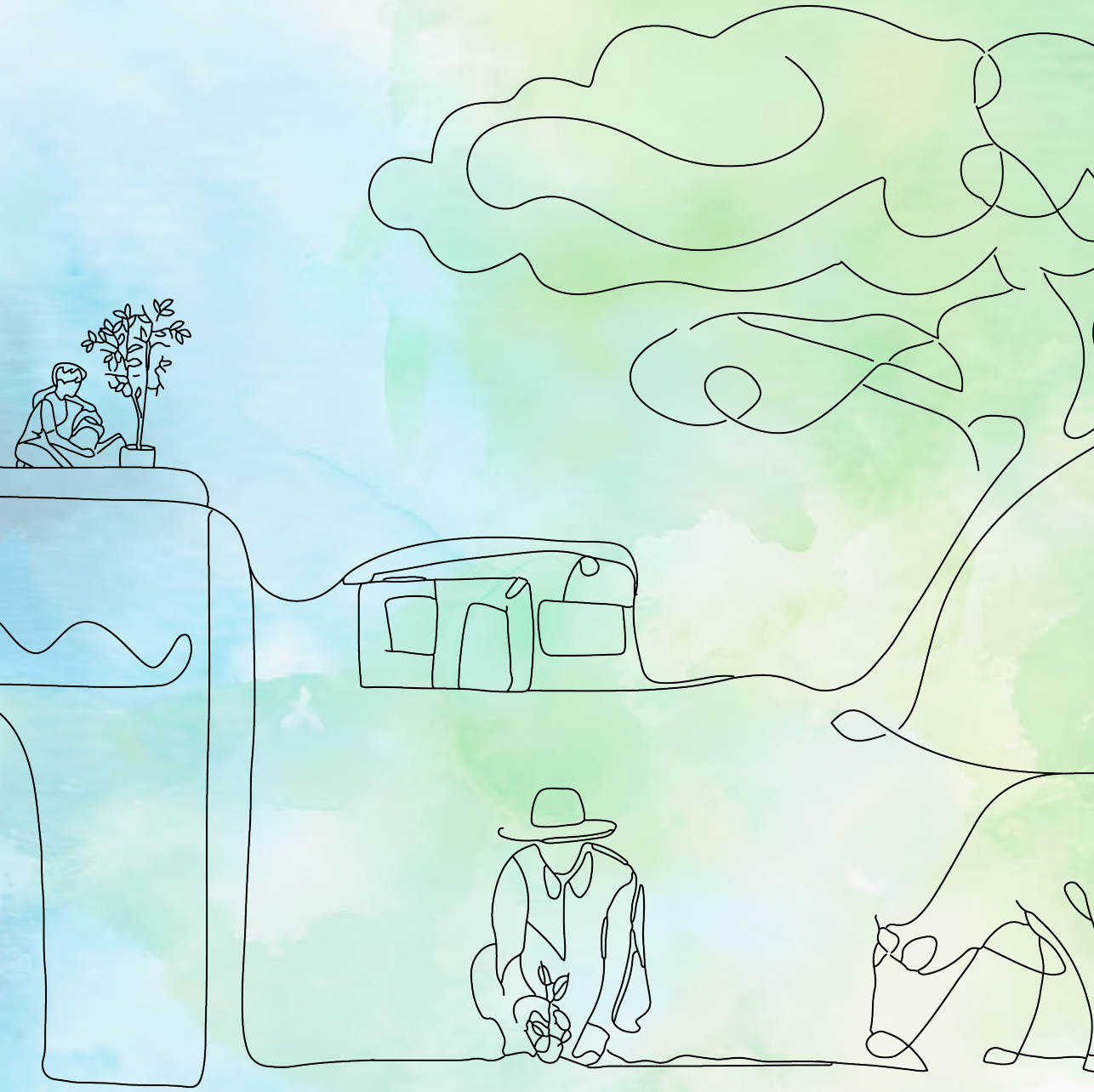
Rooting in the city

Urban Agriculture-Led Design for High-Density Housing in Ahmedabad, India



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Foreword

Growing up on the dairy farm of my parents, I always have been fascinated with agriculture and the landscapes surrounding it. Helping around the farm and later working for neighbouring farmers helped expand my knowledge to different agricultural practices. At the same time, since primary school, I have been drawing a lot, from cartoons to later buildings and cities. Through sketching and later building with legos, architecture became a second world through which I could explore creativity and time. Fastforward, being in the Master Architecture track eventually brought this interest into a practice I really enjoy.

These two practices, seemingly first two seperate worlds, came together during the fieldtrip to Ahmedabad. By hearing stories from teachers, students and household residents together with observations of the city a culture of living amongst nature became visible. Small but noticable aspects like birdfeeders in the courtyard, placement of leftover foods for animals, seeing cattle roam around the city, started the idea that agriculture can be combined with housing. Seeing that this integration can lift challenges the city currently faces, while also providing a way to support households' livelihood, the idea became a concrete concept for my reasearch and design.

The contribution this project demonstrates is that urban density does not solely has to depend on maximising floor area, but can also be measured through the quality of everyday life it supports. By reintroducing productive landscapes into and around housing, the project seeks to strengthen households livelihoods, food systems, and the local climate of the city, while also creating awareness in sustainable food practices for future urban developments. The project seeks to soften the boundary between city and countryside to have them become more shared, productive and interconnected.



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Chapter 01

Introduction

1.1 Reading guide

Research focus
The main architectural question this report will answer is how low-input urban agriculture can support households' everyday livelihoods and engagement in sustainable food practices, all in the context of low-rise, high-density housing on underused urban and peri-urban plots in Ahmedabad, India. What is researched is the relationship between housing and agriculture and what can happen and happens when these two systems are integrated with eachother.

Storyline and products
The structure of the report is divided into four main chapters that each inform eachother to finally come together in chapter 5 to form the conclusion. This guide provides you, the reader, to navigate to specific parts of the chapters as desired, without having to go through the whole. The overall order of the chapters do provide the order of the storyline of the report.

The research- and design generates numerous products that are highlighted and used in the report in a more concise manner and are fully layed out in the last chapter containing the appendix and references. This applies to:

- Ahmedabad plant database, pg. 204
- architectural spaces analysis, pg. 98
- UA x Arch integration analysis, pg. 99 - 101
- design drawings- and models, pg. 102 -
- climate- and construction pg. 150 - 189

When it comes to visual sources (figures, diagrams, imagery), they are made/ taken by the author unless other specified in its description and figure list.

Terminology
Breaking down the terminology, clear definitions and abbreviations of certain words will be stated here that are further used throughout the report.

- *Urban agriculture (UA)* includes the cultivation, processing, and distribution of agricultural products (food or non-food) in urban and suburban areas and can provide environmental, economic, and social benefits to the surrounding communities.
- *Household livelihood* means the full combination of capabilities, assets, and activities that a family uses to make a living and meet its basic daily needs.
- *Low-input UA practices* are context dependent components of UA that do not require high-tech elements for it to work and be implemented into the build environment. Specifying for Ahmedabad, factors like time, resources, money, knowledge (accessibility) are important in determining if the UA practice is consi dered low-input.
- *FSI (Floor Space Index)* is the ratio of a building's builtup floor area to the plot area.
- *GSI (Ground Space Index)* is the ratio of ground floor area to the total land area.
- *High-density housing* is put in relation to the Ahmedabad context. The local government states a FSI of 1,8 for the zone Rajiv Nagar is in, while the goal for the project is to reach this target. This all while maintaining a low-to-moderate GSI to preserve sufficient ground-level space (GSI) for UA and public/open space.

1.2 Abstract

Ahmedabad is undergoing rapid urbanisation driven by economic growth, migration, and an increasing demand for affordable housing. While urban expansion supports economic development, it simultaneously contributes to the loss of agricultural land, environmental degradation, and growing distance between food production and consumption. Existing urban agriculture initiatives in India are predominantly small-scale and often introduced as an afterthought within the built environment, limiting their spatial, social, and economic impact. At the same time, limited research exists on how urban agriculture can be architecturally integrated into dense housing typologies while responding to local cultural practices and everyday livelihoods.

This research investigates how low-input urban agriculture can be integrated into low-rise, high-density worker housing in Ahmedabad to support sustainable food practices, strengthen household livelihoods, and improve environmental quality. Through literature research, precedent studies, urban analysis, and design exploration across multiple scales, the study examines the spatial relationship between housing, food production, community life, and urban structure. Particular attention is given to the cultural characteristics of Indian living patterns, the realities of urban agriculture practices, and the climatic conditions of Ahmedabad.

The findings indicate that urban agriculture can contribute to household food production, health, biodiversity, microclimate improvement, and social interaction when integrated into the spatial structure of housing rather than treated as an additional layer. The research demonstrates that productive landscapes can function simultaneously as food-producing systems, social spaces, ecological infrastructure, and identity-forming elements within the urban fabric.

The resulting design proposes a framework in which urban agriculture is embedded across the dwelling, cluster, neighbourhood, and city scale. By combining productive landscapes with low-rise, high-density housing, the project offers an alternative approach to urban development that balances density with quality of life. In doing so, it contributes architectural strategies for rapidly urbanising cities and expands the discourse on urban agriculture from a policy and planning perspective toward its spatial and architectural integration within everyday urban living.



1.3 Context

Brief

Rapid urban growth has brought significant challenges, including unaffordable housing, strained infrastructure, and massive displacement of human beings. With the UN predicting that over two-thirds of the world's population will be urban by 2050, these pressures are expected to intensify. This report will explore design strategies to promote adequate housing in contexts experiencing a process of rapid urbanization by embedding itself within the context of Ahmedabad – a rapidly growing first-tier city in India (figure 1).

Ahmedabad, home to approximately 9 million people, faces numerous challenges. Like many other Indian cities, it is frequently hit by climate-related phenomena such as water scarcity and rising temperatures exacerbated by the urban heat island effect. Demographic studies predict a 1.5 million population increase by 2030. While many aspects of Ahmedabad's daily life mirror global metropolises, a growing social inequality gap widens, triggered by place-specific environmental and social challenges. The current state of affairs concerning dwelling in Ahmedabad needs policymakers and designers invested in exploring sustainable housing types and models that can foster healthy and resilient urban communities.

Design solutions are to be explored to address the social and spatial challenges posed by Ahmedabad's rapid urbanisation and housing shortage. The focus is on developing inclusive dwelling communities within the city's existing urban fabric, learning from its historical "pol housing". By doing so, drawing inspiration from this historic housing type, the report will engage in creating new imaginations of urban communities based on the low-rise, high-density housing approach.



Figure 1. *Location of Ahmedabad in the Gujarat state, west India*

Local economical practices

Agriculture has been the backbone of India's rural economy, sustaining approximately 58% of the population and contributing nearly 18% of the national gross domestic product (Dani, 2026). Between the 4th and 2nd milenia BC there existed a mosaic of different adaptations in the Gujarat state, such as hunting and gathering, pastoralism (cattle herding), agriculture and various specialized craft production strategies. Later when cities started to emerge, the capacity of the population to mobilise these different production systems rose by integrating them into their economic structure (Kumar, 2024). That is why nowadays, cities like Ahmedabad show a wide diversity in economic output both within the city and through export of goods, such as handmade clothes, decorations, food, herbs and plants.

Even though the development of Gujarat is generally more towards non-agriculture (cattle, milk), the state has achieved a good development in the field of agriculture due to availability of perennial rivers (barmasi nadi) in Gujarat (Vansiya, 2021). One of these is the Sabermati River, flowing right through the hart of Ahmedabad. Because of this location, the city has a hot and humid climate, easy access to raw cotton fields from the state and a plentiful water supply from the river. Ahmedabad became one of the major cotton producing districts which layed the foundation to the flourishing textile industry in 1891, to over 90 mills all over the city in 1960 (Ahmedabad Textile Mill's Association, 2026).

There has also been a large increase in the cultivation and production of horticultural crops in the state (Vansiya, 2021). Together with edible plants, they largely make the traditional medicine practices of India. The practice is based on medicinal plants and exhibits a strong connection to healthy living, diet and folk healing, practiced by communities all over the country. Cropping patterns differ between states because of different climate- and economic factors which meant that states also yielded different medicinal plant practices. The knowledge is passed from generation to generation through verbal and writing. Current literature review shows that numerous plant species are crucial to regional healing practices and that this knowledge is still practiced today.

Due to the hot and arid climate, proper seasonal climate response was and is still needed. Climate data from Dani (2026) on rainfall, temperature, and extreme weather events from 2014 to June 2025 show intensifying climate fluctuations characterized by delayed monsoon onset, concentrated rainfall events, extended dry spells, and increasing heatwave frequency. These climatic disruptions reduced yields of crops, while increasing input costs, pest infestation, and dependence on irrigation. Nearly half of the farming households reported supplemental migration. This meant that secundary work was taken on by family members as a way to generate more income to sustain farming. Other adaptation strategies included crop diversification, drought-resistant seeds, micro-irrigation and crop insurance. However, the coping mechanisms remain insufficient for long-term resilience. Nonetheless, generally speaking, farm productivity in Gujarat currently is good enough when compared to other states in India (Vansiya, 2021).

LULC Area (km^2)					
Year	**2014**	**2016**	**2018**	**2020**	**2022**
1 Water Bodies	10346.94	7993.51	7972.64	12053.13	10071.48
2 Forest	7265.99	4000.12	2853.45	5392.48	5079.58
3 Agriculture Land	116569.71	115736.88	115199.41	115760.27	113991.45
4 Built-up	9407.38	10291.54	10650.18	11681.60	12858.53
5 Barren land	17143.62	17924.93	17359.32	13823.75	18240.93
6 Scrubland	35298.37	40085.01	41996.99	37320.77	35790.03
Total	**196032.00**	**196032.00**	**196032.00**	**196032.00**	**196032.00**

Figure 2. *Temporal variation of land use land cover classification from 2014 to 2022 in the Gujarat state, Jodhani et al. (2025)*

1.4 | Problem statement

Urban sprawl
In figure 4, the urbanisation of Ahmedabad is mapped out from 1997 up until 2021, using data from Yatoo et al. (2020) and the proposed plans of the Ahmedabad Urban Development Authority (AUDA) (2021). What can be seen is that a suburbanization, also known as urban sprawl, is initiated where a large percentage of metropolitan areas for residential and business activity are decentralized to other locations (Avadia & IRJET, 2018). This greenfield development results in land use change over the years where agricultural land gets replaced and pushed further out of the city by urban development.

Due to Ahmedabad's unique location on the Sabarmati River, pushing fields for agriculture more outwards comes with the consequence that the soil gets less and less fertile. Furthermore, as mentioned before, Gujarat farmers struggle with other aspects like higher maintaining costs, knowledge acquirement and lower payouts. The workers that do still practice traditional farming around the city notice that their daily wage, even though they provide most of the labor, only represents a third or a fifth of the added value, while the rest goes to the owner (Aubron et al., 2015). This way, city jobs provide more stable income which only fuels the urban sprawl and creates this loss of interest in agricultural practices for the city.

Economic (trade) systems
Textile and food are two of the main economic outputs of the city generating jobs and work that outputs the main economic drive of the city. Urbanisation comes with the consequence that most of these economic systems become international end products are exported all over the country and rest of the world. Transportation costs and greenhouse gas emissions create higher total costs, while also harming the climate more than keeping these sytems more local. Within India, most of the agricultural transportation is done by train. At last, the external added costs are passed on to the buyers that have to pay extra. By keeping the food system (partly) more local, there are less parties inbetween the farmer and the buyer and external costs can be minimised. Surplus produce can later always still be exported outside of the city.



Figure 4. *Urbanisation and land use change of Ahmedabad (1997–2021), own work based on Ahmedabad Urban Development Authority (2021); Yatoo et al. (2020)*



Figure 3. *Indian farm labourers sort rice at the Sardar Patel Farm at Kathwada village, Panthaky (2009)*



Figure 5. *Indian labourers gather Ladys Fingers or Okra at Sardar Patel Farm at Kathwada village, some 30 kms from Ahmedabad, Panthaky (2012)*

The urban–rural tension
Urban sprawl is unavoidable and city jobs currently provide more secure income to the households. Both provide for the economic output of the city but in a different way. On the one hand lost agricultural land should be replaced for maintaining a more local food production network, while on the other hand a loss of interest in agriculture arises due to the current state being not sufficient enough to sustain a households income, making it a non-appealing practice to find work in. Since living among nature and traditions around local food practices are important parts of the culture of the city (figure 6), the tendency highlights the importance of a solution that softens these challenges.

Agriculture within the city fabric
What if it was the other way around; bringing agriculture into the city to support the households while still allowing for secundary jobs that together sustain everyday livelihoods of these households. The practice would provide a way to practically and socially engage into (shared) farming inputs. Architecturally, this spatial strategy uses (underutilized) surfaces and spaces for UA, transforming static envelopes into dynamic ecological systems.

UA is not a new concept and already gets implemented in cities all over the world. However, existing approaches often overlook the socio-economic realities of low-income households, regarding limited time, financial resources, insecure access to land and water and low awareness of cultivation practices. Especially in India, where displacement, unaffordability and strain on the infrastructure are big challenges cities like Ahmedabad face. Because of this, in architecture and urban planning, UA practices often come as an aftertought after housing typologies are already build. They then do not always support UA in a truly meaningful way (figure 7).



Figure 6. *Spatial and social characteristics of households in Ahmedabad, illustrating the importance of community-oriented, ground-connected living among nature*

Focus
The research aims on the spatial relationship between low-rise, high-density housing and combining it with agriculture in the context of rapid urbanizing Ahmedabad. It is integrated in a way that is socially accessible, climatically responsive, economically viable, supports everyday livelihoods and spreads awareness. The focus aims to resolve or soften these previously stated problems by making it the main research question of the report. The numerous challenges that arise are divided into sub-questions that are then catagorised into one of the five research contexts.

Because UA often comes as an aftertought and no substantial amount of space is reserved for its practices, there is a lack of local research into what low-input UA types can be practiced and on what scale they work the most optimal. Thereby noting that the current status of UA in India is not yet clearly mapped as well.

Residents in the city often do not have a sufficient knowledge base of the technical requirements of UA which is logic, since their main income is often generated from another branch of work than agriculture.

If UA can even be added depends on how the daily routines of residents of Ahmedabad look like and need to be mapped since they can have changed over time. On the city scale the local context determines how UA practices can be implemented on public spaces and require insights before it can be done so.

On the cluster- and typology scale, on all three income levels, the spatial characteristics are needed as a tool to extract where there are opportunities for implementing UA in them. On the other hand, the minimal spatial requirements of the different UA practices are also needed to be able to achieve this. Because these measurements need to be adapted to the local climate of Ahmedabad, it requires further research before they can be used.

Lastly, long-term participation is what makes implementing UA into the city successfull or not. Strategies for- and phasing of the project needs to be stated to at least propose how it functions over time in the future. This cannot fully justify the successfullness, while researching and analysing literature and casestudies does make the project more viable and creditable. In the next section the gathered challenges will be put into sub-questions and will be researched in the next chapter.



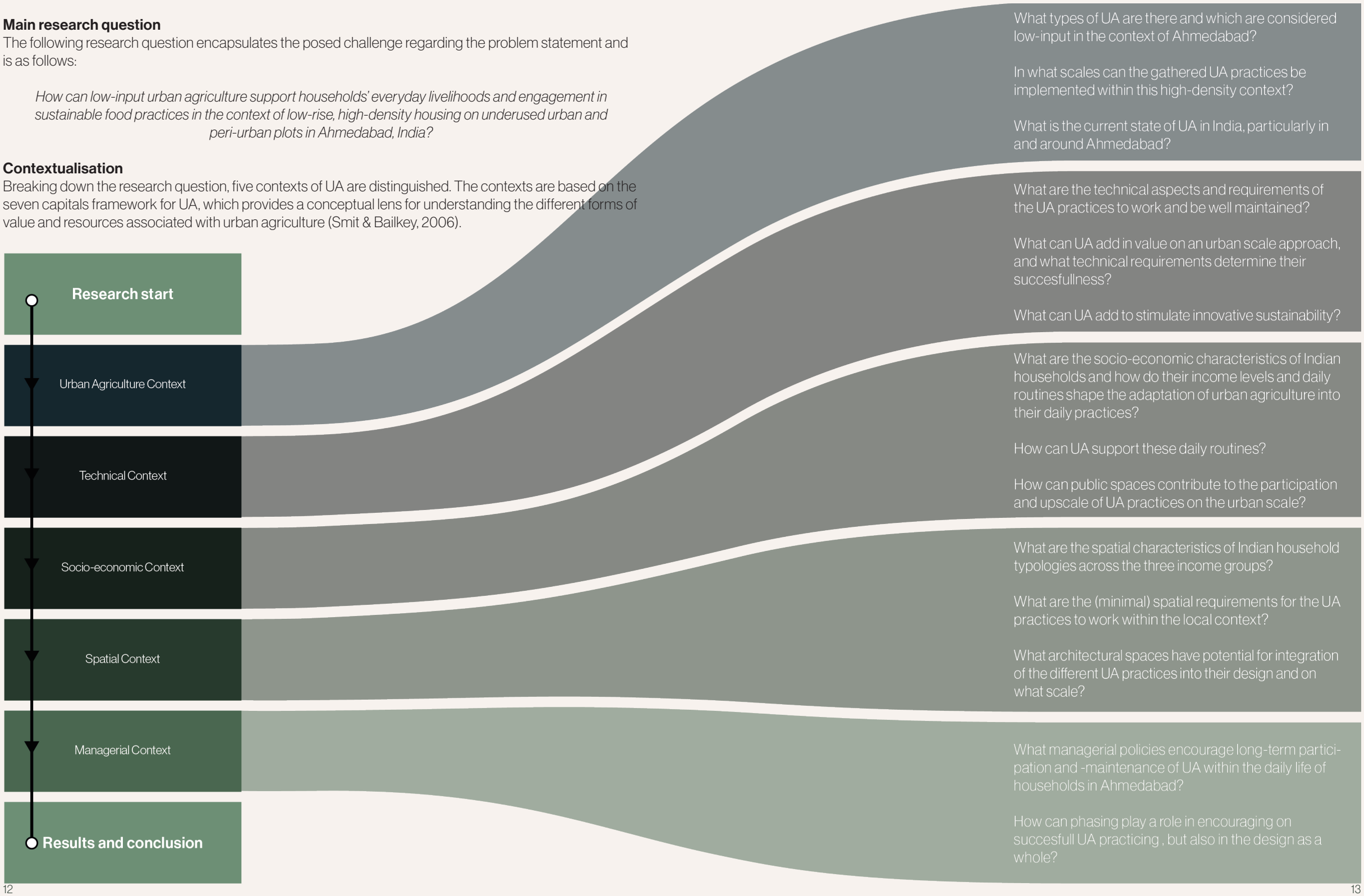
Figure 7. *Informal and small-scale urban agriculture practices integrated into leftover urban spaces in Indian cities, Koduganti & Patil (2024)*

1.5 | Research- and design questions

Main research question
The following research question encapsulates the posed challenge regarding the problem statement and is as follows:

How can low-input urban agriculture support households' everyday livelihoods and engagement in sustainable food practices in the context of low-rise, high-density housing on underused urban and peri-urban plots in Ahmedabad, India?

Contextualisation
Breaking down the research question, five contexts of UA are distinguished. The contexts are based on the seven capitals framework for UA, which provides a conceptual lens for understanding the different forms of value and resources associated with urban agriculture (Smit & Bailkey, 2006).



1.6 | Relevance

Agricultural displacement
Urbanization and urban sprawl are ongoing and unavoidable processes that also bring a lot of benefits to a city. Production and infrastructure costs are shared, there is more efficient labor market connecting while enterprises also learn more from each other (Sridhar, 2016). However, to account for the displaced agricultural land, bringing parts of that land back into the urban fabric can help city planning while still allowing for economic growth of the city. It keeps city food systems more local and supports the daily livelihoods of the households while also keeping the spatial diverse and breathable qualities of the peri-urban regions.

Research gap
There currently is a lack of research and casestudies of UA integrated into Indian housing typologies. By integrating low-input UA into dense Indian housing fabrics, it offers the potential to address multiple challenges simultaneously, working on the local but also the city scale. It can soften the environmental challenges cities face, such as the urban heat island effect and can also improve the climate on the city scale as a whole. Especially in Ahmedabad, where the local government is reserving specific plots for centralized green structures in their urban development plans (Ahmedabad Urban Development Authority, 2021) to already address these challenges. On top of that, local challenges like waste management, both air pollution and -quality, housing conditions and sustainable food practices are points that UA typologies can stipulate on.

There currently is a lack of housing models that combine low-rise, high-density living with low-input UA, while also responding to the cultural and spatial characteristics. This project therefore investigates how new housing typologies can integrate food production into everyday domestic life, rather than treating it as an additional layer at the end of the design process. This way, the research contributes architectural strategies for rapidly urbanizing (Indian) cities to promote sustainable living environments, offering insights relevant to both UA and the architectural practice itself. This research addresses the research gap by examining how architectural design can enable productive land use within dense urban plots, like those found in Ahmedabad.

1.7 | Objective and motivation

There is a rising trend of urbanizing cities to create housing designs based on high-rise, standardized towers to generate high floor-space indexes that thus pose high density housing design (figure 8). However, especially in the Indian culture, connection to the community and the floor level is essential for their day-to-day living. Gathering from interviews of residents in Ahmedabad by K. Marnane and K. Greenop, they state: “Space to build relationships with neighbors is therefore critically important for resident’s social enjoyment and mutual economic and social support, and establishes safety through shared knowledge of local community members”. As Andrew Wright Associates poses in figure 9, there are other spatial strategies to achieve the same amount of density on the same plot. By arranging more- and lower units the goal is to keep this engagement between households and communities.

UA on the other hand is also embedded in the history and culture of India, where home gardens and composting are longstanding traditions and knowledge about the subject is often shared through family, friends and neighbors (Koduganti & Patil, 2024, p. 188-190). By combining UA with housing the objective is to not only design high-density housing but integrating it with agriculture production to create typologies that combine private, collective and productive space all in the context of Ahmedabad city.



Figure 8. *Repetition of high-rise, standardised housing towers that together form a cluster, Ahmedabad, India*

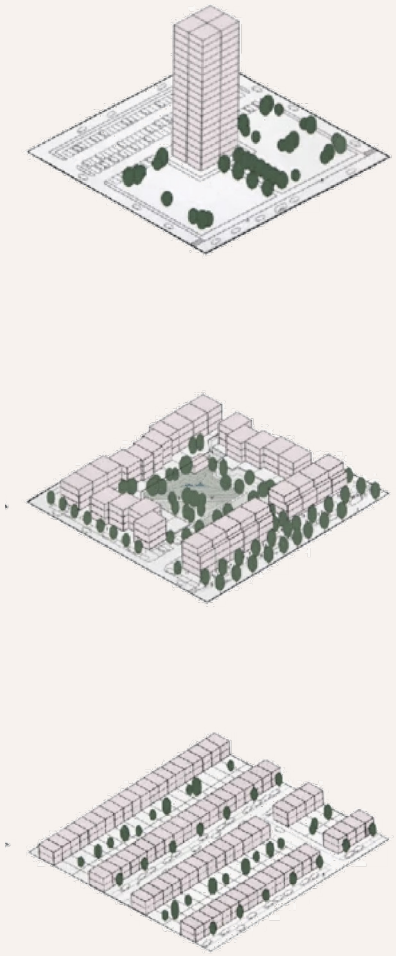


Figure 9. *Three different types of urban areas with 75 dwellings per hectare, Andrew Wright Associates (1999) in Topçu en Southworth (2014)*

Motivation
Growing up on a dairy farm in Flevoland, the Netherlands I saw and learned about agriculture from a very early age, often working at different companies such as corn- and tulip farms. In the recent years the family farm has grown into a bio-dynamic dairy farm, which is a step above organic farming, working even more with nature and biodiversity. When I started studying architecture in Delft it stood out to me that the city is disconnected from the countryside and that many people don't exactly know where their food comes from and how it is produced. On the other hand, the city also contributes a lot of value to people in providing aspects like work, amenities and leisure. When both are important and bring value to life there does not always have to be a strict boundary between them. In other words, that they can coexist. In the Netherlands this is already seen more and more where allotment gardens produce and sell locally-sourced vegetables and herbs (figure 10).



Figure 10. *Satelite image of allotment gardens in the urban fabric nearby the family farm, (Google Earth, 2026)*



Figure 11. *Aerial view of the agricultural landscape of the Noordoostpolder, Netherlands*

1.8 | Scope

The chosen site for implementing the proposed design is an open plot next to the Rajiv Nagar metro station, situated on the westside of Ahmedabad (figure 12). By choosing underused plots in the city, they provide direct access to the soil and space for harboring housing and agriculture.

Housing will be provided for low-, middle- and high-income households and, even though they each have their own wants and routines, they will all still be able to participate in practicing UA. On top of housing, there will be facilities in the programme that scale UA to the city level which are combined with other amenities like squares and shops to provide selfsustaining urban design.

It is important that UA practices are integrated in the daily routines of households in a way to support but not burden their livelihoods. Knowledge and participation are also factors that make UA practices more known and is often done with the help of policies and managing strategies. Even though the viability and managerial strategy are proposed through literature review and case study analysis, refinement and further research may be needed before them being implemented into the building process. On top of that, the selected UA practices are specified to those that are relatively low-input and can work within the climate conditions of Ahmedabad. This means that there are types of UA practices that are not touched upon and are left out of this proposed framework.

Next to low-rise, high-density housing, there has to be a sustainable amount of area and space reserved for practicing UA. By creating possibilities for more (surface) area this can be achieved so UA can really support households and sustainability on the city scale, without becoming too diminished. As referred to in the reading guide, high-density housing is subjective to what personally is thought to be 'high'. The density is measured in FSI and is targeted to 1.8 (based on the urban development plan scheme for the area), while maintaining a low-to-moderate GSI to preserve sufficient ground-level space for UA- and public space.



Figure 12. *The Rajiv Nagar plot*

Chapter 02

Methodology

2.1 | Methods

In this section the research- and design strategy are explained and what techniques and tools are used to answer the subquestions and ultimately the main research question. Furthermore, the expected outputs of each context are highlighted.

Methods per context
The UA context is researched through literature review and fieldwork. With the literature the low-input UA practices are defined and catagorised into the scale (typology, cluster, urban) they work in. Using fieldwork, the current state of (urban) agriculture in and around Ahmedabad is analysed.

The technical viability of the project is tested through literature review into the material- and maintenance requirements of the identified low-input UA practices. The research is then extended to the urban scale and combined with research into innovative sustainability on that scale.

To understand the socio-economic realities of the Ahmedabad households better, there is conducted fieldwork through informal conversation. On top of that literature review is conducted into how public spaces can support this social and economic participation of UA on the urban scale.

The spatial context gathers the characteristics of Indian household typologies through fieldwork and casestudy analysis and thus combining observation and analytical data from housing in the city. Using literature review the (minimal) spatial requirements for the UA practices are then researched. Ultimately, the two are combined by using research by design so the potential of spaces for integration of UA are identified and iterated.

For the managerial context, successful UA case studies are analysed together with literature review into UA management policies to find fitting strategies that encourage participation and can encapsulate the phasing of the final design on the housing-, cluster- and urban scale.

