City pig farm
A design-based research on urban livestock farming

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Abstract

Over the last centuries, the global food system has managed to provide a growing global population with more and better food. Yet, the system is criticised for its negative effects, like increasing food miles, monocultures, a lack of transparency and poor animal welfare. The recent trend to farm more food in an around cities (urban and peri-urban farming) seems to provide an alternative to the existing system. Urban and peri-urban agriculture (UPA) comes with many potential benefits, from reducing food miles and improving local urban climate to supporting social coherence in local neighbourhoods and improving personal health. At the same time, the field of UPA is very diverse and not each project addresses each of the potential benefits. This paper addresses urban livestock farming as a specific form of UPA. "Livestock farming" is hereby defined as raising domesticated animals, such as cattle, pork, poultry or fish for the production of food. Each of these types of farming has different needs and implications when included in the city. This study specifically looks into pig farming in an urban setting. It states that design-based-research is a useful research strategy to explore the possibilities and probabilities of this type of UPA. It draws on the design-based study 'City Pig', conducted at The Why Factory (2009), Delft University of Technology. The results of this study can be evaluated in order to get a grip on the possible benefits of this specific type of urban livestock farming. An important limitation is that it concerns virtual, un-built design proposals. As built, productive examples of UPA are still scarce in the Netherlands and beyond this design-based-research method could fill a gap and help gathering knowledge for future project. Therefore, this paper not only evaluates of a specific type of UPA, but also tests on whether research-by-design studies, can form a useful tool to further develop UPA in general. The aim of this paper is therefore two-fold: What are the potential benefits of urban pig farming and how can un-built design projects help to answer that question for future 'real' projects.

KEYWORDS

urban agriculture; urban farming; food production; food system; green washing; design-based research

1. INTRODUCTION

In recent years, interest in growing food in cities has increased (Mok et al., 2014). In the Netherlands a number of studies have been published giving an overview of built and planned projects in the Netherlands and beyond, for example: *Stadslandbouw* (Veen, Breman & Jansma, 2012), *Stadsboeren in Nederland* (Van Bergen et al., 2013), *Food for the City* (Van der Sande et al., 2012). Projects like the restaurant *Uit je eigen stad* in Rotterdam, where food is grown next to where it is served, show how farming can become an interesting and attractive part of the city (Van Bergen et al., 2013). This type of farming within or in proximity to the city is known as *"Urban and Peri-urban Agriculture (UPA)"*. Veen, Breman and Jansma (2012) define UPA as follows: *"the production, processing and marketing of food and related products and services in urban areas, making use of urban resources and waste"* (p. 4). This definition implies that UPA can comprise of a wide variety of projects, from the beehive on a private roof over a neighbourhood garden run by a local community, to a high-tech farm with stacked fields in a closed building. De Graaf (2013: 40) elaborates:

"[UPA projects] differ in their relation to the soil and the built environment, their relationship with the essential flows of the city, and in the impact they have on public space socially and aesthetically. Thus they offer different benefits to the city, and respond to different opportunities."

In the Netherlands however, urban and peri-urban agriculture today is still in its infancy (Veen, Breman & Jansma, 2012) and a number of questions around the topic have to be addressed. Where can it be applied, how can it be financed and importantly, what can it actually provide? How can we study the possibilities of UPA?

Examining examples of UPA in the Netherlands is interesting beyond the context of the country itself. The Netherlands has a long tradition of innovation in agriculture. Although relatively small and densely populated, the country is a globally relevant food producer. The combination of close proximity of farming and cities together with the knowledge in innovative and productive farming could lead to new solutions of UPA, which are relevant in many other countries.

This paper addresses urban livestock farming as a specific form of UPA. Livestock farming can be defined as the raising of domesticated animals, such as cattle, pork, poultry or fish for the production of food. Each of these examples of livestock farming has different needs and implications when situated in the city. This study specifically looks at pig farming in an urban setting. It uses design-based research, which is a useful research strategy to explore the possibilities and probabilities of this type of UPA. It draws on the design-based study 'City Pig', conducted at The Why Factory (2009) as part of Delft University of Technology. The results of this study are evaluated in order to get a grip on the possible benefits of this specific type of urban livestock

farming. An important limitation is that it concerns virtual, un-built design proposals. This implies that many relevant parameters are not known and the actual performance of the pig farms and their effect on the surrounding cannot be measured. But built, productive examples of UPA are still scarce in the Netherlands. This design-based research method could fill this gap and help gather knowledge for future projects. In that sense, this study is not only an evaluation of a specific type of UPA, but also a test as to whether research-by-design studies can be a useful tool to further develop UPA. The aim of this paper is therefore two-fold: What are the potential benefits of urban pig farming and how can un-built design projects help to answer this question and contribute to future 'real' projects.

In order to address these research questions this paper elaborates on the concept of urban and peri-urban farming in a Dutch context and its possible benefits. Then design-based research is explained as a research strategy, exemplified by the work of The Why Factory. The City Pig project is an important research outcome, which will be described and used as case study for urban livestock farming. Based on these research outcomes it is possible to reflect on the benefits of urban livestock farming as well as on the design-based research methodology and its implications on future UPA projects.

2. URBAN AND PERI-URBAN FARMING IN THE NETHERLANDS

Introducing agriculture into cities may initially seem paradoxical. It was the separation of harvesting and dwelling, which made cities possible in the first place. In a process that took between five and ten thousand years (Fresco, 2012), humans began harvesting grain and slowly developed agriculture. As a consequence they had to stay at one place rather than travel in search of food. And as agriculture slowly became a reliable source of food, there was time to concentrate on things other than food: specialisation became possible, language evolved, health improved and culture became further developed.

