Urban Farming in the Western Garden City

A study on the employment and benefits of urban farming techniques in three neighbourhoods of Amsterdam

Joaquin Rafael Valdes Troncoso
Faculty of Architecture & the Built Environment, Delft University of Technology
Julianalaan 134, 2628BL Delft
joaquinvaldes.vanhaaften@gmail.com

Abstract

The linear food supply chain is putting significant pressures on our resources and our environment. Moreover, global warming is leading to climate change, making our environment more uncertain and challenging food safety around the globe. Therefore new ways of producing food locally need to be researched. This paper investigates how food can be produced within the boundaries of the city of Amsterdam. It studies the suitability of different urban farming techniques within the infrastructure of the neighbourhood through three different scenarios. The scenarios are based on the three pillars of sustainability (social, economic and environmental) and measure a set of indicators (food production, monetary income, job creation, water retention, energy production, esthetic values, social values and biodiversity). The results of the scenarios are afterwards compared to the social and spatial needs of the neighbourhood, from which the most suitable scenario can be chosen. The research has been done for three neighbourhoods from the New West borough in Amsterdam: Geuzenveld, Osdorp Midden and Middenveldsche Akkerpolder. The results show that for Osdorp Midden and Geuzenveld, the scenario focusing on economics is the most suitable for helping with the high rate of poverty and unemployment in the neighbourhood. On the other hand, for Middelveldsche Akkerpolder the scenario focused on creating social values can help strengthening the missing social ties and create a sense of community in the neighbourhood.

Keywords: Urban Farming, Circularity, Spatial Typologies, Value Creation, Neighbourhood, Urban Planning, Nieuw West.

I. Introduction

The current (linear) food supply chain is so unsustainable that for every dollar spent on food two dollars go incurred on economic, health and environmental costs . Furthermore, the future of our planet is becoming more uncertain, therefore, new ways of food production and of waste treatment needs to be considered. The circular economy (CE) is one approach that can help solve this problem. By growing food regeneratively, closing the waste loop and producing food locally, one can restore ecosystems, minimize greenhouse gases and reduce food waste (Ellen Macarthur Foundation, 2019).

Because the population in urban areas is expected to grow by 2.5 billion inhabitants by 2050, meaning that around 80% of the world population will be living in cities (Ellen Macarthur Foundation, 2019). Within cities, lays the problem but also the solution to our unsustainable food supply chain. By looking into ways of producing food locally one can help alleviate its negative effects, while also creating social values for the city such as food safety, job creation, food awareness and increasing inhabitants health (Romkema, 2013).

This paper explores how urban farming (the production step in the CE supply chain) can be applied in three problematic neighbourhoods of the New West borough in Amsterdam (Geuzenveld, Osdorp Midden and Middelveldsche

Akkerpolder), which characterizes itself for its low social/spatial cohesion and the dominance of low-income communities. By looking at the infrastructure the neighbourhoods have to offer, through three different scenarios, the paper aims to find the social, environmental and economic values that can be created in the neighbourhood. Its findings can be used as a starting point for governments and planning professionals who want to implement CE food supply chains into the neighbourhood. Likewise, the methodology used in this paper can be recreated for other neighbourhoods in other cities.

Based on the problem statement above, the main research question that this paper answer is as follows:

How can urban farming techniques make neighbourhoods self-sufficient on food and also bring social, environmental and economic values?

Sub-questions are:

What is the historical and social/spatial context of the New West borough?
What are the urban farming techniques that can be used in the neighbourhood?
How do the scenarios arrange the farming techniques within the spatial infrastructure of the neighbourhood?
What are the economic, environmental and social values that each scenario creates for the neighbourhood, and which scenario suits the neighbourhood the foremost?

II. Method

The research method behind this paper is as follows.

Firstly, a literature study has been conducted on suitable urban farming techniques that can be implemented within the neighbourhood. Four different techniques were chosen (SPIN farming, roof farming, urban garden and indoor hydroponics) based on the suitability of the techniques within the spatial infrastructure of the neighbourhood.

Secondly, the spatial infrastructure of three neighbourhoods was calculated (see Appendix I). This was done by dividing the neighbourhood into different spatial typologies, and employing CAD and web mapping software the surfaces were calculated. The typology selection was made based on the type of ownership within the neighbourhood, this means it was divided between public, communal and private buildings and outdoor spaces. Only the buildings and public spaces belonging to the communal and public realm were considered applicable for urban farming. The reason for this is that organisationally, communal buildings (owned by housing corporations), and public buildings and spaces (owned by the municipality or corporation) are easier to comply with then with individual private owners.
The spatial infrastructure of the neighbourhood is divided as follows: (i) Buildings: collective and public buildings. (ii) Spaces: squares and vacant plots, parks, stream beds, and community spaces.

Thirdly, three different scenarios based on the three pillars of sustainability, social, environmental and economic were created. Each scenario focuses on a specific way of implementing the urban farming techniques within the spatial infrastructure of the neighbourhood. From each scenario, besides food production, a set of social, environmental and economic values (indicators) are calculated.

In the last step, the archived values of each scenario are put into relation with the specific social/spatial problems of the neighbourhood, from which the most suitable scenario can be chosen. This scenario can work as the starting point for a strategy that will help solve the social/spatial problems of the neighbourhood.

III. Context

The research was conducted in the borough of Nieuw West, also known as the Wester Garden Cities. It is a borough in the city of Amsterdam that compromises 14 different neighbourhoods. It has a total of 150000 inhabitants, whom all come from very diverse backgrounds, which over the years has created for significant social tensions in the area.

The history of the neighbourhood dates back to 1934 when the General Expansion Plan was adopted. The design was set up by Cornelis van Eesteren, the urban planner and the head of the department of public works. Van Eesteren was a key figure within the CIAM and "het nieuwe bouwen" and advocated for the separation of functions. This became visible in the design of the Western Garden City where working, living, recreation and traffic were strictly separated (van Rossem, 1993). The General Expansion Plan was also designed according to the ideas of the Garden City, where the neighbourhood had to work autonomously from the rest of the city (Kopp, 2010).

While traditionally cities were built with closed buildings blocks, with streets on the outside and private courtyards on the inside. With the General Expansion Plan building blocks got an open character. They were designed as continuous strokes, towers, hook-shaped and L-shaped blocks, they were optimally oriented towards the sun and surrounded by collective green spaces. Because of this light, space and air would solve the hygienic and overcrowding issues characteristic of the traditional working-class neighbourhood (van Rossem, 1993). This spatial setup becomes evident from the data collected on the spatial infrastructure of the neighbourhood. Neighbouhrood such as Geuzenveld and Osdorp Midden, builded according to General Expansion Plan, have a high ratio between the outdoor space and indoor space, respectively 167% and 158% as much outdoor space. On the other hand Middelveldsche Akkerpolder, built in the 80s with closed building blocks, has a ratio of 39% between outdoor and indoor space, meaning there 2.55x as much indoor space then outdoor space.

When Western Garden City was built, after WWII, it provided housing for families living in the city that needed more space. This changed during the 60s and 70s, as a significant part of these families moved out, and instead, a great influx of guest workers from Morocco and Turkey moved in, changing the social composition of the neighbourhood. As a consequence social tensions started to build up between old and new inhabitants. Moreover, the appreciation for the open public spaces changed. The reason for this, is the friction between the new inhabitants and the social-cultural codes (homogenous and white) the design was based on. Added to this is the fact that local government and housing corporations have had fewer funds for maintaining public spaces, resulting in a further deterioration of the outdoor areas (Kopp, 2010). This friction becomes visible these days where neighbouhrood reports sow low social cohesion between inhabitants, relatively high rates of criminality and a strong feeling of unsafeness between inhabitants

Today, the New West borough is under redevelopment. The goals of the municipality is to bring more variety in the housing stock in order to attract more affluent users to the neighbourhood, boost the area, which is believed to help lower income communities gain upwards mobility. The approach towards the public space is to make the green areas smaller, better defined and privatised, giving the public space a more urban character.

IV. Results

Urban farming belongs to the production step in the CE supply chain. It can be defined as growing food (vegetables, fruit, fish and livestock) within and around the city. One of the main differences between urban farming and regular farming is that urban farming is directly related to the food demand of the city instead of the national or world market. Moreover, urban farming adds functions and qualities to the city, such as opportunities to recreate and have social interactions between inhabitants (Romkema, 2013).

Urban farming provides the city mostly in vegetables, fruit and herbs. Because of strict laws and health risks, it is more challenging to farm livestock within the city boundaries (Romkema, 2013).. That is why for this research there will be only looked at the production of vegetables, herbs and fruit.