Methods used for each research context

Urban agriculture context
Literature review
Fieldwork

Technical context
Literature review

Socio-economic context
Literature review
Fieldwork

Spatial context
Fieldwork
Literature review
Research by design

Managerial context
Literature review
Casestudy analysis

Figure 13. *Methods used per research context*

2.2 | Theoretical framework

Before the pre-design research is conducted, first the theoretical background of the project is presented to clarify the design approach based on the selected theory below. First the theory of the 7 capitals of UA are layed out. Then the Continuous Productive Urban Landscapes (CPUL's) theory is introduced as a way of urban structuring with UA on the city scale. Zooming in to the neighborhood scale, the Radburn principle is introduced as a way of structuring routing, security, amenities and open space. While the principle does not directly touch upon productive landscaping, the model creates open, low-traffic, spaces that lend themselves well for implementation of UA. Lastly, UA is approached on the typology scale using the block to row typology scheme by Gropius. It describes how the building, and otherwise isolated object, can produce different relationships between the dwelling, the street and spaces between buildings, using different building configurations.

The 7 capitals of UA
UA can contribute to cities on multiple interconnected levels, extending beyond food production alone. According to Jac Smit and Martin Bailkey (2006), community-based UA contributes to several forms of "community capital", including human, social, cultural, political, economic, built, and natural capital (figure 14). Together, these dimensions position UA not merely as a food system, but as a spatial and social framework capable of supporting more resilient and liveable urban environments (Smit & Bailkey, 2006).



Figure 14. *The seven capitals of UA*

At the human level, UA can improve nutrition, health, practical skills and environmental awareness, while also supporting knowledge transfer between generations and communities. Socially and culturally, shared food production strengthens neighbourhood cohesion, collective ownership and everyday interactions, while preserving local food traditions and agricultural knowledge embedded in communities. Politically, UA can stimulate local organisation and shared responsibility, enabling residents to collectively manage productive spaces and strengthen their agency within the neighbourhood. Economically, UA can supplement household livelihoods through food production, reduced food expenses and small-scale income generation, particularly for low- and middle-income households. Spatially, productive landscapes contribute to the built environment by transforming underused land into multifunctional spaces that combine dwelling, food production and social interaction. Environmentally, UA can improve biodiversity, reduce urban heat island effects, stimulate composting and waste reuse, and contribute to healthier local microclimates.

The different capitals are grouped or put into their own research context so that every capital is touched upon in the report. This way, UA is researched in its whole. The human and political are in the managerial, the cultural, social and economic are in the socio-economic, the built in the spatial and the natural in the technical. Through division, subquestions relating to the capitals are asked in each of these contexts.

Urban - CPUL's

The term 'Continuous Productive Urban Landscape (CPUL)' defines a concept for the coherent integration of UA into urban space planning. The design concept makes case for considering UA as an essential element of sustainable infrastructure that enables sustainable urban food systems for leisure and the benefits for the environment, economy, culture and society as a whole (Bohn&Viljoen Architects, 2004).

CPULs do not aim to erase urban tissue. Instead, they build on and over characteristics inherent to the city by overlaying and interweaving a multi-user landscape strategy to present reclaimed open space (Viljoen et al., 2005. p 11). These open spaces then run continuously through the urban fabric, connecting all kinds of existing spaces and extending all the way to the surrounding rural area. The process of how these continuous landscapes are created is layed out in figure 15 below. CPULs are designed primarily for pedestrians, bicycles and emergency vehicles, so as to allow healthy vegetation and varied occupation (Viljoen et al., 2005, p. 12). While quality spaces the city already has will remain largely the same, the model poses for repurposing of underused open plots that can adopt the proposed design strategies and thus integrating UA into the urban fabric.

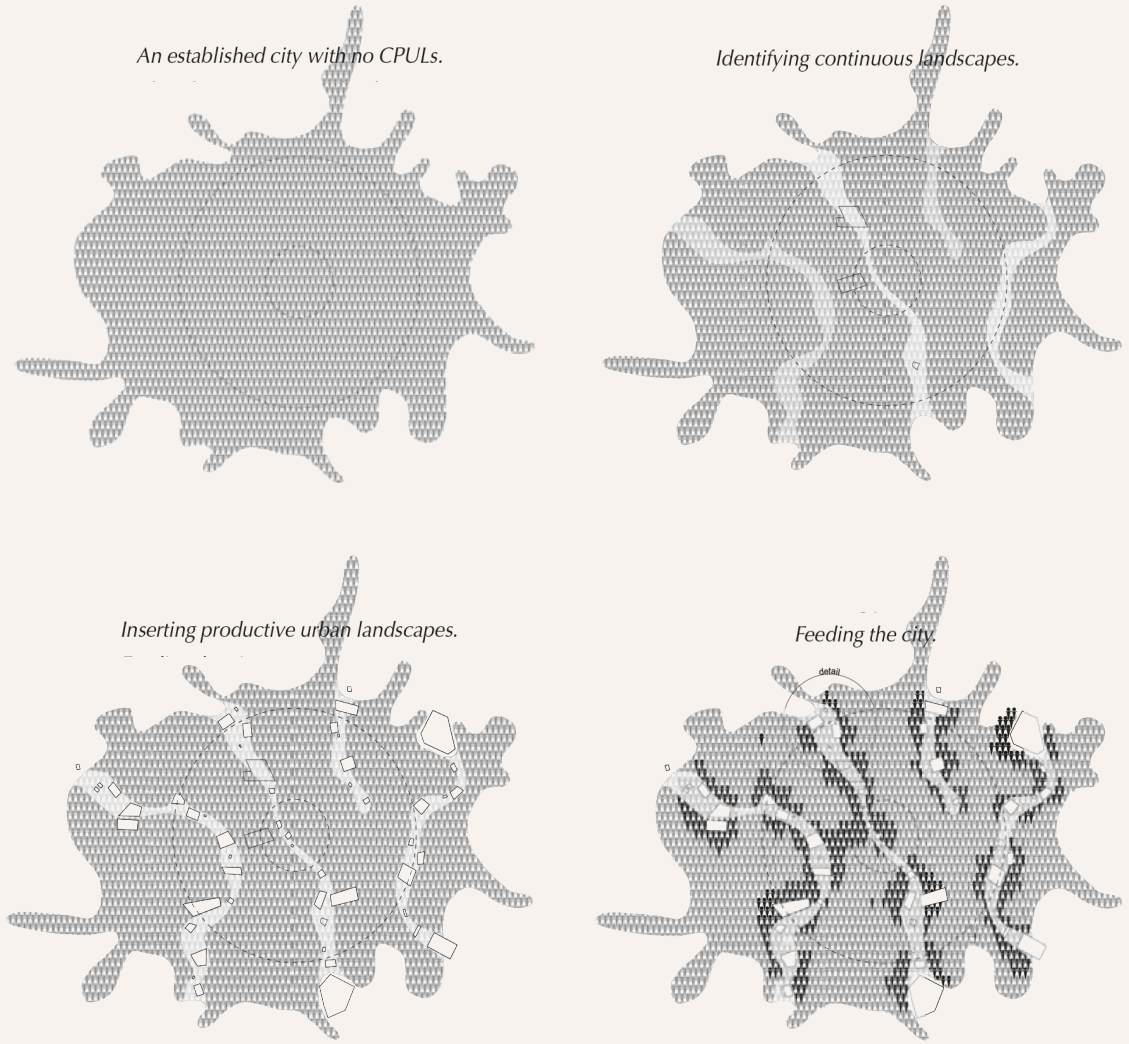


Figure 15. *The steps of creating a CPUL city, Viljoen et al (2005)*

CPUL's often include livestock, but consist largely of vegetation, which is locally managed. The main production will be carried out by local occupants who rent the land and work on it commercially. What is noted is that this trading and seasonal consumption will never be fully self-sufficient in food production. Cities are still required to bring food into the city, but less of it and in a more focused, need-oriented way (Viljoen et al., 2005, p. 12).

The implementation of CPULs is a slow process varying with the city under consideration. The most advantageous areas are which, at the moment, are mono- or non-use (Viljoen et al., 2005, p. 15). Examples are car parks, parking, railway embankments, fields and brownfield sites. The emphasis on connection and movement, on uninterrupted routes between local urban centres, influences their layout and positioning. An example city detail of part of a CPUL (figure 16) is presented by Viljoen et al. in their book '*Continuous Productive Urban Landscapes (CPULs): Designing Urban Agriculture for Sustainable Cities*'. What can be noted is tat while some areas hold many activities, other parts are mainly greenery to make this continuous landscape. Extending back to the city scale, a network of these CPULs can become a structure where certain circulation or amenities are shared and thus open space up for connecting them together. This way, the principle can connect larger spaces of any size and designation with eachother.

From the CPUL framework, this research takes forward the principle on the city scale of continuously interweaving UA with underused open spaces, creating a connected productive landscape through the urban fabric towards the rural edge. The resulting structure prioritises pedestrian movement and non-vehicular access, with vehicle access primarily limited to servicing and emergency use. Although the productive landscape is predominantly vegetative, it also incorporates livestock where appropriate.

At the typology scale, spaces are rented and cultivated by local occupants for household use, while at the wider CPUL scale, commercial forms of production are in addition embedded within the connected productive landscape. The landscape may alternate between high-amenity spaces, productive areas, and mixed-use spaces, depending on local conditions and needs. What remains consistent is the presence of a continuous landscape structure running through the urban fabric, maintaining ecological, productive, and recreational connections. Finally, individual CPULs can be connected at the city scale, allowing them to share amenities and resources and creating opportunities for additional UA spaces.



Figure 16. *Urban integration of a CPUL city, Viljoen et al (2005)*

Plot - The Radburn principle

In urban planning, neighborhood concepts have been an important way in creating hierarchal layouts within the design. However, there are different ideas on how to approach these concepts, each with their own design intentions. First, there was the idea for neighborhoods by Clarence Stein and Henry Wright where-after the neighborhood unit idea of Clarence Perry became known. To set out the characteristics of these neighborhood ideas it can be better understood what design intentions are important in them and how benefits can be blend with the current way of living of households in the city.

During the City Club of Chicago competition of 1915, the problems cities were facing were summarised by John Nolen, president of the national conference on city planning (Patricios, 2001). Problems like traffic congestion, crowded living and working conditions and an unfavourable living environment were mentio-ned and are problems Ahmedabad still struggles with to this day.

With the creation of the Radburn principle they incorporated ideas of other urban design to further build their idea on. The superblock and the cul-de-sac were ideas already earlier introduced and formed an important base for the principle. In his 1971 essay The Superblock historian Alan Colquhoun defines the superblock as 'large pieces of real estate in the city, each of which is financed and organised as a single entity' (Colquhoun, 1981). This would mean that the block encapsulates housing as well as amenities within the same plot. Cul-de-sac is on the other hand a term commonly referred to a dead-end streat. Since its introduction and use in 1928, the cul-de-sac has been a design principle, also used in India, to create a clear hierarchy of public space (Southworth, Ben-Joseph, 2004).

The design of the Radburn neighborhood model was in essence a hierarchical one that commonly holded four to six superblocks bounded by major roads and natural features. The superblock principle is used in an less extreme form, since critics noted (Mumford, 1961) that the superblock olbiterates the fine grain of the city and destroys the possibility of spontaneous social life and instead turns the neighborhoods into traffic machines (Wang, 2025). Clusters were arranged in an overlapping manner to support joint use of amenities such as hospitals and schools. The cul-de-sac principle then controls and diverts traffic so that shared open space becomes a medium for all sorts of activities and interactions. It is introduced as a way of dealing with vehicles and the danger of them to pedestrian safety (Wang, 2025). Their idea of creating a three-level hierarchy of open space ties in with the Indian way of living and expanding to six scales of public open space.

As an adaptation on the Radburn principle, Perry identified four additional design principles for his idea of neighborhood design. First, a central neighbourhood or community centre was to contain various institu-tional sites, including a school, grouped round a central green space. Secondly, local shops or apartments were to be located at the outer corners of the neighbourhood. Thirdly, scattered small parks and open spaces, located in each quadrant of the neighbourhood, were to form 10 per cent of the total area. Fourthly, the layout of the internal streets was to be a combination of curvilinear and diagonal roads to discourage traffic (Wang, 2025).

Using the milder version of the superblock, overlapping clusters can remain closed off from the public streets. This way, households have more privacy and security in practicing UA. Creating an inner curved and angled road network of the clusters, this hierarchy can be further strengthened. Integrated amenities and shops then serve as a local way of sharing and exchange. Larger amenities like the marketsquare can then be centralised on the scale of the building plot as a whole. Further security and safety is then provided by creating a three-level hierarchy (pedestrian, oneway streets, arterial roads). Open space for UA beco-mes more accessible this way as well. The green structures created with UA attribute to the principle of Perry that each clusterblock should have open spaces and greenery scattered through them.

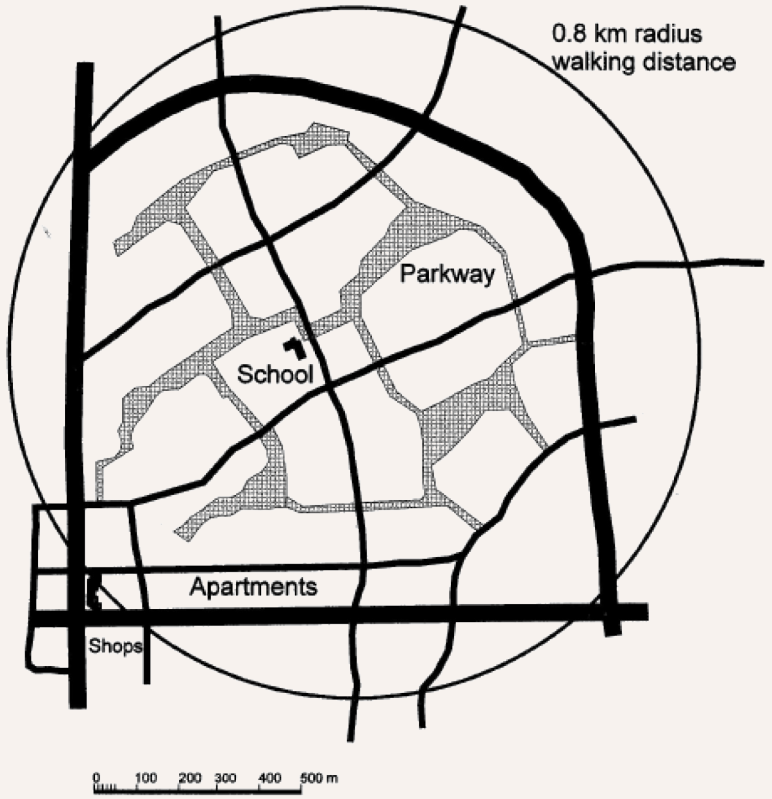


Figure 17. *Radburn- typical neighbourhood composed of six superblocks, Patricios (2001)*

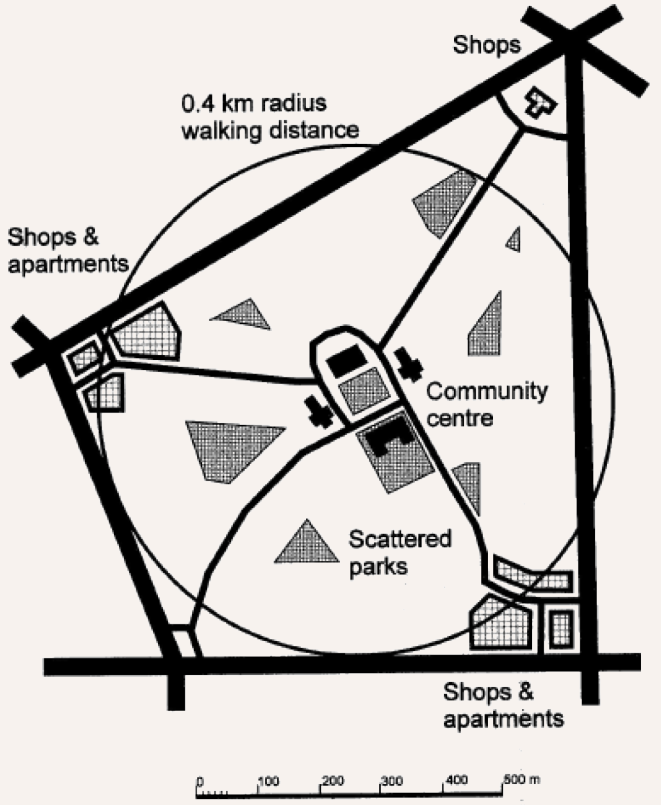


Figure 18. *Perry - neighbourhood unit, Patricios (2001)*

Cluster & typology - The Indian wada
The project draws on the spatial organization of the traditional Indian wada, particularly the relationship between individual residential units and a shared inner courtyard. This principle is reinterpreted through a contemporary configuration in which row-like housing units collectively form a perimeter block.

The wada developed from the wadi, described as a rural grouping of huts around a central open space (Bronn, YEAR). This arrangement formed the basis of the urban wada (figure 19). The wada courtyard is associated with the residential dwelling or household while the chowk is a larger shared space serving the residential cluster. These central chowks became the focal point of the wada clusters, usually dominated by a tree or temple. In the wada, this open space became integrated into the built form as a courtyard or a sequence of courtyards. In traditional pol housing the wada was incorporated into the dwelling typology, whereas in row-housing the wada is located at the front and back of the dwelling.

In combination-type housing clusters, the wadas of ordinary residents formed the majority of the residential fabric. The wada served as a residential centre, while the chowk acted as a shared centre at the cluster level. While segregation was practiced, it was not stringent (BRONNN). This means that, using this overlapping configuration, a social mix is more likely to succeed, as it has done so in the past. The overlap offers opportunities for social interaction between different households and groups, although spatial configuration alone cannot guarantee social mixing. The courtyard is the organising element of the house and the rooms are arranged and build around it. Different scales of open space and their sequence of entrances from street to courtyard can be noticed that relate the wada to the surrounding street and city plan (BRONNN). On the cluster level the chowk forms a bigger space for activities and social activities that is more shared with the households, instead of the wada that is more privately owned.

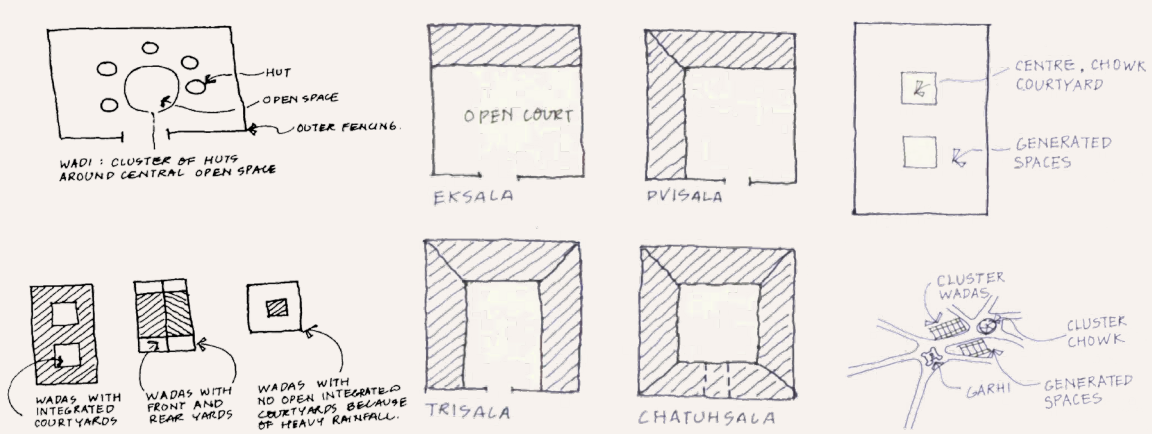


Figure 19. *Relationship of build form to open space, typical planning of housing structures, space generation on wada- and cluster level, Gupta (2013)*

Framework
Gathering from Smit and Bailkey (2006), UA practices extend way further then just the build- and economical capital. To be able to do research into- and design with UA as the main focus, a holistic approach is needed so that the other capitals (human, social, cultural, nature, political) are not overlooked. In the pre-design research, capitals are grouped together to form five research contexts which within the research will take place. Gathering from the problem statement, the sub-questions branch out to give answers to each specific context and together answer to the seven capitals of UA.

Regarding to what UA can to on the urban scale, the principle of the CPUL is implemented into the design. Using an open, underused plot in the city, (that otherwise does not have any productive landscapes outside

of the research campuses), it aims to overlay and interweave the multi-user landscape strategy that is presented by Viljoen et al., 2005. The project is limited in the way that it will not actually create a continuous landscape throughout the city but rather sets an example on how landscapes can become productive landscapes. By replicating the principle across the city the last goal of a succesfull CPUL city can be achieved, namely to feed the city. Within the plot, the greenstructures of each cluster will not physically be all connected together, since the nature of the cluster is to be more secure from its public surroundings. However, at the sides of the cluster, where two typologies meet, the greenstructure is extended up until the public street. A jali wall seperates the two to ensure security, while allowing for greenery to go through. By implementing permeable paving public streets become more green and strengthens the creation continuous green landscapes. Lastly, the marketsquare is where all the clusters are formed around. Here the dimensions of public space allow for opportunities to create productive landscapes so that not all productive landscapes are secluded in the cluster courtyard but some are also publically accessible. It is the centre of the design that ties all the greenstructures of each cluster together.

The design of the Radburn neighborhood model is implemented to create hierarchical layouts within the clusters- and urban design. Each cluster has access to the vehicular- and emergency road system but the roads themselves are directed around the cluster groups. This way smaller scales of open space are created at public courtyards and inner pedestrian streets. Together with the scales of open space within the cluster it ties in with the Indian idea of living based on their six existing scales of public open spaces. The superblock Alan defines is used in a less extreme form, where indeed the clusters are arranged where amenities are shared between clusters. Integrated amenities and shops then serve as a local way of sharing and exchange. Larger amenities like the marketsquare can then be centralised on the scale of the building plot as a whole. Overlapping clusters remain closed off from the public streets, this way, households have more privacy and security in practicing UA. By creating an inner curved and angled road network of the clusters, this hierarchy of open space is further strengthened. The marketsquare also hosts a central community centre where workshops, meetings and events are combined with productive green space to generate a good UA knowledge base together with long-term participation into the practice. The green structures created with the configuration of the clusters attribute to the principle of Perry that each quadrant should have (public) courtyards and greenery scattered through- and around them. The layout of the internal streets is a combination of ortogonal- and diagonal roads to discourage traffic through these smaller streets.

While the cluster together form this perimeter block, using the theory from Grupa, the block is opened up more to the public space around it. The wadas of the housing typologies are orientated on the front and back of each unit and makes the dimensions of these units rectangular and in row housing formation. The otla of the groundfloor dwellings are the public wada while their terrace/balcony becomes the private wada. The high-income typology has its own, more private and seperated wada in the form of a kitchen garden and balconies/terraces. That is why, instead of horizontal, these typology buildings are more vertically centred in their form. Where two typology buildings meet an alcove is now created instead of making a fully closed off perimeter block. This way, a clear bordering between dwelling ownership between each typology is ensured while the overlapping configuration allows for a social mix of different household groups. The central chowk Grupa talks about is the cluster courtyard, that is only accessible by the residents of that cluster, being the space for UA, social interaction, religious practices and other activities. A tree and temple provide shade and a place to rest instead of just move through.

The distinction between the household-level courtyard and the larger chowk informs the project's differentiation between private and public space. This is further developed through the introduction of recessed alcoves along the street-facing edges, providing opportunities for public interaction while maintaining the privacy of the inner courtyard through a jali screen. Different scales of open space and their sequence of entrances from street to courtyard are implemented to relate the wada to the surrounding street-, cluster- and city plan. The public scales of these spaces are from big to small: Market square, streets with alcoves (public courtyards), otla (semi-public wada). The private or shared forms of open spaces from big to small are: Cluster chowk, shared roofs, balcony/terrace (private wada).

Chapter 03

Assessment



3.1 | Pre-design literature research

Using literature review, research is conducted into the urban agriculture-, technical-, socio-economic-, spatial- and managerial context of the project. Using this order, the types of low-input UA are identified. Then, these practices are related to what scales they can work within whereafterthe current state of UA in India is reviewed.

In this section the types of UA practices are researched in its quantity and whether they can be considered low-input (in the context of Ahmedabad). Then they are catagorised into what building scale they work in. Having gathered the UA practices, they are matched to the current UA status in India to help gather practical innovations and challenges that have arisen in the past and present. In this section the UA practices are analysed on their technical requirements. First soil-based-, then soil-less farming is researched on its technical requirements. Next, the professional scale of UA is further researched.

The socio-economic characteristics of Ahmedabad households are then analysed for their daily routines and how they shape the adaptation of UA practices into them. Using this literature review, it can be extracted how public spaces like squares can contribute to participation and stimulation of UA practices on the urban scale level. Then the minimal spatial requirements for the UA practices to work within the local context are researched. Together with the fieldwork and site analysis discussed in the next chapter, the gathered literature can answer the other two subquestions of this context. In the last section, policy and managerial strategies for long-term participation in UA practices is researched and how phasing can play a role in encouraging succesful UA integration for the project design as a whole.

3.1.1 | UA context

In this section the types of UA practices are researched in its quantity and whether they can be considered low-input (in the context of Ahmedabad). Then they are catagorised into what building scale they work in. Having gathered the UA practices, they are matched to the current UA status in India to help gather practical innovations and challenges that have arisen in the past and present.

Types
The types of agriculture can be divided into herb, shrub, vegetable, tree, horticulture and cattle farming. When it comes to UA, these types are divided into two ways of practicing them. On the one hand, the traditional way of farming that is soil-based and on the other hand, a more and more emerging type of farming practice, soil-less farming (figure 20).

Soil-based farming includes, as the name suggests, all types of UA that require soil in its process. These include planters, climbers (plants growing on the facade), allotment gardens and field farming. Cattle farming also requires land for the animals to graze and move about. Soil-less farming is a more technical way of farming using water or vapor, combined with nutrients, as the main resource for plant growth. An advantage of this practice is that it can be practiced both in- and outside, using limited space. Hydroponics uses nutrient-enriched water flowing along the roots of the plant, while aeroponics uses a water vapor to deliver the nutrients to the roots through the air. A third way of soil-less farming is through aquaponics. This system combines aquaculture and hydroponics to cultivate both plants and aquatic animals. Aquaponics setups cycle nutrients through a closed circuit of bacteria, fish, and crop plants. The system uses nutrifying bacteria to convert fish waste into nutrients for plants, which in turn purify the water for the fish. This way, an external source is not needed.

The specific requirements for each type of UA practice to work is further researched in the next section, the technical context.

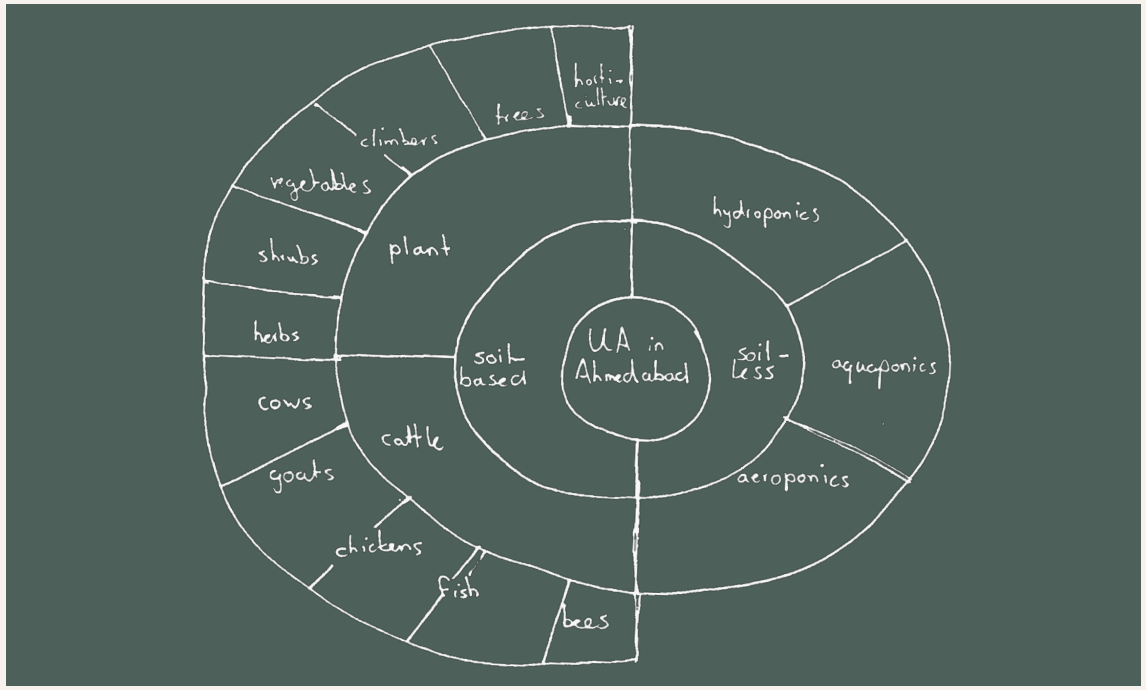


Figure 20. *The different types of UA practices*

Working scales
Markerink (2014) talks in his paper '*Integrating urban farming into buildings'* about the distinction of four ways in which a building can get connected to UA; the plot, facade, roof and interior. De Vries en Fleuren (2015) expand on these four to create a total of 7 spaces for practicing UA, adding the communal, professional and public scale (figure 21).

They acknowledge that general terms like roof gardening and communal gardens can be further specified into what type of UA is practiced, since it makes a difference in the spatial scale of them. Furthermore, they elaborate on the urban scale of UA. Urban public green structures can become places of food production and can even become commercial/professional. This entails creating so called vertical farms that maximise produce by stacking plants in a controlled indoor environment. These structures become more high-tech and large-scaled, but do also contribute back in a larger scale as well. Produce can feed surrounding neighborhoods, create jobs and spread knowledge of sustainable food practices.

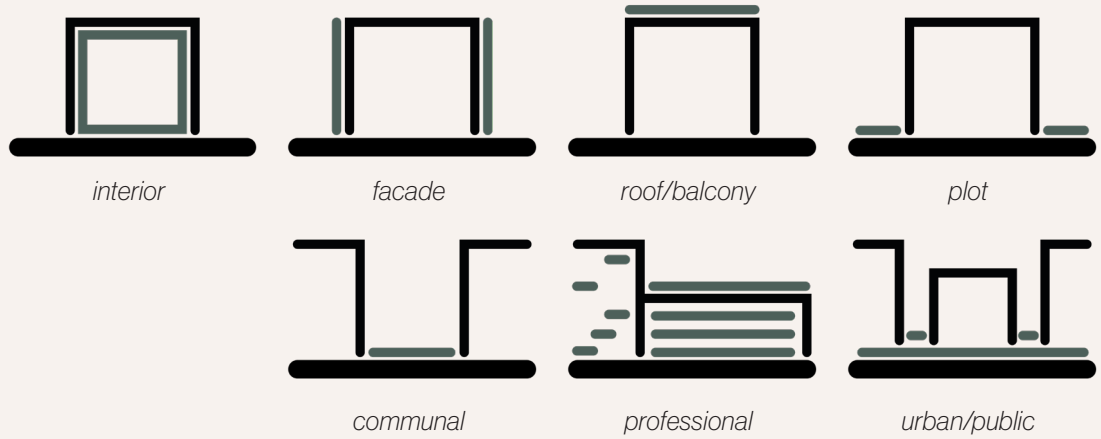


Figure 21. *The different spaces of UA practices, own work based on Markerink (2014); De Vries en Fleuren (2015)*

Low-input
Markerink (2014) rates the five UA spaces on their their technical-, functional-, social- and architectural value, based on casestudies (figure 22). To determine, whether the UA practices can be considered low-input, their functional- and technical value become important. What can be noted from figure 22 is that, even though some ways (roof, interior) score relatively lower on these factors, they in return score higher when it comes to the social- and architectural value. Determining what is low-input UA thus requires a deeper delf into their values before decisions can be made.