The development of agriculture and cities remained dependent on each other for the next few centuries. For a long time, the size of a city depended on how much food could be grown in its vicinity and how quickly this food could be transported into the city:

"Given the physical difficulties of getting food into town, it is hardly surprising that most pre-industrial cities were compact by modern standards. A day's journey by car, a distance of around 20 miles, was the practical limit for bringing in grain overland, which limit the width of the city's arable belt. The simple laws of geometry meant that the larger a city grew, the smaller the relative size of its rural hinterland became, until the latter could no longer feed the former." (Steel, 2008: 70)

Cities located on a river or the sea had an advantage here. Transport via sea has always been cheaper than land transport. A close connection to the sea made it possible for cities like London, Antwerp, Venice or Ancient Rome to grow more quickly by receiving a supply from a larger hinterland (Steel, 2008). The rise of railways in the nineteenth century reduced this dependence on sea transport. Innovations in preservation and refrigeration eventually led to today's global food system, one where production and consumption are distributed worldwide.

Yet contrary to this movement towards a globalised food system, there is a long history in developed countries of local food production, based on small productive individual and collective gardens (Mok et al., 2014; Kimmerle, 2011). The main aim of these gardens has changed over the years. The early focus for urban farming was on food production. The German 'Armengärten', which dates back to the late 18th century or the 'Victory Gardens' in the UK during WWII are examples of UPA with the aim to ensure food security (Mok et al, 2014). Later, recreation and health became important, as in the German 'Schrebergarten', which developed in the 19th century. Today, multiple social aspects play a role in contemporary UPA, such as social cohesion and placemaking. Also the ecological effect of local food production has become an important potential benefit of UPA. Hynes and Howe (2004) illustrate how the aims of UPA has changed over time:

"Community gardens and small farms in U.S. cities are not altogether new. However, their purposes today – neither short-term welfare during periods of recession, nor philanthropic charity to uplift 'the masses', nor patriotic war relief, all of which catalysed earlier urban horticulture movements [...] – are new. Their goals include teaching inner-city children ecological literacy and diverting them from the streets; cleaning up overgrown neighbourhood eyesores and pushing out drug dealing, that, like weeds, overtakes neglected vacant lots; growing and preserving food from seed to shelf; restoring nature to the industrial and post-industrial city using heirloom plants and bird and butterfly gardens; and bringing the farming tradition of the rural South to northern industrial cities. These are but a handful of the reasons that urban gardeners have given when asked why they garden." (Hynes & Howe, 2004)

The possible benefits of UPA have to be seen in relation to the disadvantages it has compared to traditional farming practices. Land prices in and around cities are generally higher in urban areas than rural areas. Traffic and industries can cause more pollution in air and soil and therefore make urban areas less suitable for food production. Shadows of buildings can limit the sunshine hours. Farming is not easily implemented in cities, but there are a number of potential benefits that could balance the disadvantages and make it worthwhile to include agriculture in urban areas. Mok et al. (2013), Visser et al. (no date) and Veen, Breman and Jansma (2012) provide a systematic over-

view of these potential benefits, which can be summarised as individual benefits, economic benefits, social and cultural benefits and ecological benefits.

2.1 Individual benefits

UPA can increase the aesthetic attractiveness of a neighborhood, withholding the citizens of moving to other places (Hynes & Howe, 2004). When children are introduced to growing food, it can have a positive effect on their eating habits in later years (Veen, Breman & Jansma, 2012). Green spaces can also be a place for recreation. Physical activity in green areas can have a general positive effect on health, well-being and recovery. This can play a special role in health care and day care, such as so-called 'care farms' (Veen, Breman & Jansma, 2012).

By providing knowledge on food and how it is being grown, UPA can be seen as culturally important. UPA projects as part of the education of children at schools can provide practical insight in farming, and farming your own food can contribute to satisfaction and self-esteem (Veen, Breman & Jansma, 2012). A closer contact between food producers and consumers can create new opportunities for food, which are not available in the traditional food chain: for example ethnic vegetables for a specific local community or fragile fruit, which is not suitable for long periods of transit (Veen, Breman & Jansma, 2012).

2.2 Neighbourhood benefits

UPA can increase the aesthetic attractiveness of a neighbourhood, lessening the likelihood of citizens of [or: withholding the citizens of] moving to other places. UPA has the potential to mitigate outside temperatures and retain rainwater, thereby improving the local climate and reducing the urban heat island effect (Veen, Breman & Jansma, 2012). The maintenance of green farming areas can replace the maintenance of public green areas or the landscape around the city. UPA on vacant urban sites can prevent degradation of the adjacent neighbourhood (Veen, Breman & Jansma, 2012).

If a UPA project involves local inhabitants, it can support community building and social cohesion in the neighbourhood. It can offer people from different social and ethnic backgrounds the chance to work together; food can be an easy topic to connect otherwise separate social groups. Collaborating on an UPA project can get local inhabitants 'involved', supporting their identification with the neighbourhood (Veen, Breman & Jansma, 2012).