4.1 Farming types

There are a lot of different farming techniques, from conventional rural outdoor farming to high-tech indoor farming. For the simplification of this research, four different farming techniques are chosen. In Appendix II a more complete overview of current farming techniques and its characteristics are presented. The farming techniques used for this research are the following (de Graaf, 2011):

Forest Gardening

Forest gardening is a way of spatially organizing plants in four to seven layers, with trees, bushes, plants, roots, etc. The system is bound to the ground and practically organizes itself, this makes forest gardening interesting as a way of maintaining green areas. Forest gardening can provide the city with edible products such as fruits, roots, mushrooms, and nuts, while also providing the city with non-eatable products such as bamboo, wood and medicinal plants.

SPIN-Farming

SPIN farming stands for Small Plot INtensive Farming, and it refers to the cultivation of vegetables, spices and fruit in vacant plots and semi-open lawns around the city. A SPIN farmer usually has different locations throughout the city that are being optimally used depending on the needs (sun, water and wind) of the cultivated crops.

Roof Farming

Roof farming integrates the cultivation of crops with a layer of ground on an impermeable membrane on the roof. Within the layers of the roof, there often is a drainage system and an irrigation system.

There are different systems, an extensive one and an intensive one. Extensive means that there is being made use of a lightweight substrate with depths until 15 cm, mostly suited for vegetables and herbs with a small root. Intensive means that the depth of the ground is more than 15 cm, and it makes use of an open ground system allowing for a greater range of crops.

Hydroponics

Hydroponics is an indoor method in which plants are grown in a solution of nutrients with water, without soil. The system offers the possibility of controlling the environment, which can bring 4 to 6 times more harvest a year. Because of this, the total yield can lay around 20x higher than in conventional farming. When the hydroculture system is combined with fish farming in tanks, we talk about aquaponics.

4.2 Scenarios

For the research three different scenarios were put together based on the three pillars of sustainability, social, environmental and economic were created. Each scenario focuses on a specific way of implementing the urban farming techniques within the spatial infrastructure of the neighbourhood. The spatial infrastructure has been calculated and is visible in the appendix of this paper. Furthermore, it is important to note that the surface configuration in each scenario has not been based on scientific research but through architect outlook on the situation.

4.2.1 Social scenario

The social scenario focuses on creating a sense of community within the neighbourhood, it makes use of outdoor farming types on the roofs and in the communal and public outdoor spaces. The infrastructure employed for urban farming are relatively small compared to the other scenarios, but these can be further expanded if inhabitants are willing.

SCENARIO	Collective Buildings		Public Buildings		Colective spaces		Parks		Squares		Stream beds	
	Farming type	%	Farming type	%	Farming type	%	Farming type	%	Farming type	%	Farming type	%
Social	Roof farming	50	Roof farming	50	SPIN	50	SPIN	25	SPIN	25	-	-

3.4.2 Economy scenario

The economic scenario focuses on bringing economic prosperity within the neighbourhood. It opens up the possibility for job creation and monetary income. The farming systems employed are mostly hydroponics on the roof, while on the ground a combination of hydroponics and SPIN farming. The infrastructure employed for urban farming are significantly high throughout the neighbourhood, which means the neighbourhood will be further densified.

SCENARIO	Collective Buildings		Public Buildings		Colective spaces		Parks		Squares		Stream beds	
	Farming type	%	Farming type	%	Farming type	%	Farming type	%	Farming type	%	Farming type	%
Economy	Hydroponics	80	Hydroponics	80	SPIN/hydroponics	40/40	SPIN	40	SPIN/hydroponics	40/40	SPIN	40

3.4.3 Environmental scenario

The environmental scenario focuses on creating ecological values within the neighbourhood. By making use of urban gardens in the outdoor spaces and roof farming on the roof, this scenario can help restore biodiversity, reduce the Heat Island Effect, purify the air and help store water in case of heavy precipitation. The infrastructure used is high, the reason for this is that this scenario wants to create as much environmental benefits as possible, this is made possible by greening up as much space within the neighbourhood.

SCENARIO	Collective Buildings		Public Buildings		Colective spaces		Parks		Squares		Stream beds	
	Farming type	%	Farming type	%	Farming type	%	Farming type	%	Farming type	%	Farming type	%
Environmental	Roof farming	80	Roof farming	80	Urban forest	60	Urban forest	60	Urban forest	60	Urban forest	60

4.3 Comparison of scenarios

In this section, the different scenarios will be compared for every neighbourhood. Afterwards the scenarios are measured against the social/spatial problems in the neighbourhood from which the most suitable scenario for the neighbouhroodcan be chosen. It is important to note that not all problems can be solved through urban farming and spatial interventions. Urban farming can work though, as a connecting structure to which other social/spatial projects can be linked to.
The comparison of the scenarios is done by testing a set of values (indicators) that are created by employing urban farming techniques in the neighbourhood. The indicators are divided between quantifiable and non-quantifiable values. The quantifiable values are food production, monetary income, job creation, energy balance and water retention. The non quantifiable values are biodiversity creation, esthetics and social cohesion. The way these indicators were calculated is explained in appendix III.

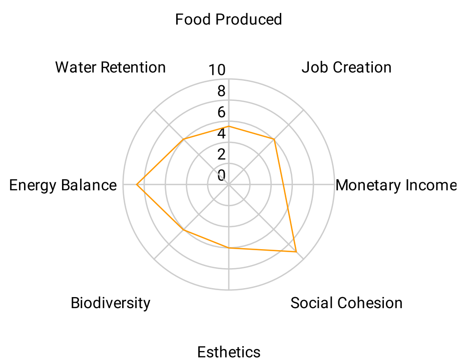
4.3.1 Geuzenveld

From the policy plan 2019 Geuzenveld-Slotermeer the main social problems in the neighbourhood are poverty, unemployment and functional illiteracy. From the report 28% of the inhabitants are living under the social minimum (in comparison to 16% of Amsterdam), 13% reported to be unemployed (7% of Amsterdam) and 40% is functionally illiterate (20% in Amsterdam). It also states that these factors are bringing an array of other social problems in the neighbourhood such as criminality and feeling unsafe in the neighbourhood (41%), obesity (52%), loneliness (23%), descirmination (24%) and loitering youth, which 18% has reported as being troubling (Gemeente Amsterdam, 2019b).

The policy plan reported that the mains spatial problems is a lack of social and retail facilities, the inhabitants also reported that the public spaces are depraved and that public spaces should offer the possibility for meetings and activities.

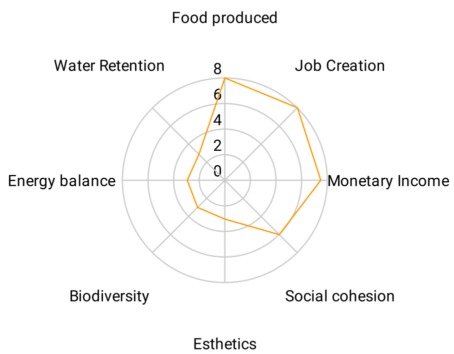
The main social and spatial problems in Geuzenveld are high levels of poverty/unemployment, functional illiteracy and a lack of social infrastructure. In order to help solve this problem, it is important to create jobs and help strengthening the economic position of the inhabitants. The economy scenario has the means to do that, it offers the possibility on a yearly basis to create up to 2969 jobs and bring 11.571.571 euros into the neighbourhood. It is important to note that this scnearios scores very low in the environmental and esthetic indicators, it is therefor important for designing professionals to take this into account when applying this scenario as main strategy. Adding to this scenario the facilities for retailing the goods, such as markets, restaurants and shops can help solve the los social cohesion of the neighbourhood.