UA on the housing scale is often practiced not to maximise produce, but to stimulate interaction and provide leisure (Koduganti and Patil, 2024). This means that UA practices on this scale are low-input, unless the technical knowledge or investment makes them not. Aeroponics requires a controlled environment to work within and can thus be considered high-input. As for the other UA practices, they are low-input, even though not always profitable in its smallest working size.

Criteria | Case Study	PLOT 1.		ROOF 3.	4.	5.	FACADE 6.	7.	INTERIOR 8.	9.	PLOT 10.	ROOF 11.	12.	FACADE 13.[1]	14.[2]	INT 15.[3]
1. The urban farm consists of relatively few components.	yes	yes	no	no	no	yes	no	no	no	no	no	no	no	no	no
2. The components are relatively small and lightweight.	no	no	no	no	no	yes	yes	yes	yes	no	no	no	no	yes	no
3. Connections between components are relatively simple.	yes	yes	yes	yes	yes	yes	no	no	no	no	no	no	yes	yes	yes
4. Maintenance and harvesting requires relatively little effort.	no	no	no	no	no	yes	yes	yes	no	yes	yes	yes	no	yes	no
5. The urban farm can relatively easily change shape/area.[4]	no	yes	no	no	yes	yes	yes	no	no	no	no	yes	yes	yes	no
Technical value	2	3	1	1	2	5	3	2	1	1	1	2	2	4	1
1. The urban farm delivers relatively many types of food.	yes	yes	yes	yes	yes	no	no	no	yes	no	no	yes	yes	no	yes
2. The urban farm needs a relatively small amount of resources.	no	no	no	no	no	yes	yes	no	no	yes	yes	no	no	no	no
3. The urban farm produces a relatively small amount of waste.	no	no	no	no	no	yes	yes	yes	no	yes	yes	no	no	yes	no
4. The user can easily change the grown types of food.	yes	yes	yes	yes	yes	no	no	yes	yes	no	no	yes	yes	yes	yes
5. The urban farm has no risk of externally caused contamination.	no	no	no	no	no	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Functional value	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3
1. The urban farm is easily accesible, when on plot.	yes	yes	no	no	no	no	yes	no	yes	yes	no	no	yes	no	yes
2. The urban farm stimulates people to interact.	yes	yes	yes	yes	yes	no	no	no	yes	no	no	yes	yes	no	yes
3. The urban farm stimulates physical activity.	yes	yes	yes	yes	yes	no	no	no	yes	no	no	no	yes	no	yes
4. The urban farm has an educational program.	yes	no	yes	yes	no	no	no	yes	yes	yes	no	yes	yes	no	no
5. The urban farm stimulates the biodiversity.	yes	yes	yes	yes	yes	no	no	no	yes	no	no	no	no	no	no
Social value	5	4	4	4	3	0	1	1	5	2	0	2	4	0	3
1. The urban farm has an effect on the building exterior from streetview.	no	no	no	no	no	no	yes	no	yes	no	yes	yes	yes	yes	yes
2. The urban farm has an effect on the building exterior from high view.	no	no	yes	yes	yes	no	yes	no	yes	no	yes	yes	yes	yes	yes
3. The urban farm has an effect on the building interior.	no	no	no	yes	no	yes	yes	yes	yes	no	no	no	no	yes	yes
4. The urban farm has an effect on the routing outside the building.	yes	yes	no	no	no	no	no	no	no	yes	yes	no	yes	no	no
5. The urban farm has an effect on the routing inside the building.	no	no	yes	yes	yes	no	no	yes	yes	no	no	yes	yes	yes	yes
Architectural value	1	1	2	3	2	1	3	2	4	1	3	3	4	4	4
Average value	2,5	2,5	2,3	2,5	2,3	2,3	2,5	2,0	3,3	1,8	1,8	2,5	3,3	2,8	2,8

Figure 22. *Evaluation of 15 urban agriculture case studies through twenty criteria, Markerink (2014)*

On the cluster scale, communal and professional efforts can integrate UA into the architectural fabric. Communal farming is similar to farming on the household level, the scale is just bigger and fields are either lent or shared with eachother. However, on the professional level, the farming is taken over by a certain company or group, aiming for high production and -efficiency. Here the requirements become more advanced, while at the same time there is also more money and time to put into this required higher input. Here is where an important division is to be made when it comes to only selecting low-input UA practices. On the professional scale the higher input also results in higher output, which indirectly also supports the surrounding households back again. Either in terms of produce, job creation and knowledge distribution.

On the urban scale open public spaces, such as squares and parks, can also become spaces for UA. While the aim is again not to maximise produce, the environmental benefits of vegetation and biodiversity can be mixed with produce landscapes.

Summarising the three scales, a low-input UA practices framework for Ahmedabad is setup (figure 23).

Typology scale		Cluster scale	Urban scale
Interior *horticulture* *herbs* *fish/aquaponics* *hydroponics*	Facade *horticulture* *climbers* *vegetables*	Communal *horticulture* *shrubs* *vegetables* *trees* *chickens* *goats* *cows* *bees*	Urban/public *horticulture* *shrubs* *vegetables* *trees* *climbers*
Roof/balcony *horticulture* *shrubs* *vegetables* *chickens* *fish/aquaponics* *hydroponics*	Plot *horticulture* *shrubs* *vegetables* *trees* *chickens* *fish*	Professional *shrubs* *vegetables* *trees* *cows* *goats* *chickens* *hydroponics*	Professional *shrubs* *vegetables* *cows* *goats* *chickens* *hydroponics*

Figure 23. *Types of low-input UA practices and their working scale(s)*

Status of India

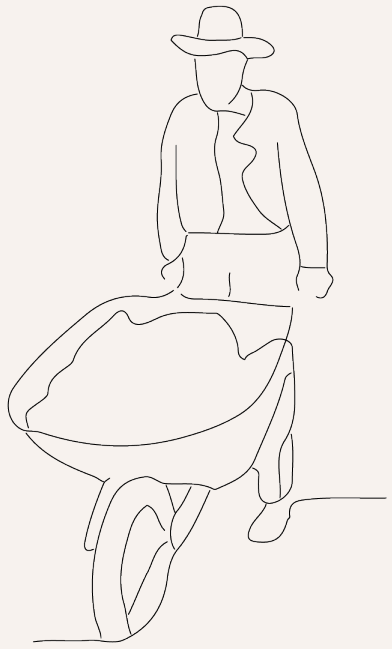
UA is not an entirely new concept to India. There are examples of operations in other Indian cities like Kolkata, Pune and Bengaluru that try to relief the pressure and loss of interest in agriculture in the form of practicing UA. It are slowly emerging projects, focussing on aquaculture and chemical-free food production by utilising all small spaces to grow vegetables and greens (Patil et al., 2026). Observations and interviews from Koduganti and Patil (2024) dive further into this by breaking down the age, tasks, and UA requirements named by UA practicioners (figure 24).

A significant proportion of Indian residents involved in UA fell within the 41-60 year age range. UA-practicionars from diverse age groups collaborating and combining technology and innovative approaches while currently embracing traditional and organic farming methods, which the older age group more commonly favors. Younger individuals involved in the study have inclination toward innovation and a keen aspiration for sustainability. Women constitute the majority, primarily focussing on growing ornamental plants, leavy greens, herbs, medicinal species. Men are more inclined to cultivate a broader array of fruits and vegetables. It highlights the difference between growing fresh/safe, teaching and how to grow and nurture and that men see it more like a project and focus on how much they can grow and yield. Women were primarily involved for the daily upkeep of the garden while tasks involving heavy lifting and transportation and tool handling were typically managed by men. Responders from informal settlements (97%) and formal settlements (65%), indicated that their engagement in UA was primarily motivated by leisure/personal hobby (Koduganti en Patil, 2024).

Further determants if UA would be practiced are be based on resources, such as soil, water, seeds, fertilisers and sun exposure. This is where the architectural design can come into play where it can help provide and store these needed resources. Access to nourishing and fertile soil is a fundamental requirement for promoting robust plant growth. When soil area is limited respondants ventured to alternative gardening methods, like hydroponics. Hydroponics is a technique of growing plants using a water-based nutrient solution rather than soil. Regarding seeds, responders mentioned: “Most seeds come in bulk, and not many households find that useful. Growing ready made samplings can overcome that.” Another way is obtaining seeds from their ancestrial lands. Fertilisers come mostly in the form of compost and manure for maintaining soil fertility and plant well-being. Many urban formal households prefer organic inputs rather than syntetic fertilizers, even though those are readily available on the market (Koduganti and Patil 2024). Seasonal variations in sunlight patterns inpact UA’s layout, planting schedules and harvest times. Herbs and microgreens require less sunlight, but overall, limited sunlight hinderes overall plant growth.

Benefits and challenges

Although women take lead in UA practices, it is noteworthy that men also make a substantional contribution to cultivation efforts.



Youngsters: "We have an inclination toward innovation and a keen aspiration for sustainability".

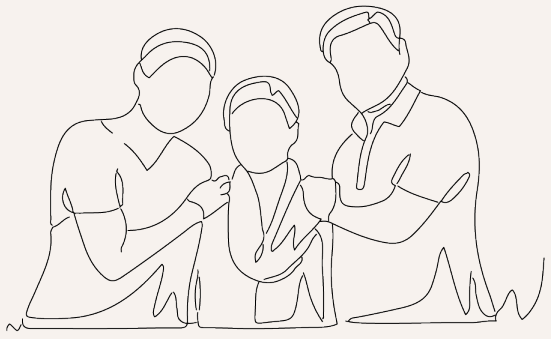
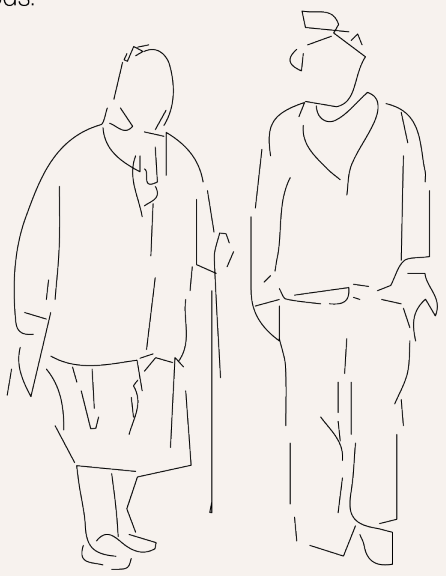


Figure 24. *Input of the current state of UA in India, own work based on Koduganti and Patil (2024)*



Addaptive strategies such as vertical stacking, composting and reuse of materials are practiced.

The older age group commonly favors traditional and organic farming methods.



Spatial constraints strongly shape these practices. In formal housing, cultivation is typically limited to small balconies, while in informal settlements, access to land is more flexible but insecure.

Knowledge exchange from young and old through friends, neighbors and social media platforms.

Another farmer from Prune: *"We don't want to spray chemicals. 70% of formal and 20% of informal settlement practicioners practice composting mainly with their kitchen waste".*

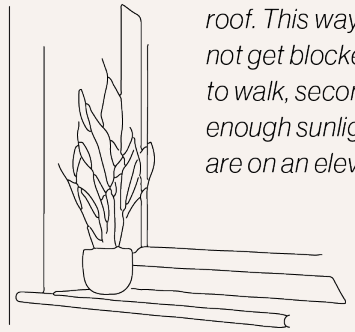
Homegarden waste composting is a longstanding tradition in Indian households.

"We are a group of gardeners. We save and share plants among ourselves and try to keep them alive in our garden. Now we rarely buy seeds."



"She waters and takes care of my plants. I do the same when she is away."

"Hence, we used planks as a base for growing plants on our roof. This way, the space does not get blocked for other people to walk, second, the plants get enough sunlight because they are on an elevation".



"I wish to grow so many more plants, but where is the space? I know how to grow potatoes and all such vegetables, but I don't have enough space."



Leisure, aspiration, teaching sustainable food practices

"Whenever construction or demolition was going on, we get soil from there. The subsurface is very fertile. It doens't need too many inputs and is moist too."

Construction worker in Bangaluru: *"This land is not ours, how can we grow here'?'. "This land is empty, so I am growing here, if the municipality decided to build a house here, there is a risk that they would come and clear mt gardens. I am not allowed to farm here officially." "I wish to grow so many more".*

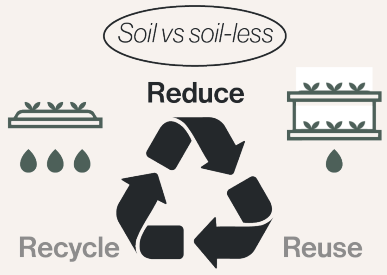


3.1.2 | Technical context

In this section the UA practices are analysed on their technical requirements. First soil-based-, then soil-less farming is researched. Next, the professional scale of UA is tackled and analysed, where innovative sustainability practices will also come to light. Using the literature from this context, together with the site analysis of Ahmedabad, a database of herbs, plants, shrubs and trees is setup. They are catagorised into type, size, resource requirements and main purpose. Using this information, the households themselves can choose in what practices they want to invest, depending on how much time, money and resources they have at their disposal.

Soil-based
Looking into plant agriculture, the key environmental components that are needed for them to grow are sun, water and nutrient rich ground. Depending on the type and specie of the plant, the balance of these resources differ. Typology layouts determine the amount of sunlight exposure into the home and thus directly inform what spaces can be used for practicing UA. By means of crop rotation and homebased composting, it can be ensured that the soil stays nutrient-rich and that waste management is practiced. For cattle farming, fields for grazing are needed catering to the wellbeing of the animals. Instead of sun, a space of shade is required in the form of a shed, combined with food- and water storage. Depending on the animal, they can either be integrated with the housing typology or in the shared cluster courtyard. For UA products like milk, honey and eggs, on-site processing also requires equipment and space, so that they are properly extracted.

Water reuse
Sufficient water supply can be more difficult to sustain. The first way of saving water is by means of reducing. Traditional, soil-based, agriculture yields relatively more produce, while soil-less farming uses significantly less water. By means of reducing pressure on water supply it is more logical to practice soilless farming. However, these structures have a higher initial investment cost since they require more technology and materials to work. They can however still be considered low-input in the way that they are relatively easy in practice and costs can be shared among households. It is important to note that the space does need architectural quality and form, since otherwise the space will most likely be encroached instead of used for practicing UA.



For the reuse of water there are different types of water that can be looked at, each having their own challenges. The first way is by means of rainwater collection. Rainwater use for watering plants and feeding cattle does not require filtering, making it viable way in providing an extra water supply to the households. The roof and terraces become spaces for rainwater collection which can be stored in tanks underground. Because the rainfall in Ahmedabad is very erratic, it is important to be able to store as much water as possible when it does rain. In the courtyards recharge pits can be constructed. These are strategically placed to recharge shallow aquifers. Their size is between 1 and 2 meters wide and 2 to 3 meters deep, filled with boulders, gravels and coarse sand (Bhattacharya & Rane, 2009). This way, groundwater gets replenished which later can be pumped up again without depleating the local ground waterbody too much.



Another way of recycling grey- and waste water. Concluded in a study on waste water-irrigation on in-household water contamination in Ahmedabad by Falkenberg et al. (2018), using waste water calls the need for a closed off water storage unit and clear boundary between water and living. Systems need to be more high-tech since even light contact with the water can contaminate the whole household. A safer way of recycling of water is by using grey water instead of waste water. Grey water is lightly contaminated water from for example showers, washing and cooking. What is important for this system to work is a clear seperation of waste- and grey-pipes and storage.



Irrigation
Relying solely on rainwater brings the complication that the UA practices cannot be carried out year-round but only certain months of the year. Using irrigation, water is distributed more efficiently on the land and reliefs peaks in water use. Higher yields can also be achieved when the resources like water are kept year-round at the plants' disposal. Ideally, the water source would be higher then the plants themselves so gravity can assist with bringing the water to the plants more efficiently (Carpenter & Carpenter, 2023).

Drip irrigation is generally considered the most efficient irrigation method. In this system, water is slowly and uniformly emitted from plastic tubing, either on te surface of the soil or just below it, then percolates into the root zone via pores in the soil (Carpenter & Carpenter, 2023). When looking at low-input drip irrigation, there are several options like soaker hoases, drip tape and water emitters. Drip tape requires only a low pressure and flow rate to work, where other methods rely more on this water pressure. Pressure-sensitive emitters deliver a higher flow at higher water pressures and pressure compensating emitters provide the same flow over a variable range of pressure. Depending on the water source, the irrigation method can be chosen using these components and it can be decided if an external pump is needed (Carpenter & Carpenter, 2023).

Spray irrigation is another option, and is a way of overhead water delivery, comparable to aeroponics. As stated before, these systems are more high-tech and, considering the Ahmedabad arid climate, water is not available in abundance and would evaporate too quickly to be considered a viable way of irrigation. The same goes for (sub)surface irrigation, needing large bodies of water at once and requiring bigger systems to function. These types of irrigation are more often implemented on large-scale farms.



Figure 25. *Drip irrigation system deployed on a vegetable field,* Carpenter & Carpenter (2023)

Herbs
Herbs are often harvested 7–21 days after germination. They are highly nutrient-dense, flavorful, and space-efficient. Common species include radish, mustard, beet, fenugreek, basil, and coriander. They can be grown in shallow trays (5 cm soil depth) and stacked vertically. Herbs require frequent watering but minimal overall water use, depending on the species. While some species prefer swampy conditions, others can thrive for years without rainfall or irrigation. Some even become more potent when drought stressed. Most fall somewhere in the middle, needing an average of 2,54 cm of water per week (Carpenter & Carpenter, 2023). They do not require a lot of sunlight to grow, as long as the soil they grow on is nutrient enough. This makes herbs for example perfect for indoor growing in kitchen gardens or animal feed.

Shrubs, vegetables, climbers, trees, horticulture
Falling under the same umbrella, these plants are produced outside and are relatively the same in terms of size and requirements. Much of the large-scale plant production in many parts of the world is monoculture, where a single crop is grown in a field over and over. It provides higher efficiency but also comes with challenges like loss of diversity and rapid spread of diseases (Pimentel et al., 2005). However, especially in smaller settings like UA, crop rotation remains a simple but effective tool to overcome this. In crop rotation, different crops are rotated throughout the production cycle, which also preserves soil nutrition (Welbaum, 2015). Here again, water and sunlight needs differ, depending on the species. Together with the site analysis on what species can grow in Ahmedabad, the plant database will be further fueled with their specific technical requirements.

Cows
A cow in the Indian context produces around 3 liter milk- and 30kg of manure per day. Around 5 kg of food per day is required to achieve this. Sheds can then be designed based on the amount of cows, influencing storage, and space for shade and -grazing. Their daily water need is relatively higher, because of the hot climate, and is around 40 litres. According to the Indian Council of Agricultural Research (ICAR, 2013), an adult dairy cow requires a total footprint of 10,5m^2. It is further divided into 3,5m^2 of shaded space and 7m^2 of roaming space.

Goats
In Ahmedabad, goats are commonly kept for milk, meat, and manure. Providing proper shelter centralizes feeding, milking, resting, and manure collection, while still allowing goats to roam within the shed or the adjacent outdoor space. For a goat, an area of 9m² of shed and roaming space is required. Next to the shed, storage for food, water and manure are also to be incorporated. Storage size per goat according to the ICAR states: 0.2 m² for food, 20 liters of water per day, and a 0,1 m³ manure collection pit. The minimal requirements can easily be scaled up by adding modules and adjusting spaces according to the herd size.

Chickens
Using data from Council et al. (1994) on the nutrient requirements of poultry, it can be noted that an adult chicken consumes around 1,2 liters of water and around 0,6 kg food per week. A shaded space of 0,9m^2 is needed combined with a minimum of 1,2m^2 of outside roaming space. For chickens it is important they receive morning sun and darkness at sundown since they rely heavily on natural light to regulate their internal biological clock. Morning sun stimulates their egg production and health, while afternoon shade protects them from overheating and signals that it is time to wind down for the night."

Fish
Fish raised in tanks or small ponds produce nutrient-rich water, which can be circulated to grow vegetables and herbs hydroponically, reducing fertilizer needs and water consumption. On a household scale, indoor fish tanks of 0.5–1 m² can supply sufficient nutrients for stacked trays of herbs or leafy greens. At a community scale, an outdoor pond of 10–15 m² can support multiple fish species and larger hydroponic beds, while also serving as a helophytic filter to filter greywater. Fish require minimal food consumption but do need a secure confined space to live in. The technical requirements for aquaponics are researched on the right.

Bees
Bees produce honey and wax and do so by polinating nearby crops and plants. In return, the yield of these plants increases. The requirements for beekeeping are mostly material, meaning they only need to be fed with sugar syrup is nectar is scarce. When that is required fluctuates, since bees are heavily influenced by the different seasons and climates. For example, during monsoon season it is important they get enough food not to abandon their comb and keeping the comb sufficiently dry during this time (Khelwani, 2026). The beehive/clay pot acts as the 'shed', while an extractor and suit are other materials needed for the practice to work. For the placement it is important that, especially during summer, it is not in direct sunlight but in a place of shade and close proximity to flowering crops and water.

Soil-less
Soilless-farming uses the principle of vertical stacking of planters to reduce its footprint and feeding nutrient-rich water via irrigation. This way the system used 88% less water than traditional farming methods (Awal, 2023). Proper amounts of sunlight or artificial light are still required for the plants to grow, however, using this system, vegetable farming can be practiced indoors as well. Furthermore, it may be applied to current horticultural methods ranging from small-scale hydroponics to large-scale controlled environmental agricultural operations. It has the ability to create year-round production in virtually any region if combined with the appropriate techniques (Wallace-Springer, 2022). Of the three main types, the two that are considered low-input are further analysed on their technical requirements.

Hydroponics
In hydroponics plants are fed and nutrient-rich water solution to maximise plant development while using the minimal amount of water. Water is pumped from a reservoir up to the tube tray where the plants are nested in. There the water flows along the roots of the plants before returning back into the reservoir. Attached to the reservoir there is an air pump with an air stone for adding oxygen to the water. Nutrients are added to the reservoir externally by the farmer (Wallace-Springer, 2022).

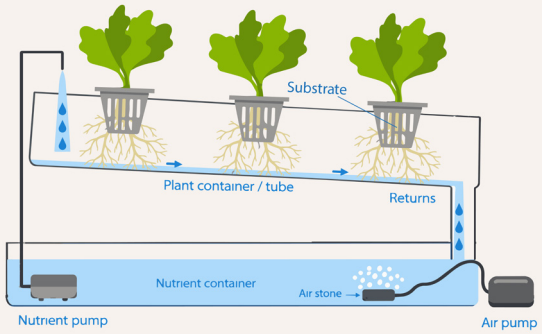


Figure 26. *Hydroponics system components, based on Königer (2022)*

Aquaponics
Aquaponics integrates fish production with plant production through the use of the hydroponic growing system. The fish are used as a way of making the water naturally more nutrient-rich. Plants are alternatively nourished using nutrient-rich fish water that has been filtered and converted to nitrates or, when needed, by external nutrients that are added to the water (Wallace-Springer, 2022). The system cannot solely rely on the fish for providing nutrients, however, it eliminates the need for an airpump and even the water pump, depending on the positioning of the aquaponics system. Since large bodies of water are needed to scale up aquaponics, which also makes the practice more high-tech, the application scale of aquaponics remains on the typology scale.

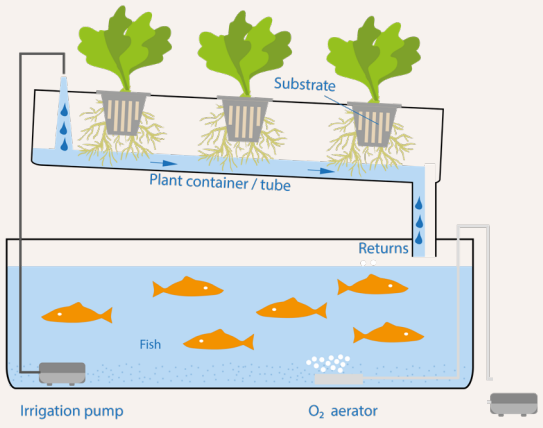


Figure 27. *Aquaponics system components, based on Königer (2022)*

Stacking
The stacking of the system can be arranged in different orientations, with each their pros and cons. The A-frame trellis is made out of a lightweight structure of PVC pipes that may be arranged either vertically or horizontally to create a triangular extrusion of its footprint, angled towards the light source (Awal, 2023). The main benefit is that it is simple in system and structure, while also taking up relatively less space.

Another way of growing is using stacked beds. Instead of angled, here the beds are flat and stacked on top of eachother. Even though this method provides more room for growing, it does need artificial light to work, since the beds deprive eachother from getting enough sunlight.

The trellis can also be orientated vertically to create columns of alternated plants. The produce is less compared to the other two methods, but it does provide maximum space efficiency while also providing sunlight for every plant.

The last system is designed using a drum centrated around a single lightsource. It is least commonly used but offer the possibility to be stacked, providing space efficiency (Awal, 2023).

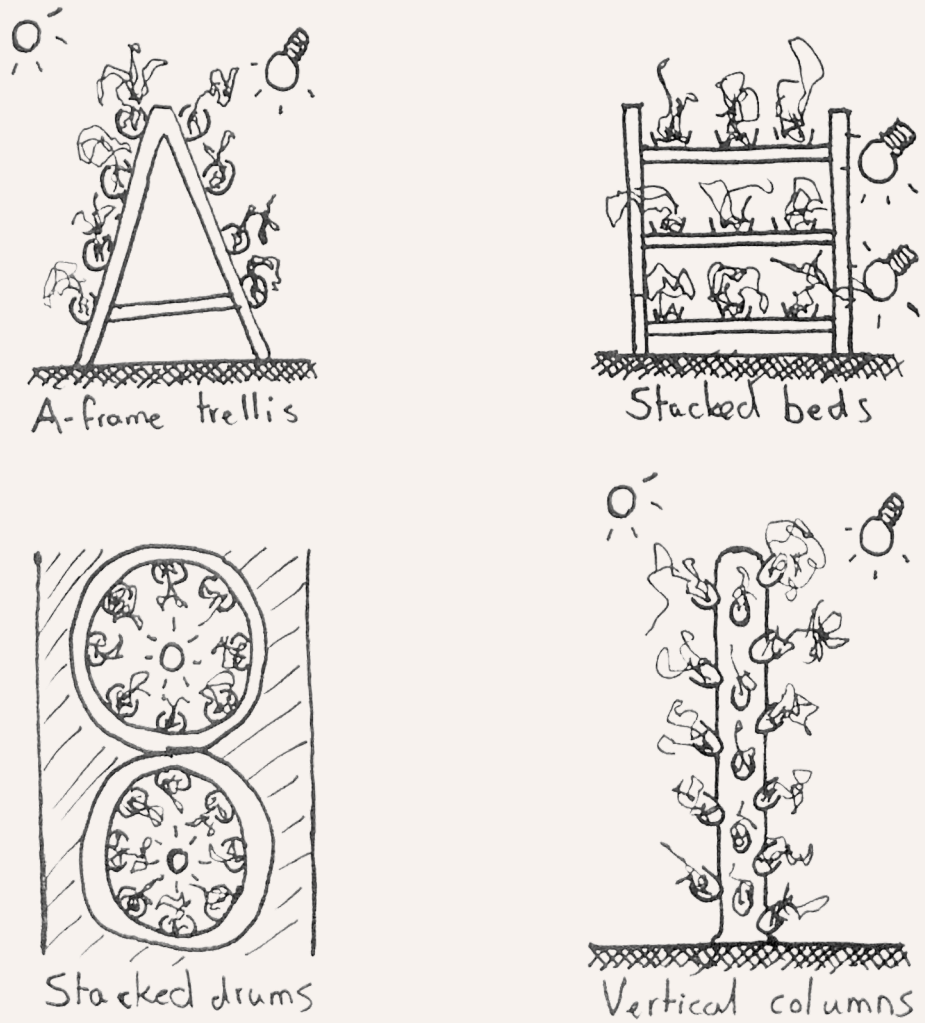


Figure 28. *The system layouts for practicing soilless farming, own work based on Awal (2023)*

Vertical farm
On the professional scale, urban farming is scaled up to maximise produce and create surpluses to sell. In order to not take up too much space within the urban fabric, produce is stacked vertically instead of horizontally. These so called 'vertical farms' implement soil-less farming practices in controlled indoor environments using systems of hydroponics and aquaponics. In this part of the technical context, the necessary components of a vertical farm are analysed and researched so they then can be applied into the design during the design process. Using the local Ahmedabad context, the design ultimately proposes a vertical farm that can work in that local climate, situating right in the hart of the city.

Level components
Indoor soil-less farming requires good controlling of the internal environment. That is why, above production levels, sufficient space needs to be reserved for environmental control systems. Below, preperation rooms for cleaning and germination of seeds are to be positioned that serve as the first growth phase of the plants. On the ground floor, produce is sold or directly used in for example a restaurant. This creates the need for office space and packaging areas within the vertical farm itself as well. Since large trays and systems need to be logistically moved all the time, sufficient elevator space needs to be reserved alongside storage facilities. The watering system requires huge amount of resources each day which combined with the need for electricity for artifical lighting and other machines, calls for sufficient reserved space for installations and storage. Below groundlevel management of food waste can be handled, ensuring a seperated enviroment from the production layers. ToyokiKozai (2016) sumarises in its diagram(figure 29) how each level of the vertical farm should have their own specific function and labels all level compents that are needed for a vertical farm to work properly.

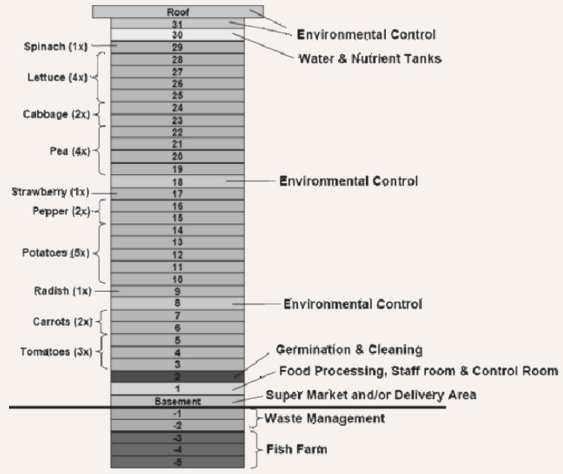


Figure 29. *Model for a vertical farm, ToyokiKozai (2016)*

Waste management
Vertical farms produce relatively much food waste. By acting as a service for managing this waste, manure from nearby cattle herding clusters can also be processed here properly if a surplus is generated from them. There are a number of procedures for decomposing organic waste. One of these is an anearobic digestor. In processing tanks, waste is crushed and digested, air is removed and which ultimately creates methane-rich biogas together with by-products reusable for bedding or fertilizer (Awal, 2023). Sewage-related waste water can also be handled in this system. A certain amount of bio-waste would generate and lower the need for external electricity, lowering total greenhouse gas emissions (figure 30).

