density of vacant offices is in the Randstad area, where more than 20% of space is available for rent (appendix figures 2, 3) (CLO et al., 2016). Such buildings generate losses to municipalities, and often they do not meet the performance standards of today. The abundance of such structures can be an opportunity to bring back agriculture to cities.

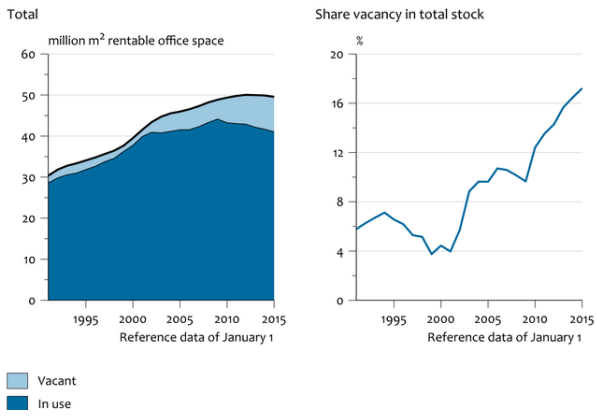


Figure 2. Floor space and vacancy of office space[2].

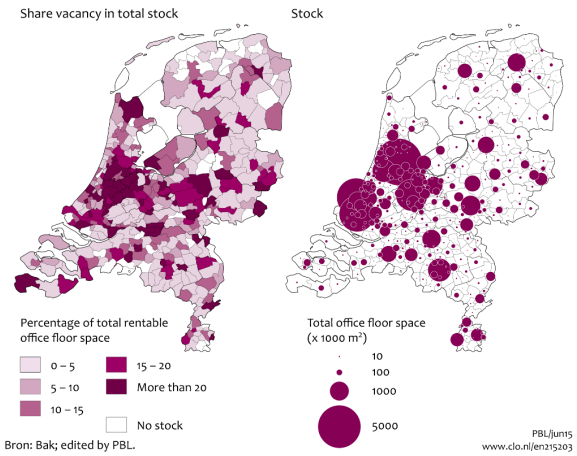


Figure 3. Vacant office floor space by municipality, 2015[2].

[1] (CLO et al., 2016), [2] (UN, Department of Economic and Social Affairs, Population Division et al., 2019)

1.3) Context of Sloterdijk. Can urban farming be the answer?

Sloterdijk office district developed rapidly from 1983 around the redesigned railway station. It is a "work only" district deprived of full-time inhabitants and greenery, a zone of temporary activities and a giant transportation hub. It suffers from a lack of activities and functions, integrating the local community. Aside from social issues, the condition of some older buildings leaves much to desire. Created in the '80s, offices of that time do not meet today's building physical and energetic performance standards. Example of such a construction is this research focus, "de Knip".

Amsterdam aims to redevelop the entire neighbourhood according to "Vision 2040"plan and construct around 7500 flats, which will be followed by population increase (Gemeente Amsterdam & Ruimte en Duurzaamheid, 2020). In such circumstances, the Urban Farms providing local food production, spaces for social interaction and integration, are discussed as viable solutions for problems stated above. Unfortunately, in many cases, such enterprises struggle to compete with traditional farms, and due to high energy consumption in combination with smaller production scales, can be even less sustainable.

Figure 4. de Knip[(1)], VEN[(2)] buildings - Sloterdijk, The New Farm - the Hague[(3)], Einstein office building[(4)] - Sloterdijk

1.4) Objectives & Relevance:

In Sloterdijk's context, the general question arises: How to use the increasing number of vacant buildings to improve overall living and public space quality in the neighbourhood. Is it technically possible to design an urban farm that will be able to compete with traditional food providers, while providing a selection of healthy foods for the neighbourhood? What new public functions can synergistically coexist alongside such a farm with a benefit for the local community?