Geuzenveld: Community-based



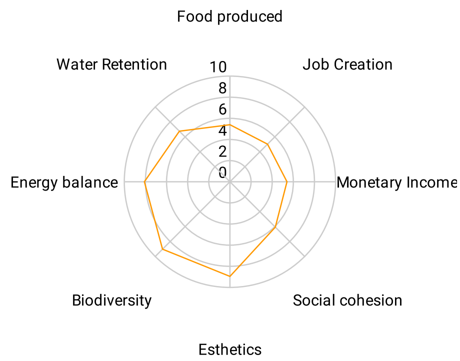
79% food demand

Geuzenveld: Market-based



505% food demand

Geuzenveld: Ecology-based



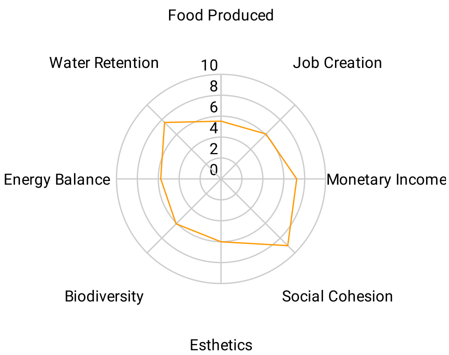
58% food demand

4.3.2 Akkerpolder

Akkerpolder is neighbourhood built during the end of the 80s, it is built in high density using closed building blocks. From the policy plan 2019 two main problems were revealed. Firstly, there is a lack of social cohesion in the neighbourhood. The burglary index is 225 (79 in Amsterdam), which has lead for people to feel unsafe. Other reports have revealed that loitering youth is causing trouble in the neighbourhood, caused by a lack of social facilities for the youth. This lack of social cohesion is further aggravated by a second problem, the aging of the inhabitants. which is causing for less social interactions in the neighbourhood. As inhabitants have aged they are experiencing stagnation in the housing market. The parents who moved into the neighbourhood in the 80s, are 55+ now, and are experiencing a lack of suitable housing (over 49% has reported that their house is not suitable for growing old); on the other hand, the children from then are making their way onto the housing market now, but are unable to find a suitable housing. This stagnation is causing for less social interactions as the older inhabitants are not making place for younger and new inhabitants, who bring more dynamism to the neighbourhood. A lack of public and community buildings is pushing this lack of social cohesion even further (Gemeente Amsterdam, 2019a).

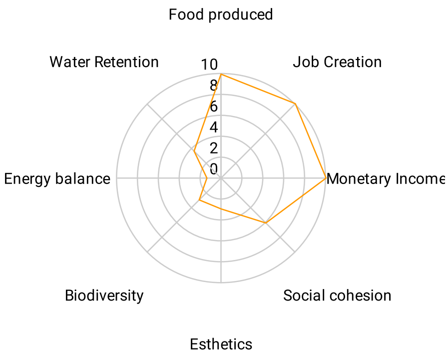
The scenario that seems the most suitable for this neighbourhood is community-based farming, as this can help create stronger bonds between the inhabitants who are now at cross purposes. By placing urban farming in the communal and public spaces, inhabitants will have more opportunities to interact and build bonds with one and other.
It is important to note that with this scenario, the food produced lays at 85% of the total demand for the neighbourhood, this means the neighbourhood will not be selfsufficient. If self sufficiency is wantes, it is therefore important for planning professionals to incorporate to this scenario farming techniques with high yields, such as hydroponics.

Akkerpolder: Community-based



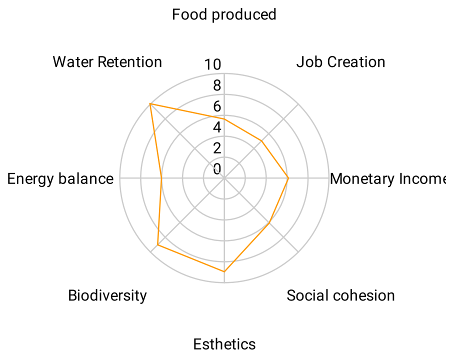
85% food demand

Akkerpoler: Market-based



829% food demand

Akkerpolder: Ecology-based



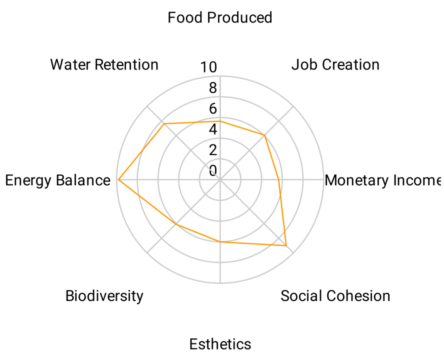
119% food demand

4.3.3 Osdorp Midden

Osdorp Midden is a neighbourhood of Osdorp, built in the 50s and 60s. From the policy plan social exclusion seems to be one of the main problems in the area. Social exclusion is a situation where due to circumstances (lack of financial means, descirmination or lack of care) inhabitants aren't able to fully participate in society. This situation appears to be quite frequent in Osdorp (13% versus 8% in Amsterdam). Factors that are causing this are a high rate of unemployment (22.9% and 18.8% in Osdorp Midden Noord and Zuid), poverty (around 36% is reported to be living under the social minimum, 25% in Amsterdam), lack of education (28% of parents have a basic education level, compared to 48% in Amsterdam), criminality (41% report feeling unsafe in the neighbourhood, the highest rate in whole Amsterdam) (Gemeente Amsterdam, 2019c),

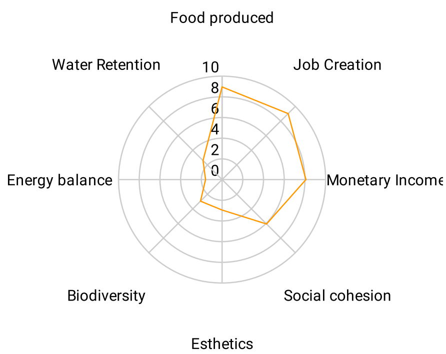
In order to solve these problems, a scenario needs to be chosen that focuses on bringing economic prosperity and employment while also strengthening the social ties within the neighbourhood. Therefore the most suitable scenario will be the economic scenario. By placing high yield indoor systems in the neighbourhood, inhabitants can cultivate and sell to a market rate their own fruits, herbs and vegetables. This will bring 3942 jobs and 14986203 euros into the economy of the neighbourhood. If this is put into relationship with social projects focusing on strengthening the social ties and education level in the neighbourhood, a big part of the problems in the area can be addressed. The same as ecnomy scenario in Geuzenveld, this scenario scores low environmental and esthetic values, it is therefore importantfor planing professional to take this into account when developing a strategy.

Osdorp-Midden: Community-based



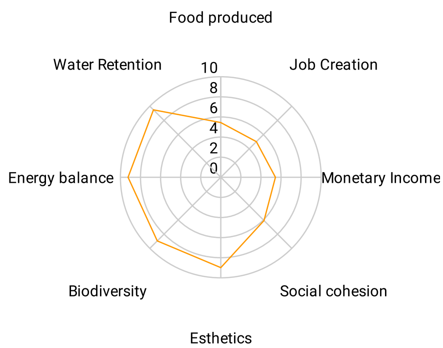
94% food demand

Osdorp-Midden: Market-based



658% food demand

Osdorp-Midden: Ecology-based



77% food demand

5. Conclusion

The purpose behind this paper was to investigate ways to produce food within the boundaries of the city of Amsterdam. The research studied, through three different scenarios, the suitability of different farming techniques within the spatial infrastructure of three neighbourhood located in the borough of New West. For each scenario a set of indicators were calculated, and compared to the social/spatial needs of the neighbourhood, from which the most suitable scenario was chosen.

The results displayed that for the neighbourhoods Geuzenveld and Osdorp Midden, which showed high rates of poverty and unemployment, the economic scenario would be the most suitable, as this can create job opportunities and boost the economy of the neighbourhoods. The down side of this scenario is its low score on environmental and esthetic values, this has to be taken as an attention point for design professionals in order to create a healthy environment. For the Middelveldsche Akkerpolder, which showed low social cohesion between the inhabitants, the social scenario is the most suitable, as this can help strengthening social ties in the neighbourhood. An important attention point is that this scenario, with 85% food demand covered, does not make the neighbourhood self sufficient. In order to do so, design professionals can incorporate indoor farming techniques to with a yields in order to meet this demand.

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Appendix I: Spatial Infrastructure

The data resulting from measuring the spatial infrastructure on Autocad is displayed below.

	Public spaces				Building Typologies		
Neighbourhood	**Courtyards**	**Squares/plots**	**Parks**	**Stream beds**	**Collective housing**	**Public building**	**Private housing**
Geuzenveld	308958	30136	146130	83547	87105	23241	91737
Osdorp-Midden	196226	27719	107944	22930	127551	13895	-
Middelveldsche Akkepolder	54123	52698	-	193393	37790	17361	218353

Appendix II: Urban Farming types

Information about the different farming techniques are displayed below. The four famring techniques used during the research have been completed with four other types of farming techniques, two conventional ones and two high tech ones Data has been extracted from (de Graaf, 2011).