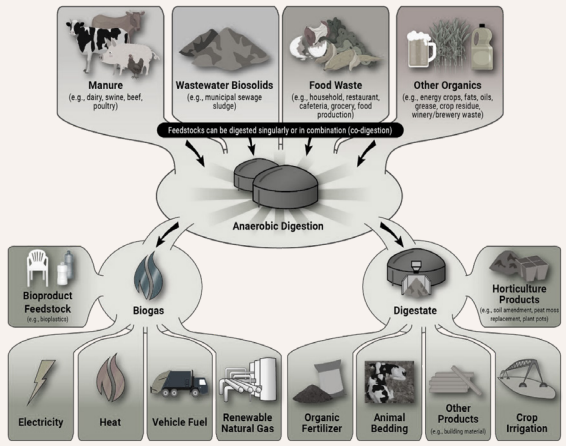


Figure 30. *System of an anearobic digestor, Awal (2023)*

Water consumption
Water use for the hydroponic- and aquaponic systems requires the water to enter the plant through its roots with which nutrients are absorbed. The remaining water evaporates back into the atmosphere through the leaves. The water that is not absorbed by the plants and flows back out of the system is subsequently recycled where nutrients are added to the water. This way the water system can become a closed loop system (ToyokiKozai, 2016). The evaporated water of the plants can also be reused by means of dehumidification. There are specific machines for this purpose that can recover this water and thus recycle it. The system adopts a natural method of purifying water (Awal, 2023).

Greywater that gets recycled needs a different storage tank then water in the closed loop system which should both be placed on the environmental control levels, above the production layers. This way, with the use of gravity, the nutrient-rich water can flow through the growing systems of each layer and be collected on the lowest production floor to then be reused.

Lighting
The range of light intensity needed for enhancing the growth of vegetation is contingent on the setting and time, product, heat and CO^2 content of the air around plants. Considering all of these factors, the typical range of light intensity used is around 4100-16400 lx when high-pressure sodium lamps are used. The amount of light necessary in a closed environment for vegetation growth is around 18 hours per day (Adhikari, 2019). To control the production line, it needs to be determined whether the vertical farm will use only artificial light or both artificial- and natural light.

Daylight approaches rely on the availability of natural light, which is controlled by the height of the building site and the surrounding environment. Because daylight strategies are also influenced by the weather, determining seasonal variables. Ambient temperatures and sunshine probability, is an important stage in daylight design. If this technique is used, the vertical farm should be designed to have maximum amount of light penetration inside the building. Openings in the wall and roof should be made as per the light requirements of the indoor plants. Orientation, shape and building angle can control the amount of solar gain (Awal, 2023).

Glazing
Vertical farming works with controlled indoor environments when it comes to temperature and humidity, but that does not mean that the facade should not have any windows. Windows and openings are needed for natural cooling systems to work and can also let in outdoor humidity levels, which can be preferable during and after monsoon season. The glazing needs to withstand force and have enough strength. Transparency allows for maximum natural light entering the production floors, while it needs to be taken into account this also accompanies extra solar heat gain.

In terms of glazing options it is advised to use either double or triple layered glass, to reduce this indoor heat gain. A low-e glass coating can also be applied to the glass which consists of a transparant metal layer that also reduces heat gain. This option however does come with higher costs (Kesaria, 2017).

Building envelope
To be able to control indoor temperature levels better, the building facade should try to keep outdoor solar gain out, while indoor heat should still be able to conduct out of the building. This is important because employees will constantly be working on the production floors while the systems themselves also generate excessive heat.

There are two main ways of facade buildup that can achieve this outcome. The first way is by applying an outer skin material that has a high albedo (reflection) coefficient so that solar heat is reflected instead of conducted (Kesaria, 2017). Materials are often coated white and thus create monotonous, closed blocks with just vents and windows where needed. Moreover, solar heat is reflected in all directions, including to housing around the vertical farm. This means that, locally, outside temperatures around and on these houses rise.

A more expensive and time laborious way is to create a double skin facade. This way the second facade does not need to be reflective and can have a more conductive nature (high U-value) (Kesaria, 2017). Depending on the outer skin material and permeability, a shade is casted in the cavity between the two layers, reducing direct solar heat gain of the building. The inner facade layer can become more open and can contain more windows than in the first scenario. Using this facade layout, UA can become part of the inbetween cavity as well, which in result showcases UA practices to the outside viewers. The windows then need to become points of access to the cavity and the produce that is grown there.

The cavity depth is a little less important if it is not a closed of system, however, learning from case study analysis of Kesaria (2017), they should not be slimmer than 0,4 meters, to not obstruct windflow and still be able to reduce heat gain during the hot summer months. If it becomes too wide, the cavity space cannot hold its cooler microclimate and will gain more heat. The rate of heat transfer through convection is dependent on height and depth of the cavity and is lost if these values become too high.

Thermal isolation
The materialisation of the facade further depends on its architectural value, thermal isolation, embodied energy and lifespan. Most of the year the outdoor temperature in Ahmedabad is higher then the desired indoor temperature. During the day heat should be kept outside, while at night the vertical farm can benefit from night cooling and -ventilation from outdoor air. Using this, the buildup of the facade does not necessarily need to isolate all outdoor air, but rather delay the heat gain of the facade up until the air starts to cool during the evening (Kesaria, 2017). This is called the decrement factor of the facade. It is a positive value and should be aimed to be between 0 and 1. To calculate the decrement factor the indoor maximum temperature difference should be divided by the outdoor maximum temperature difference and the time lag is the time inbetween when these maxima are reached (Kesaria, 2017). The key is to maximise the time lag to reduce the indoor heat gain.

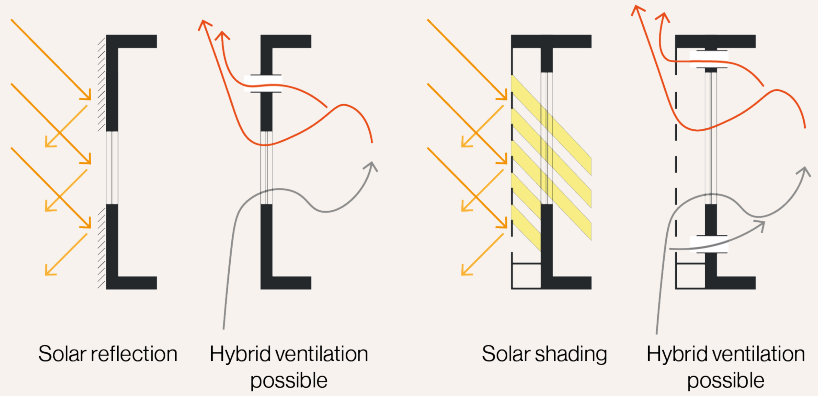


Figure 31. *Thermal facade versus double skin facade on solar heat gain- and ventilation strategy*

Shading
By creating a double skin facade, the benefit that is added in terms of shading is that an overhang is created, casting shadow on the level below. This form of shading, however, only works then the sun shines at the right angle and thus does not provide sufficient shading the whole day. This is where the second skin can help. A jali, a commonly used (second) facade in Indian architecture, is a perforated clay stone or latticed screen, usually with an ornamental pattern that is stacked and repeated along the facade. Their main purpose is to control light, air flow and create visual privacy. These stones create shadow when the sun shines on them at not a right angle, meaning they provide shade when the overhang does not and vice versa. A combination of the two can thus further reduce solar heat gain of the vertical farm building.

Ventilation
When choosing for a double skin facade, different permeabilities of the outer shell allow for different types of ventilation to work. When the cavity is used for practicing UA, a corridor type of double skin facade should be chosen, allowing air exchange through the outer shell (Kesaria, 2017). This way, natural (night) ventilation can be combined with mechanical ventilation when required. Ventilation can be achieved through either using windows (cross ventilation) or vents. Depending on the window opening system, ventilation potential can be maximised. By using either side hung (turned inwards) or vertical sliding up, the maximum ventilation potential can be reached, while also still being able to acces the plants in the cavity without harming them.

Cooling
Evaporative cooling is a natural process in which a liquid that has evaporated in the air comes into touch with a solid or liquid and cools it (figure 32). The evaporative cooling effect increases with the temperature difference between the two devices called evaporative coolers use the evaporation of water to chill the air (Awal, 2023). This form of cooling is often applied in greenhouses, where cooling and maintaining a constant indoor temperature are also important. To create cool air, the fan sucks warm air via the moist pad and vents. The pads are continuously re-damped to maintain the process as the heated air evaporates the water from them. Moist air is released through a vent from the roof or an exterior wall into the building when this air is cooled (Scott, 2009). Combining evaporative cooling with natural ventilation and cooling vents, a hybrid system using the double skin facade can be created to further contol the indoor climate and save up on external resources like electricity.

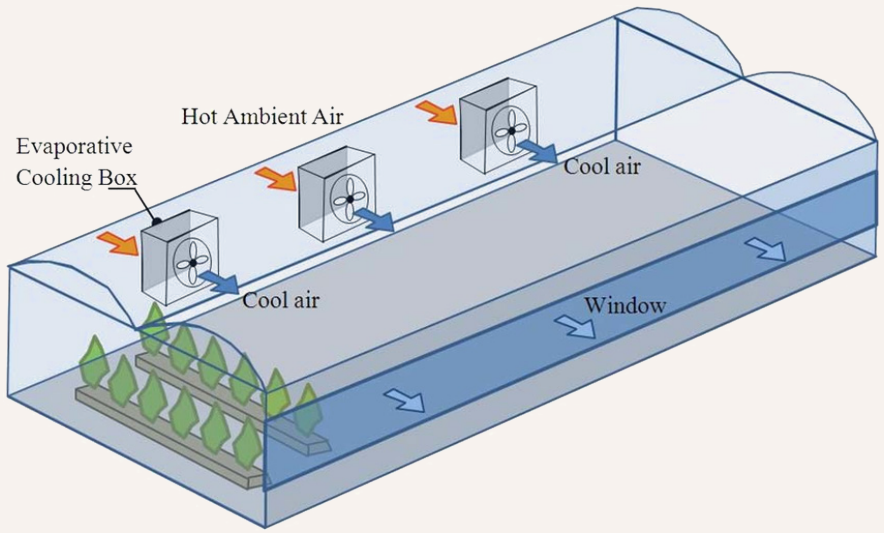


Figure 32. *Evaporative cooling boxes in greenhouse, Franco et al (2014)*

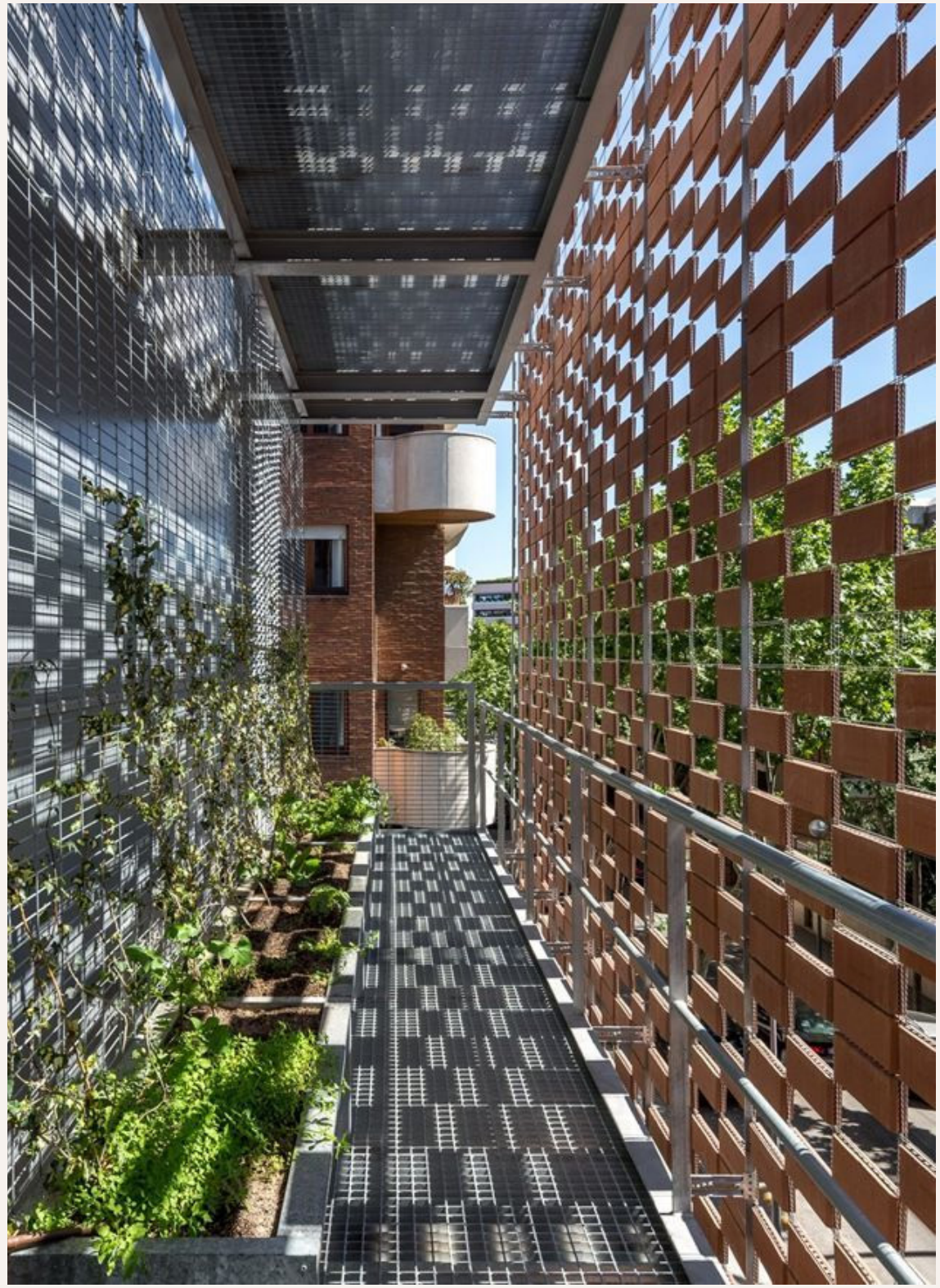


Figure 33. *Teresianas School double skin green facade, Garcia (2015)*

3.1.3 | Socio-economic context

In this context, the socio-economic characteristics of Ahmedabad households are analysed for their daily routines and how they shape the adaptation of UA practices into them. Then it can be extracted how UA can support these daily routines on the socio-economic level without becoming a burden to them. Since accurate data for this is site specific, these subquestions will be analysed in the next chapter during the fieldwork and site analysis. However, what will be researched in this section, using literature review, is how public spaces like squares can contribute to participation and stimulation of UA practices on the urban scale level.

Squares as a meeting place
For the lower classes the place of meeting was the temple courtyard. People of the same faith would meet and interact. Marketplaces were another place for this, which formed on public squares. In India, the marketsquare is the biggest form of public space. They often originate where two or three main crossroads (chowks) meet (Sharma, 2015). For the squares to become landmarks they are often found along special sites or -buildings. On the design plot, a (historical) site or -building is not apparent, but with the introduction of a vertical farm, it can become a new landmark for the design, allong with its marketsquare.

The pavilions and open spaces were mostly enclosed by arcades of buildings on the sides and had characteristics that formed an image of the space, meant solely for the act of leisure. The layout of architectural elements, the hierarchal organization of decorative symbols and the practice of gardening were all organised according to this principle (Sharma, 2015).

Activities and spaces
The concept of space in the Indian context is that "there is no outer space without inner space". It is constructed by the participation of the self. Public squares are not limited to having special sites and/or buildings and can also form around ordinary domestic spaces, street corners and open spaces. These public spaces can be catagorised into 2 types; streets and squares. Streets developed around built or unbuilt spaces as means to facilitate the spread of settlements. Squares developed as as result of grouping of houses around the courtyard, which later formed agotas. In the nature of public squares, the square is a more attractive space to spend time on than on the street, which is more functional in nature (Sarma, 2015).

More modern squares, such as the square of the Salt Lake City Centre in Kolkata, India, also incorporate a form of waterbody into their design. The project, by Charles Correa, incorporates a so called 'kund' which is the Indian term for a waterreservoir/holy waterbody often associated with Hindu temples (Sharma, 2015). It becomes a way of water reuse while also becoming a space for relaxation and social interaction.

Two other important factors for social interaction to happen is leveling and bordering. Leveling creates segregation of activities which divide the space, while to much leveling can make the square unable to host bigger activities. In order to not further constrain the square, the absence of boundary walls make it an integral part of the urban fabric rather than feeling like a gated complex (Sharma, 2015). However, safety should be taken into account towards for example the surrounding road(s).

Knowing of space
Squares are defined by three elements: walls of the surrounding buildings, the area of the ground and the sky over the square. Squares are often designed as formal (strong sense of enclosure, order) or informal spaces (asymmetrical, relaxed, variety of architecture). Indian squares are often seen as informal spaces which means they have an asymmetrical, relaxed character with a wide variety of architecture around them (Sharma, 2015). The surrounding architecture and streets can enhance the use of the square and vise versa, meaning turning part of the square into a productive landscape can stimulate UA practices in the design as a whole.

UA practices and the introduction of the vertical farm can make the square feel unique, which helps households and visitors create a form of knowing of space in the urban fabric. The formal part of the marketsquare then becomes UA shaping the greenery and other structures like the kund. The informal part becomes the social- and economic infill, the farming, markets, events as such. The totality of activities create a commercial hub that can attract people from many different classes and backgrounds.

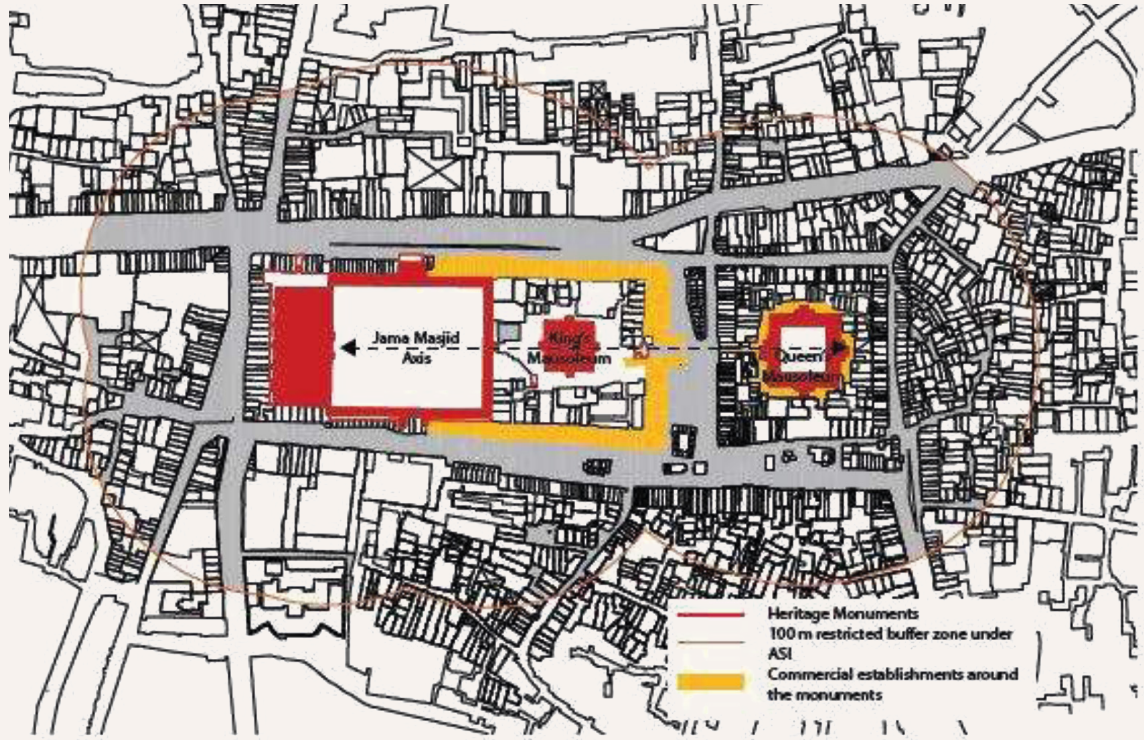


Figure 34. *Manek Chowk square in Ahmedabad, Sharma (2015)*

3.1.4 | Spatial context

In this section the minimal spatial requirements for the UA practices to work within the local context are researched. Together with the fieldwork and site analysis discussed in the next chapter, the gathered literature can answer the other two subquestions of this context. Using the spatial characteristics of Ahmedabad household typologies across the three income levels, together with the spatial dimensions of the UA practices, potential architectural spaces for UA integration can be extracted. Using research by design, iterations of UAxArch typology spaces are then bundled together to form a handbook for the further design of the project.

Soil-based UA dimensions
In this section, the dimensions of the space needed for UA practices to work are layed out. What needs to be taken into account is that most of these practices also need some sort of processing- and selling facility, which also takes up space in the design. The layout and minimal dimensions of these spaces will not be researched, but adequate space is to be reserved for the placement of these facilities, allongside the UA practices.

Herbs
Herbs are a versatile and space-efficient component of UA, suitable for in- and outdoors. Common culinary and medicinal herbs in Ahmedabad include basil, coriander, mint, curry leaf, and fenugreek. They can be grown in raised beds, containers, or hydroponic trays, making them compatible with modular 1×1 m layouts. Typically they are grown in shallow trays (5 cm soil depth) and when stacked vertically, allow for multiple layers on the same footprint; 1 m² of floor space with 3–5 stacked trays can supply a household year-round.

Shrubs
Food shrubs are woody, perennial plants that produce leaves, fruits, or seeds for culinary, medicinal and commercial use. They are compact, drought-tolerant, and suitable for rooftops, courtyards, or community gardens. Shrubs typically occupy 0.5–1.5 m² per plant, allowing high-density planting and intercropping with herbs and leafy greens beneath their canopy. On a household scale, 4–5 shrubs (~8 m²) can supply regular culinary needs, while on a community scale, 40–50 shrubs (~80 m²) are needed to generate a surplus to sell.

Shrub horticulture focuses on cultivation for aesthetic, structural, and ecological purposes rather than food production. In household gardens, shrubs can be grown in medium to large pots or small beds in courtyards, balconies, rooftops, or indoor courtyards. Small ornamental shrubs typically require 1 m² of space per plant, while larger shrubs may occupy 2 m², with heights ranging from 1–3 m depending on species. Shrubs contribute to garden structure, creating natural borders, defining pathways, or providing layered planting under trees. On a community scale, shrub horticulture can enhance public green spaces, parks, and streetscapes, creating pleasant, structured, and ecologically diverse environments. Its flexibility and moderate space requirements make it ideal for integration into modular urban gardens alongside productive plants.

Therophyte vegetables
Therophyte vegetables are fast-growing, short-cycle annual crops that complete their life cycle in a few weeks. Common examples suitable for Ahmedabad include lettuce, spinach, radish, mustard greens, beans, and cucumbers. These crops can be grown in raised beds, containers, or hydroponic systems, fitting well into household rooftops, courtyards, or community gardens. In modular UA layouts, 20–30 m² can supply supplemental leafy greens for a family, while community gardens can scale production to serve several households.

Geophyte vegetables
Geophyte vegetables are crops that grow from underground storage organs such as bulbs and roots. Common examples include onions, garlic, potatoes, ginger, and turmeric. These crops are space-efficient in household and community gardens, requiring moderate soil depth and well-drained beds. On a household scale, 4 m² can provide some food production for a family, while community-scale plots can expand proportionally. Geophytes are ideal for rotation and intercropping with leafy greens, herbs, or shrubs to maintain soil fertility and prevent pests. They require moderate irrigation, especially in Ahmedabad's hot-arid climate, and benefit from mulching and partial shade during peak summer.

Climbers
Climbers are a crop type that can grow well in Ahmedabad's hot climate. Common edible climbers include bottle gourd, bitter gourd, ridge gourd, cucumber, beans, pumpkin, and grapevine. These plants require relatively little ground space, typically about 0.5–1 m² per plant and can grow 2–5 m vertically or horizontally when supported by structures such as trellises, pergolas, fences, or building facades. This allows productive cultivation on rooftops, courtyards, or narrow garden edges where horizontal space is limited. Climbers can also help create shaded areas, for example when grown over pergolas that form semi-covered walkways or gathering spaces. In addition to food production, climbers can function as living borders or green screens when planted along fences or structural frames. Dense foliage can provide visual boundaries, light shade, and wind protection, while maintaining airflow and permeability.

Trees
Fruit trees provide a long-term food source, producing fresh fruit while also contributing shade and microclimate regulation. In Ahmedabad's hot-arid climate, suitable species include mango, guava, lemon, pomegranate, fig, custard apple and jamun. Many of these species are well adapted to high temperatures and seasonal drought. For urban settings, dwarf or semi-dwarf varieties typically reach 2–4 m in height, allowing them to be integrated into courtyards and community gardens. Bigger size fruit trees can still be used, but are better applied in public spaces since they need more space. A small tree usually requires 6–9 m² of space, while a bigger tree requires around 20m². Hights for these bigger trees are mostly between the 5-15 m.

Tree horticulture focuses on the cultivation of trees for ornamental, leisure, and ecological purposes. In urban India, it is more common for trees to be shared in courtyards, community gardens, or public spaces, rather than each household having its own tree. Beyond leisure, trees enhance biodiversity by supporting birds, insects, and other organisms, while also contributing to the aesthetic quality and ecological resilience of urban landscapes. That makes trees a key component of urban green space design.

Plant horticulture
Plant horticulture at the household scale is typically practiced using pots and planters, allowing ornamental plants to be grown in small and flexible spaces such as balconies, courtyards, rooftops, or indoors. Small ornamental plants usually grow in pots with a diameter of 15–25 cm, occupying approximately 0.02–0.05 m². Medium plants require pots of 25–40 cm in diameter, corresponding to about 0.05–0.12 m², while larger ornamental plants or small shrubs may use containers of 40–60 cm, occupying 0.12–0.28 m². This compact footprint allows many plants to be grouped together. Because containers are movable and adaptable, horticulture can easily coexist with productive gardens.

Cows
Due to the scale of the cow shed, it spatially can only be placed as a standalone object in either the cluster- or urban scale. Based on the average household size of low-income households of 6 people, every household would need a cow to suffice basic dietary needs or create a small surplus. Grouping the cows from households would in this case be more efficient, where produce and costs are equally shared. According to the Indian Council of Agricultural Research (ICAR, 2013), an adult dairy cow requires a total footprint of 10,5m^2. It is further divided into 3,5m^2 of shaded space and 7m^2 of roaming space. For monthly storage of food and manure of a cow, respectively 1m^2 and 1m^3 is needed. Because the space for roaming can be extended to the area of the enclosed courtyard, it becomes possible to tend even larger groups of cows within the cluster.

Goats
For a shed an area of of 9m^2 is needed per goat and another 9m^2 for grazing space. Food and water storage are sized to 0.15 m^2 for hay, 20 litres for water and a 0,5 m^3 for a manure collection pit.

Chickens
On the household scale, the coop can be made as a standalone object or be integrated within the housing typology itself. Based on the average household size of 6 people, 3 chickens suffice and even create a small surplus. For 3 chickens, a shaded space of 2,5m^2 is needed combined with a minimum of 3,5m^2 of outside roaming space. It is also possible to have the cluster chickencoop where households share the produce made from it. Placement would be in the courtyard and can be either fixed or flexible in the way that the coop can be moved with weels. Overhangs or other places of shade can be locations where simple structured chickencoops can be placed. The structure responds to minimizing the physical ground connection when combined with the modularity of wheels, to ultimately take no fixed area within the space.

Fish
Fish farming can be done on the typology scale by integrating it with hydroponics to create a closed-loop aquaponics system. Indoor fish tanks of 0.5–1 m^2 can supply sufficient nutrients for stacked trays of herbs or leafy greens. At a community scale, an outdoor pond of 10–15 m^2 can support multiple fish species and larger hydroponic beds, while also serving as a helophytic filter to treat greywater.

Bees
Beekeeping can be integrated the urban fabric through community- or professional beehives, providing pollination, honey, and wax. Cluster-scale hives can occupy 6-9 m^2 depending on the number of colonies. Using specific hive types and bee species ensures safety to households and minimizes disturbance to them. Beehives also foster biodiversity and ecological resilience, supporting urban flora and attracting beneficial insects.

Soil-less UA dimensions
In this section as well it needs to be taken into account that these practices need some sort of processing- and selling facility, which also takes up space in the design. The layout and minimal dimensions of these spaces will not be researched, but adequate space is to be reserved for the placement of these facilities, allongside the UA practices. The technical requirements and layout of the professional scale of UA is however researched in the previous context and will also feature the spatial dimensions of the soil-less practices.

A-frame trellis
The frame can be arranged either vertically or horizontally to create a triangular extrusion with an angle around the 70 degrees. This way the plants are properly angled toward the light sources. Depending on the height of the trellis, the foodprint can be calculated and extruded as long as needed. In its smallest dimension the foodprint is 1,5 m, the height 2 m and the growing length 4,27 m (Szen, 2017).

Stacked beds
Simple in-line pipe beds are stacked to create this design. The spacing between the layers and the amount of layers is dependent on the plant that is grown. In its smallest dimension, the width of the beds is 1,5 m and can be extended in length as long as desired (Szen, 2017).

Stacked drums
The drums are typically fixed to a wall and can be mounted above eachother if wall height allows it. The diameter of the drum is 0,6 m and the foodprint it lays out on the floor is 0,8 x 1,0 m (Szen, 2017).

Vertical columns
Height of the vertical columns can vary but often ranges between 1,5 and 2,0 meters. For a 2 meter column, it contains forty holes with a diameter of 10 cm with a 20 cm vertical spacing between them. Each column takes up a footprint of 1m^2 and can be placed next to eachother using this boundary dimension between each one (Sulit et al., 2023).