2.3 Economic benefits

UPA can provide new job opportunities in the city, whether directly related to farming or to visitors coming for recreation and education. The localised production of food can also provide economic benefits. This could be

in the form of selling directly to the consumer, without a costly distribution chain, which can make the food cheaper. On the other hand, distinct products with a local connection can be sold for a higher price, providing a better income (Veen, Breman & Jansma, 2012). The attractiveness of UPA beyond its direct economic model can also increase the attractiveness of the neighbourhood, resulting in higher land prices. It can be a way to make productive use of otherwise unused areas or buildings. And eventually, UPA can be a place for individual development. For example, UPA can offer chances for the long-term unemployed to re-integrate into the regular labour market by providing certificates and training competences (Veen, Breman & Jansma, 2012). By offering the consumer insight into how his food is grown, farmed and processed, UPA can help to re-establish trust in the food system. If the consumer becomes involved in the quality and origin of the food he buys, this can provide leverage for food coming from traditional sources (Veen, Breman & Jansma, 2012).

2.4 Ecological benefits

Crop and livestock farming can extend the habitat for wildlife in the city, thereby contributing to biodiversity. If local or rare crops are farmed, UPA can add to agricultural diversity.

By connecting to nutrient, waste, water and energy streams of the city, UPA has the potential to connect or close different resource cycles. UPA projects can collect and retain rainwater and make use of urban wastewater. When wastewater and GTF (abbreviation for: Green, Garden, Fruit) waste are used as fertilizers in UPA, the depletion of minerals and production of artificial fertilizers can be reduced. Different types of UPA projects can make use of excess heat from other urban programs, return heat from greenhouses or bring energy from biogas installations to the city (Veen, Breman & Jansma, 2012).

UPA can have a positive impact on the reduction of greenhouse gasses (GHG). A shorter distance between producer and consumer can reduce the transportation of food and the related GHG emissions. UPA also allows for carbon sequestration. Finally, by raising the awareness pf seasonal availabilities, it can stimulate a more sustainable and ecological diet (Veen, Breman & Jansma, 2012).

As stated before, these are all *potential* benefits of UPA. As the diversity of possible types of UPA projects implies, not each project will come with all of these potential advantages. A community garden run by volunteers for example may not sell any food and therefore may offer no direct economic benefits, but it could greatly contribute to the social cohesion of the neighbourhood. A series of private rooftop beehives could have no measurable impact on the food miles of the local population, yet playing a vital role for the local ecosys-

tem. And a closed aquaponic farm could become a thriving business, without bringing the social benefits of a participatory project.

Eventually, more built and running examples are necessary to provide more insight into the positive (and negative) effects of the different types of UPA:

"The development of urban agriculture in the Netherlands is surrounded by a multitude of claims and questions, which in many cases are not or insufficiently supported and answered. [...] All in all, this means that while our gut feeling says that urban farming can contribute to social, economic and ecologic sustainability, there is still little hard (scientific) proof for these claims." (Veen, Breman & Jansma, 2012: 37)

It is with this background that design-based research offers interesting possibilities. Unbuilt design proposals could help to clarify some of the mentioned claims and questions in order to prepare the ground for more built projects. This was one of the drivers behind the 'City Pig' project of The Why Factory.

3. DESIGN-BASED RESEARCH AS A RESEARCH APPROACH

The examined study explores the implications of urban pig farming as one kind of UPA in a general, not site-specific sense. Although sited on a given location, it aims to gain insight in urban pig farming beyond the local context and make the findings applicable on other locations and potentially inform other possible UPA programs. The study uses spatial and architectural design as research method. The presented approach is what Nijhuis and Bobbink (2012: 252) describe as 'design-based research': *"designs (or the process of designing) are used as a vehicle to make spatial problems visual and spatial ('framing') and to generate solutions."* The study is in line with both aspects of this definition: it makes the implications of urban livestock farming visual and spatial and it aims to provide general solutions of how an urban pig farm can be integrated into the urban fabric.

A design-based research approach has been used in a number of projects as part of The Why Factory. The Why Factory is a chair at the Faculty of Architecture and the Built Environment at Delft University of Technology and was set-up in 2008 by Professor Winy Maas, principal and co-founder of the Dutch architect firm MVRDV. Both institutions share an interest in visionary thinking about urban futures. As Winy Maas puts it:

"We produce models and visualizations for the cities of the future. Our ultimate mission is to reveal through bigger projects the mechanisms of thinking about, and ultimately producing a series of critical alternatives through images." (Maas et al., 2011: 13)

For the production of these visions and models, The Why Factory combines education in the faculty's Master of Science (MSc) program with research activities. The Why Factory's MSc design studios are based on on-going research projects and are set-up as systematic design explorations. Two elements are important in this set-up: a guided solution-finding process and a generalisation of the process. The first element means that the students need to work on complementary strategies, for example choosing different scales or exploring different technologies. The aim of the group work is not to get a few good solutions, but to cover a wide spectrum of diverse possible solutions, which can be analysed in relation to each other. The second element implies that the assignment should not be site specific, to allow general conclusions on the given topic. Often, the studios explore a topic with a 'model city' as a base, developed under one guiding aspect: for example mobility, bottom-up planning or automation, and without geographical context. Klaasen (2007) states that a degree of context-less design is inherent to a research-by-design approach in urban design:

"In the case of urban design a scientific approach involves the dissociation of objects of design from a specific design context, i.e. the designing of theoretical models – resulting in designs that in spatial-ecological and/or socio-cultural and/or economic-technical terms are independent of a specific situation. By leaving aside characteristics of specific contexts one can focus on essentials – from simple ones like universal spatial organisation principles to more complex ones that include some contextual characteristics, and therefore might not be universal, but certainly are non-localised."

While MVRDV works towards built architecture and applied urban plans, the design-based research of The Why Factory results in visual representation of data and of imagined architectural and urban structures. The role of these visual representations is two-fold: that of visual thinking and visual communication.