Properties of farming system				
System	**Conventional farming**	**Periurban farming**	**Urban Forest**	**SPIN Farming**
Yield (kg/m2/year)	5-7	4-6	1-4	6-10
Average size (hectare)	22.3	5,1	0,5-1	Untill 0,5
Harvest per year	3-4	3-4	2-3	4-5
Climate bound	Yes	Yes	Yes	Yes
Season bound	Yes	Yes	Yes	Yes
Suitable for roof	No	No	No	Posible
Suitable for closed spaces	No	No	No	No
Layering of cultivation	No	No	No	No
Combination with fish/poultry	No	Posible	Yes, no control	Yes
Biodiversity enhancing	Equal	Yes	Yes	Yes
Waterretention	Yes	Yes	Yes	Yes
Type of underground	Open ground	Open ground	Open ground	Open ground
Use of pest control and cultivated plants	Yes	Organic	No	Organic

Properties of farming system				
System	**Roof Farming**	**Hydroponics (roof)**	**Aquaponics**	**Polydome**
Yield (kg/m2/year)	6-10	40-60	40-60 + 512kg/m3 Tilapia	55-65
Average size (hectare)	Untill 0,5	0,02-1	0,03	1-2
Harvest per year	4-5	7-8	7-8	2-8
Climate bound	Yes	Partly	Partly	No
Season bound	Yes	Prolongs season, no	Prolongs season, no	Yes
Suitable for roof	Yes	Yes	No	No
Suitable for closed spaces	No	Yes	Yes	Yes, both
Layering of cultivation	Stagewise	Yes	Stagewise	Stagewise
Combination with fish/poultry	Posible, chicken	Yes, fish	Yes	Yes
Biodiversity enhancing	Yes	No	No	Posible/no
Waterretention	Yes	No	No	No
Type of underground	Substrate, open ground	Ebb/flow system, NFT	Ebb/flow system, NFT	Open ground, NFT, substrate
Use of pest control and cultivated plants	Posible	Posible, organic	No	Organic

Appendix III: Value Creation

In the third appendix of this paper the process of calculating the different values (indicators) will be explained. The created values for this paper can be divided between quantifiable and non- quantifiable values. The quantifiable values are food, jobs, monetary income, water retention and energy production. The non-quantifiable values are social cohesion, biodiversity and aesthetics.

Under we see the indicators for each scenario grouped, this score was used in order to plot the radar chart visible in the next page.

Akkerpolder

Social Scenario	
Value	Grade
Food Produced	5.5
Job Creation	6
Monetary Income	7.2
Social Cohesion	9
Esthetics	6
Biodiversity	6
Energy Balance	5.8
Water Retention	7.7

Economy Scenario	
Value	Grade
Food produced	10
Job Creation	10
Monetary Income	10
Social cohesion	6
Esthetics	3
Biodiversity	3
Energy balance	1.3
Water Retention	3.6

Environmental scenario	
Value	Grade
Food produced	5.7
Job Creation	5
Monetary Income	6.1
Social cohesion	6
Esthetics	9
Biodiversity	9
Energy balance	6
Water Retention	10

Geuzenveld

Social Scenario	
Value	Grade
Food Produced	5.5
Job Creation	6
Monetary Income	5.2
Social Cohesion	9
Esthetics	6
Biodiversity	6
Energy Balance	8.7
Water Retention	6.1

Economy Scenario	
Value	Grade
Food produced	8
Job Creation	8
Monetary Income	7.5
Social cohesion	6
Esthetics	3
Biodiversity	3
Energy balance	2.9
Water Retention	2.9

Environmental scenario	
Value	Grade
Food produced	5.4
Job Creation	5
Monetary Income	5.4
Social cohesion	6
Esthetics	9
Biodiversity	9
Energy balance	8.1
Water Retention	6.8

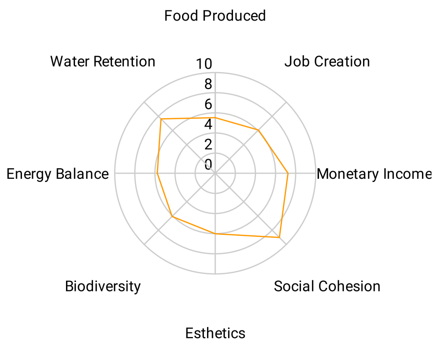
Osdorp Midden

Social Scenario	
Value	Grade
Food Produced	5.6
Job Creation	6
Monetary Income	5.7
Social Cohesion	9
Esthetics	6
Biodiversity	6
Energy Balance	9.8
Water Retention	7.6

Economy Scenario	
Value	Grade
Food produced	9
Job Creation	9
Monetary Income	8.1
Social cohesion	6
Esthetics	3
Biodiversity	3
Energy balance	1.6
Water Retention	2.6

Environmental scenario	
Value	Grade
Food produced	5.5
Job Creation	5
Monetary Income	5.5
Social cohesion	6
Esthetics	9
Biodiversity	9
Energy balance	9.3
Water Retention	9.5

Akkerpolder: Community-based



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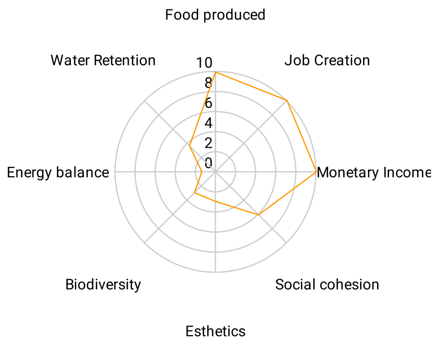

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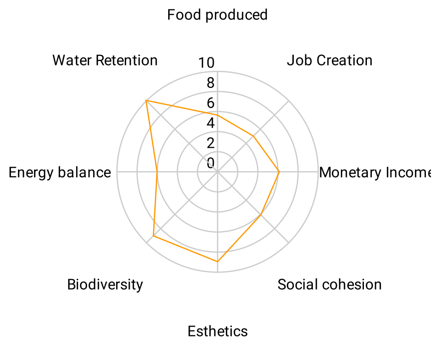

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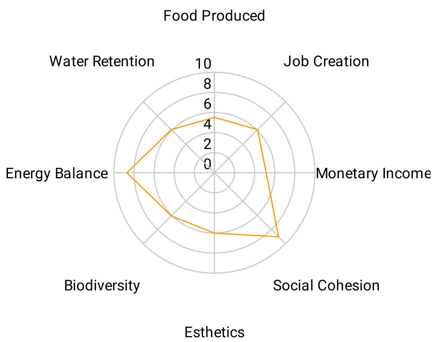

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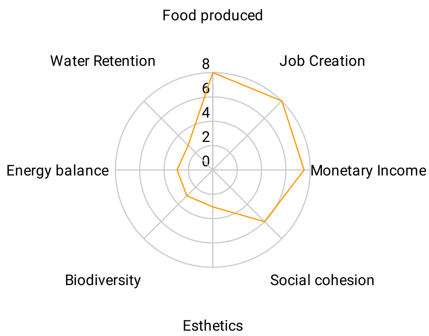

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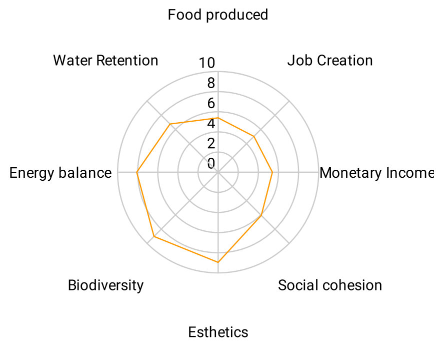

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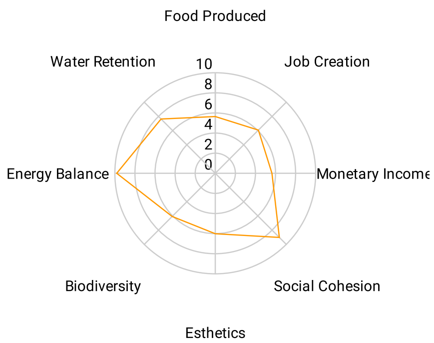

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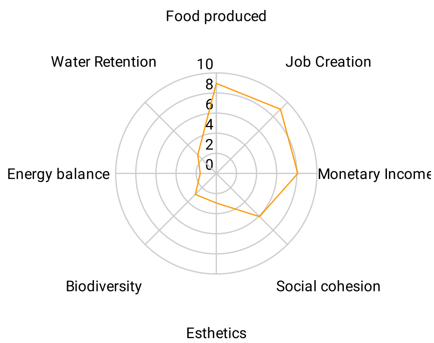

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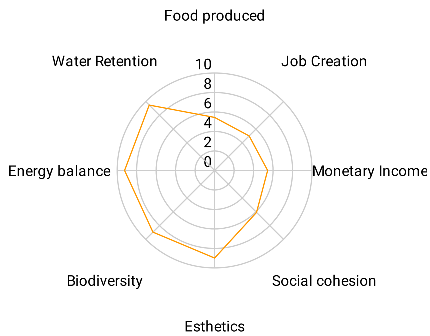

Food Production

Neighbourhood	Collective buildings				
	Surface (1)	Farming Type	Yield (2)	% (3)	Food produced (4)
Neighbourhood (scenario)	Surface	Roof farming	x	50	surface*x*0.5

Total Food (5)	Rate (6)	Grade (7)
Sum of all produced food	total produced/total demand * 100	(rate*5/highest rate)+5

The next scheme explains the calculation behind the food production in the neighbourhood.