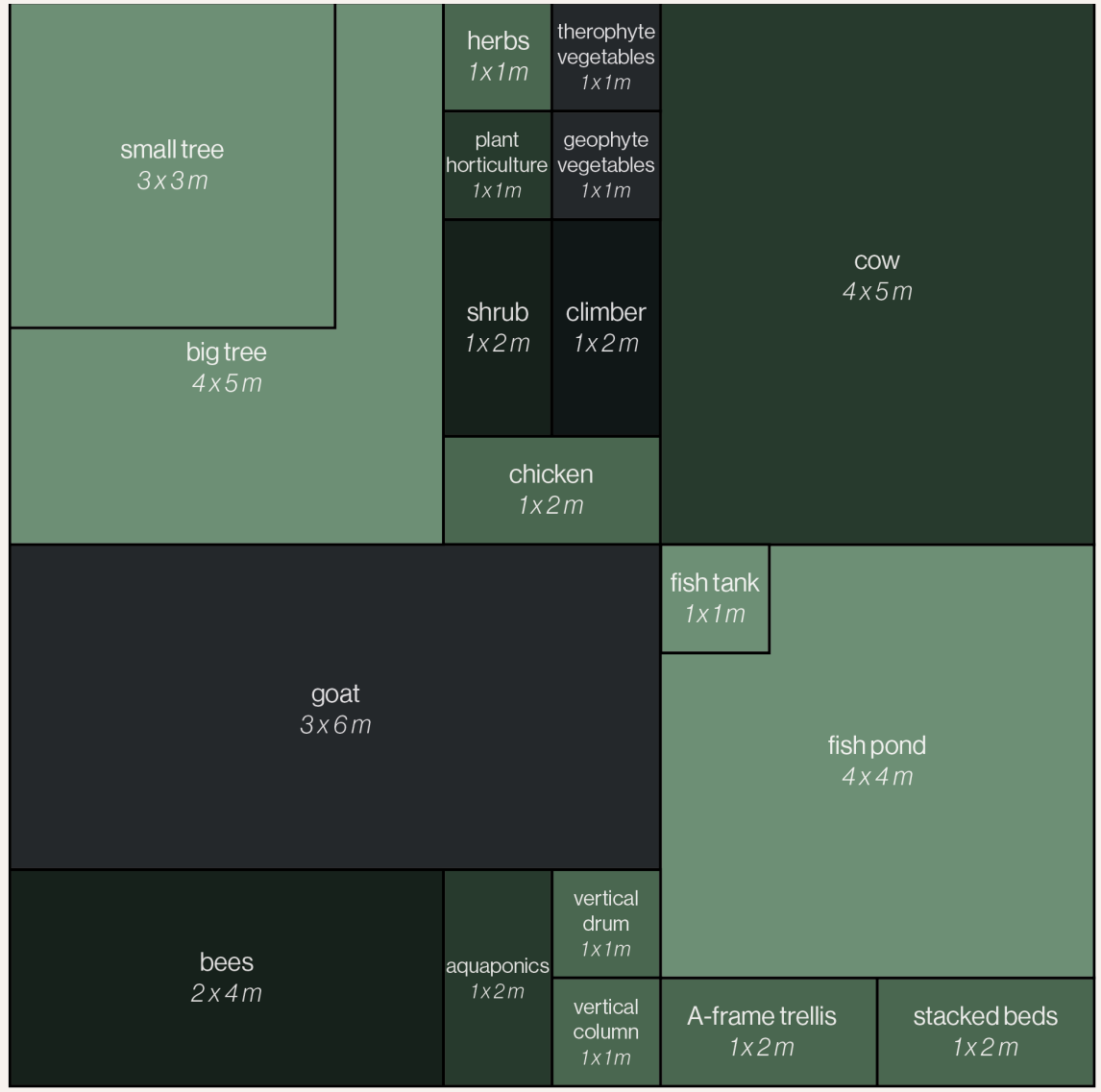


Figure 35. *Minimal spatial footprint dimensions of the low-input UA practices*

3.1.5 | Managerial context

In this section policy and managerial strategies for long-term participation in UA practices is researched and how phasing can play a role in encouraging succesful UA integration for the project design as a whole.

Soil-based UA dimensions
UA in India is generally not governed through a single national policy. Instead, it is implemented through a combination of national programs, state initiatives, municipal actions, and community-led practices. This decentralized approach allows cities and regions to adapt urban farming strategies to local social, spatial, and environmental conditions.

Collaboration
In a recent study (2024), Pradhan and Bhardwaj state that UA is most effective when responsibilities are distributed between state governments, municipalities, local organizations, and residents. Municipalities play a crucial role in implementation through land allocation, rooftop gardening schemes, training programs, and community initiatives. Residents contribute local knowledge, maintain gardens, exchange seeds, and share resources.

For NGOs, people's participation in the working process is crucial for ensuring long-term community development and is considered a pledge to bring about change in people's lives (Carmin 2003; Kumar and Prakash 2016). Participation should continue beyond the initial design phase. The design process should therefore create mechanisms that allow residents to keep contributing to decisions, activities, and management. Over time, residents can continue to adapt and operate on the created spaces as they see fit.

In the Asian context, the community architect network (CAN), which is the Asian network of community architects and planners, engineers, young professionals, lecturers, and academic institutes (Duangputtan & Mishima, 2023), can be proposed. In this network, the community is the primary player in the development design and implementation and the community collaborates with local and state authorities and community stakeholders to formulate solutions to community problems (Luansang et al. 2012).

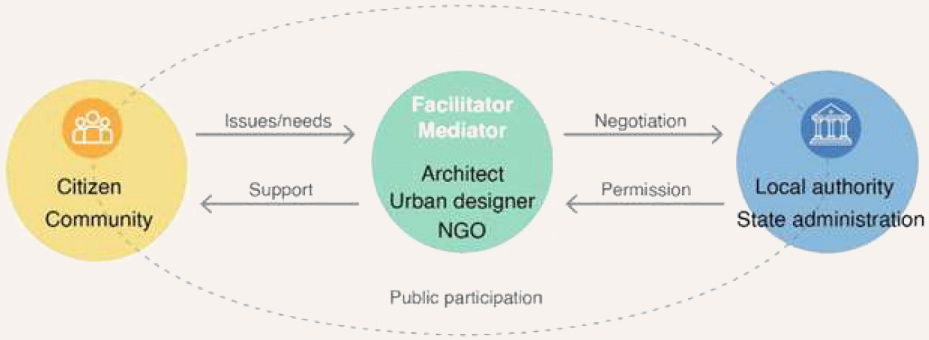


Figure 36. *Practical participation framework, explaining the roles and collaboration among the main actors, Duangputtan & Mishima (2023)*

Responsibility
Participation does not automatically equal reliable maintenance. As noted by Pradhan and Bhardwaj (2024), voluntary labour, participation can disappear when people's circumstances change. They noticed that after the COVID-19 lockdown was lifted, residents were able to find employment, resulting in a decrease in the number of urban farm workers. Therefore it is important that UA projects distinguish between participation (choice of engaging) and responsibility (being accountable for keeping something functioning). Sense of ownership also helps in this regard, rather than keeping all UA fields community (and publicly) managed.

Land ownership
Lack of ownership and insecurity in access to cultivable land is the predominant factor responsible for declining interest in farming and investment in new methods of agriculture (People's Resource Centre India, 2022). The primary reason for the decline in erop agriculture in urban and peri-urban Delhi is the insecurity associated with access to land for agricultural purposes. Areas should also be identified where the land can be commonised for agricultural activities and land trusts should be formed to manage the urban agrarian activities on these lands. This land reform and license-based system for communal land management could create opportunities for disadvantaged people to secure access to farmlands and necessary infrastructure. A public scheme should be started for all small plots of public lands for a limited - but long enough - tenure to individuals and citizen groups who would apply for getting these plots and grow food on them (People's Resource Centre India, 2022).

Knowledge exchange
Education on UA practices in informal settlements is mostly achieved by peer learning through friends and neighbors. Formal settlements acquire knowledge through online training workshops and social media. Social networks act as hubs for knowledge exchange, facilitates the sharing of gardening insights, problem solving and exchange of resources and harvests (Koduganti and Patil, 2024). Accessibility to social interaction and these social platforms thus is a vital policy to make sure UA practices can even be undertaken. Initiatives by NGOs can be utilised and encouraged to provide training on a neighbourhood scale and develop community initiatives of waste-to-food programmes in various settlements (Duangputtan & Mishima, 2023). Physical communication infrastructure is another way of this sharing of knowledge and includes structures like event spaces, noticeboards and markets.

Storage- and waste management
A major reason for food wastage is inadequate storage facilities for local produce and the produce imported from other states. Most waste is dumped in sewage systems which contributes to the pollution of nearby rivers. Through composting and decentralised waste management practices, human and animal waste can be managed to convert it into useful input for food production. Necessary knowledge and technical skills should be provided to encourage the adoption of decentralised/household-level sewage management (Duangputtan & Mishima, 2023).

Security
In the research of Duangputtan & Mishima (2023) they divide the designed UA spaces into public, semi-public and private zones. For example, the community vegetable garden was planned for the public zone, where anyone can pick vegetables. It is placed close to the project's entrance next to the road to attract people. A free-range chicken farm that is easily accessible is situated in the center of the site, which is a semi-public area. In the private, inaccessible zone, a cultivated food forest is placed with fruits, herbs, and quickgrowing vegetables (Duangputtan & Mishima, 2023). For both clear landownership and security of produce it is important to clearly distinguish these three zones in the design and incorporate it in the policy and management of them.

Finance and investment
The project should develop economic functions progressively, rather than assuming maintenance funding existing when starting execution. While community based UA practices are needed to kickstart large-scale participation, produce and events can also generate income in return to further phase the rest of the project. The key is that the productive/economic component supports the continuity of the social and spatial system.

Phasing
Before construction is started, it is important to map and organise the initial phase of the project. Involved residents, organisations and autorities need to be in agreement who takes on different taks like security of landownership and maintenance responsibilities. Land ownership should be clearly stated and can relate based on the tenure system. Knowledge and skills should be put out to the UA users who then also can create a community representation group. Initial funding and investment is needed from organisations and authorities to be able to kickstart UA practices, when they at first will not generate income yet. A governance structure with land distribution together with an agreement across parties can be expected outputs from this phase.

While construction on the typologies an clusters can start right away, it is advised, following the research above, to first create a small portion of the total UA interventions of the project as sort of a pilot. Basic infrastructure is provided but fields and spaces can adapt after the initial land preperation when the households starts to use it.

With the UA pilot, a platform for knowledge distribution, workshops and events can be setup, building a social network around it. Together with the areas of improvement learned during the pilot phase, UA practices can be expanded to the rest of the project where each cluster can make it their own.

Depending solely on volunteers can make UA practices disapear in the long run. On the typology is scale, it is always up to the household if and in what degree UA is practiced, it acts as sort of a bonus to the whole. On the cluster scale, tenure and sharing of tools and sheds for maintenance gives each household parts of landownership while working within the same cluster. On the public scale, management is not necessary all the time and should be maintained by local organisations. The same goes for the professional scale of the UA practices, the organisation is responsible, while local residents can contribute to this scale in the form of job execution and produce selling.

As time goes on, through a cycle of observing, discussing, deciding, modifying and maintaining, adaptations and changes can be made where households and organisations see fit. What the paper of Pradhan and Bhardwaj (2024) showed is that participation changed over time, volunteers became less available, knowledge gaps appeared, and funding became uncertain. Participation needs to be designed as a long-term governance and maintenance system, not only as a task to be ticked of in the early phases of the project. The community is the primary actor where the participatory design creates collaboration and relationships between households and organisations. Events, workshops and collective activities bring together these different groups.

Ultimately, the research suggests that the success of UA depends less on establishing the spaces themselves alone than on creating the conditions that allow them to remain active and adaptable over time. Participation should therefore be understood as an ongoing relationship between the physical environment, community, and organisations, rather than as a fixed stage in the development process. The physical space does act however as a way to translate the requirements of the managerial policies into spaces within they allow to succeed and flourish.

3.2 | Site analysis

In this section an analysis of the site is conducted. It consists of three parts; the analysis of the Rajiv Nagar plot itself, the case study analysis and the fieldwork documentation. With the plot analysis, the site characteristics and its connection to the surrounding areas is mapped. Using case study analysis, both housing typologies found in Ahmedabad and projects incorporating UA practices into their design on each scale (urban, cluster, typology) are analysed. With the mapping of typical dwelling layouts across the three income levels, UA practices can be connected to certain spaces where they can be incorporated. This UA x Arch framework then can work as an iteration tool during the design process. The design can even influence this framework gathering feedback through research by design.

Regarding the UA case studies, they form a base for knowledge and implementation of the gathered pre-design research into the build environment. Lastly, fieldwork on the plot, the collaboration with the CEPT University students and insights of Ahmedabad as a city are documented and analysed on what can be learned from them, before starting the initial design process.

3.2.1 | Ahmedabad and plot surroundings

In the first part of the site analysis, the city and surroundings of the plot are examined and mapped. Then the analysis is zoomed to the proposed plot which together form the base for the casestudy analysis and fieldwork to build upon.

Perimeter connections
The plot has excellent connectivity and lots of amenities nearby, making it a premium, currently underutilized plot, like many others in the city (figure 37). What can also be noticed in this figure is that dense housing clusters surround a shared small open spaces used for parking and hosting activities like for children to play together.



Figure 37. *Mapping of the open public spaces around the site*

Amenities
West of the plot the main road, Feet Ring Road, is positioned and crosses vertically through the horizontal, spinal roads going above and below the plot. It is this main road where most of the amenities like restaurants, clothing shops, barbers, food stands cloth together, attracting both vehicular- and pedestrian crowds. Enterprises and smaller, more local businesses that do not need direct access to crowds of people but rather generate income through services, are located more along these horizontal roads that do connect back to the main road (figure 38).

Because the plot is on the east side surrounded by more open plots, gardens and parks, a loss of density of amenities also naturally occurs here. The distance from the center to the main road is around 300 meters, meaning this does not cause direct problems and most amenities are still within walking distance of the future households living on the plot.

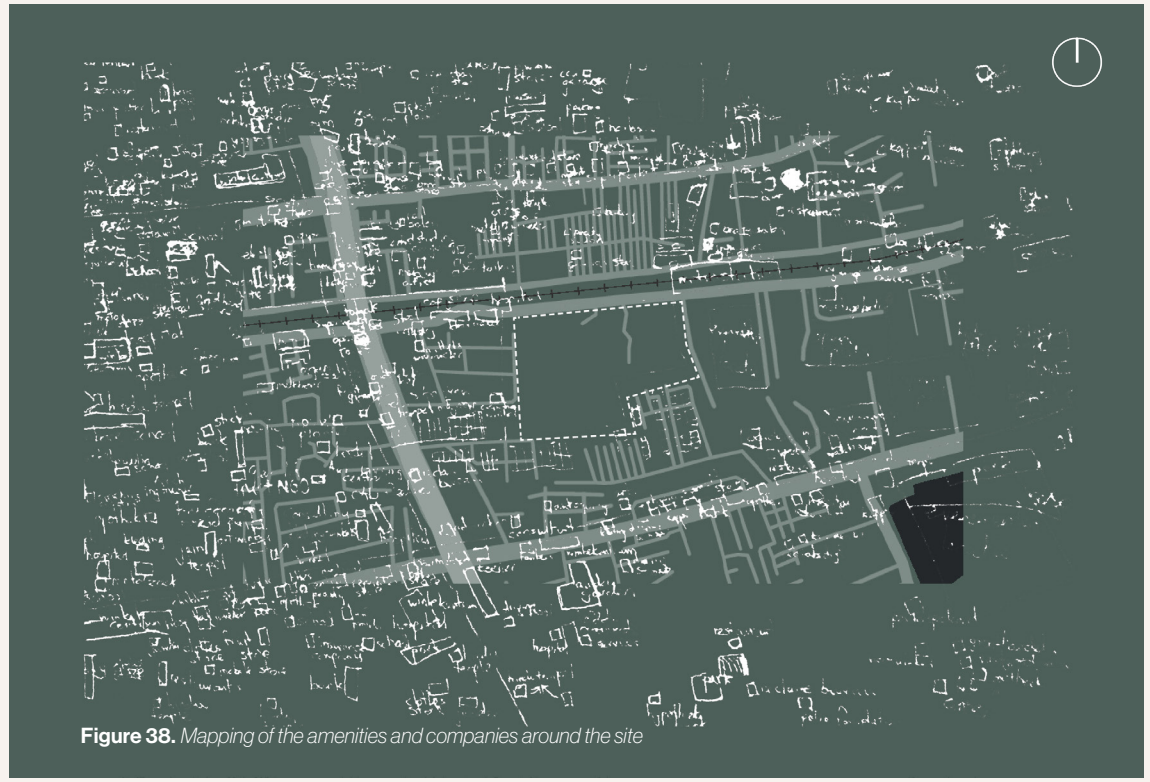


Figure 38. *Mapping of the amenities and companies around the site*



Public versus private space
Due to the high density of housing around the plot it becomes evident that public roads and pavements become transition zones between the private dwellings and the public street (figure 39). Larger public structures consist of open plots, gardens, parks and lakes. Connecting the map to figure 37 shows that pockets of open space and parking are centred and shared by housing build around that open area and form another transition zone between public and private.

Figure 39. *Public versus private space mapping*

Buildings
The buildings around the north-, west- and south side are roughly around the same density and vary between one and four building layers. There are a few buildings recently build that have a relatively high building height of between seven and 14 stories. These buildings are apartmentblocks, like found in other parts of the city, that repeat the main floorplan and extrude it vertically, generating a relatively high FSI on a small footprint. The apartments are mostly lived in by middle-income households. However, in these buldings, the connection to the groundlevel is totally lost.

Connectivity
The location is well connected to the rest of the city through multiple public transport options. The site is situated next to a metro station and buslines. Under the metrostation also runs a traintrack, connecting the city to its souther regions. However, the closest train station is about 1,7 kilometres away. Other important structures situated nearby are the APMC market, an event venue, educational institutions, religional temples, parks and museums, making the site a premium spot to live within the city.

When looking at the road network to and around the plot, distinctions can be made when it comes to pedestrian- and vehicular road hierarchies. The vehicular roads can be further divided into one-way and two-way roads and into whether they are locally connected roads or they connect to the bigger road network of the city (figure 40).



Figure 40. *Connectivity and circulation around the site*

Border sections
The circumference of the plot creates six sides which interact one way or the other with the surrounding environment. By making a street section of each of these sides using digital mapping, a first impression of the interactions of these sides with the surrounding is sketched. The fieldwork in the next section can build further on this base by capturing current imagery of the site.

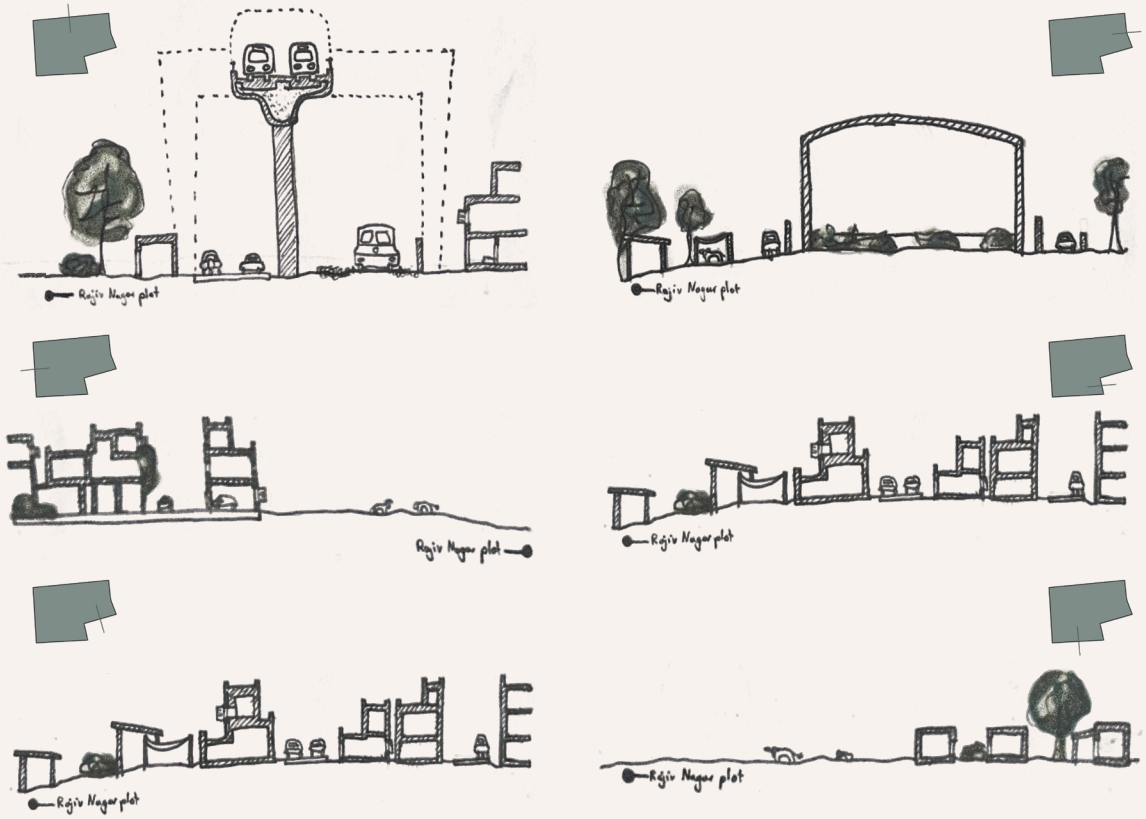


Figure 41. *Sections of the connection to the surroundings of the plot*

3.2.2 | Rajiv Nagar plot

In this second part of the site analysis, the proposed site is examined on its climate characteristics so that possible species that can be grown on the plot can be determined. Then the remaining characteristics of the plot are mapped.

Plant species analysis
To determine the plants and trees that can grow in the Ahmedabad climate, a local analysis has been conducted. The conclusion of this analysis will bring together a database for plants, their main purpose, typical spatial characteristics and required resource needs. This way, the different species can be linked to architectural spaces while also giving the individual households a choice in what species they want and can grow, depending on their available time and resources.

Horticulture
A floralistic analysis of Ahmedabad by Jadeja et al. conducted in 2011, forms the base of the analysis. Out of the total 1015 angiosprems there are trees (19,8%), shrubs (14,87%), under shrubs (8,08%) and herbs (57,24). Herbs are dominating the city due to the semi-arid climate conditions and erratic rainfall. Furthermore, the shrubs and be observed as a dominent species in the area (Jadeja et al., 2011). While the herbs dominate in amounts, most flora found in and around the city are non-food horticulture plants.

Trees
Moving to trees, specifically fruit trees, a more recent study maps all of them in the city (TOA, 2023). The most common trees found are Neem, Copperpod and Kanaji. Other, less common species are Saragvo, Saptparni, Gulmohar, Garmalo, Peplo, Rato, Shirish amongst others.

Food producing plants
Gujarat University Campus is aiding in the biodiversity conservation by providing a large range of plant species on their land. Herbs are dominated on campus, followed by trees, shrubs, climbers and geophytes (Nainesh&Sumesh, 2013). Among the four life forms of the biological spectrum (Raunkier, 1934) in the study area, therophytes were dominant with 40,48%, followed by phanerophytes, geophytes, chamaephytes and cryptophytes. Therophytes are annual plants that complete their entire life cycle within a single growing season, survivaling harsh conditions as dormant seeds. Phanerophyts are mainly trees and shrubs that are drought resilient and stay exposed all-year round. Geophytes store their energy mainly underground, sprouting when conditions above ground improve during the monsoon season. The other two types are mainly buds and algea and thus will not be further examined in this analysis.

Gujarat Science City Campus too hosts a lot of green cover and vegetation and plays an important role in the biodiversity of the city. Because of the rapid urbanisation the spaces of vegetation have decreased from 33% to 27% from 1999 to 2011 (Chaudhari et al., 2020). Diving into the analysis Chaudhari et al. conducted, here too a list of all plants appearing on the plot is stated. The study was carried out in 2020 on a total of 6495km² of land. It indicated 73 species total that belong to 44 genera and 32 families. Shrubs dominated the place (44%), followed by herbs (21%), trees (15%), climbers (14%) and grass (6%).

Now that most therophyte plants species are listed, the geophyte species are left. The land surface temperature analysis that uses satelite data from Patel et al., 2025 is used for this part of the analysis. Geophyte plants grow primarly under the ground and thus are heavily influenced by this fluctuating temperature. The study highlights a stark difference in temperature in the different climatical seasons. Since 2014 the average annual temperature has gone up to 41,29 degrees up until 2023. But, due to more vegetation being planted from 2020 on (Ahmedabad Urban Development Plan), temperature averages have flattened or even in years were negative, comparing it to the year before (Patel et al., 2025).

Pre-monsoon seasons noticed relatively higher heat, where the monsoon season itself and post-monsoon brought the lowest land surface temperatures (32,13 degrees in 2020). Monsoon rainfall immediately affects and benefits vegetation health. It causes instant cooling before vegetation becomes the lead factor for extending surface temperature reduction during the post-monsoon season (Patel et al., 2025). Using this data (figure 42), possible geophyte species can be selected and added to the plant database.

YEAR	LST (°C)			NDVI		
	Pre-Monsoon	Monsoon	Post-Monsoon	Pre-Monsoon	Monsoon	Post-Monsoon
2014	45.643	35.598	32.739	0.307	0.459	0.356
2015	48.885	39.201	33.579	0.284	0.452	0.336
2016	46.645	38.189	32.104	0.289	0.483	0.346
2017	50.052	40.196	31.948	0.315	0.441	0.345
2018	48.937	40.693	32.955	0.292	0.494	0.345
2019	49.221	38.418	32.352	0.292	0.494	0.345
2020	47.552	39.261	30.347	0.314	0.478	0.353
2021	45.316	38.619	30.691	0.322	0.496	0.354
2022	51.581	39.438	33.273	0.297	0.468	0.335
2023	49.335	40.586	32.133	0.274	0.477	0.362

Figure 42. *Seasonal variations of the land surface temperature (LST) and normalised difference vegetation index (NDVI) between 2014-2023 in Ahmedabad, Patel et al. (2025)*

Current situation

The site is an open plot next to the Rajiv Nagar metro station on the westside of Ahmedabad. The site is located next to a busy and vibrant road, but itself is a sandy, open plot. The total area is around 3,2 hectares and 65 meters above the median sealevel. Currently, there are Naka workers squatting on the area, having provided a form of temporary housing for themselves. Naka workers are daily wagers that gather every morning at large intersections or crossroads (nakas) where they seek work for the day from small construction contractors. Some of these households, now living on the southeast side of the plot, were able to realise a more permanent form of housing for themselves. On the plot there are also three cattle sheds present, hosting cows, goats and dogs (figure 43). What also can be noticed is a natural pedestrian path forming throughout the years, crossing right through the plot.



Figure 43. *Current Naka workers on- and around the site*



Figure 44. *Selfmade cow shed currently on site with the Rajiv Nagar metro station in the background*



Figure 45. *Clusters of housing on site*

Soil composition
An important thing to notice is that the soil type changes depending on the closenesses to the Sabermati River, the river flowing right through the heart of the city. Looking at data from national Gujarat soil maps, a change from very deep, well drained, fine Ustifluvent soil to a more loamy, mixed Ustochrept soil can be noticed, the further the soil is away from the river (Seghal, n.d.). The difference between the two soil types is that the soil along the river has better moisture retention combined with good drainage posibilities, while the soil further away is often more mixed which makes the water retention inconsistent and less reliable (Soil Survey Staff et al., 1999). The soil closer to the river is also more nutrient rich, allowing for more versitile planting options.

The plot, like many other open plots in the city, fall inbetween these two soil types and offer better agricultural potential than the peri-urban soil, where agriculture currently is practiced more and on bigger scales. Farming on the peri-urban does in return require relatively more resource inputs to succeed when compared to farming closer to the Sabermati river. While parts of the plot can be unstable in water retention and drainage, design solutions can overcome these problems and turn parts of the plot into cultivatable land.

Natural elevation
Looking at the elevation differences, a slight dip in the terrain of approximately 3 metres between the lowest and highest point can be noted at the middleright part of the plot. This is where rainwater will naturally flow to, which becomes an important node during monsoon season. Appropriate draining systems or alterations in elevations that divert water pressure to other parts of the plot are among the strategies that can relief pressure on the soil during these times.



Figure 46. *Natural elevation lines of the terrain*

Wind, sun
The predominantly wind direction blows from the southwest side. The average wind speed is 3 m/s with the maximum wind speed of around 8 m/s. The average ambient temperature is 28C° and varies from 11,5C° to 44,4C° (indianclimate.com, 2026).

In the winter the altitude of the sun is at its lowest, at a 44 degree angle. On the spring and autumn equinox the sun has an angle of 67 degrees at its highest point during the day. Finally, during the summer the sun reaches its highest altitude of 87 degrees. (figure 47).

Natural phenomenons
Flooding during monsoon and earthquake hits are the most frequent circumstances the city deals with. Ahmedabad falls into seismic Zone III (Moderate Damage Risk Zone), meaning local authorities have elevated building structure regulations to harbor the safety build structures in the city (Mohan et al., 2018).

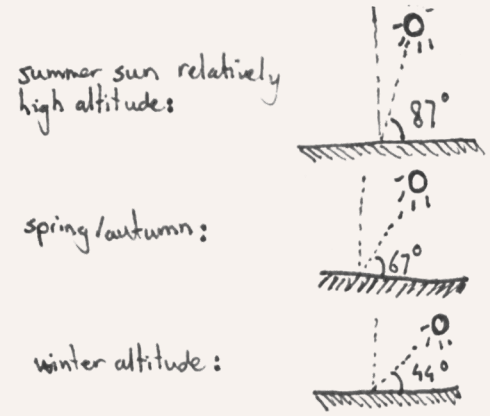


Figure 47. *Low- and high sun altitude angle projection*

Seasonal changes throughout the year
Ahmedabad's hot semi-arid climate significantly influences housing design and UA practices throughout the year. The extreme heat and limited rainfall during summer increase the need for shade, drought-tolerant vegetation, efficient irrigation, and soil-moisture conservation. The monsoon season introduces opportunities for rainwater harvesting but also requires adequate drainage and protection against waterlogging. During the post-monsoon and winter periods, relatively favourable temperatures create suitable conditions for growing a wider range of seasonal vegetables and for increasing the use of outdoor communal spaces. Water depth analysis shows that underground water levels change from 20 - 36 meters (pre-monsoon) to 10 - 20 meters post-monsoon (Jena & Singh, 2024). This calls for a seasonally responsive approach that integrates climate-appropriate plant selection, seasonal crop rotation and water-sensitive landscape- and cluster design to maintain comfort and resilience of urban spaces throughout the year.

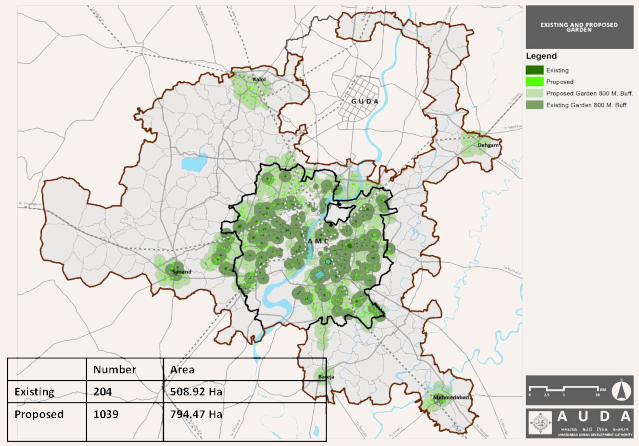


Figure 48. *People wade through a waterlogged road after heavy rains in Ahmedabad, India, Dave (2023)*

AUDA building regulations

In the second revised development plan of 2021 by the Ahmedabad Urban Development Authority (AUDA), the proposed site is labeled as a R1 residential zone. With this classification a restriction is bound to its allowed FSI. The lowest permissable value is 1,8, with a maximum of 2,7. There is also a plan to reduce liabilities on the Ahmedabad core by developing growth centres on the peri-urban of the city. These centres keep the principles of compact growth and sustainable development also happening in the core and divert them to five designated districts (AUDA, 2021).

In the town planning scheme on development of gardens and lakes in the city there are existing and proposed gardens. Currently there are 204 existing garden structures counting up to a total of 509 ha. The plan proposes 1039 more gardens adding a total of 794 ha to the existing green structure areas (figure 49). A trend can be seen where instead of bigger green structures (2,49 ha per garden) there is proposed to make more, but smaller green structures that stretches more of the city fabric (0,76 ha per garden).