"Visual thinking implies the generation of ideas through the creation, inspection, and interpretation of visual representation of the previously non-visible (knowledge discovery), while visual communication refers to effective distribution of ideas in visual form." (Nijhuis & Stellingwerff, 2011)

Examples of such projects include *Sunny Water Lilies* (2010), a proposal for a solar thermal energy plant to improve the spatial qualities of green infrastructure (figure 1), *Vertical Village* (2011), a model for evolutionary vertical urbanism that combines social and physical 'village' qualities with urban densification (figure 2) and *Transformer* (2014), a scenario based on smart, transformable building materials and how these could change architecture and urban life (figure 3).

Figure 1 Sunny Water Lilies as geothermal power plants (courtesy: The Why Factory, 2009)

Figure 2 Vertical Village: Evolutionary vertical urbanism (courtesy: The Why Factory, 2009)

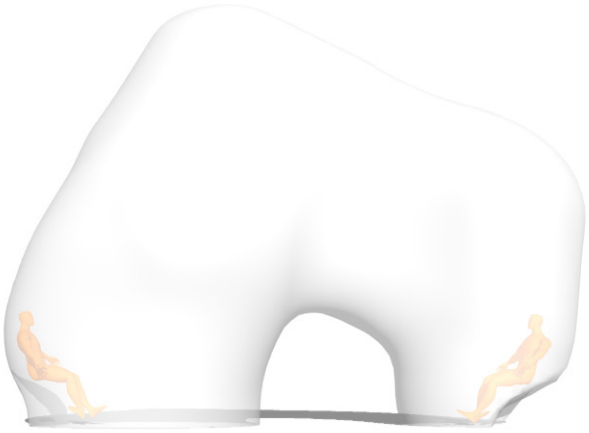

Figure 3 The Transformer: future building materials (courtesy: The Why Factory, 2009)

The City Pig project of 2009 stands out from the projects by The Why Factory, as the designer-client relationship for this project comes close to the process of 'real' architectural design, as it has a given plot and a building design assignment. The project was hypothetical and not meant for construction, but the realistic background makes it an interesting research-by-design case study.

4. CITY PIG FARM AS AN EXAMPLE

The chosen case study for this article is the 'City Pig' project, a series of pig farms designed for a location in The Hague in the Netherlands. 'City Pig' was a study commissioned by the Centre for Arts and Architecture 'Stroom' in The Hague as a contribution to the program 'Foodprint: Food for the City', which ran from 2009 until 2012. The Why Factory developed City Pig in a multidisciplinary team with designers and researchers from TU Delft, Wageningen UR and the 'Innovatie Netwerk'. Students from the Why Factory's MSc program took part in the development of the first proposals. The project was presented as an animation movie at the first manifestation of the 'Foodprint' program, a public exhibition in The Hague in the summer of 2009. Together with the other projects of the program, the project was later documented in the publication 'Food for the City' (Van der Sande et al., 2012)

The 'City Pig' study takes an unusual position in the field of UPA in two respects. Firstly, it is a proposal for an urban life stock farm, located within the city and claiming to be economically feasible. Most current examples for

UPA focus on growing crops, and livestock farming is the exception. Secondly, the case study is not a built project, but a hypothetical design, developed for an exhibition. The choice for this case study is a conscious one: the aim is to reveal the potential of urban livestock farming, while at the same time testing how far unbuilt design projects can serve as case studies in the field of UPA. As stated before, UPA in the Netherlands is still in its infancy and more examples will be needed to get insight into the effects and benefits it can have. If unbuilt projects can provide such insight, it can be beneficiary for the development of UPA in general.

The topic of the 'City Pig' study was proposed by Annechien ten Have-Mellema, who played the important role of the 'client' in this project. Owner of a pig farm herself, she initiated the project in her role as member of the board of LTO Nederland, the Dutch Federation of Agriculture and Horticulture. She joined the project to raise awareness on alternative ways for pig farming. The sector has a negative public image because industrial pig farming with large stables is generally criticized and not considered animal friendly by public opinion in the Netherlands. On the other hand, biologically produced pork has still a limited share in the Dutch market due to its higher price. A pig farm in the city would allow consumers to see how pork is produced and support biological farming. The scope of the study was limited. The focus was therefore more on presenting the design proposal in an accessible way to a wider public than producing a realistic feasibility study for a soon-to-built project.

The City Pig project consists of eight design proposals, presented as a narrative. After a general introduction on the theoretical implications of local food production, a functional pig farm with the main components is illustrated. Eventually the eight proposals are shown on their specific locations. The site for all eight farms is the 'Brinkhorst', a mixed, partly industrial area within the city proper of The Hague. The site was chose as the exhibition took place here and as the area will be developed in the future.

The archetypical farm (figure. 4) illustrates basic requirements for a feasible pig farm. The size is large enough for about 200 sows at any time, producing about 4.300 pigs per year. A farm of this size is large enough to be feasibly managed by two full-time farmers. It includes stables of different size for the pigs, from farrowing to fattening. All stables are dimensioned according to the regulations for biological farming, thus larger than the standard industrial pig stables. Next to storage areas, the farm includes a biogas plant, where the pigs' manure is transformed to energy. A visitor centre and a restaurant for visitors are added. To avoid transportation of living animals, a small slaughterhouse is included in the design.