(1) The surfaces are calculated using Autocad.
(2) The yields of the different farming type are presented in the Appendix …
(3) The percentage of the farming types have been chosen through the architects' outlook on the situation. The full scheme of surfaces corresponding to each scenario can be found on page 5.
(4) Food produced is calculated by multiplying the surface by the yield/m2 by the percentage of farming.
(5) The total food is calculated by summing up all the values for food production in the neighbourhood.
(6) The rate is calculated by dividing the total produced food by the total demand of the neighbourhood, then it is converted to percentages by multiplying it by 100.
(7) In order to compare the different scenarios, a grading system needs to be created. For that the total produced food is multiplied by 5, then divided by the highest obtained rate (830), finally, 5 is summed up in order to get the final grade.

OSDORP MIDDEN	Collective buildings				
	Surface	Farming Type	Yield	%	Food produced
Osdorp Midden (Social)	149914	Roof farming	8	50	599656
Osdorp Midden (Economy)	149914	Hydroponics	50	80	5996560
Osdorp Midden (Environmental)	149914	Roof farming	8	80	959449.6

GEUZENVELD	Collective buildings				
	Surface	Farming Type	Yield	%	Food produced
Geuzenveld (Social)	87105	Roof farming	8	50	348420
Geuzenveld (Economy)	87105	Hydroponics	50	80	3484200
Geuzenveld (Environmental)	87105	Roof farming	8	80	557472

AKKERPOLDER	Collective buildings				
	Surface	Farming Type	Yield	%	Food produced
Akkerpolder (Social)	37790	Roof farming	8	50	151160
Akkerpolder (Economy)	37790	Hydroponics	50	80	1511600
Akkerpolder (Environmental)	37790	Roof farming	8	80	241856

Parks					Squares				
Surface	Farming Type	Yield	%	Food produced	Surface	Farming Type	Yield	%	Food produced
175166	SPIN	8	25	350332	71638	SPIN	8	25	143276
175166	SPIN	8	40	560531.2	71638	SPIN/hydrop	8/50	40/40	1662001.6
175166	Urban forest	2.5	60	262749	71638	Urban forest	2.5	60	107457

Parks					Squares				
Surface	Farming Type	Yield	%	Food produced	Surface	Farming Type	Yield	%	Food produced
146130	SPIN	8	25	292260	30136	SPIN	8	25	60272
146130	SPIN	8	40	467616	30136	SPIN/hydrop	8/50	40/40	699155.2
146130	Urban forest	2.5	60	219195	30136	Urban forest	2.5	60	45204

Parks					Squares				
Surface	Farming Type	Yield	%	Food produced	Surface	Farming Type	Yield	%	Food produced
-	SPIN	8	25	-	52698	SPIN	8	25	105396
-	SPIN	8	40	-	52698	SPIN/hydrop	8/50	40/40	1222593.6
-	Urban forest	2,5	60	-	52698	Urban forest	2.5	60	79047

Public buildings					Collective spaces				
Surface	Farming Type	Yield	%	Food produced	Surface	Farming Type	Yield	%	Food produced
59273	Roof farming	8	50	237092	286977	SPIN	8	50	1147908
59273	Hydroponics	50	80	2370920	286977	SPIN/hydro	8/50	40/40	6657866.4
59273	Roof farming	8	80	237092	286977	Urban forest	2.5	60	430465.5

Public buildings					Collective spaces				
Surface	Farming Type	Yield	%	Food produced	Surface	Farming Type	Yield	%	Food produced
23241	Roof farming	8	50	92964	308958	SPIN	8	50	1235832
23241	Hydroponics	50	80	929640	308958	SPIN/hydro	8/50	40/40	7167825.6
23241	Roof farming	8	80	92964	308958	Urban forest	2.5	60	463437

Public buildings					Collective spaces				
Surface	Farming Type	Yield	%	Food produced	Surface	Farming Type	Yield	%	Food produced
17361	Roof farming	8	50	69444	54123	SPIN	8	50	216492
17361	Hydroponics	50	80	694440	54123	SPIN/hydro	8/50	40/40	1255653.6
17361	Roof farming	8	80	69444	54123	Urban forest	2.5	60	81184.5

Stream beds							
Surface	Farming Type	Yield	%	Food produced	**Total Food**	**Rate**	**Grade**
28434	-	-	-	-	2478264	94	5.6
28434	SPIN	8	40	90988.8	17338868	658	9.0
28434	Urban forest	2.5	60	42651	2039864.1	77	5.5

Stream beds							
Surface	Farming Type	Yield	%	Food produced	**Total Food**	**Rate**	**Grade**
83547	-	-	-	-	2029748	79	5.5
83547	SPIN	8	40	267350.4	13015787.2	505	8.0
83547	Urban forest	2.5	60	125320.5	1503592.5	58	5.4

Stream beds							
Surface	Farming Type	Yield	%	Food produced	**Total Food**	**Rate**	**Grade**
193393	-	-	-	-	542492	85	5.5
193393	SPIN	8	40	618857.6	5303144.8	829	10.0
193393	Urban forest	2.5	60	290089.5	761621	119	5.7

Job creation

Neighbourhood	Spatial infrastructure				
	Surface (1)	Farming Type	Labour/m2 (2)	% (3)	Labour hours (4)
Neighbourhood (scenario)	Surface	Roof farming	3.8h/m2 (3)	50	surface*x*0.5

Total labour hours (5)	Total full time jobs (6)	Employement rate (7)	Grade (8)
Sum of all labour hours	total labour hours/ (hours worked a year)	Total full time jobs/total inhabitants	(rate*5/highest rate)+5

The next scheme explains the calculation behind the job creation for each scenario.

(1) The surfaces are calculated using Autocad.
(2) The labour hours for outdoor roof farming and SPIN farming is 3.8h/m2 a year (Glavan, Černič Istenič, Cvejić, & Pintar, 2016)
The labour hours for Indoor farming is 21.6h/m2 a year (source)
There was no clear data on the number of labour hours needed for maintaining a forest garden. From (Romkema, 2013) it can be deduced that the maintenance of public green spaces comes down to 0.1hours/m2.
(3) The percentage of the farming types have been chosen through the architects' outlook on the situation. The full scheme of surfaces corresponding to each scenario can be found on page 5.
(4) Labour hours are calculated by multiplying the surface by the labour/m2 by the percentage of farming.
(5) The total hours are calculated by summing up all the labour hours in the neighbourhood.
(6) The total number of jobs created is calculated by dividing the total labour hours by the hours worked a year.
(7) For each scenario, there is an employment rate calculated, by dividing the number of jobs by the total number of inhabitants.
(8) In order to compare the different scenarios, a grading system needs to be created. For that the total created full-time jobs is multiplied by 5, then divided by the highest obtained rate (4000), finally, 5 is summed up in order to get the final grade.