	Number	Area
Existing	204	508.92 Ha
Proposed	1039	794.47 Ha

Figure 49. *Development and proposal of gardens and lakes throughout the city, AUDA (2021)*

On the existing garden map (figure 50), a spotty, unconnected green network can be seen. At the Rajiv Nagar plot there is opportunity to add onto these structures and potentially connect them to eachother, creating local CPUL's. Using UA practices together with landscape design, urban structures like production fields, space along traintracks, gardens and parks can contribute to creating these continuous productive urban landscapes when they are connected together (figure 51).

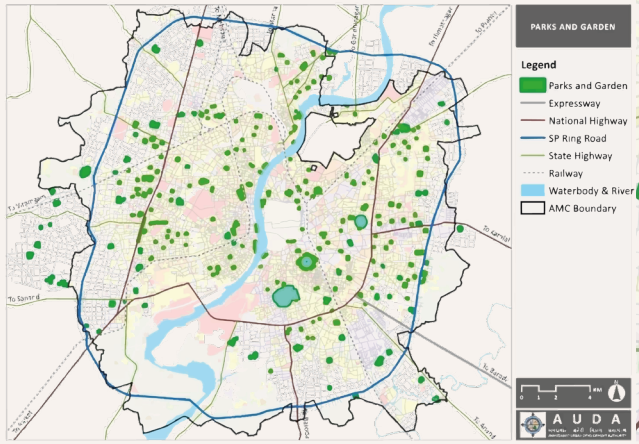


Figure 50. *Existing parks and gardens in the city, AUDA (2021)*

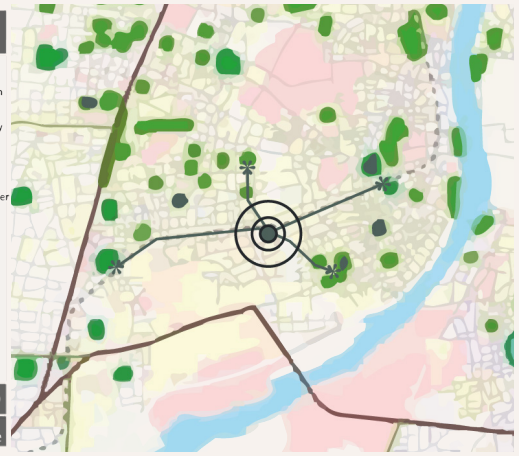


Figure 51. *Possible CPUL connections to and from the plot*

First spatial mapping of the site

Looking back at the site analysis, a first division of the plot is made in terms of footprint buildup. Working with the characteristics of each part of the site together with its connection to the surroundings, a 5 x 5 meter spacing grid is filled. The squares are labeled for either UA, roads, public nodes or housing, creating a color-tiled 2D plan (figure 52). The map can serve as a base for the urban design plan, getting constantly updated during the design process through research by design.

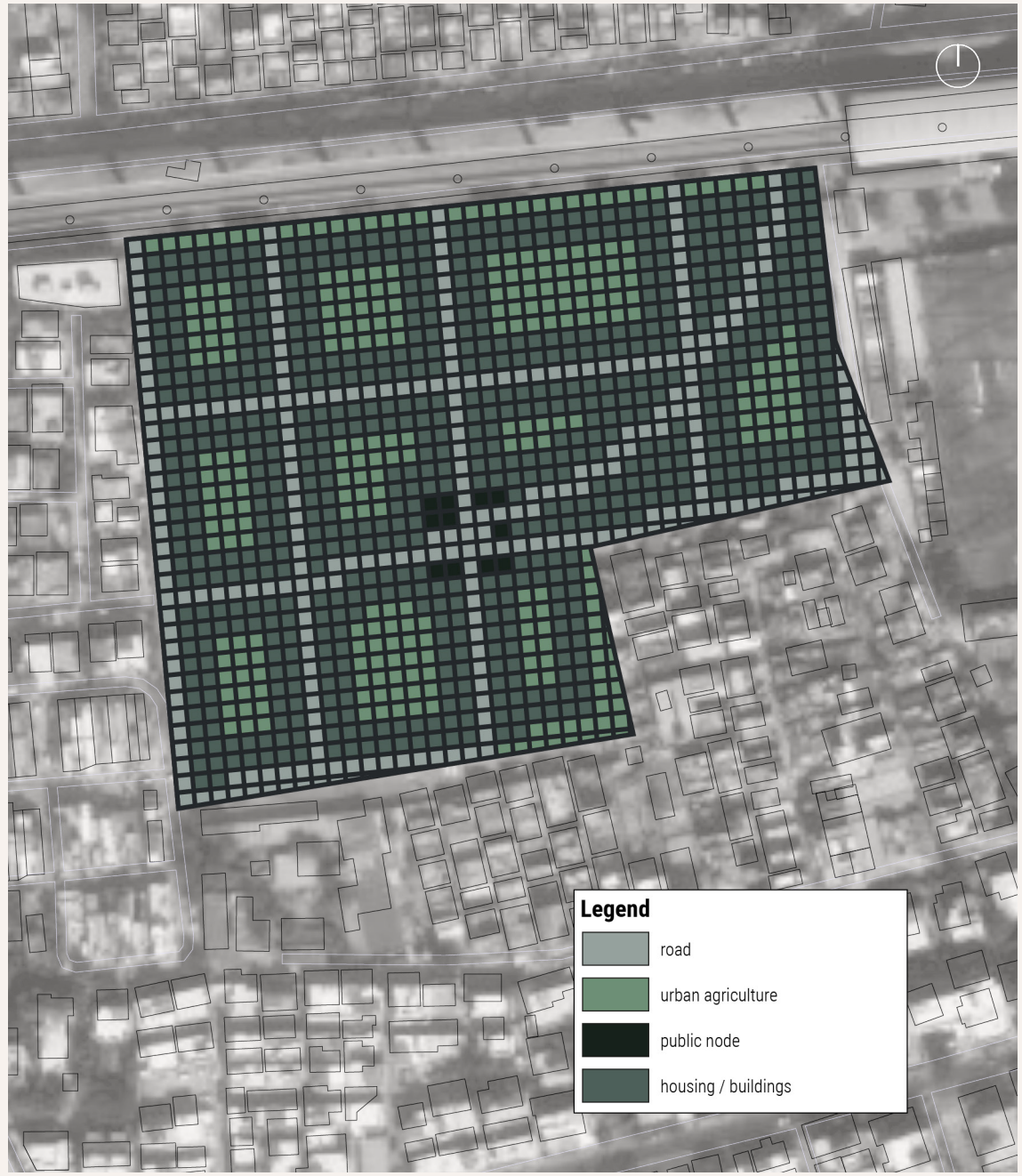


Figure 52. *Spatial footprint mapping of the plot*

3.2.3 | Case studies

Using the first three case studies, a base for implementation of UA practices is sketched. Projects for the spatial-, technical- and managerial context are chosen to analyse how each case established their vision into the build environment across the three scales. The second part of the analysis delves into three more case studies, chosen to paint a picture of spatial layouts of typical housing dwellings. The three dwelling types are selected based on the low-, middle- and high-income groups of the Ahmedabad households. The dwelling analysis forms the base for the types of spaces and their relative scales commonly build and expected when designing housing in the city.

Jintai Village, Bazhong, China (Rural Urban Framework)
Looking at the plan of Rural Urban Framework called Jintai Village, it managed to successfully incorporate agriculture into its housing- and urban design. Because the project works on both of these scales, it can relate to the proposed site in Ahmedabad and is thus further analysed.

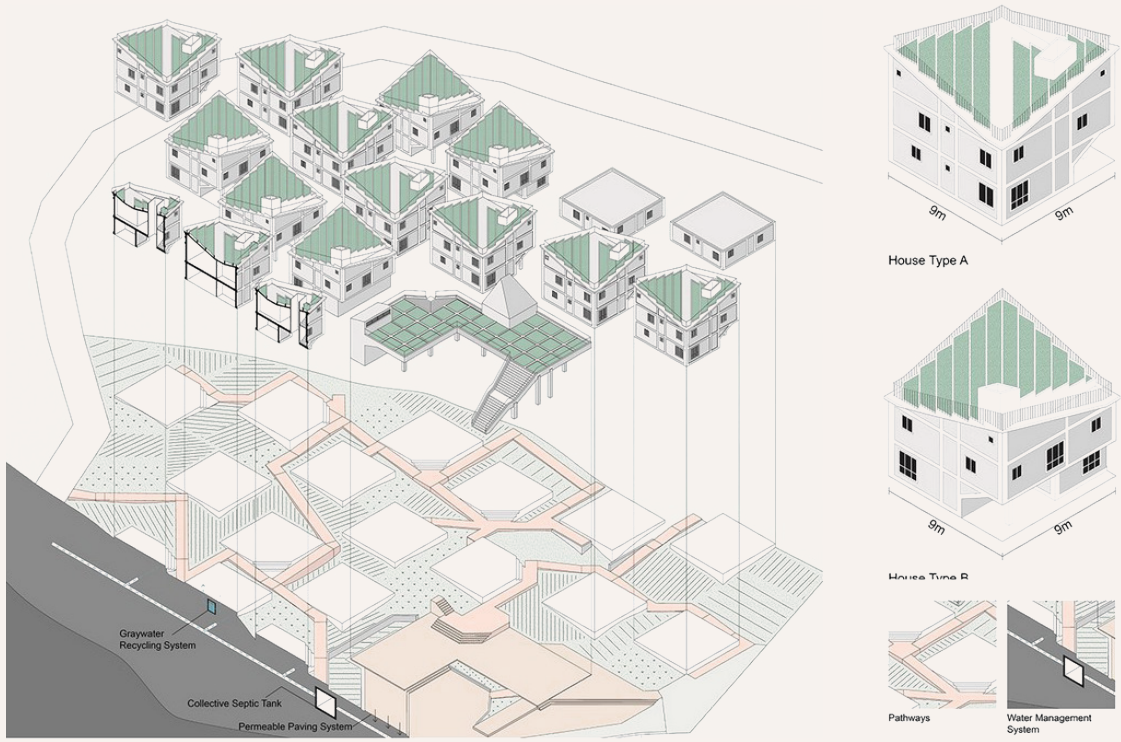


Figure 53. *Housing types and placement on the plot of Jintai Village, Rural Urban Network (n.d.)*

The Jintai Village is situated in Bazhong, China and has a mix of traditional architecture combined with more new technologies. First of all, it can be noticed that UA practices are implemented on the typology-, plot- and communal scale. The roof of each dwelling unit is stepped and forms surfaces where agriculture can be practiced, mirroring the agricultural landscape of the location. The produce can only be accessed by the dwelling owners and thus create this form of security and privacy of the UA practices.

Spaces on the ground floor are reserved for family-owned gardens and -workshop rooms. UA input on the plot scale is more shared and has a semi-private nature, since they are placed directly adjacent to the vehicular and pedestrian road system. This gradient of privacy opens fully on the communal urban scale. The community center forms a sheltered space, despite being open on the sides. On the roof, public and shared agriculture allotments create a more social, larger-scaled type of UA integration.

The village is situated on a more remote location, helping with security and bordering of spaces, while otherwise being a fully public form of UA that anyone can access. The dwelling unit consists of three levels with a central shaft going through the middle, generating natural ventilation and light. The facade buildup consists of structural concrete columns and -beams together with a clay brick infill. The two base units then get repeated and afterwards connected together to form a tight, but open, urban fabric structure that interconnects housing with UA.

Aspects to be noticed are:
- stepped roof landscape
- UA implementation on three working scales
- gradients of privacy of the UA practices
- repetition of the building unit



Figure 54. *Model of three building units, Rural Urban Network (n.d.)*

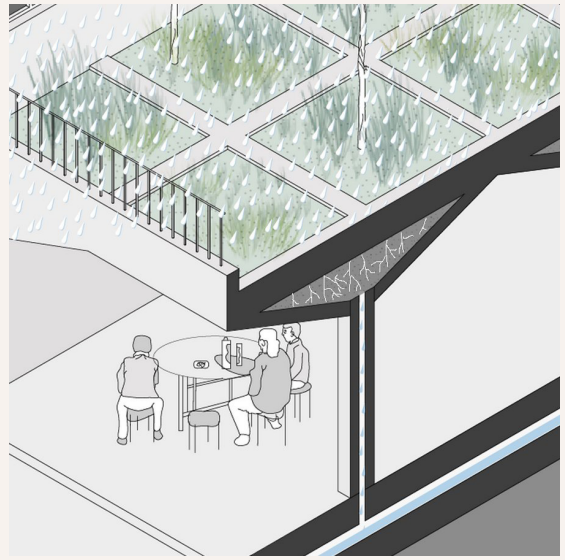


Figure 55. *Axonometric impression of the public courtyard with a farmable rooftop in a grid of plots, Lau (n.d.)*



Figure 56. *Axonometric impression of the building layout and natural ventilation shaft, Lau (n.d.)*



Figure 57. *Birds-eye view of the finished Jintai Village project, Rural Urban Network (n.d.)*

GROWx, Amsterdam, The Netherlands (Amsterdam Institute for Advanced Metropolitan Solutions)

Moving from the typology- to the commercial scale, there is an opportunity to provide a large-scaled, soilless farming system that creates jobs, produce surplus and economic growth. Vertical farm projects already exist and vary in their layout, type of soil-less UA and thus technical design. However, in terms of their overall building layout, uniformity can be found.

In Amsterdam, the AMS has created such a building, often referred to as the 'pink farm', because of the pink artificial light used on their growing beds. The building features a functional design that spans an estimated 1,300 to 2,000 m^2 on a industrial site. The production floors are layed out around the food flat concept consisting of large, fully enclosed climate cells arranged in a multi-tier, stacked configuration to maximise vertical space. This internal layout is structured to enable a logistical flow where robots transport cultivation trays between dedicated zones of the building.

The system utilizes an advanced, custom-engineered, led setup designed to maximize vertical space and boost crop yield. To achieve this, a liquid-cooled system is installed, which uses integrated water-cooling to extract excess heat directly from the source. This innovation allows the pink lamps to be placed close to the plants without causing leaf burn, enabling tightly stacked growing layers while also regulating production floor temperatures. The building is further divided into three sections, the processing & managing floors, the production floors and the environmental control floor.



Figure 58. *Hydroponic planters in the GrowX farm, AMS Institute (z.d.)*



Figure 59. *GrowX farm worker, AMS Institute (z.d.)*



Figure 60. *Stacked beds system, AMS Institute (z.d.)*

Aspects to be noticed are:

- double level height on production spaces
- stacked beds as a mode of efficient stacking of UA
- circulation as a means of grouping zones together
- relatively low water consumption
- high productivity
- high investment due to the large working scale
- extensive agricultural knowledge needed
- creation of jobs
- design freedom in the layout of the production floors
- produce surplus supports local food systems
- education hub creation



Figure 61. *Birdseye view of the GrowX farm, Growy Amsterdam (2023)*

Cities Without Hunger, Sao Paulo, Brasil (NGO)

In Sao Paulo, a NGO (non-governmental organisation) dedicated their work into reclaiming underused non-viable urban land for agriculture practices. They provide participants with locally grown produce for self-consumption, while also hosting commercial activities and -workshops. By doing so, they support the local food system and create jobs and support local businesses. The project is chosen because their output plays an important role in contributing to the reduction of environmental impacts, making urban areas more resilient. Workload and responsibility are managed by different groups which, when working together, make the project viable.

Aspects to be noticed are:

- provides facilities for small businesses
- community based but managed by a local NGO
- practice space for working and social activities
- community based knowledge
- education through workshops
- interest-based participation



Figure 62. *Resident and NGO-worker working on the plot, Cidadessemfome (2025)*



Figure 63. *Local business exchange, Montag Suzano (2003)*



Figure 64. *The agricultural plot in Sao Paulo, Montag Suzano (2003)*



Figure 65. *Educational UA workshops, Montag Suzano (2003)*



Figure 66. *View of schoolchildren visiting the agriculture plot, Deutchman (n.d.)*

The second part of the analysis delves into three more case studies to paint a picture of spatial layouts of typical housing dwellings of Ahmedabad across the three income-level groups.

Gujarat Housing Board, Ahmedabad, India (C. Correa)
For the low-income-group (LIG), the Gujarat Housing Board is analysed. The housing project, originally developed as a masterplan, organized housing into four primary typologies. The spatial layout of these typologies featured units ranging from 20 to 40m². They are centered around internal courtyards with narrow staircases as the main circulation route to the upper levels.

There are three floorplan layouts that are vertically stacked to create the base unit, which is then finished by placing two units together with a staircase in between them. On the roof, water tanks are placed, with each unit of apartments having access to one. On the ground floor, the apartment follows a linear sequence, constrained by the 2.83m grid with a total area of 20m^2. It contains a kitchen, multi-purpose- and wet room at the end. Access is provided by a small front yard. The first floor typology has two rooms, a kitchen and a terrace, with its bathroom and toilet positioned on the ventilated verandah facing the internal courtyard. Its area is around 30m². The top unit is reached via a longer flight of stairs and consists of a room and a kitchen with a front terrace and a larger verandah again overlooking the courtyard. The total area of this unit is 20m².

Aspects to be noticed are:
- low-rise housing of three building levels
- stacking form creates big terraces
- shared circulation route
- units build around a private, central courtyard
- spaces: kitchen, multipurpose room, study room, toilet, bathroom, terrace, verandah
- over the years, encroachment happened adding floor area to each unit

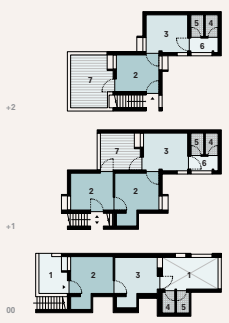


Figure 67. *Dwelling unit plan & typology, Van den Berg et al. (2026)*

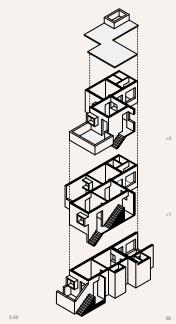


Figure 68. *Axonomnetric drawing of dwellings over different floors, Van den Berg et al. (2026)*

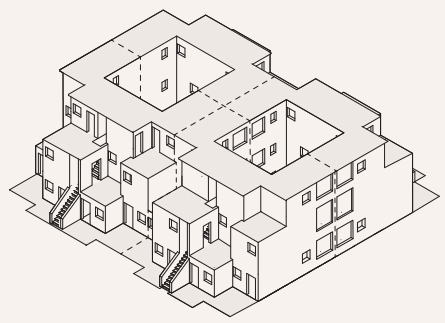


Figure 69. *View of the housing typologies, Van den Berg et al. (2026)*



Figure 70. *View of the housing typologies, Van den Berg et al. (2026)*

Arvind Parishkaar, Ahmedabad, India (Arvind Smartspaces)
Looking at the middle-income-group (MIG), Arvind Parishkaar is a large residential project designed as a "city within the city". The two phases include 720 and 560 dwellings for the masterplan, together forming a sizable residential community within the urban fabric of Ahmedabad. The plan reflects a vertical design strategy in which built mass is concentrated on a plot and extended upwards, allowing a large portion of the site to remain open and accessible at ground level.

At the building scale, the block is organised as a modular system of two types of 2BHK (two bathrooms, one hall, one kitchen) apartments. The apartments are mirrored against eachother to create space for a larger ventilation shaft in the centre. The typical apartment is about 80 m² and includes two bathrooms and a semi-open kitchen connected to a balcony. From the entrance, spaces gradually become more private the deeper you go into the home. The living room is the first and most public area, followed by a shared bathroom that is accessed from both the living space and the opposite bedroom. The second bedroom, with its own bathroom is the most private part of the unit. The living room functions as the primary social space for receiving guests and everyday family activities. The kitchen is positioned adjacent to this area to remain connected to the social zone. The attached balcony provides natural ventilation, daylight, and space for other domestic activities such as drying clothes.

Aspects to be noticed are:
- high-rise housing of fourteen buildinglevels
- repetition of units horizontally and vertically
- shared circulation cores
- gradient of privacy within the housing typology
- semi-open kitchen layout
- gated community with their own amenities provided within
- spaces: kitchen, hall, living room, two bedrooms, toilet, bathroom, terrace

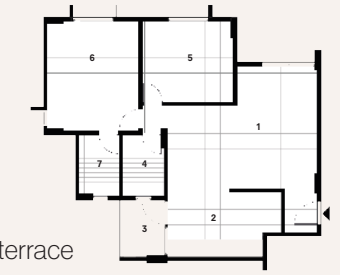


Figure 71. *Base unit floorplan layout*



Figure 72. *Living space unit layout, Arents & Keurentjes (2026)*

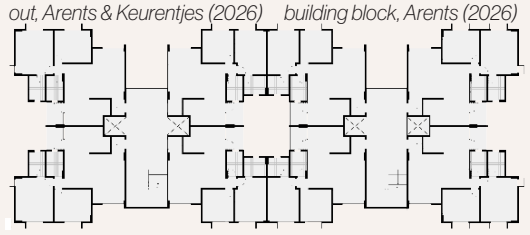


Figure 73. *Floorplan drawing building block, Arents (2026)*

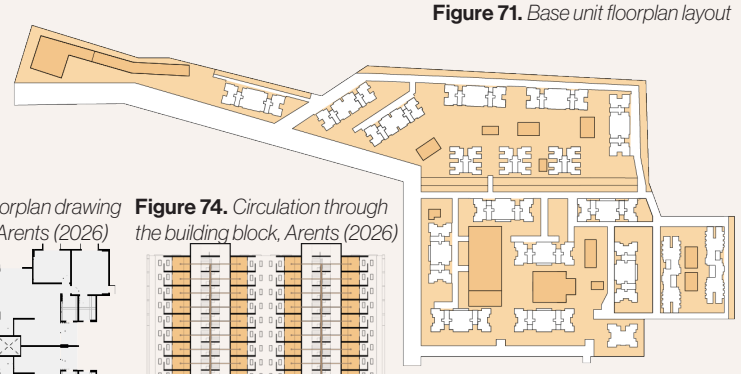


Figure 74. *Circulation through the building block, Arents (2026)*

Figure 75. *Urban masterplan layout with shared amenities and green spaces*

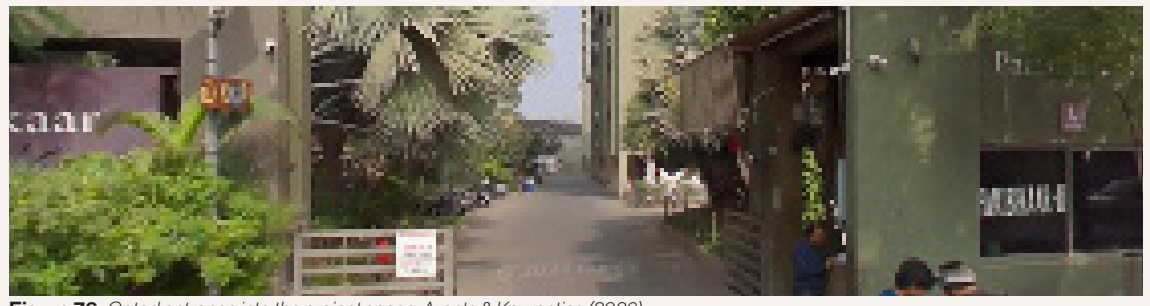


Figure 76. *Gated entrance into the project space, Arents & Keurentjes (2026)*

Greenfield Shantigram Township Apartments, Ahmedabad, India (Adani Realty)
Lastly, looking into the high-income-group (HIG), Greenfield Township offers 3 BHK- and 4BHK apartments and penthouses in a peaceful community within Shantigram neighborhood. Surrounded by tree-lined streets and overlooking a vibrant football field, it combines luxery living with good urban connectivity. The apartments create bright big spaces within the block, while the surroundings provide a lot of amenities to again create the 'city within a city' idea. The building consists of mirrored apartements creating a total of four per floor. What can be noticed is that the public spaces flow into eachother without having clear borders, whereas the private rooms are more secluded. The layout of the floorplan ensures outside views in every direction and providing both balconies and terraces all on the same floor. Floor areas of the apartments range from 108 m^2 to 200 m^2 and were finalised in 2019.


Figure 77. *Impression of the Township Apartments, Adani Realty (n.d.)*

Aspects to be noticed are:
- high-rise housing of twentytwo building levels
- repetition of units horizontally and vertically
- most amenities situated close by
- shared circulation cores
- large open spaces
- multiple balconies
- on-suite bathrooms
- seperate servant circulation core and entrance
- spaces: foyer, storage, kitchen, dining room, drawing room, office, living room, three bedrooms, guest room, two on-suite bathrooms, a common bathroom, wash yard, terraces, balconies


Figure 78. *The penthouse living room, Adani Realty (n.d.)*


Figure 79. *The penthouse bedroom, Adani Realty (n.d.)*



Figure 80. *Building level- and dwelling unit floorplan, Adani Realty (n.d.)*


Figure 81. *Ground floorplan high-income dwelling towers, Adani Realty (n.d.)*

3.2.4 | Fieldwork

During the fielwork on-site, different aspects of the project are perceived and documented. First, the city as a whole is analysed on what forms of UA practices already can be found in the city. Afterwards, the different forms of housing in the city are mapped to see how they emerged and tackled challenges associated with building housing in the city. Using this base, together with conversations of local residents, the daily routines of different households can be pieced together to see how UA practices can be interweaved into this routine, without becoming a burden to the households. Then the Rajiv Nagar plot, together with its surroundings, are perceived and mapped on their current situation and how they interact with eachother. Here is also where the collaboration with CEPT University students contributed to fieldwork exploration of the plot itself. Lastly, the Sardar Patel farm is visited. The farm is located on the peri-urban of Ahmedabad and forms to paint a picture of how agriculture is currently practiced and what components and challenges need to be taken into account when working with agriculture practices.

UA practices in the city
Moving from the peri-urban to the hart of the city, it is noticed that agriculture is practiced in relatively small amounts in terms of scale and diversity. Households that have empty space on their window sills or plot themselves, put pots there with herbs or small flowers (figure 82). This way, UA is not hindering household residents while the available floor space is maximised, but it also leaves almost no space for practicing UA in the first place.

In many courtyards a birdfeeder can be found. Birds are not part of agriculture practices but do strengthen the cultural aim of residents to live as close to- and among nature (figure . en. en.). Animals and insects are an important factor in agriculture, providing polination and biodiversity to the city. Other green structures that add to the biodiversity of the city are mostly city-planned parks and gardens and are bigger in scale.

Open plots with either sand or greenery can also often be found outside of the old city centre, mostly on the westside of the Sabermati river(figure 83). These fields are already contributing to the biodiversity and microclimate and also offer great potential for combining housing with UA practices. That brings us to the proposed site at the Rajiv Nagar metrostation. The naka workers on the site have relatively much space which resulted in emergence of UA practices in the form of tending cattle (cows and goats), as well as having dogs (figure 85). Self-made sheds provide shade and secluded space for the animals, while also having enough space to roam around the plot (figure 84). But because there are no clear borders for the animals, it turns out they often roam and litter the streets and roads around the plot (figure 86).

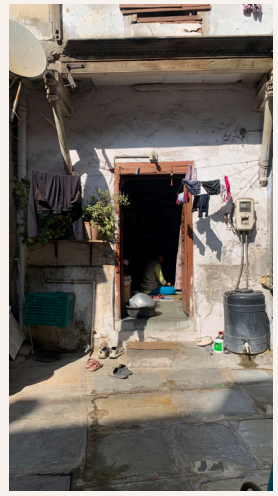
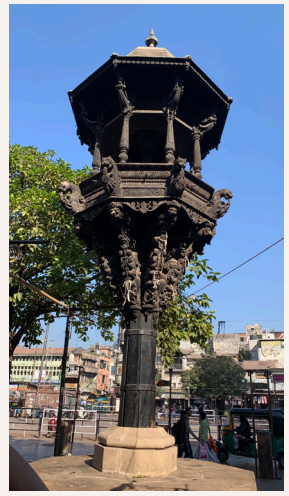




Figure 82. *Planters on an elevated surface, bird feeder, food leftovers for the animals, bird feeders*



Figure 83. *Greenfield open plot in the city*



Figure 84. *Cow shed on the plot*



Figure 85. *Dogs on the plot*



Figure 86. *Cows roaming the street*

Agriculture produce as an economic drive

Fresh food and vegetable markets in Ahmedabad are a major contribute to the city's urban informal economy and its broader food supply network (figure 87). These markets function as gathering places and are often hosted on marketsquares, where two major roads cross. Even though agriculture is a less dominant sector it still holds significance for Ahmedabads economy. The major industries are formed around textiles, pharmaceuticals and food processing, where the latter can be the next step in the production process of agriculture. This way, agriculture generates a continuous economic activity across multiple scales, including primary agricultural production, wholesale aggregation, transportation and retail vending.

The distribution of fresh produce in Ahmedabad is organised through regulated mandi systems, which connect rural production zones to urban markets (Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, 2023). This way, Ahmedabad's food supply chain is largely originating from nearby farming districts and locally distributed. This indicates a strong reliance on domestic agricultural networks rather than country-wide trade channels. Import dependency for fruits and vegetables is generally restricted to non-indigenous or out of season products that are not widely cultivated within the regional climatic context (Agri Asia, 2024).

During the fieldwork the annual shopping festival was also happening, which dedicated a part of the city centre to locally produced produce and dishes, celebrating the culture and way of life around it (figure 88). Having seen the importance of agriculture to the city and state as a whole, the integration of UA with housing can have significant benefits to the livelihoods of the cities' households.



Figure 87. *Manek Chowk market building*



Figure 88. *Annual food festival entrance, AhmedabadHD (2025)*

The layouts of daily living

To be able to integrate agriculture with low-rise, high-density housing, first it must be understood what traditional housing means in the cultural context of households living in Ahmedabad. In a lecture called A House in the City, professor Kashi talks about the first imagination of a house. It was to construct with 4 walls and a roof, to later add a tree for shading. Within the space, rooms got further divided into semi-open- and closed spaces. The tree became the center of the house, where the room to the street turned into a public place of exchange. When these houses started to flock together, poll houses were created that shared a courtyard in the middle with a central gate for security (figure 89).

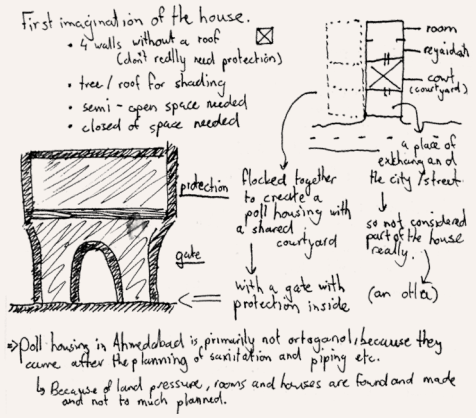


Figure 89. *Aspects of the imagination of the house (notes)*

Later row housing came in the mix where instead of the courtyard, the living room became the middle of the house. Often rooms were not labeled, mainly because they could serve multiple purposes. When they eventually did start labeling rooms for the middle- and high-income housing, the sizes of the different rooms started to change with them. Clusters of homes are often oriented towards a central green space, fostering community and recreation. Where the courtyard becomes a more private shared space, the street becomes the public node that promotes social interaction.