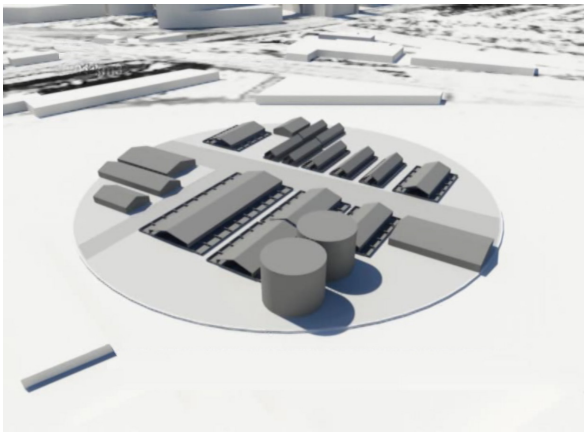

Figure 4 Archetypical Farm (courtesy: The Why Factory, 2009)

A major challenge for urban livestock farming is the required fodder. The footprint of the farm is limited, but a farm of this size requires about 1.400 tons of fodder per year, equal to about 2.2 km2 of cropland (figure 5). In the City Pig project, the proposal is to connect the pig farm to the waste stream of the city and its surrounding. Instead of growing pig fodder – or importing it from other countries, as most current pig farms in the Netherlands do – waste from the nearby greenhouse industry in the Westland and residual products (GFT waste) from nearby food-industry, supermarkets and fresh markets are used. Pigs are omnivores and can therefore play an important role in the resource and nutrient flow of the city.

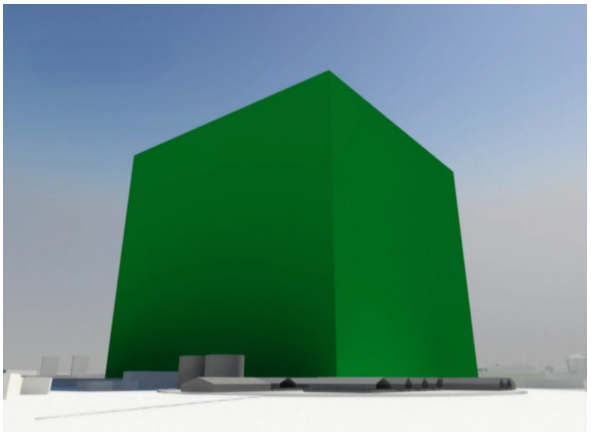

Figure 5 Spatial requirements of fodder production (courtesy: The Why Factory, 2009)

Not all GFT waste is suitable for pigs. Waste, which cannot be fed to the pigs, can be fermented in the biogas plant, together with the pigs manure (figure 6). With a capacity of about 50.000 tons of GFT waste and 5.500 tons of pig manure, the biogas installation would have the capacity to produce about 18.000 MWh of electricity per year, enough for about 5.000 households. The remaining residue could be used as fertilizer for crop plants (figure 7).

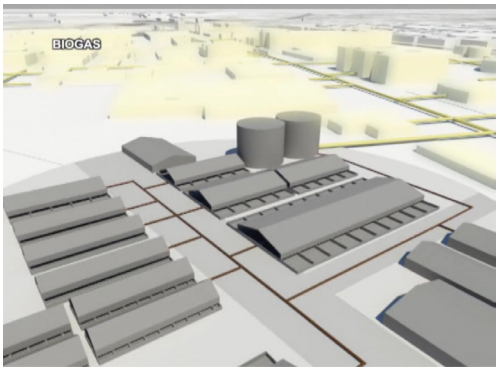

Figure 6 Biogas network (courtesy: The Why Factory, 2009)

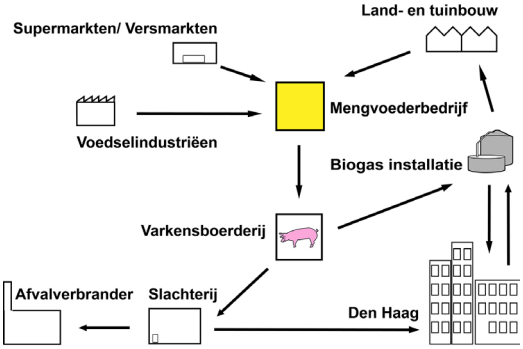

Figure 7 Resource cycle (courtesy: The Why Factory, 2009)

Placing the archetypical farm on this location reveals one large challenge for the project. Within an estimated radius of 400 metres, the stench of the farm would be too strong to have housing or offices in this area. In a dense urban area, a pig farm would need to be closed with a filtered ventilation system. For the archetypical farm, the closed system is visualized with a transparent cupola (figure 8).

Figure 8 Snowball (courtesy: The Why Factory, 2009)

Based on the archetypical farm, eight designs were developed: The Snowball, The Stack, The District, The Balconies, The Terrace, The Bridge, The Office and The Strip (figure 9). Each design has a different location within the Brinkhorst and offers different ways to interact with the surrounding. However, all eight designs use the same program and the same surface areas as the archetypical farm. For this study, four of the eight designs are chosen as they represent the strongest difference in approach.