OSDORP MIDDEN	Collective buildings				
	Surface	Farming Type	Labour/m2	%	Labour
Osdorp Midden (Social)	149914	Roof farming	3.8	50	284836.6
Osdorp Midden (Economy)	149914	Hydroponics	21.6	80	2590513.92
Osdorp Midden (Environmental)	149914	Roof farming	3.8	80	455738.56

GEUZENVELD	Collective buildings				
	Surface	Farming Type	Labour/m2	%	Labour
Geuzenveld (Social)	87105	Roof farming	3.8	50	165499.5
Geuzenveld (Economy)	87105	Hydroponics	21.6	80	1505174.4
Geuzenveld (Environmental)	87105	Roof farming	3.8	80	264799.2

AKKERPOLDER	Collective buildings				
	Surface	Farming Type	Labour/m2	%	Labour
Akkerpolder (Social)	37790	Roof farming	3.8	50	71801
Akkerpolder (Economy)	37790	Hydroponics	21.6	80	653011.2
Akkerpolder (Environmental)	37790	Roof farming	3.8	80	114881.6

Public buildings					Collective spaces				
Surface	Farming Type	Labour/m2	%	Labour	Surface	Farming Type	Labour/m2	%	Labour
59273	Roof farming	3.8	50	112618.7	286977	SPIN	3.8	50	545256.3
59273	Hydroponics	21.6	80	1024237.44	286977	SPIN/hydro	3.8/21.6	40/40	2915686.32
59273	Roof farming	3.8	80	112618.7	286977	Urban forest	0.1	60	17218.62

Public buildings					Collective spaces				
Surface	Farming Type	Labour/m2	%	Labour	Surface	Farming Type	Labour/m2	%	Labour
23241	Roof farming	3.8	50	44157.9	308958	SPIN	3.8	50	587020.2
23241	Hydroponics	21.6	80	401604.48	308958	SPIN/hydro	3.8/21.6	40/40	3139013.28
23241	Roof farming	3.8	80	44157.9	308958	Urban forest	0.1	60	18537.48

Public buildings					Collective spaces				
Surface	Farming Type	Labour/m2	%	Labour	Surface	Farming Type	Labour/m2	%	Labour
17361	Roof farming	3.8	50	32985.9	54123	SPIN	3.8	50	102833.7
17361	Hydroponics	21.6	80	299998.08	54123	SPIN/hydro	3.8/21.6	40/40	549889.68
17361	Roof farming	3.8	80	32985.9	54123	Urban forest	0.1	60	3247.38

Parks					Squares				
Surface	Farming Type	Labour/m2	%	Labour	Surface	Farming Type	Labour/m2	%	Labour
175166	SPIN	3.8	25	166407.7	71638	SPIN	3.8	25	68056.1
175166	SPIN	3.8	40	266252.32	71638	SPIN/hydrop	3.8/21.6	40/40	727842.08
175166	Urban forest	0.1	60	10509.96	71638	Urban forest	0.1	60	4298.28

Parks					Squares				
Surface	Farming Type	Labour/m2	%	Labour	Surface	Farming Type	Labour/m2	%	Labour
146130	SPIN	3.8	25	138823.5	30136	SPIN	3.8	25	28629.2
146130	SPIN	3.8	40	222117.6	30136	SPIN/hydrop	3.8/21.6	40/40	306181.76
146130	Urban forest	0.1	60	8767.8	30136	Urban forest	0.1	60	1808.16

Parks					Squares				
Surface	Farming Type	Labour/m2	%	Labour	Surface	Farming Type	Labour/m2	%	Labour
-	SPIN	3.8	25	-	52698	SPIN	3.8	25	50063.1
-	SPIN	3.8	40	-	52698	SPIN/hydrop	3.8/21.6	40/40	535411.68
-	Urban forest	0.1	60	-	52698	Urban forest	0.1	60	3161.88

Stream beds								
Surface	Farming Type	Labour/m2	%	Food produced	Total Labour hours	Total full time jobs (rate)	Employement (%)	Rate
28434	-	-	-	-	1177175.4	613	4	6
28434	SPIN	3.8	40	43219.68	7567751.76	3942	25	9
28434	Urban forest	0.1	60	1706.04	602090.16	314	2	5

Stream beds								
Surface	Farming Type	Labour/m2	%	Food produced	Total Food	Total full time jobs	Employement (%)	Rate
83547	-	-	-	-	964130.3	502	3	6
83547	SPIN	3.8	40	126991.44	5701082.96	2969	19	8
83547	Urban forest	0.1	60	5012.82	343083.36	179	1	5

Stream beds								
Surface	Farming Type	Labour/m2	%	Food produced	Total Food	Total full time jobs	Employement (%)	Rate
193393	-	-	-	-	257683.7	134	3	6
193393	SPIN	3.8	40	293957.36	2332268	1215	31	10
193393	Urban forest	0.1	60	11603.58	165880.34	86	2	5

Monetary Income

Typology	Total food produced (kg) (1)	Total turn-over (€) (2)	Operational kosts (€)	Rent kosts (€)
SPIN Farming	80% of total food	Total food (kg) * 3.75€/kg	20% total turnover (3)	10% total turnover (5)
Roof Farming	80% of total food	Total food (kg) * 3.75€/kg	20% total turnover (3)	10% total turnover (5)
Hydroponic (roof)	80% of total food	Total food (kg) * 3.75€/kg	40% total turnover (4)	20% total turnover (6)
Hydroponic (ground)	80% of total food	Total food (kg) * 3.75€/kg	40% total turnover (4)	20% total turnover (6)

Turnover after kosts (€)	Taxes (€) (7)	Profit (€)	Inhabitants	
Turnover - (operation+rent)	33% turnover after kosts	Turnover after kost - taxes	Total inhabitans	
Turnover - (operation+rent)	33% turnover after kosts	Turnover after kost - taxes		
Turnover - (operation+rent)	33% turnover after kosts	Turnover after kost - taxes		
Turnover - (operation+rent)	33% turnover after kosts	Turnover after kost - taxes		
			Euros/inhabitant	**Grade (8)**
		Total: Sum of all the profit	Profit/inhabitants	(euros/inh)*5/1500+5

The next scheme explains the calculation of the financial income for each farming type. The calculation has been taken over from (Romkema, 2013).

(1) 20% of the total yield is lost due to quality issues.

(2) For the calculation of the monetary income, lettuce has been used. 1kg of lettuce costs on average 3.76€

(3) For outdoor farming, 20% of the total turnover has been used as operational costs. Operational costs include equipment and water.

(4) For indoor farming, 40% of the total turnover has been used as operational costs. Operational costs include electricity, heating, water and equipment.

(5) The rent costs for outdoor farming has been set at 10% of the total revenue.

(6) The rent costs for indoor farming has been set at 20% of the total revenue.

(7) A 33% tax rate has been set on the total income after the costs.

(8) in order to compare the different numbers, a grading system under 10 needs to be calculated, for this, the profit/inhabitants are multiplicated by 5 and divided by the highest obtained result, in this case (1500), finally, 5 is summed up in order to get the final grade.

Geuzenveld Social

Typologies	Surface	Food produced (kg)	Turnover (€)	Operational kost (€)	Rent (€)
Roof Farming (community)	27576	353107	1327683	-265537	-132768
Roof Farming (commercial)	-	-	-	-	-
Hydroponics (roof)	-	-	-	-	-
Hydroponics (ground)	-	-	-	-	-
SPIN farming	40236	257510	968238	-193648	-96824
Urban Garden	-	-	-	-	-

Geuzenveld Economy

Typologies	Surface	Food produced (kg)	Turnover (€)	Operational kost (€)	Rent (€)
Roof Farming (community)	-	-	-	-	-
Roof Farming (commercial)	-	-	-	-	-
Hydroponics (roof)	44120.8	3531072	13276831	-5310732	-2655366
Hydroponics (ground)	42728.4	2517434	9465551	-3786221	-1893110
SPIN farming	120085.6	3105407	11676330	-2335266	-1167633
Urban Garden	-	-	-	-	-

Geuzenveld Environment

Typologies	Surface	Food produced (kg)	Turnover (€)	Operational kost (€)	Rent (€)
Roof Farming (community)	-	-	-	-	-
Roof Farming (commercial)		520349	1956511	-391302	-195651
Hydroponics (roof)	-	-	-	-	-
Hydroponics (ground)	-	-	-	-	-
SPIN farming	-	-	-	-	-
Urban Garden		360257	1354566	-	-135457

Turnover after kosts (€)	Taxes (33%)	Turnover after taxes	Inhabitants	
929378	-306695	622683	15700	
-	-	-		
-	-	-		
-	-	-		
677766	-223663	454103		
-	-	-	**Euros/Inh**	**Grade**
		1076787	69	5.2

Turnover after kosts (€)	Taxes (33%)	Turnover after taxes	Inhabitants	
-	-	-	15700	
-	-	-		
5310732	-1752542	3558191		
3786221	-1249453	2536768		
8173431	-2697232	5476199		
-	-	-	**Euros/Inh**	**Grade**
		11571157	737	7.5

Turnover after kosts (€)	Taxes (33%)	Turnover after taxes	Inhabitants	
-	-	-	15700	
1369558	-451954	917604		
-	-	-		
-	-	-		
-	-	-		
1219109	-402306	816803	**Euros/Inh**	**Grade**
		1734407	110	5.4

Osdorp Midden Social

Typologies	Surface	Food produced (kg)	Turnover (€)	Operational kost (€)	Rent (€)
Roof Farming (community)	27575.5	669398.4	2516937.984	-503387.5968	-251693.7984
Roof Farming (commercial)	-	-	-	-	-
Hydroponics (roof)	-	-	-	-	-
Hydroponics (ground)	-	-	-	-	-
SPIN farming	40236	1313212.8	4937680.128	-987536.0256	-493768.0128
Urban Garden	-	-	-	-	-