General typology observations

During the fieldwork different layouts of housing were mapped out to understand how they work and what similarities and differences can be found between them. Multiple areas within the city were used; a poll within the walled city centre, the proposed plot where the naka workers live and the Greenfield Shantigram Township Apartments case study. Through observation and conversation it is examined how residents use their home, street, and shared space throughout the day. Extra attention was given to food preparation, social interaction, household work, leisure and the relationship between indoor and outdoor space.

The observations revealed that daily life extends far beyond the boundaries of the dwelling itself. Activities such as cooking, washing, resting, socialising, caring for animals, and small-scale economic activities frequently take place in semi-public- and outdoor spaces. Streets, courtyards, thresholds, and shaded areas function as important extensions of the home, creating opportunities for social interaction and community life. The strong connection to the ground was found to be a recurring characteristic across both low- and middle-income households, allowing residents to maintain visual contact with neighbours, observe activities in the street, and participate in everyday social life. In the high-income typology households live more private and secure from the public space and often have a servant carrying out the domestic activities.

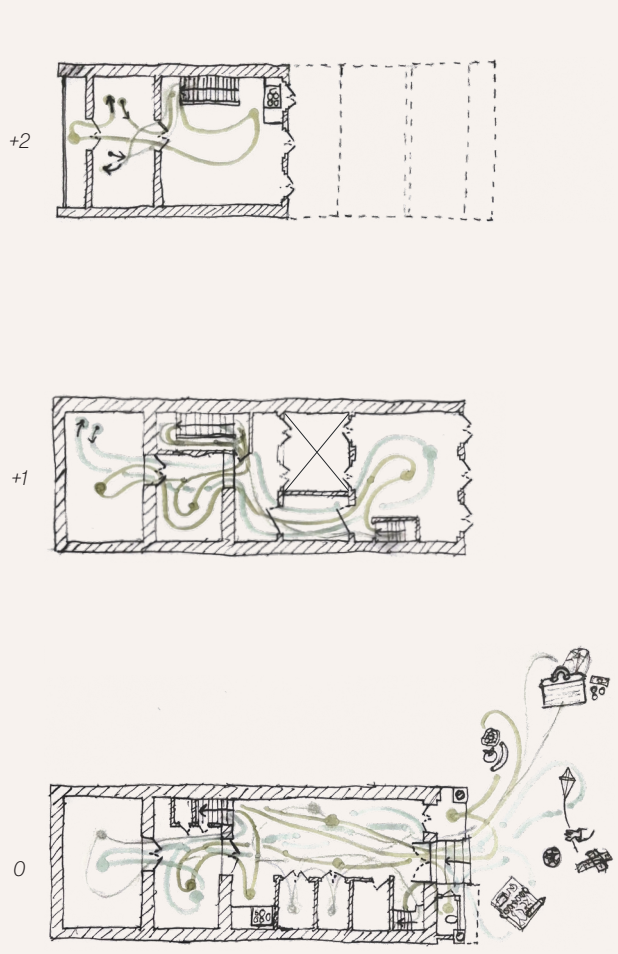
The findings informed the design proposal by emphasising the need for ground-connected living, flexible communal spaces, and opportunities for integrating productive landscapes into everyday routines. Rather than separating living from food production and social activities, the project needs to support the interconnected way in which these practices already occur within the city fabric.

Kadva Patel Pol

The polhouses within the housing cluster vary in width and are between the 2 and 5 meters in height, which translates to 2 to 4 floors. Traditionally, the polhouse follows a linear spatial sequence from public to private. In this case the sequence would be: otla (veranda), khaki (receiving room), chowk (courtyard), parsal (family space), resodu (kitchen), andordo (bedroom/storage). The groundfloor is used more for receiving guests and daily household activities, while the upper floors are reserved for sleeping and private family life.

The fieldwork also highlighted the importance of flexibility within the living environment. Spaces often accommodate multiple functions throughout the day and change according to season, climate, and household needs. Shaded outdoor areas become places for rest during hot periods, while streets and open spaces are used for social gatherings and for children to play on. In addition, many households maintain a close relationship with nature through the tending of animals, feeding of birds, or cultivation of small plants and food crops where space allows them to. Plants would often be placed in the central courtyard of the polhouse where light and rainwater enters the typology from above. In this typology, the roof cannot be accessed and is thus not used for domestic activities or growing crops.

Below, the routing and circulation through- and around the pol house is mapped based on the daily routines of different family members living there together. This way it can be seen where, when and on what scale UA practices can be added to these daily routines (figure 90).



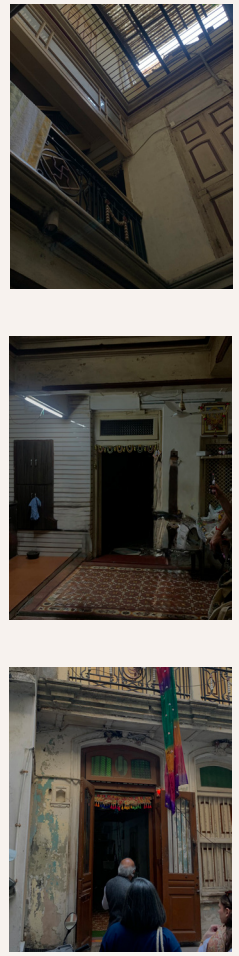


Figure 90. *Pol - Floorplans showing the circulation of different household members through- and out of the dwelling + dwelling imagery*

Site dwellings

Observations of the Naka workers currently living on the Rajiv Nagar site revealed a semi-temporary form of living. Self-built shelters are constructed from lightweight and recycled materials provide basic accommodation while remaining adaptable to changing household needs and uncertain land tenure. The houses tend to be build next to eachother to create clusters of households that live close to eachother. Daily activities such as cooking, washing, socialising, and resting frequently extend into shared outdoor spaces, creating strong community interaction despite limited infrastructure. As they mentioned, they have everything they need, and thus have adapted but not changed their daily way of living.

By also mapping their daily routing it can be seen where, when and on what scale UA practices can be added to these daily routines (figure 91).



Figure 91. *LIG/EW - Floorplan showing the circulation of different household members through- and out of the dwelling + dwelling imagery*

Greenfield Shantigram Township apartment

Lastly, the high-income household routines are sketched based on typology layout and their way of living (figure 92). The servant does most of the domestic activities like cooking, cleaning and washing while the rest of the household is either at work or school. This way, the servant can also tend to UA practices tied to the proposed apartment design of the high income buildings to use for the household's self-consumption.



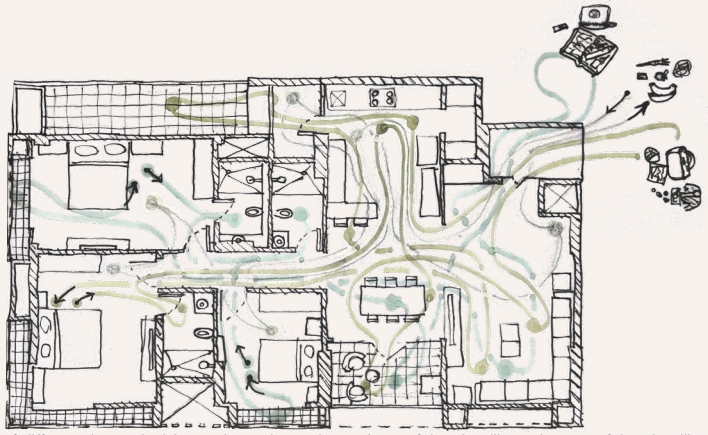


Figure 92. *HIG - Floorplan showing the circulation of different household members through- and out of the dwelling + image of the dwelling*

The site

On the Rajiv Nagar plot the characters of the dwellings, open spaces and changes over time are documented. Using this information, the challenges the households face can be extracted so the proposed design can help overcome these.



Figure 93. *Rajiv Nagar plot in 2011, Google Earth (2026)*



Figure 94. *Rajiv Nagar plot in 2016, Google Earth (2026)*



Figure 95. *Rajiv Nagar plot in 2021, Google Earth (2026)*



Figure 96. *Rajiv Nagar plot in 2026, Google Earth (2026)*



Figure 97. *Typical dwelling with their main form of transport*

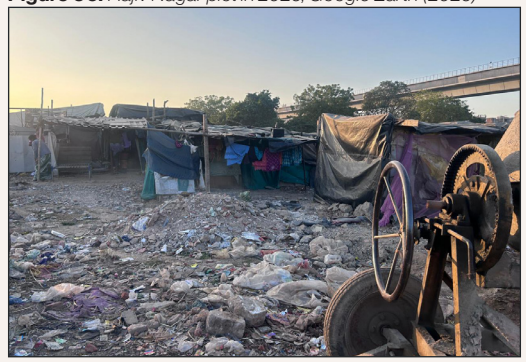


Figure 98. *Cluster of dwellings*



Figure 99. *Household's goats playing on a pile of materials*



Figure 100. *Typical materiality of the dwellings*



Figure 101. *Busy northern road with the train- and metro line*



Figure 102. *Religious temple under the tree*



Figure 103. *Naturally formed pathway going diagonally*



Figure 104. *Open field in the middle where children play*



Figure 105. *Sanitary space made next to each dwelling*



Figure 106. *Water is gathered from a pump nearby every day*



Figure 107. *High concrete wall seperating the squatters from the permanent naka worker houses*



Figure 108. *Schoolbus dropping off the children*



Figure 109. *North entrance of the plot*



Figure 110. *Storage space on the plot*



Figure 111. *High wall seperating the plot from the event space*



Figure 112. *Religious temple under the tree*



Figure 113. *Selfmade cow shed*



Figure 114. *Pile of materials- and waste*



Figure 115. *Entrance onto the metro platform*



Figure 116. *No secure land ownership and -tenure*

Cognitive mapping

A second site visit was conducted where the focus was more on the surroundings of the site. Next to mapping activities and field of views, special attention was put on the ambient noises, smells and surrounding architecture that could be noticed. Next to imagery, a cognitive map was made to capture and bring together all these components. In collaboration with fellow students and CEPT University students, the whole site was mapped and brought together in figure 117.

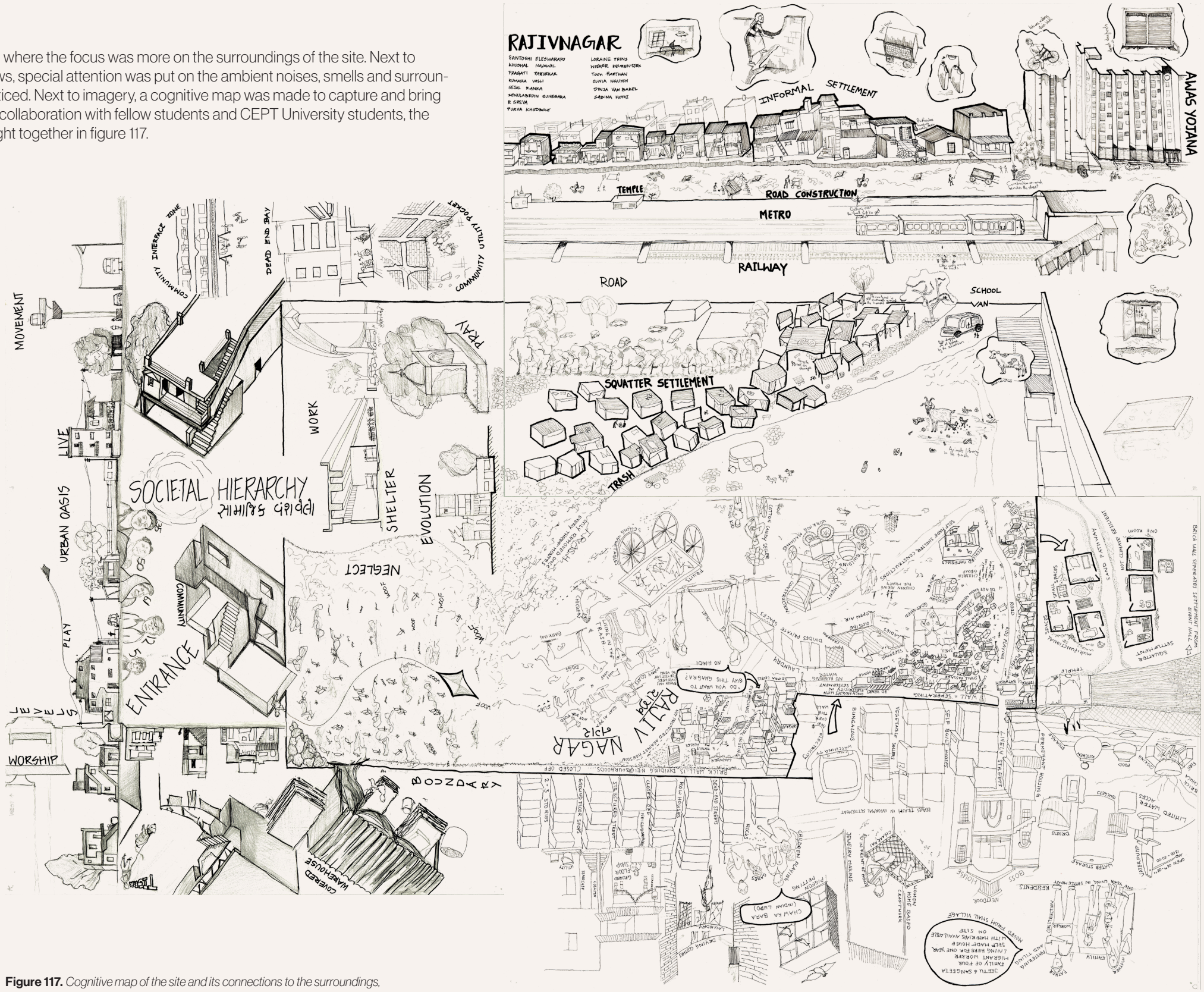


Figure 117. *Cognitive map of the site and its connections to the surroundings,*

Below there is more imagery on the surroundings of the site.



Figure 118. *Housing at the other side of the train line*



Figure 119. *Street is under construction*



Figure 126. *Surrounding housing of 2-4 stories high*



Figure 127. *Dwelling entrance next to the westside of the plot*



Figure 120. *Water well becomes a place of social interaction*



Figure 121. *To get water households have to get over the wall*



Figure 128. *Shops, storage and sleeping under the highway*



Figure 129. *Street next to the elevated highway*



Figure 122. *Monotenous MIG dwelling towers next to the station*



Figure 123. *Bigger religious structure*



Figure 130. *The elevated highway*



Figure 131. *Typical housing unit north of the train line*



Figure 124. *Walking down from the metro station with on the left the train line and on the right the street under construction*



Figure 125. *Narrow alleys between housing units*



Figure 132. *Religious temple structure next to the road*



Figure 133. *Public plinth on the groundfloor of the building*

Defining what makes the site high-density

As part of the fieldwork a collaborative design exercise was organised with students from CEPT University to explore different approaches in achieving dense housing on the project site. Working in groups, students developed urban plans based on low-rise, middle-rise, and high-rise housing typologies. The objective was not only to compare density values, but also to investigate how different spatial configurations influence the quality of living, access to public space, and the relationship between residents and their environment.

The exercise revealed that higher building heights do not automatically result in a better urban environment. While the high-rise schemes generated larger quantities of open space at ground level, these spaces often became detached from everyday life and less integrated with residential activities (figure 134). The increased distance between dwellings and the ground reduced opportunities for informal encounters, social interaction, and direct engagement with public space. In contrast, the low-rise and middle-rise schemes maintained a stronger physical and visual connection between residents, the street, and communal spaces (figure 134). Daily activities could more easily spill into the public realm, reinforcing the social character that is commonly observed in Indian neighbourhoods.

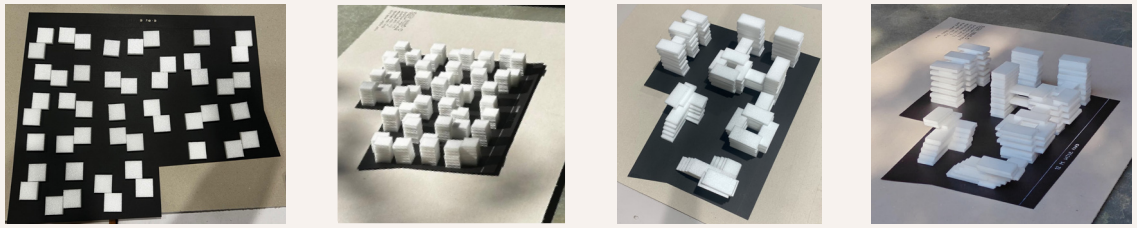


Figure 134. *The same FSI on low-rise (left), middle-rise (middle) and high-rise (right) builing typologies on the Rajiv Nagar plot*

Another important finding was that accessibility to open space proved to be as important as the amount of open space itself. In the low-rise scheme, shared spaces were encountered more frequently as part of daily movement patterns instead of in the high-rise where there was 'too much' open space to have it all be used directly. The exercise therefore highlighted that density should not only be understood as a numerical measure, but also as a spatial- and social condition that shapes how people experience and use their environment. The success of dense urban environments depends not only on how many people can be housed, but also on how well the urban fabric supports social interaction, accessibility, and connection to the ground level.

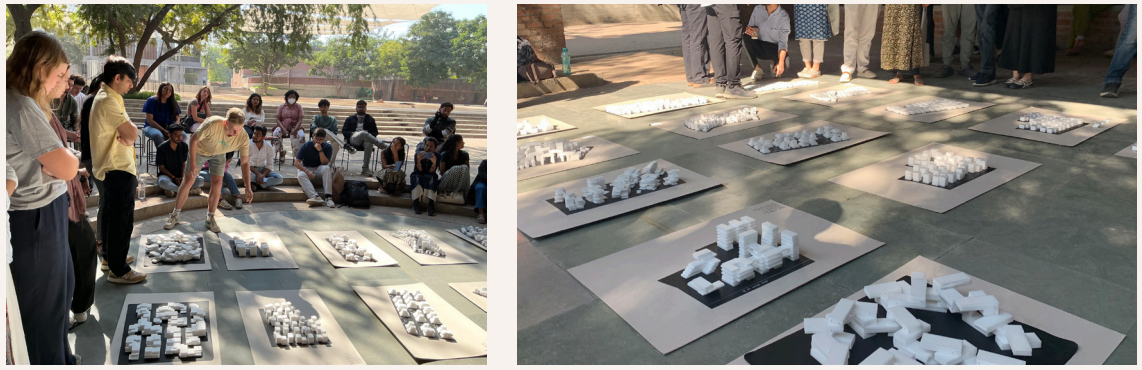


Figure 135. *Comparison and justification for the different means of creating high-density housing*

Illustration of a day on the plot

As a last collaboration with the CEPT students a 'day in the life' poster was created, illustrating the daily experiences and routines of a chosen resident of the Rajiv Nagar plot (figure 136). On the poster the day of Raju, a young kid living with his parents, is mapped, accompanied with his daily activities and how the build environment can and should respond to those activities.

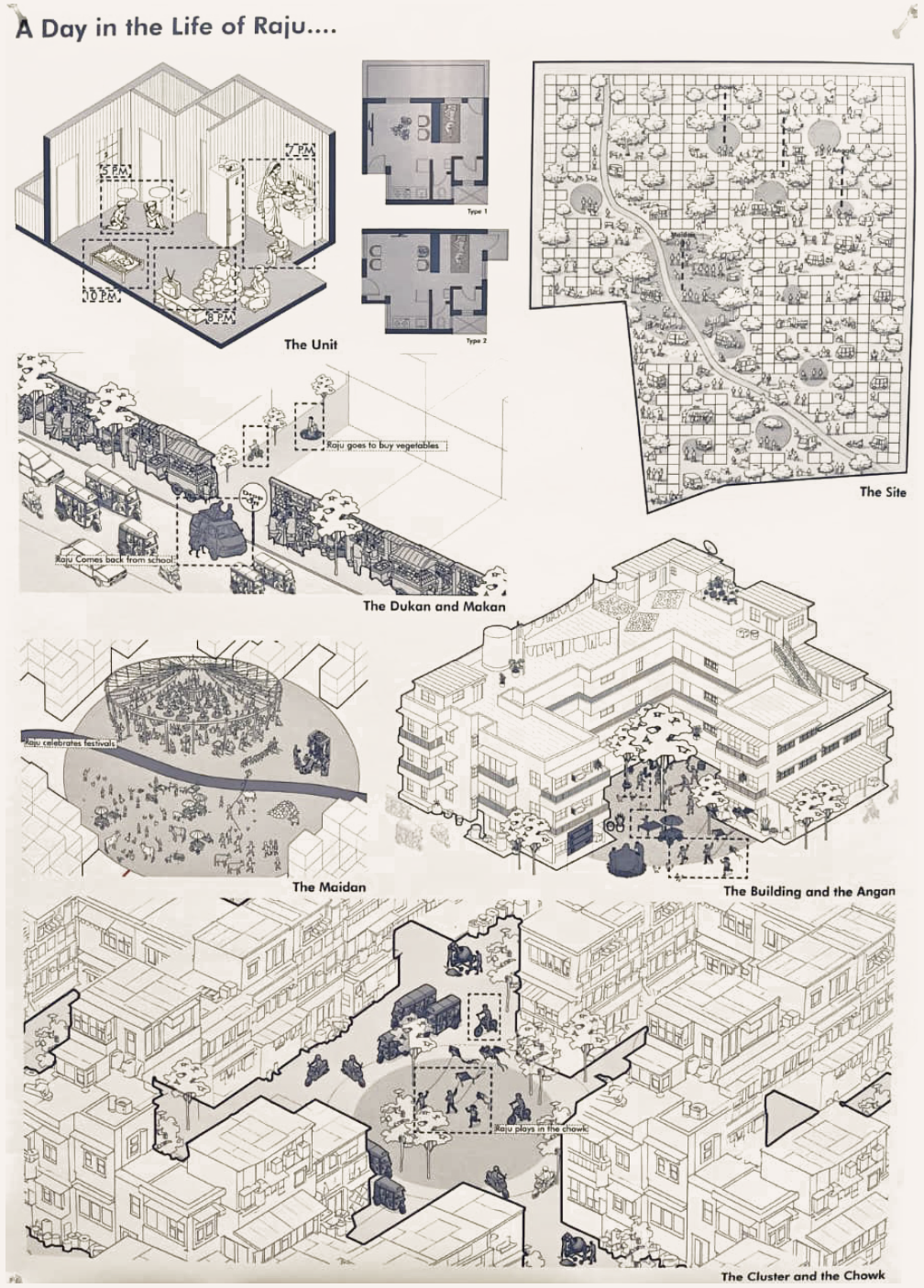


Figure 136. *A day in the life on the Rajiv Nagar plot on the typology-, cluster-, and urban scale*



Figure 137. *Entrance of the farm*



Figure 138. *Soil-based farming fields*



Figure 139. *Provided housing for farm workers*



Figure 140. *Soil-based irrigated farming fields*

Sardar Patel Farm visit

What becomes clear from the fieldwork is that many residents and students in Ahmedabad don't see Gujarat as a big agriculture state, refering more to other states such as Hydrabad and Bengaluru. The reason could be that the practice is not seen often and thus is not being practiced much. Because of the local climate it is evident that agriculture is practiced in Ahmedabad in smaller amounts, but still significant for the economy of the state. To observe and experience the agriculture practices of the city, a farm on the peri-urban is visited. Seeing and learning how agriculture is really practiced can sketch a stronger base for implementing UA and expanding it to the hart of the urban fabric.

The farm has a total of 40 hectares of farmland and is combined with a crafting space where handmade objects are created and workshops are held. The current owner inherited the farm from his father and since it always has been a place for organic agriculture production. The farm workers get paid as well as getting a share of the produce, whereas the rest gets sold in their shop and on the markets in the city. Spreading awareness of organic agriculture practices is also a spearpoint of the business. He expanded on the knowledge from his father by connecting with other businesses in countries all over the world, including The Netherlands.

One of the main challenges of practicing agriculture in Ahmedabad is providing sufficient water. The farm works with water smartly in systems such as raised beds, drop irrigation and crop rotation to ensure soil fertility. This way fertilisers are not necessary during the growth process. Using these systems, lots of different species and types of agriculture are now grown on the farmlands, from small plants to big trees. By working with these systems within housing units, UA can be properly implemented and work succesfuly within the urban fabric of Ahmedabad.

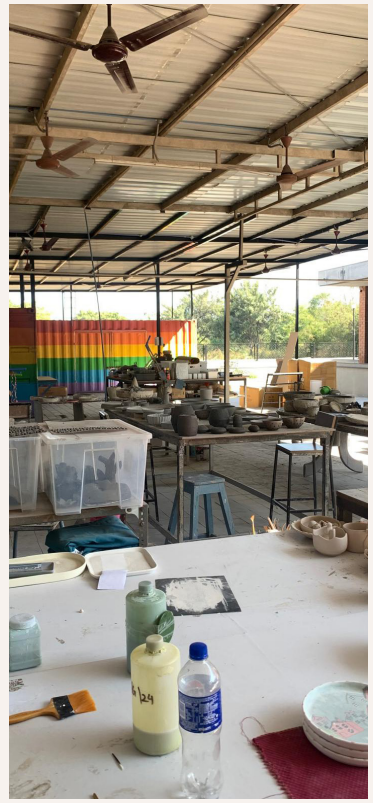


Figure 141. *Pottery workshop studio*



Figure 142. *Shop and extra spacing*



Figure 143. *Vegetable and tree farming*

Chapter 04

Design Proposition

4.1 | Design framework

In this section the research result outputs are brought together to form outcome products that are used informing the final design. The pre-design research is used for this as the site analys, case studies and field-work will already directly fuel parts of the design. Finally, the design is layed out in the next section.

Low-input UA practices with their characteristics, working scale and spatial requirements
Combining the gathered research, the low-input UA types are positioned into their working scale, placement and footprint. It serves as spatial guiding for implementing the practices into the build environment and the final design.

Type of UA	Soil-based / Soil-less	Working scale	Placement	Footprint (m)
Herbs	*soil-based / soil-less*	*typology*	*interior*	*1 x 1*
Vegetables	*soil-based / soil-less*	*typology, cluster, urban*	*roof, balcony, facade, plot,*	*1 x 1*
Plant horticulture	*soil-based / soil-less*	*typology, cluster, urban*	*interior, facade, roof, balcony, plot, communal, urban*	*1 x 1*
Climbers	*soil-based / soil-less*	*typology, urban*	*facade, urban*	*1 x 2*
Shrubs	*soil-based*	*typology, cluster, urban*	*roof, balcony, plot, communal, urban, professional*	*1 x 2*
Small tree	*soil-based*	*typology, cluster, urban*	*plot, communal, urban, professional*	*3 x 3*
Tree	*soil-based*	*typology, cluster, urban*	*plot, communal, urban, professional*	*4 x 5*
Cow	*soil-based*	*cluster, urban*	*communal, professional*	*4 x 5*
Goat	*soil-based*	*cluster, urban*	*communal, professional*	*3 x 6*
Chicken	*soil-based*	*typology, cluster, urban*	*roof, balcony, plot, communal, professional*	*1 x 2*
Fish pond	*soil-less*	*typology*	*plot*	*4 x 4*
Fish tank	*soil-less*	*typology*	*interior, balcony*	*1 x 1*
Bees	*soil-based*	*cluster*	*communal*	*2 x 4*
Vertical drum	*soil-less*	*urban*	*professional*	*1 x 1*
Vertical column	*soil-less*	*typology, urban*	*roof, balcony, professional*	*1 x 1*
A-frame trellis	*soil-less*	*typology, urban*	*roof, balcony, professional*	*1 x 2*
Stacked beds	*soil-less*	*typology, urban*	*roof, balcony, professional*	*1 x 2*
Aquaponics	*soil-less*	*typology, urban*	*interior, balcony, roof, professional*	*1 x 2*

Figure 144. *Low-input UA practices with their characteristics, working scale and spatial requirements*

Ahmedabad plant database
In this database the most known and used species that can be grown in Ahmedabad are layed out. They are evaluated based on their type, main purpose, technical- and spatial requirements. Using this database households can choose, based on their availability of time and resources, what types of agriculture they want and can invest in.

While not every possible species that can grow in Ahmedabad is included, the most commonly grown and found are added to the database. The database is constructed with the use of floral data of the Gujarat Science City Campus (Bharat et al., 2020) and the Gujarat University Campus (Modi & Dudani, 2013), both found in Ahmedabad, together with additional data from Trees of Ahmedabad (2023) and Nandaniya et al. (2025). Using literature from the ICAR, AAU, TNAU and the RHS, the requirements of each species is added. The compiled data is intended as design guidance rather than definitive technical specifications. Below, an overview of the database is presented while the full listing is found in the appendix of the report.

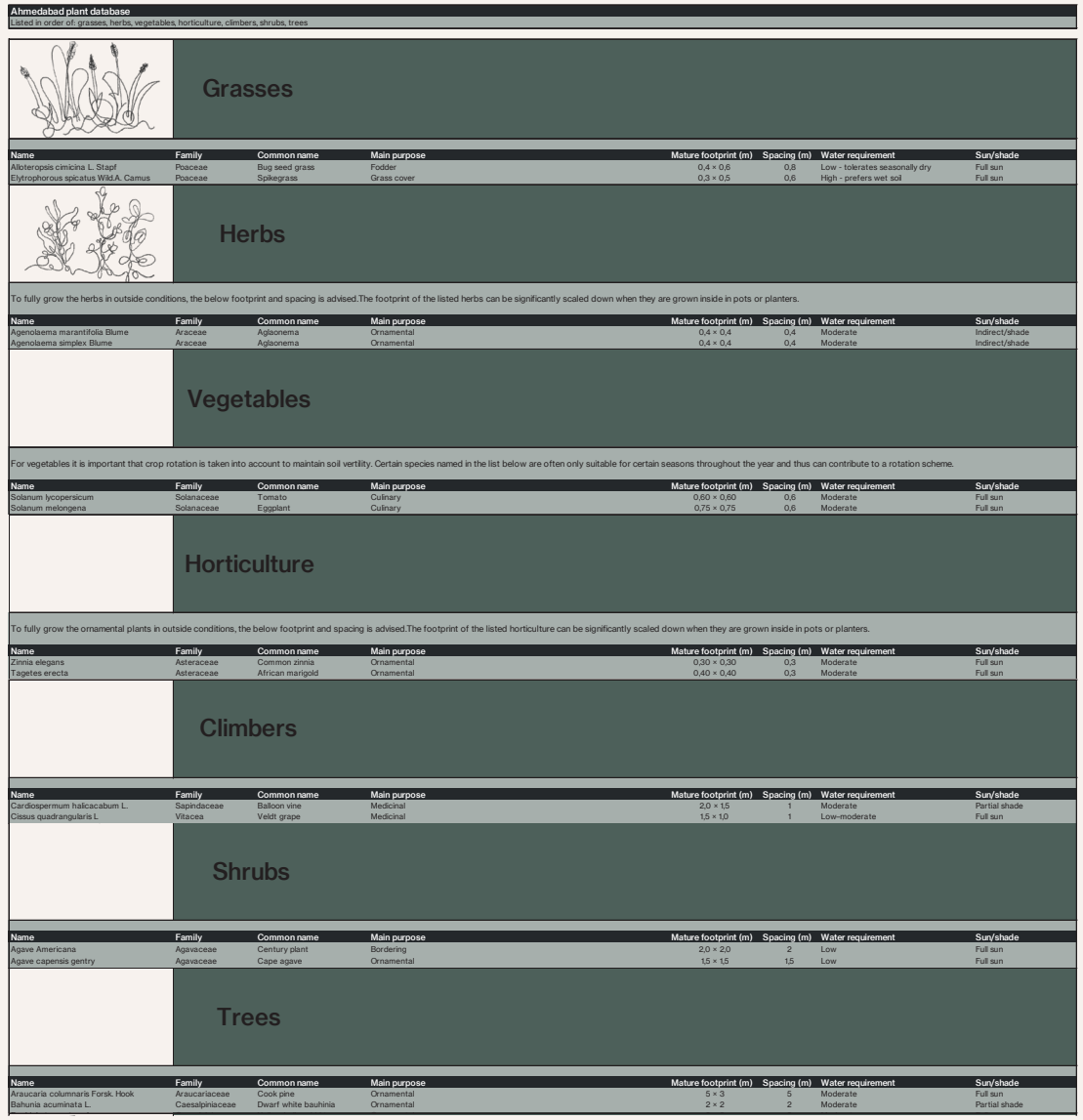


Figure 145. *Ahmedabad plant database*

Daily routines of Ahmedabad households with UA integrated in them

Bringing the fieldwork together, below are the daily routines mapped of a stay-at-home mother, naka worker father and children of the family (figure 146). During different times of the day each household member is able to practice UA inbetween their existing schedule, meaning UA practice work load can be shared to form less of a burden and more of a leisure and produce-oriented activity. This way UA can contribute to the livelihoods of the households, while still allowing for a second job to be able to fully sustain a living.