[(1)] (van Dijk, 2006), (Horecatrends, 2017) [(2)], (The New Farm, 2018) [(3)], (Foursquare, 2016) [(4)]

The research's general scope is specific and revolves around practical implementation of urban farming techniques and their impact on adapted buildings' architecture. It aims to determine their spatial requirements, water and electricity demand, carbon footprint and technical limitations (e.g. the most suitable position in the building). Furthermore, the investigation should provide conclusions about the necessity to implement water collection and treatment systems, renewable energy sources, and their possible impact on the building's envelope. Generally, research should provide a toolbox of solutions, guidelines and starting points for further design and implementation of urban farming in various refurbished buildings.

Currently, Urban Farming practises struggle in competition with traditional farming. Therefore, they often become suppliers for exclusive restaurants, which makes them a marketing tool rather than a real solution. Systematic approach from the governmental level (e.g. tax exemptions) to individuals' dietary habits may improve the situation. This project aims to design a local food system that will be able to produce realistic amounts of food for the future district inhabitants and successfully compete with traditional farming.

Moreover, this project intends to combine public function like the vocational school with an urban farm. It may provide a higher quality of the architectural space and an opportunity to gain practical knowledge. Providing locally based healthy products it also aims to redefine the dietary habits of neighbourhood dwellers. The educational programme should teach students and involve the local community raising its awareness about small scale urban farming practices.

The investigation aims to determine if Sloterdijk's sustainability and public health improvement are possible by promoting dietary shift and local food production. The project focuses on putting the proposed Planetary Health Diet (PHD) guidelines into real-life context and tests their viability. Besides, to check the possibility of reducing food production environmental impact.

All the above resulted in the following design and research questions:

1.5) Overall design question

How to repurpose an existing office building (de Knip) in Sloterdijk into a vocational school and sustainable urban farm that effectively produces a selection of healthy foods for the local community?

1.6) Thematic Research Question

What are the most suitable urban farming techniques for de Knip, which would satisfy the neighbourhood future food demand for selected products?

2) Research framework

2.1) Key terms, concepts, theories, methodology

The project revolves around an adaptive reuse concept, the second life of existing buildings and nature inclusive design, in the broader scope. The research explores solutions that can be implemented in structures soon to become vacant due to not meeting today's performance standards. The growing vacancy is considered an opportunity to introduce agriculture into unused urban spaces, consequently reducing its environmental impact. Therefore, the investigation analyses the practical implementation of urban farming techniques and their implications on adapted buildings' architecture. It tackles the notions of local food systems, urban-high density farming and nutrition as well.

Due to the nature of steps that should be taken, the project relates to flow and stock research-by-design domains. In the Thematic Research, the methodological approach belongs mostly to the quantitative group of methods and is supplemented with the qualitative elements. In other words, based on data study, simulation of the future, research into cultivation methods, an urban farm

design will be proposed and compared with traditional one to achieve conclusions. Those results will later influence the repurposed building design and can become the starting points for further exploration.

2.2) Methods

The research question is divided into a set of subquestions that intend to help explore the issue more thoroughly. They are as follows:

- *What is Dutch and Planetary Health diets' composition and components water consumption, embodied land, greenhouse gas emissions in traditional farming in the Netherlands?*
- *What would be key performance indicators of future food production in the context of the proposed dietary shift in Sloterdijk?*
- *What would the urban strategy for food production look like?*
- *What are the different urban farming techniques; productivity (kg), average water (m3) and electricity consumption (kWh) and their architectural implications and requirements?*
- *What are the optimal conditions and requirements for selected crops production in a building?*
- *What would be the possible improvement in Sloterdijk sustainability?*

To answer them the investigation will be executed in six consecutive phases, which should be performed in the period between P1 and P2, below is the simplified graphic representation of research workflow. The elaborated details and detailed scheme of research and its results can be found in the appendix:

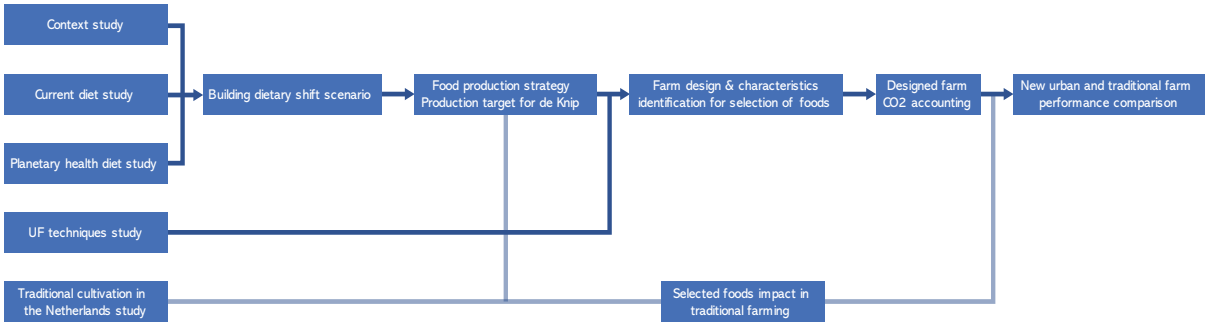


Figure 5. Simplified diagram of research process (Own work, 2020).

In short quantitative part involves Sloterdijk's future urban plans study, literature study and data analysis on urban farming and dietary habits in the Netherlands. Based on researched data, a dietary shift and future Sloterdijk's food demand scenario should be established and in parallel the food production strategy to answer the demand.

In the qualitative part of the research, the characteristics of various farming techniques ought to be investigated. The focus will be on their performance indicators, spatial requirements, positioning in the building, and the possibility of implementing the educational function. Based on that information, the urban farm will be composed of methods considered most suitable.

Finally, the designed farm characteristics will be identified and performance indicators calculated using the predicted food demand and features of farming techniques investigated in the previous part. The carbon assessment of the design will be performed. The results of all the described actions will be gathered and compared to those of traditional farming.

The result of all stages should be research paper and an assessed overview of the best performing farming techniques for the selected type of crops, their architectural requirements, to implement in an adapted building. It also finds out if the environmental impact reduction is possible when the food is produced locally. Finally, it ought to spotlight issues like the implementation of

renewable energy sources, ventilation systems, and water collection, which could be possibly further explored in the design phase.

3) Preliminary conclusions, choices and design

The general choice is that De Knip will be turned into a vocational school and urban farm, a part of a larger local food production strategy. The building should be designed for the future and be consistent with the municipality's redevelopment plans of the neighbourhood; therefore, the educational function, planned in the area is allocated in the building. Moreover, as the quality of public spaces and greenery in Sloterdijk area leaves much to desire, the building's design should strive for nature inclusiveness and provide high-quality public areas.

From a design point of view, several conclusions have been drawn. Firstly, The farming component's spatial requirements were calculated to 20850 m2 (13475 m2 interior, 7375 m2 exterior). Less space is required than in traditional cultivation(127.7 ha), which provides design flexibility in the building of 50000 m2. The farm's spatial requirements programme is as follows: for soil-based rooftop greenhouse farming and soil-based open-field farming: 3285 m^2, for the controlled environment: aquaponic 7318 m^2, hydroponic NFT 2122 m^2, aeroponic: 4444 m^2 and façade/wall cultivation systems: 1232 m^2.

The design decision is made that most of the production components will be stacked vertically in the building's tower. Such setup makes it easier to deliver water and later bring the ready crops down for storage, processing and retail. The exterior soil-based methods will be located on the rooftops creating publicly accessible gardens, and open-air educational facility for school students. Glasshouses located on the plinth, and the tower roofs will be combined with restaurants operated by students; this way, the visitors will witness the food production process, while students will receive yet another mean of practical education.