Osdorp Midden Economy

Typologies	Surface	Food produced (kg)	Turnover (€)	Operational kost (€)	Rent (€)
Roof Farming (community)	-	-	-	-	-
Roof Farming (commercial)	-	-	-	-	-
Hydroponics (roof)	44121	6693984	25169380	-10067752	-5033876
Hydroponics (ground)	42728	2517434	9465551	-3786221	-1893110
SPIN farming	120086	3183574	11970237	-2394047	-1197024
Urban Garden	-	-	-	-	-

Osdorp Midden Environment

Typologies	Surface	Food produced (kg)	Turnover (€)	Operational kost (€)	Rent (€)
Roof Farming (community)	-	-	-	-	-
Roof Farming (commercial)		520349	1956511	-391302	-195651
Hydroponics (roof)	-	-	-	-	-
Hydroponics (ground)	-	-	-	-	-
SPIN farming	-	-	-	-	-
Urban Garden		682525	2566295	-	-256629

Turnover after kosts (€)	Taxes (33%)	Turnover after taxes	Inhabitants	
1761856.589	-581412.6743	1180443.914	16050	
-	-	-		
-	-	-		
-	-	-		
3456376.09	-1140604.11	2315771.98		
-	-	-	**Euros/Inh**	**Grade**
		3496215.895	218	5.7

Turnover after kosts (€)	Taxes (33%)	Turnover after taxes	Inhabitants	
-	-	-	16050	
-	-	-		
10067752	-3322358	6745394		
3786221	-1249453	2536768		
8379166	-2765125	5614041		
-	-	-	**Euros/Inh**	**Grade**
		14896203	928	8.1

Turnover after kosts (€)	Taxes (33%)	Turnover after taxes	Inhabitants	
-	-	-	16050	
1369558	-451954	917604		
-	-	-		
-	-	-		
-	-	-		
2309665	-762190	1547476	**Euros/Inh**	**Grade**
		2465080	154	5.5

Akkerpolder Social

Typologies	Surface	Food produced (kg)	Turnover (€)	Operational kost (€)	Rent (€)
Roof Farming (community)	27576	176483	663577	-132715	-66358
Roof Farming (commercial)	-	-	-	-	-
Hydroponics (roof)	-	-	-	-	-
Hydroponics (ground)	-	-	-	-	-
SPIN farming	40236	1270691	4777799	-955560	-477780
Urban Garden	-	-	-	-	-

Akkerpolder Economy

Typologies	Surface	Food produced (kg)	Turnover (€)	Operational kost (€)	Rent (€)
Roof Farming (community)	-	-	-	-	-
Roof Farming (commercial)	-	-	-	-	-
Hydroponics (roof)	44121	2630800	9891808	-3956723	-1978362
Hydroponics (ground)	42728	2136420	8032939	-3213176	-1606588
SPIN farming	120086	768547	2889737	-577947	-288974
Urban Garden	-	-	-	-	-

Akkerpolder Environmental

Typologies	Surface	Food produced (kg)	Turnover (€)	Operational kost (€)	Rent (€)
Roof Farming (community)	-	-	-	-	-
Roof Farming (commercial)		249040	936390	-187278	-93639
Hydroponics (roof)	-	-	-	-	-
Hydroponics (ground)	-	-	-	-	-
SPIN farming	-	-	-	-	-
Urban Garden		360257	1354566	-	-135457

Turnover after kosts (€)	Taxes (33%)	Profit	Inhabitants	
464504	-153286	311218	3895	
-	-	-		
-	-	-		
-	-	-		
3344459	-1103672	2240788		
-	-	-	Euros/Inh	Grade
		2552005	655	7.2

Turnover after kosts (€)	Taxes (33%)	Profit	Inhabitants	
-	-	-	3895	
-	-	-		
3956723	-1305719	2651005		
3213176	-1060348	2152828		
2022816	-667529	1355287		
-	-	-	Euros/Inh	Grade
		6159119	1581	10.0

Turnover after kosts (€)	Taxes (33%)	Profit	Inhabitants	
-	-	-	3895	
655473	-216306	439167		
-	-	-		
-	-	-		
-	-	-		
1219109	-402306	816803	Euros/Inh	Grade
		1255970	322	6.1

Water Retention

Neighbourhood	Total surface land (1)	Collective buildings				Collective spaces			
		Surface	Farming Type	%	Water Retention	Surface	Farming Type	%	Water Retention
Neighbourhood Social	Total surface	Surface	Roof farming (2)	50	Surface*(0.5)	Surface	SPIN	50	-
Neighbourhood Economic	Total surface	Surface	Hydroponics	80	-	Surface	SPIN/hydro (3)	40/40	Surface *(0.4)
Neighbourhood Environment	Total surface	Surface	Roof farming	80	Surface*(0.8)	Surface	Urban forest	60	-

Total surface	Rate (4)	Grade (5)
Water retained Surface	Water retained surface/ surface/total surface*100	(rate*5/(highest rate)) + 5
Water retained Surface	Water retained surface/ surface/total surface*100	(rate*5/(highest rate)) + 5
Water retained Surface	Water retained surface/ surface/total surface*100	(rate*5/(highest rate)) + 5

The next scheme explains the calculation of water retention in the neighbourhood. For this, two typologies of the urban infrastructure are utilised, one belongs to the buildings (collective buildings) and the other to the outdoor spaces (collective spaces)
(1) The total surface of the land, calculated using Autocad.
(2) Building surfaces turned green add positively to the water retention in the neighbourhood. These are roofs turned into SPIN farming
(3) Outdoor surfaces turned into buildings add negatively to the water retention of the neighbourhood. These are outdoor surfaces turned into hydroponics.
(4) The rate is calculated by dividing the calculated surface by the total surface. In order to have an easier number to work with the number is multiplied by 100.
(5) In order to compare the different numbers, a grading system under 10 needs to be calculated, for this, the final rate is multiplied by 5, then dividing it by the total scored rate (22), finally, 5 is summed up in order to the final grade.

AKKERPOLDER	Total surface land	Collective buildings			
		Surface	Farming Type	%	Water Retention
Akkerpolder Social	340000	37790	Roof farming	50	18895
Akkerpolder Economy	340000	37790	Hydroponics	80	-
Akkerpolder Environment	340000	37790	Roof farming	80	30232

GEUZENVELD	Total surface land	Collective buildings			
		Surface	Farming Type	%	Water retention
Geuzenveld Social	1330000	87105	Roof farming	50	43552.5
Geuzenveld Economy	1330000	87105	Hydroponics	80	-
Geuenveld Environment	1330000	87105	Roof farming	80	69684

OSDORP MIDDEN	Total surface land	Collective buildings			
		Surface	Farming Type	%	Water Retention
Osdorp Midden Social	1070000	149914	Roof farming	50	74957
Osdorp Midden Economy	1070000	149914	Hydroponics	80	-
Osdorp Midden Environment	1070000	149914	Roof farming	80	119931.2

Public buildings				Collective spaces			
Surface	Farming Type	%	Water Retention	Surface	Farming Type	%	Water Retention
17361	Roof farming	50	8680.5	54123	SPIN	50	-
17361	Hydroponics	80	-	54123	SPIN/hydro	40/40	-21649.2
17361	Roof farming	80	13888.8	54123	Urban forest	60	-

Public buildings				Collective spaces			
Surface	Farming Type	%	Water retention	Surface	Farming Type	%	Water Retention
23241	Roof farming	50	11620.5	308958	SPIN	50	-
23241	Hydroponics	80	-	308958	SPIN/hydro	40/40	-123583.2
23241	Roof farming	80	18592.8	308958	Urban forest	60	-

Public buildings				Collective spaces			
Surface	Farming Type	%	Water retention	Surface	Farming Type	%	Water Retention
59273	Roof farming	50	29636.5	286977	SPIN	50	-
59273	Hydroponics	80	-	286977	SPIN/hydro	40/40	114790.8
59273	Roof farming	80	47418.4	286977	Urban forest	60	-

Parks				Squares			
Surface	Farming Type	%	Water Retention	Surface	Farming Type	%	Water Retention
-	SPIN	25	-	52698	SPIN	25	13174.5
-	SPIN	40	-	52698	SPIN/hydrop	40/40	-
-	Urban forest	60	-	52698	Urban forest	60	31618.8