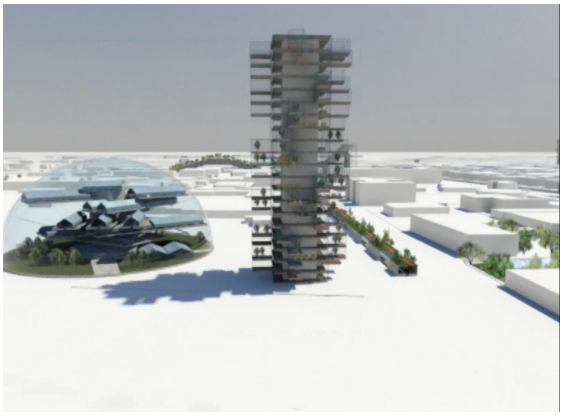

Figure 9 Eight typologies (courtesy: The Why Factory, 2009)

4.1. The Stack

This proposal stays the closest to the archetypical farm. To reduce the footprint of the farm, the different stables are stacked and connected with

ramps. This allows shrinking the dome as well. The result is a sculptural and iconic building (figure 10).

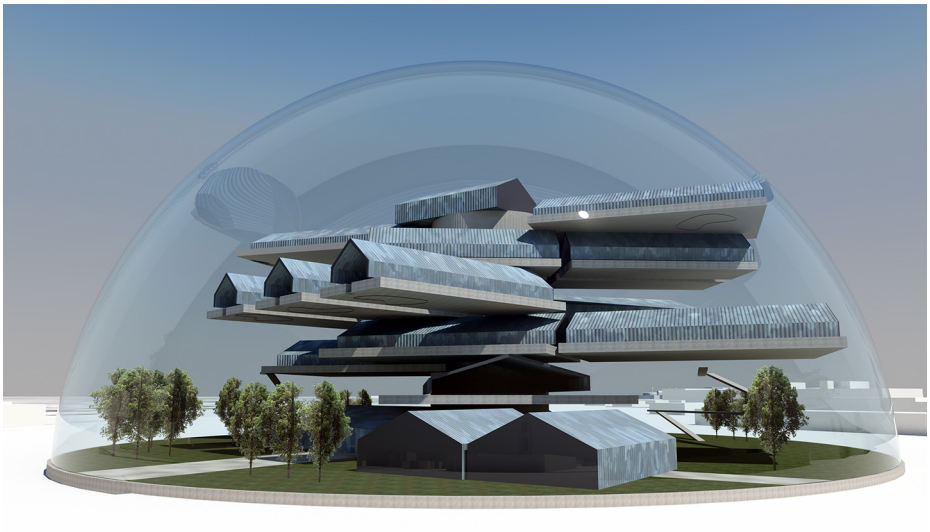

Figure 10 The Stack (courtesy: The Why Factory, 2009)

4.2 The Strip

Here, the pig farm makes use of a wide, empty strip of green between the four lanes of the central road of the area. All stables are arranged as one strip of one kilometre long, illustrating the cycle of a pig, from piglet to slaughterhouse. The rooftop is publicly accessible, allowing views into the winter gardens, which pigs can reach from their stables (figure 11).

Figure 11 The Strip (courtesy: The Why Factory, 2009)

4.3 The District

By spreading the stables out and embedding them in an intense green area with trees and shrubs, the stench hindrance can be reduced in a natural way. This design relies on additional strategies such as direct separating manure from urine in the stables to prevent the production of ammoniac. Here the aim is to integrate the farm with other urban programs, including housing and partly making use of existing buildings for storage, butcheries or restaurants (figure 12).

Figure 12 The District (courtesy: The Why Factory, 2009)

4.4 The Office

An existing vacant office building on the site meets the overall spatial requirements for the pig farm. The stables are integrated into the existing building, making use of the building's shell and the existing elevators. Ramps are added to the building to increase the capacity for vertical transportation. The former lobby is used as a slaughterhouse (figure 13).

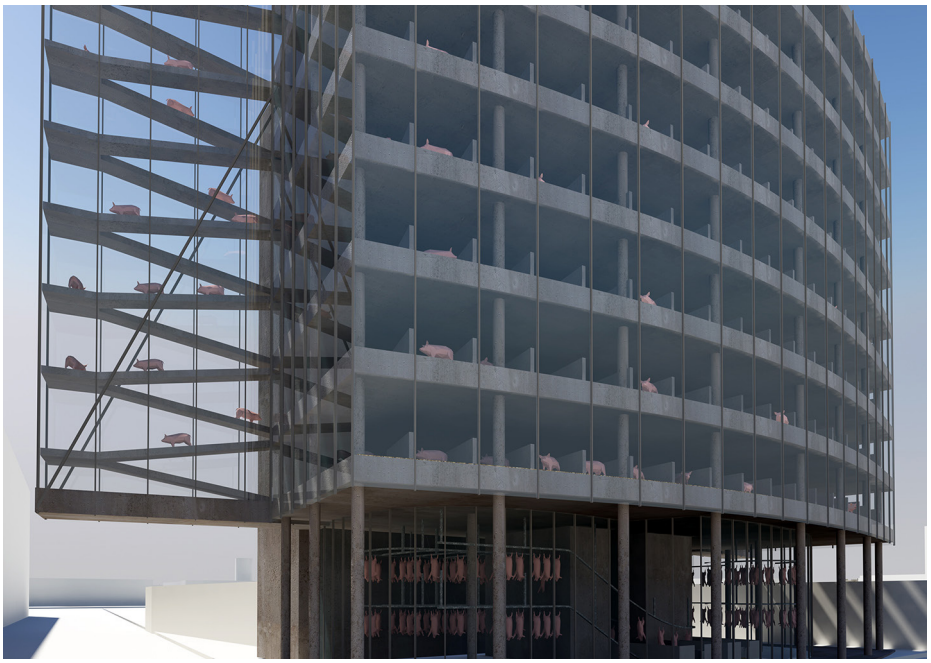

Figure 13 The Office (courtesy: The Why Factory, 2009)

All of these proposals should be seen in the context of the exhibition for which they were designed. They lack detailing and they are exaggerated in order to inspire and to provoke discussion with a wider public. This may make them less suitable as case studies than a more realistic design proposal. However, the aim of this study is not to evaluate the immediate feasibility of the design proposals, but to gain insight into possible benefits on urban livestock farming and urban pig farming in general. For this aim, the exaggerated character of the designs is accepted in this study.