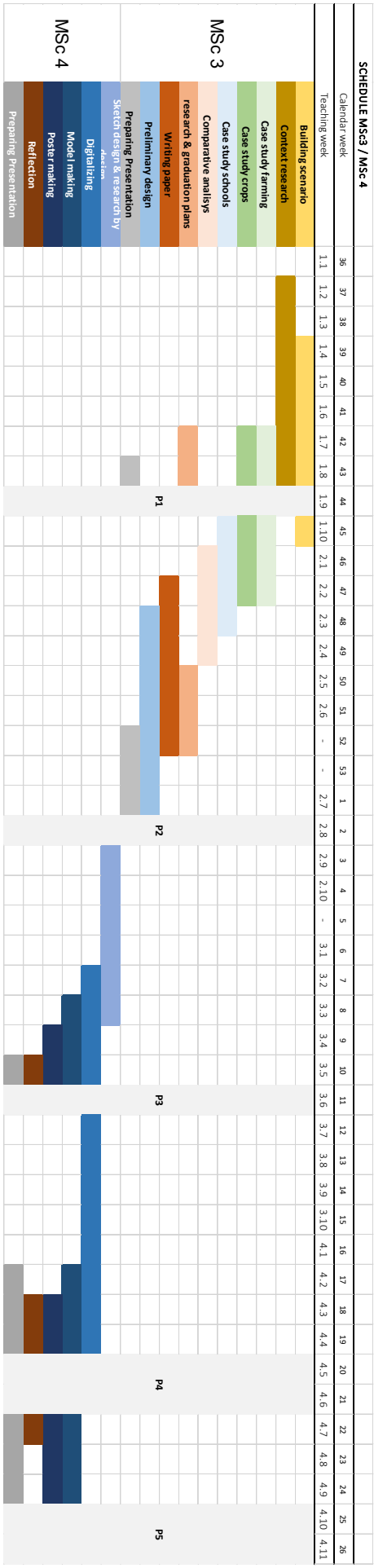
Nature should also be invited into the public areas of the building, the foyer and courtyards. The design aims to open the main lobby to the sky with a glazed roof, suspended by a network of tree-like pillars, reassembling a forest or green cave. It will become spacious and inviting, and the terracing galleries should be covered lush greenery even magnifying the effect. The ground floor aside of public area hosting the shop with locally grown products and café run by the students will include separate food storage and processing facilities.

Similar rules would apply to other now open-air courtyards in the building, as they have the potential to be developed into lively public spaces. Various farming methods that should be exhibited there to be examined by the students and visitors, at the same time creating a more friendly environment.

From a technical point of view, several conclusions have been drawn as well. The water usage is improved more than threefold and is predicted to reach 31238 m3 annually compared to traditional farming. Moreover, the farm requires substantial amounts of electricity per annum (4.8 GWh). The research has shown that the chosen methods emit less atmospheric pollution than traditional. The calculated values vary between 1.32 and 3.85 ton CO2 eq. and are depending on the share of grey and green energy utilised.

The above leads to a design conclusion that thinking about rainwater collection, treatment, and efficient management systems, implementing renewable energy sources and energy-efficient ventilation will be vital during the renovation process. Therefore those should be subjects of further exploration in the design process. It is significant to consider the architectural impact, design challenges, and possibilities those systems pose to façade design, as for now, it seems like the most suitable place to locate them.

4) Planning (Own work, 2020):