Parks				Squares			
Surface	Farming Type	%	Water retention	Surface	Farming Type	%	Water retention
146130	SPIN	25	-	30136	SPIN	25	7534
146130	SPIN	40	-	30136	SPIN/hydrop	40/40	-
146130	Urban forest	60	-	30136	Urban forest	60	18081.6

Parks				Squares			
Surface	Farming Type	%	Water Retention	Surface	Farming Type	%	Water Retention
175166	SPIN	25	-	71638	SPIN	25	17909.5
175166	SPIN	40	-	71638	SPIN/hydrop	40/40	-
175166	Urban forest	60	-	71638	Urban forest	60	42982.8

Stream beds						
Surface	Farming Type	%	Water Retention	**Total surface**	**Rate**	**Grade**
193393	-	-	-	40750	12	7.7
193393	SPIN	40	-	-21649.2	-6	3.6
193393	Urban forest	60	-	75739.6	22	10.0

Stream beds						
Surface	Farming Type	%	Water retention	**Total surface**	**Rate**	**Grade**
83547	-	-	-	62707	5	6.1
83547	SPIN	40	-	-123583.2	-9	2.9
83547	Urban forest	60	-	106358.4	8	6.8

Stream beds						
Surface	Farming Type	%	Water Retention	**Total surface**	**Rate**	**Grade**
28434	-	-	-	122503	11	7.6
28434	SPIN	40	-	-114790.8	-11	2.6
28434	Urban forest	60	-	210332.4	20	9.5

Energy Production

Neighbourhood	Inhabitants (1)	Households (2)	Energy (household) (3)	Food Production (4)
Geuzenveld	Total inhabitants	Total households	Energy/household	Total food prodduced

Food waste (5)	Agricultural waste (6)	Energy production (7)	Energy demand (indoor) (8)
Total inhbitants * 62.2kg	Total food produced *0.77	(food watse+agricultural waste)/1000 * 224.6	surface hydroponics * 15kwh

Powers (households) (9)	-Consumes (households)(10)	Rate (11)	Grade (12)
Energy produced/(energy/household)	-Energy demand hydroponics/ (energy/household)	powered households/total households *100	Rate*5/13 +5

The next scheme explains the calculation behind energy production in the neighbourhood. For this example, the neighbourhood of Geuzenveld has been chosen with the respective data. The data of the sources
(1) Inhabitants of the neighbourhood, data found on the website (Alle Cijfers, 2019).
(2) Household in the neighbourhood, data found on the website (Alle Cijfers, 2019).
(3) Energy consumed per household, data found on the website (Alle Cijfers, 2019).
(4) Total food produced in the neighbourhood, data can be found in Appendix III part
(5) Food waste, calculated by multiplying the total inhabitants by the total organic waste per inhabitant a year (van Dooren & The Netherlands Nutrition Centre Foundation, 2016).
(6) Agricultural waste is calculated by multiplying the total food production by the average straw/grain ratio of vegetables (Lal, 2005).
(7) Energy production is calculated by summing up the total waste, dividing it by 1000 in order to convert it to tons, and finally multiplying it by 224.6kWh, which is the amount of energy you can extract from every 1000 kg of organic waste (Achinas, Achinas, & Euverink, 2017).
(8) The total energy demand is calculated by multiplying the total surface of indoor farming by 15kWh, which is the yearly amount of energy per square meter indoor farming.
(9) The amount of household it powers is calculated by dividing the total produced energy by the energy demand of each household.
(10) For comparison, the energy consumed by the indoor systems needs to be turned into negative powered households, in order to do so, the total energy demand of the hydroponics is divided by the energy demand of one household.
(11) In order to rate the different scenarios, the powered households are divided by the total households, afterwards, they are multiplied by 100 in order to get a number that is easier to work with.
(12) For the final grade, the rate is multiplied by 5, afterwards, it is divided by the highest-scoring rate (13), and finally, 5 is summed up in order to get the final grade.

Neighbourhood	Inhabitants	Households	Energy (household)	Food Production	Food waste
Geuzenveld Social	15700	6750	2420	2029748	976540
Geuzenveld Economy	15700	6750	2420	13015787.2	976540
Geuzenveld Environmental	15700	6750	2420	1503592.5	976540
Akkerpolder Social	3895	1275	2650	542492	242269
Akkerpolder Economic	3895	1275	2650	5303144.8	242269
Akkerpolder Environmental	3895	1275	2650	761621	242269
Osdorp Midden Social	16050	7145	2280	2478264	998310
Osdorp Midden Economic	16050	7145	2280	17338868	998310
Osdorp Midden Environmental	16050	7145	2280	2039864.1	998310

Agricultural waste	Energy production	Energy demand (indoor)	Powers	-Households	Rate	Grade
1562905.96	570359.5626	-	236	-	9.7	8.7
10022156.14	2470307.154	3358716	74%	-361.0	-5.3	2.9
1157766.225	479365.1781	-	198	-	8.2	8.1
417718.84	148233.2689	-	56	-	2.1	5.8
4083421.496	971550.0854	1302738	74 %	-123.0	-9.6	1.3
586448.17	186129.8764	-	70	-	2.7	6.0
1908263.28	652816.3587	-	286	-	12.6	9.8
13350928.36	3222838.936	4661934	69%	-634.0	-8.9	1.6
1570695.357	576998.6032	-	253	-	11.1	9.3

Non-Quantifiable Values

The non-quantifiable values are social, environmental and esthetics. Each scenario is rated with a number from 1 to 3. Being:
1- Negative influence
2- Neutral influence
3- Positive influence

Social Cohesion

Scenario	Score	Grade
Scenario Community (1)	3	9
Scenario Economy (2)	2	6
Scenario Environmental (3)	2	6

The social cohesion is calculated by looking at the social impact that each scenario can have on the community. The way that through urban farming social ties can be created between inhabitants.

(1) The community-based scenario is score with a 3, meaning it has a positive impact on the community. The reason for this score is that outdoor farming on roofs and in the squares, parks and courtyards brings life to the public spaces, and offers the opportunity for social interactions.
(2) The economy based scenario is scored with a 2, meaning it has a neutral impact on the community. Though it is to expect that social ties within the community will grow out of this scenario, the fact that farming takes mostly place indoor makes social interaction less willing to happen.
(3) The environmental scenario is scored with a 2, meaning it has a neutral impact on the community. The reason for this is that this type of scenario doesn't actively stimulate social interaction between inhabitants.

Biodiversity

Scenario	Score	Grade
Scenario Community (4)	2	6
Scenario Economy (5)	1	3
Scenario Environmental (6)	3	9

The biodiversity rate is calculated by looking at the impact the different scenarios have on the promotion or destruction of biodiversity on the scale of the neighbourhood.

The community scenario is scored with a 2, meaning it has a neutral influence on the biodiversity. The reason for this is that the farming techniques don't actively promote biodiversity such as urban gardens do, but also don't have a negative impact on the promotion of biodiversity, like indoor farming techniques have.
The economy scenario is scored with a 1, meaning it has a negative influence on the biodiversity. There are two main reasons for this. Firstly in this scenario up to 40% of the courtyards and public square are turned into indoor farming, meaning less green areas. Secondly, indoor farming types do not interact with the outdoors, meaning they don't promote biodiversity.
The environmental scenario is cored with a 3, meaning it has a positive effect on the biodiversity in the neighbourhood. The reason for this is first, that all farming techniques in this scenario are outdoor. Second this farming type makes use of numerous crop types that together form an ecosystem. Third, by connecting the different courtyards together one can create green corridors running through the neighbourhood.

Aesthetics

Scenario	Score	Grade
Scenario Community (7)	2	6
Scenario Economy (8)	1	3
Scenario Environmental (9)	3	9

The esthetics rate is calculated by looking at the impact the different scenario shave on the aesthetic value of the neighbourhood.

The community scenario is scored with a 2, meaning it has a neutral impact on the aesthetic value of the neighbourhood. The reason for this is that this scenario makes use of open ground outdoor farming techniques, which is not aesthetically very impactful.
The economy scenario is scored with a 1, meaning it has a negative effect on the aesthetic value of the neighbourhood. The reason for this is that this scenario makes use in the community spaces and on the roofs of indoor farming techniques, indoor farming takes place in glass houses, this can be impactful on the way the neighbourhood is going to look.
The environmental scenario is scored with a 3, meaning it has a positive impact on the aesthetic value of the neighbourhood. The reason for this is that this scenario makes use of roof farming and urban gardens, this means that the neighbourhood will be greened-up, with different types of plants, trees and bushes, this will have a positive effect on the aesthetic value of the neighbourhood.