5. DISCUSSION: OUTCOME OF THE DESIGN STUDY AND POSSIBLE BENEFITS

In this paragraph, the previous examples are used to evaluate the potential benefits of urban pig farming. The four main categories from the second paragraph are used as ‘lenses’ to test potential benefit. Here the examples are treated as different variations of the same design intervention. They are discussed together, differentiating between proposals when necessary.

5.1 Potential individual benefits of urban pig farming

Individual health and well-being benefits are linked to the direct involvement with the production of food or to working outside in a green environment. Both aspects are very limited in all four proposals. The contamination of pigs is a serious challenge in pig farming. In a regular farm, visitors can only get in touch with pigs after following a strict safety procedure, including protective or entirely fresh clothes. This makes casual and occasional voluntary work, which may be possible in horticulture, difficult in a livestock farm.

From the four designs, The District could become 'recreational'. Also The Stack can be an attraction for visitors. However, compared to an open farm, the enclosed space of this proposal is more likely to invite one-off visits than to become a regular pastime.

By making livestock farming and meat processing visible and transparent, all four proposals have a cultural benefit. The proposals are also well suitable for the education of children and adults and have a positive effect on their diet: not necessarily by turning all of them into vegetarians, but by stimulating a more conscious consumption of meat. A wider variety in the farmed pig breeds could be supported through the choices of the visiting consumers. The iconic quality of all designs could add to the promotion of the produced meat and allow for relatively higher prices. Direct sales on the other hand could reduce the price and partly compensate for the higher cost of biologically farmed pig meat. Of course, the latter benefits have to be seen in relation to prices for land, ventilation and building, all of which would probably be much higher than a conventional farm building on a rural location. The possible benefit of satisfaction and self-esteem for the producer would in all cases be mainly limited to the farmers themselves.

5.2 Potential neighbourhood benefits of urban pig farming

The proposed City Pig farms would not have many of the potential neighbourhood benefits, which other UPA projects could have. All but The District work with a closed and controlled environment, which would not improve urban heat island or rain water retaining. As the projects to do not include 'productive green', the synergy with municipal maintenance of public green cannot be found. Depending on the development of the area, the projects could have a positive effect on the use of otherwise vacant areas. The Office shows, how a vacant building could be re-used for livestock farming, but the necessary adjustments to the building would not make this approach feasible for short-term temporary use. The 'District'-project could make use of vacant single storey sheds and halls, with less need for adjustments. If the concept is applied in a non-residential area, where the stench is acceptable, it could become a feasible re-use scenario.

Generally, the proposed designs are not bottom-up participatory farms and would therefore not be able to provide the benefits of local collaboration and the related community building. Pig farming comes with strict regulations around hygiene and possible contamination. Where a fruit orchard could do well without daily maintenance, a pig stable has tight schedules. This may limit the possibilities of involving volunteers in the farming. It has to be said that the disapproval of pig meat in a number of religions might lead to a segregation of social groups rather than a support to mixing.

5.3 Potential economic benefits of urban pig farming

The transparent production of meat is a strong benefit in all four proposals. The consumer can see and judge the conditions of the pigs and get into discussion with the farmer. The iconic character of the project can lead to leverage beyond the direct consumption around the farm. As mentioned above, a local and transparent pig farm could promote special products which respect animal well-being, make use of the nutrients from the city and return sustainable energy to the city. Products could be sold for a higher price than traditional industrial pig products. A local butchery and a restaurant could be a spin-off of the actual farm and provide extra income and job opportunities. Again, this has to be seen in relation to the higher land prices technical requirements and general building cost of an urban pig farm compared to a traditional rural pig farm.

5.4 Potential ecological benefits of urban pig farming

As the proposed farms are fitted with a closed ventilation system, there is little exchange with the surrounding nature and therefore little support for biodiversity. Only the 'District'-farm would add to the natural habitat in the city. The choice of non-standard breeds however could increase agricultural diversity.

All four proposals show clear benefits on the re-use of urban (GFT) waste and the provision of (waste) energy, making it one of the strongest benefits of the project. Rainwater cycles are more difficult to include, due to the closed system and carbon sequestration cannot be realized without crop farming. Regarding the reduction of food miles this project illustrates that the topic is more complex than it might look in the first place. The actual volume of pig meat is small compared to the volume of the required fodder. Thus, the impact of transporting fodder can outweigh the benefit of locally produced food. This is also the case for traditional pig farming in the Netherlands, where much of the fodder is imported from other countries. The four proposals aim to avoid this by making use of local GFT waste. This however has to be collected and moved to the stables. The more collection points the GFT is coming from, the more individual traffic this is likely to cause. Based on the current state of

the project, it cannot be stated whether the project would reduce transport related GHG emissions.

6. CONCLUSIONS

Based on the previous discussion, this paragraph draws conclusions in two directions: how did the design-based research approach play out in the study and which benefits does urban pig farming potentially hold.

6.1 Design-based research projects as case studies

As stated at the start of this essay, the design-based research approach is used for two purposes: visual communication and visual thinking.