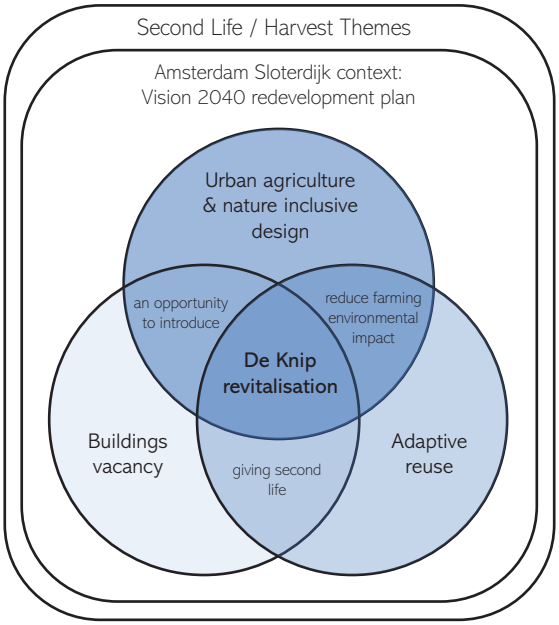


5) Literature

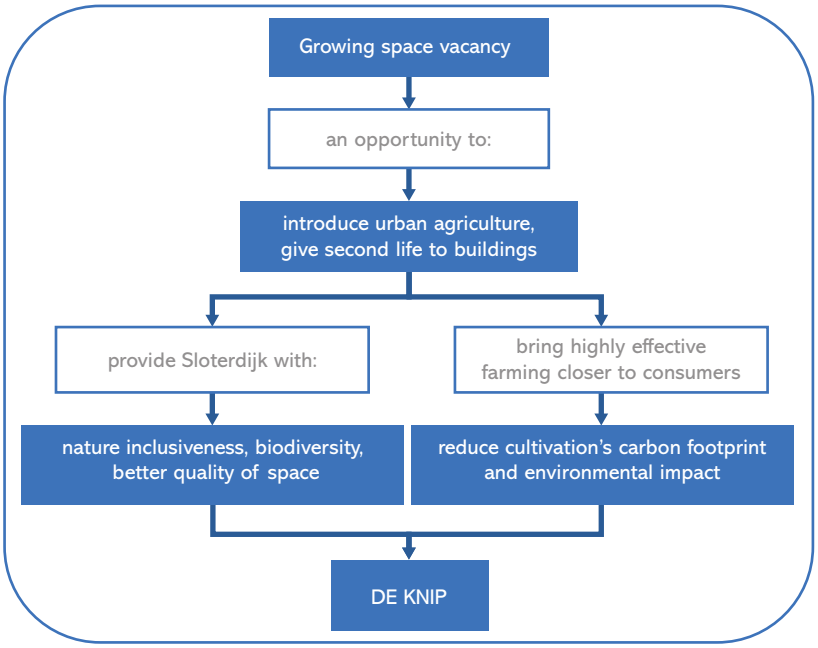
1. Boer, J. M. A., Buurma-Rethans, E. J. M., & Hendriksen, M. (2017). Health aspects of the Dutch diet. *RIVM*, 160.
2. Bruinsma, J., & Harrison, P. (Eds.). (2003). *World Agriculture: Towards 2015/2030—An FAO Perspective.* (1st ed.). Earthscan Publications Ltd. www.fao.org
3. CLO, CBS, PBL, RIVM, & WUR. (2016, January 19). *Vacancy of office space, 1991-2015*. https://www.clo.nl/en/indicators/en2152-vacancy-of-office-space
4. Gemeente Amsterdam, & Ruimte en Duurzaamheid. (2020). *Visie 2040 Sloterdijk Centrum*. 75.
5. Geurts, M., van Bakel, A. M., van Rossum, C. T. M., de Boer, E., & Ocke, M. C. (2017). Food consumption in the Netherlands and its determinants. *RIVM*, 72.
6. Hirvonen, K., Bai, Y., Headey, D., & Masters, W. A. (2020). Affordability of the EAT–Lancet reference diet: A global analysis. *The Lancet Global Health*, *8*(1), e59–e66. https://doi.org/10.1016/S2214-109X(19)30447-4
7. Jenkins, A. (2018). *Building Integrated Technical Food Systems*. Queen's University Belfast.
8. Jenkins, A., & Keeffe, P. G. (n.d.). *The Integration of Urban Agriculture and the Socio-Economic Landscape of Future Cities*. 9.
9. McDougall, R., Kristiansen, P., & Rader, R. (n.d.). *Small-scale urban agriculture results in high yields but requires judicious management of inputs to achieve sustainability*. 6.
10. Rohner, U. (2020). *The Global wealth report 2020*. 56.
11. UN, Department of Economic and Social Affairs, Population Division, Department of Economic and Social Affairs, & Population Division. (2019). *World population prospects Volume 1, Volume 1,* (Vol. 1).
12. van Rossum, C. T. M., Buurma-Rethans, E. J. M., Vennemann, F. B. C., Beukers, M., Brants, H. A. M., de Boer, E. J., & Ocké, M. C. (2016). The diet of the Dutch. *RIVM*, 144.
13. Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Vries, W., Majele Sibanda, L., … Murray, C. J. L. (2019). Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, *393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