Visual communication in the design-based research study on urban pig farming

The study was commissioned for a public exhibition. It was therefore important to communicate not only the final results, but also the background of the study (urban agriculture and livestock farming) in an accessible way to a broader public. This was partly done by presenting the study as a movie with a clear narrative. But the study went further and engaged spatial design as a means of visual communication. At the beginning of the movie, the (theoretical) spatial requirements for local food production are shown as volumes, which were placed in the city, critically highlighting on the space requirements of food production. The requirements of animal fodder are illustrated in a similar way, emphasizing that it is crucial to include fodder in the discussion of urban livestock farming. The basic pig farm in the movie is presented as a spatial design, which at the same time acts as a diagram of a generic pig farm. The stench circle is first graphically visualized before it is translated into a spatial design, a large transparent globe, which creates a controllable local environment. All of these elements engage spatial design to illustrate inherent problems of urban farming to a broader public.

On the other hand, visual communication was an important part of the communication during the study within the research team. The expertise on pig farming present in the team was visualized and translated into a spatial design. Through the design, the requirements of an economically feasible, functioning pig farm were determined. Initial ideas, such as an open park with an idyllic mud pond were visualized and then dismissed during the discussion, as it created organisational problems. The design process here helped to create and visualize a detailed brief for an urban pig farm, which could be described as a new building typology.

Visual thinking in the research-by-design study on urban pig farming

In the second part of the study, the diagrammatic 'basic' urban pig farm was translated into a number of different typologies. Each design addressed a different problem or potential. The Strip for example used an existing vacant area. Spatial design was required to test the possibility (does the program fit on the location?), the implications (how can the farm be accessed by visitors or by trucks?) and in how far the proposal can stand in for a general typology (how many of this kind of vacant strips exist in the Netherlands?). The Office was approached in a similar way: how does the program fit into the given building, how can internal circulation be adjusted and in how far is the building representative for a larger amount of vacant office buildings in the Netherlands. It has to be said here that within the limited scope of the study and the foremost aim to illustrate the ideas in a public exhibition, the elaboration of the proposals is still limited. The ventilation of the buildings for example has not been addressed, nor has the necessary delivery to and from the building. These aspects can be addressed in a follow-up study, using the same design-based research approach.

The latter two examples show, how design-based research in this study explored technical and functional implications of the concept of urban pig farming. As important are aesthetic aspects, especially as the 'attractiveness' of the design plays a role in whether it would be acceptable for local inhabitants and thereby raise the quality of the neighbourhood. Attractiveness is also important for whether the farm would become a destination for visitors and therefore become a transparent farm where visitors become informed and empowered consumers. The 'soft' quality of attractiveness is harder to translate into a general typology, which is independent of the specific location, the applied materials and the tools of representation used in the study. On the other hand, elements like public terraces and open views to the stables can be part of a general, 'inviting' typology. One challenge here is the relation between transparency, cost and an attractive appearance. More transparency will allow for more insight of the visitors into the process, but will also require more glass and therefore higher building cost. Less glass will allow for cheaper construction, but also less interaction with the inhabitants.

6.2 Potential benefits of urban pig farming

As this analysis shows, the benefits can be found in the area of empowerment and transparency, and in the connection with the city's resource cycles.

Transparency towards the consumer was the main motivation for the 'client' Mrs. Ten Have-Mellema to start this project. Most of the consumers today who buy pork in a supermarket or at a butcher don't get to see the inside of a pig stable or slaughterhouse. The physical distance between the stable and the supermarket makes it easier to disconnect the consumer's dis-

approval of industrial 'mega-stables' from the choice for or against biological produced pork meat in the supermarket. If pig farms expose the way the animals are kept, raised and slaughtered, this disconnection could disappear and more expensive but more ethic and sustainable choices could be supported. This effect is of course not limited to pig farms. The question here is if this transparency could also be achieved in peri-urban or rural settings, without the immediate problems of the proposed designs, such as the stench and high land and construction prices. It is worth noting that urban livestock farming, through its transparency towards the consumer can lead to increased animal well-being. This potential benefit has not been addressed in the sources of the previous chapters.

The synergy of nutrient and energy flows with the city is another large benefit, which urban pig farming could provide. Here lies a specific benefit of pig farming, which cannot be directly translated to cow or poultry farming. Pigs as omnivores have a special potential for making use of the cities GFT streams. Also for this aspect, it would be interesting to study how peri-urban or rural pig farms could achieve similar benefits without the disadvantages of higher cost and the stench.

Eventually, the productive, temporary re-use of vacant areas could be an interesting and surprising benefit of pig farming. The example of The Office is hereby more emblematic and provocative than financially feasible, as it includes substantial adjustments to the existing structure. The District on the other side could make use of existing vacant buildings with less investment. In areas that are far enough from other urban activities, such a temporary urban farm could function without extra technology to avoid stench. An otherwise unused area could be productively used, providing transparency in production, education, possible benefits for promoting and economically producing more biological and sustainable meat and become a temporary, attractive destination.

The study has shown potentials and challenges of urban pig farming. In a next research step, the given triangle of location (urban), content (pig farming) and project emphasis (transparent processes and resource management) could be opened.

One proposal could include a pig farm in a peri-urban or rural setting, which aims for the same main benefits. A similar design-research-study could be used to explore, how the same transparency could be achieved and how the pig stable could make use of GFT waste over a larger distance.

Another study could keep the location and the benefits, but employ different types of farming. The studies could explore how other livestock such as fish, poultry or insects could make use of organic waste and provide energy, and how the farming could be exposed to support informed consumer choices.

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