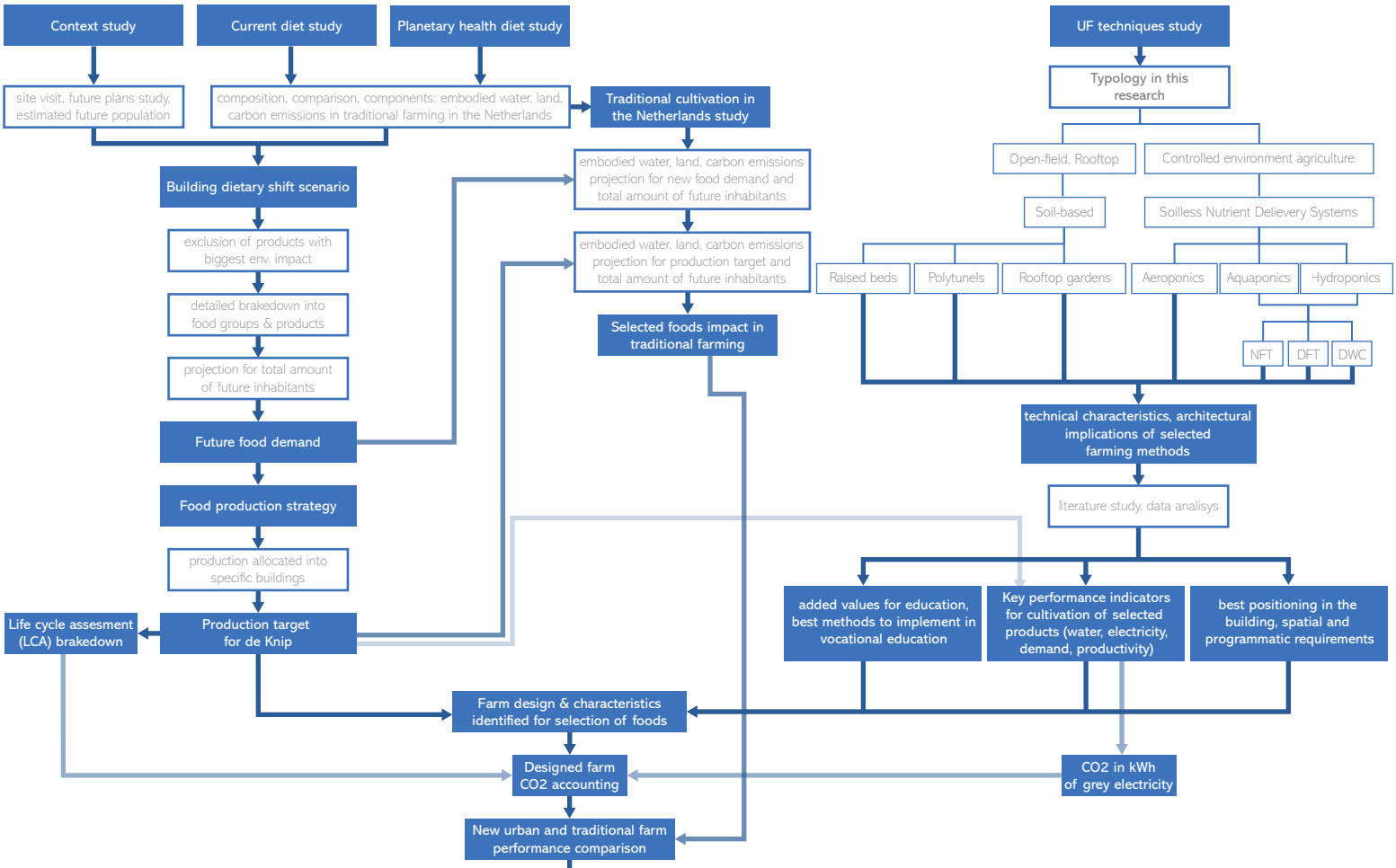
6) Appendix – visual translation of the research plan into the diagram (Own work, 2020):

Key Concepts & Themes



Problem Statement





Design conclusions & areas of further investigation