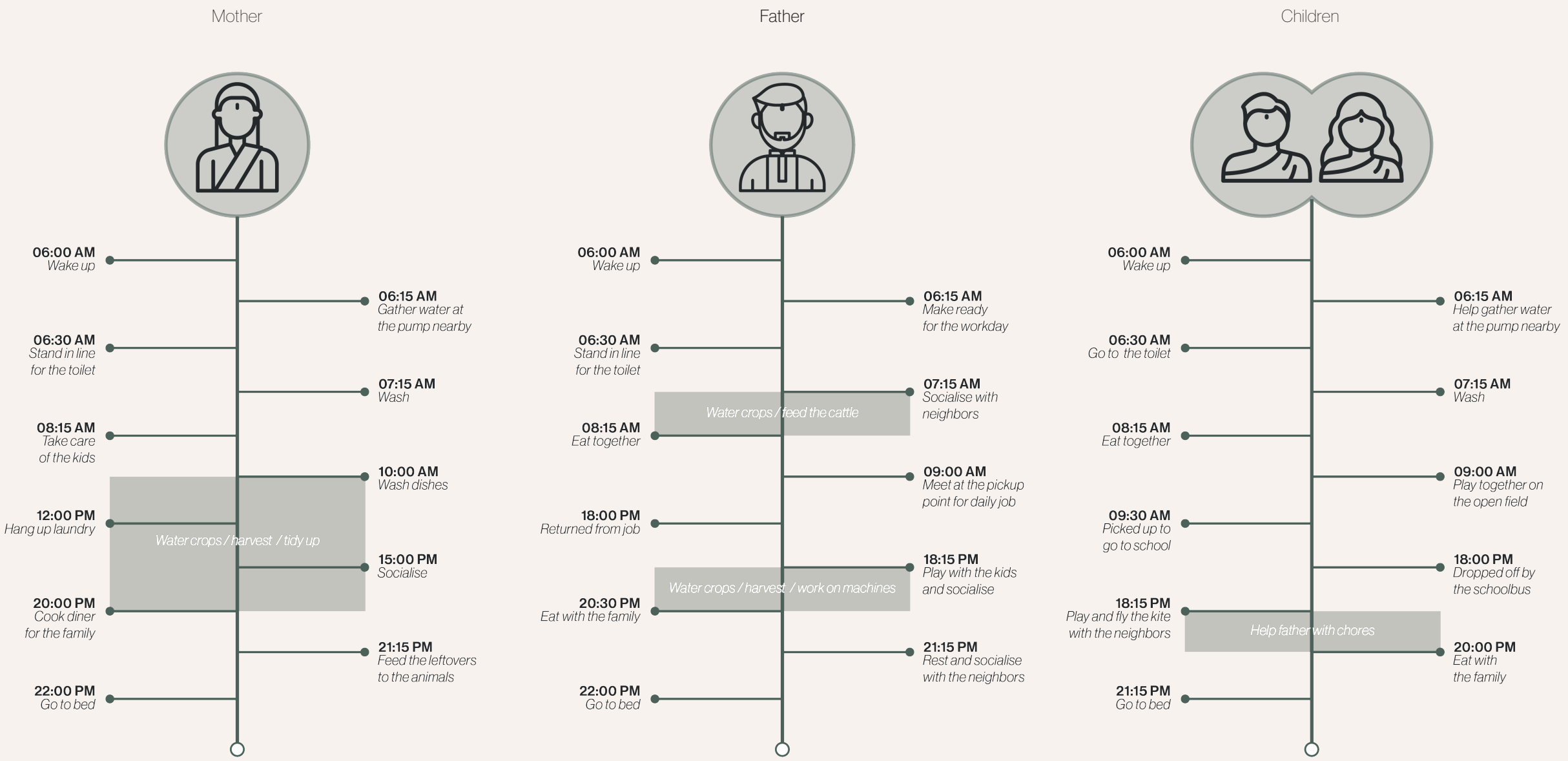


Figure 146. *Daily routines of Ahmedabad households with UA integrated in them*

Architectural spaces suitable for UA practices for each working scale
The working scales of each type of UA is further divided into what architectural spaces are suitable for hosting them in it. During the analysis it became clear that high-density housing entails that on the typology scale to be efficient with space, UA can only be practiced integrated into the kitchen in the form of a kitchen garden. The wadas, located on both ends of the typology units, and roof are other spaces on this scale that are able to integrate UA practices.

On the cluster scale the shared inner courtyard forms the space for integrating soil-based UA types. The vertical farm scales soil-less UA further and aims to maximise produce of crops. Lastly the urban scale offers spaces that promote UA to the public and as a way to trade and sell produce.

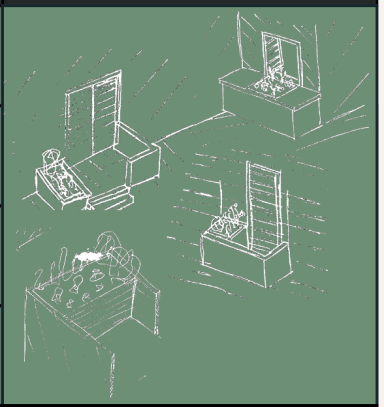
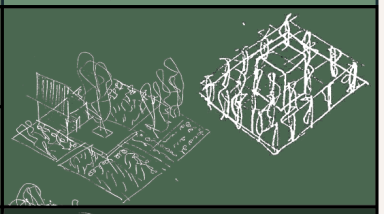
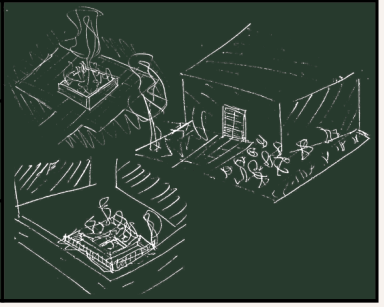
Working scale	Architectural space	Impression
Typology	*kitchen*	
	otla	
	balcony / terrace	
	roof	
Cluster	*inner courtyard*	
	vertical farm	
Urban	*public courtyard*	
	community-center plot	
	(market)square	

Figure 147. *Architectural spaces suitable for UA practices for each working scale*

UA x Arch integration
Connecting the types of UA to the gathered and analysed spaces, a base design framework is constructed that informs the design process on all three project scales (urban, cluster, typologies). The framework is used as a guide that translates the spatial- and technical requirements of different UA practices into spatial opportunities for creating productive landscapes. It identified where and how they can be integrated within the existing and proposed final design.

At the urban scale, it considers the distribution and accessibility of productive spaces and their relationship to the wider urban fabric. At the cluster scale, it informs the organisation of shared productive spaces and their relationship to collective activities and circulation. At the typology scale, it explores how UA can be incorporated into individual dwelling spaces, such as kitchen gardens, balconies, otlas and rooftops.

Together, these considerations establish a set of spatial principles that inform the placement, organisation and integration of UA throughout the project, while addressing the relationship between productive activities, architectural form and patterns of use.

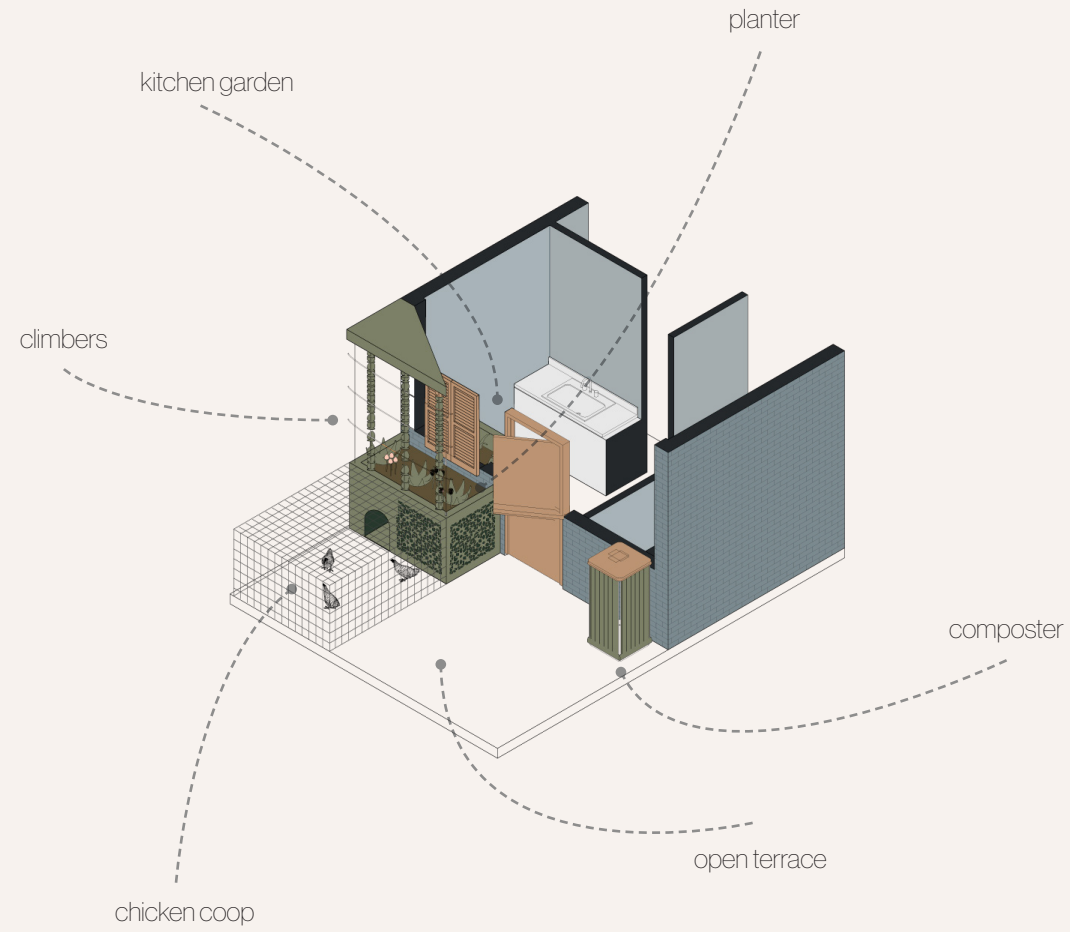


Figure 148. *UA x Arch integration within the typology*

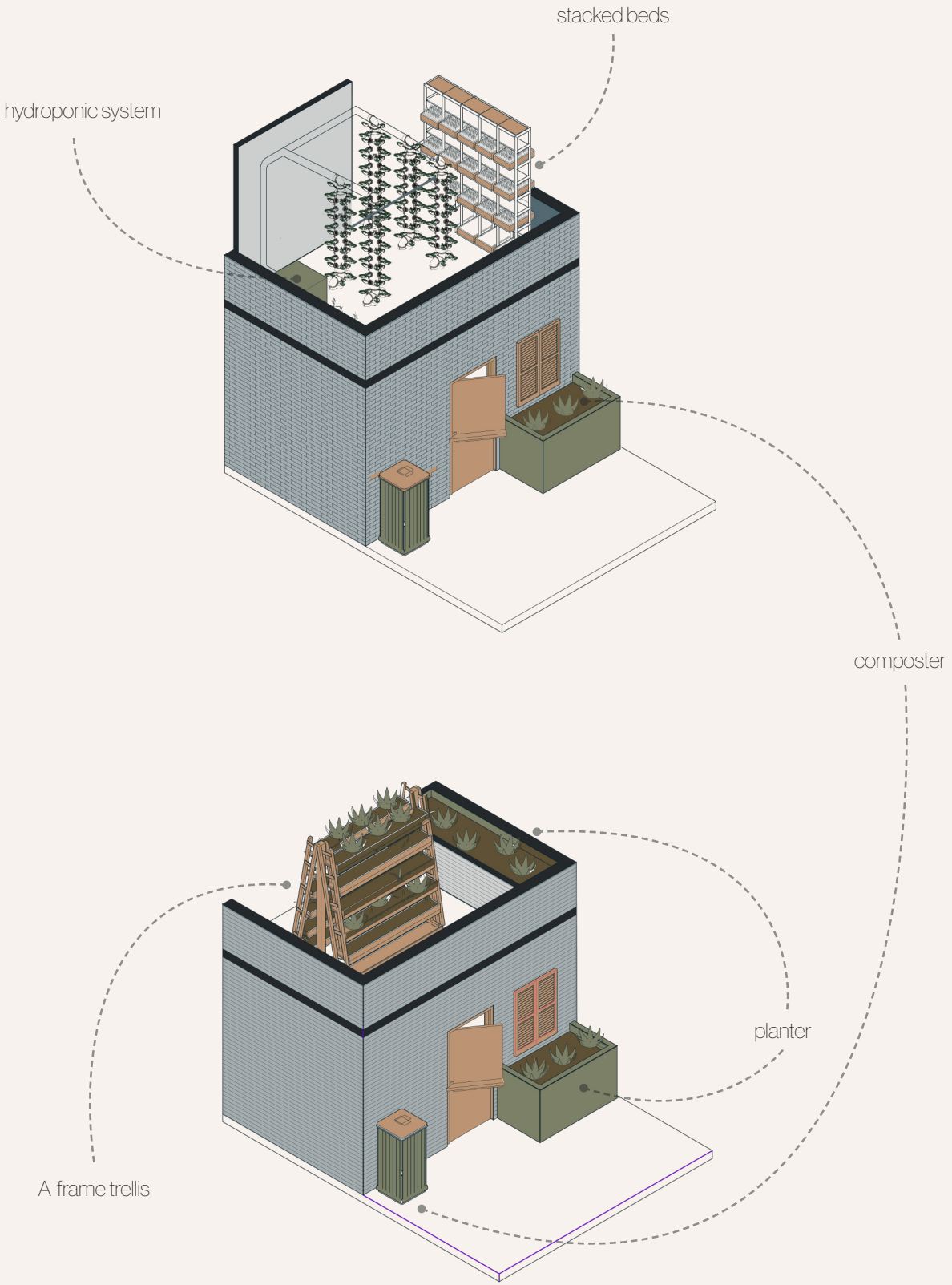


Figure 149. *UA x Arch integration on the roof of the typology*

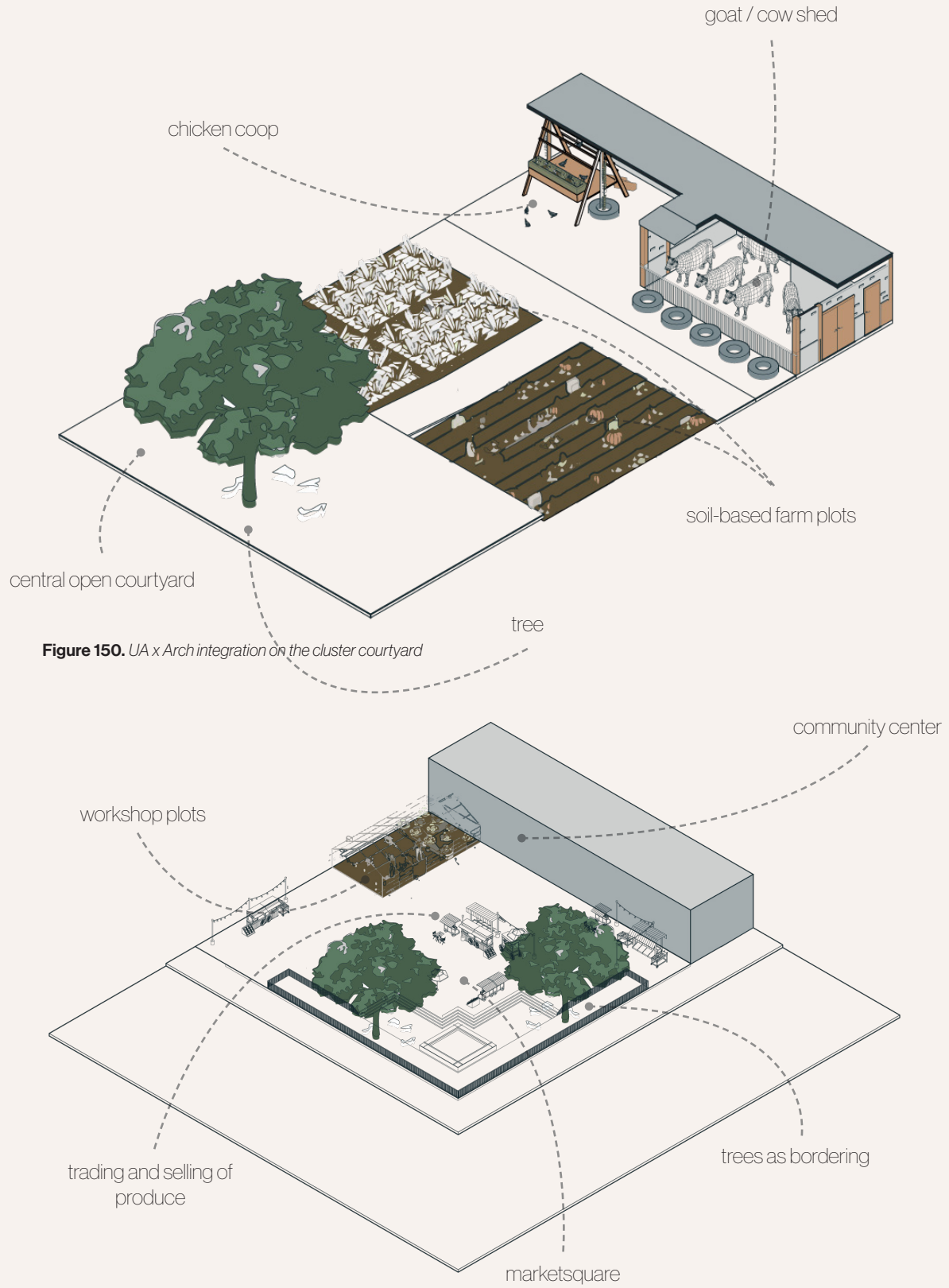


Figure 150. *UA x Arch integration on the cluster courtyard*

Figure 151. *UA x Arch integration on the urban public space*

4.2 | Design synthesis

In this section the design outputs are brought together to form the final design synthesis. The chapter is divided into three sections which will reason and lay out the design on the urban-, cluster-, and typology scale.

Figure 152. *Urban design impression*

4.2.1 | Urban masterplan

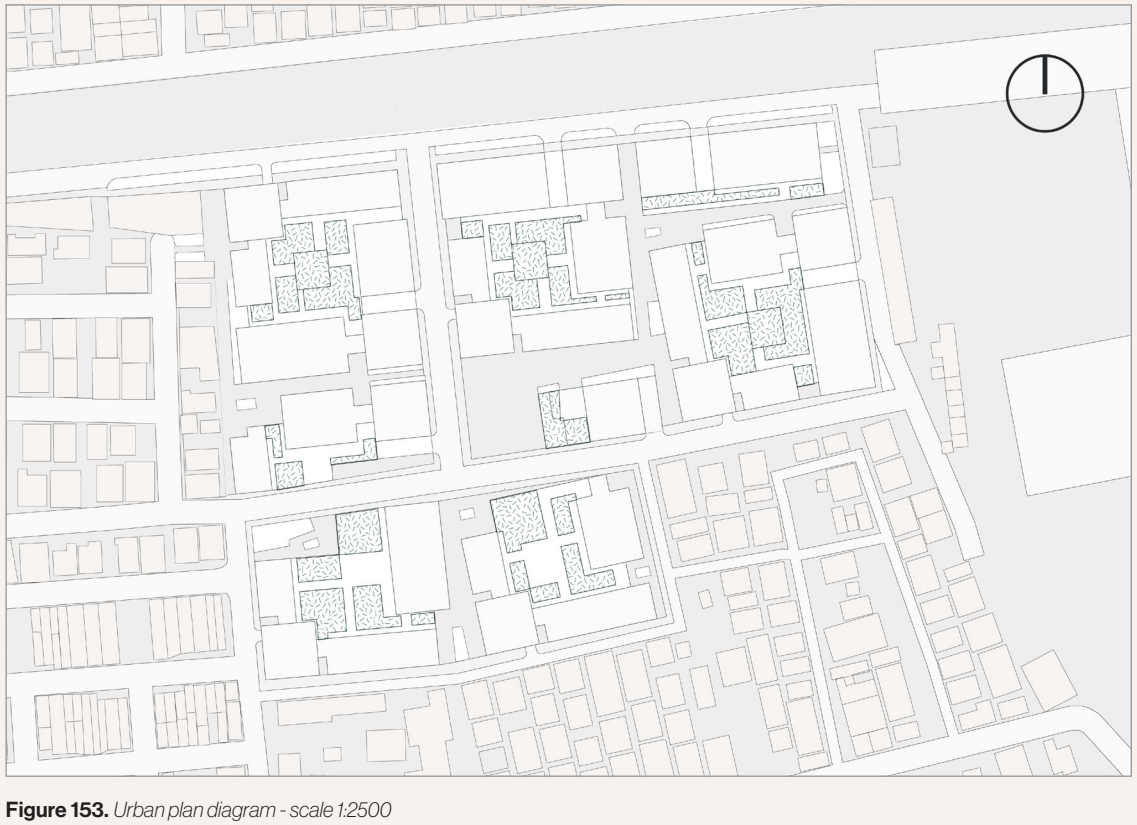


Figure 153. *Urban plan diagram - scale 1:2500*

The urban plan is buildup through repeatable clusters that are each adapted based on their interactions to their direct surroundings within the plot and the exisiting site and borders around the plot. In the hart of the clusters a shared courtyard for its residents is situated, while being closed of from the public. This courtyard becomes a place for farmable area in combination with social interaction and community activities. To ensure security of produce, the nature of these courtyards is more closed. However, at the sides, where two typology types meet, permeability can be found where jali bordering allows greenery and viewlines to blend between the cluster and the public.

In the middle of the site the marketsquare connects all the clusters that are formed around it together. Bigger-scaled activities like markets, festivals are able to be alternated here together with public space for leisure and winding down. The square can also be used by outside visitors and becomes the public node of the project. Situated along it, one of the vertical farm towers is placed. Together with shops, amenities and a community center, the groundlevel around the square becomes a public plint to its visitors and residents. The community center specifically will give the residents space to expand their agricultural knowledge base together with finding like-minded people interested in the practice. Workshops, seminars and public growing fields become the mediums to achieve this, while also make the core idea of UA more known to the public.

By keeping existing roadlines and continuing them throughout the plan they flow over and become connected to eachother. Buffers in the form of greenstructures and streets allow for transition space between the existing site and the clusters, continuing this principle of natural integration into the urban fabric.

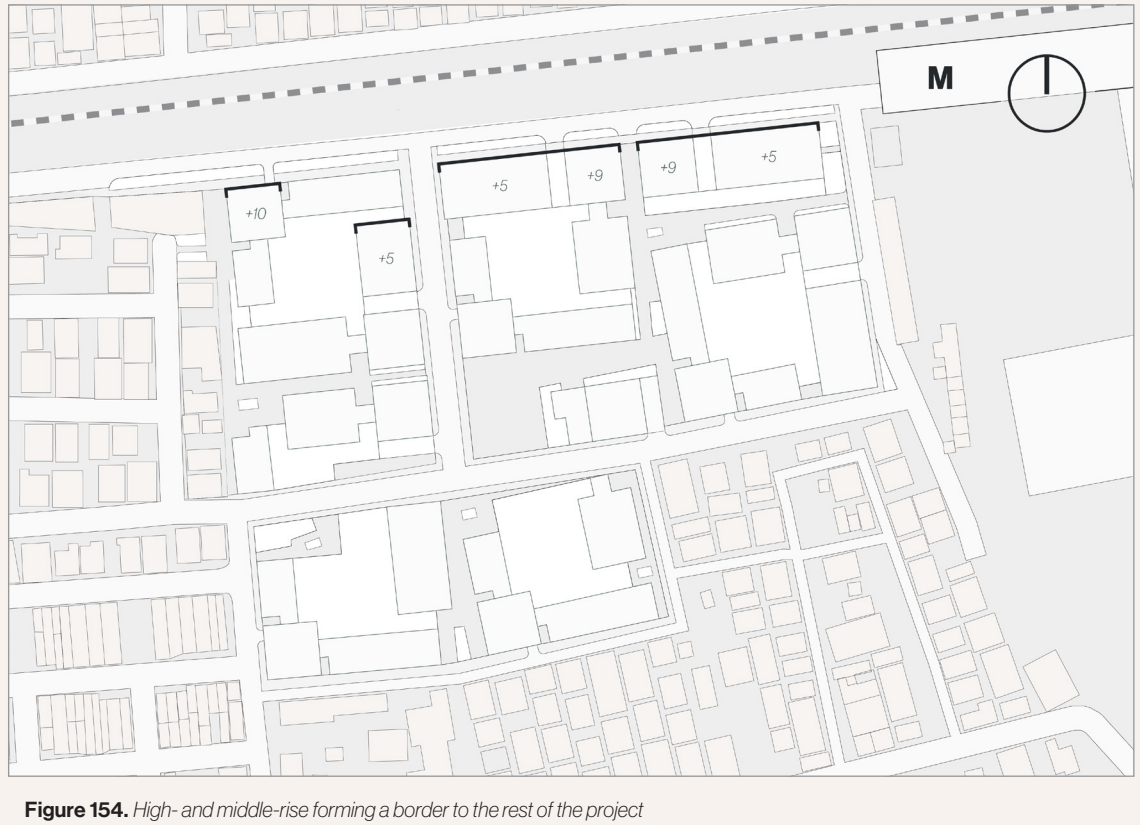


Figure 154. *High- and middle-rise forming a border to the rest of the project*

On the northside of the plot the busy vehicular road comes together with the bus-, metro- and train line, projecting both noise pollution and loss of privacy onto the site. By placing the taller building typologies along this edge in combination with a green bufferzone inbetween them, the development creates a protective barrier that noise transmission and shields the inner residential areas from the surrounding infrastructure. This way the north side of the plot also becomes less permeable through bigger block sizesallowing for a more guided infrastructure of where people walk into the neighborhood. The placement of these tall and wide buildings reduces noise pollution for the other dwellings on site.

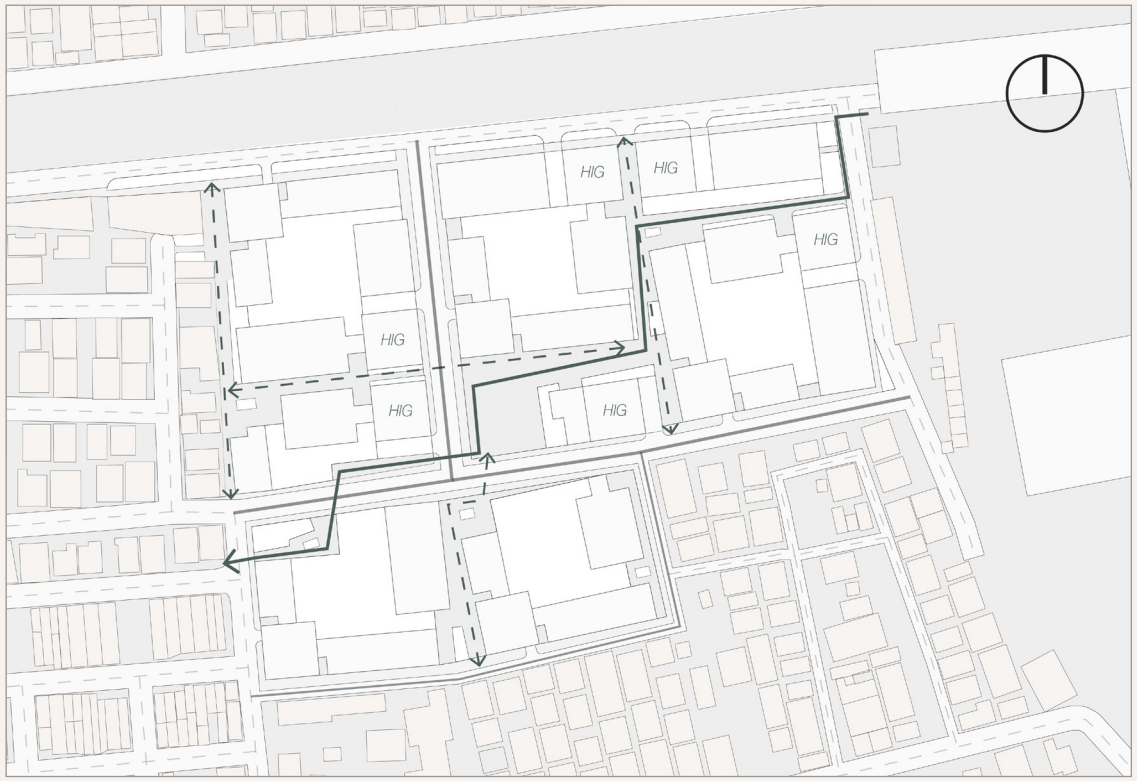


Figure 155. *The main circulation system - scale 1:2500*

The main pedestrian road is highlighted by the green arrow. It is wider than the other paths and guides the walker around the clusters to the square. The other pedestrian roads are branches from this main road to provide further access to each side of the cluster. Some of these walkpaths are relatively wider to accomodate for emergeny services to be able to reach all the units of the cluster when needed. Otherwise these streets are cut off from the vehicular road network. Within the cluster the walking paths are shared with each resident but closed off from the public.

There are two main new vehicular roads that connect to the existing vehicular roads located on the north- and eastside of the ploth, as shown above. The roads provide direct vehicular access to the clusters for the vertical farms and high income housing typologies. For the vertical farm this ensures proper logistics for loading and unloading while for the middle- and high income residents access to underground parking is provided.

While the clusters themselves already provide safety and security, the road network further diverts heavy traffic around the clusters and makes the inner public courtyards and streets inbetween them calmer, safer and more pedestrian-friendly.

The four typology types come together in the base cluster, providing a social- as well as a UA type mix within it. Each typology is oriented in a way to provide vehicular access where needed, while also not putting high-income households directly next to low-income households. The preference of the high-income group to be more sheltered from the low-income households is extended to that they are not directly placed next to existing housing at the edges of the plot.

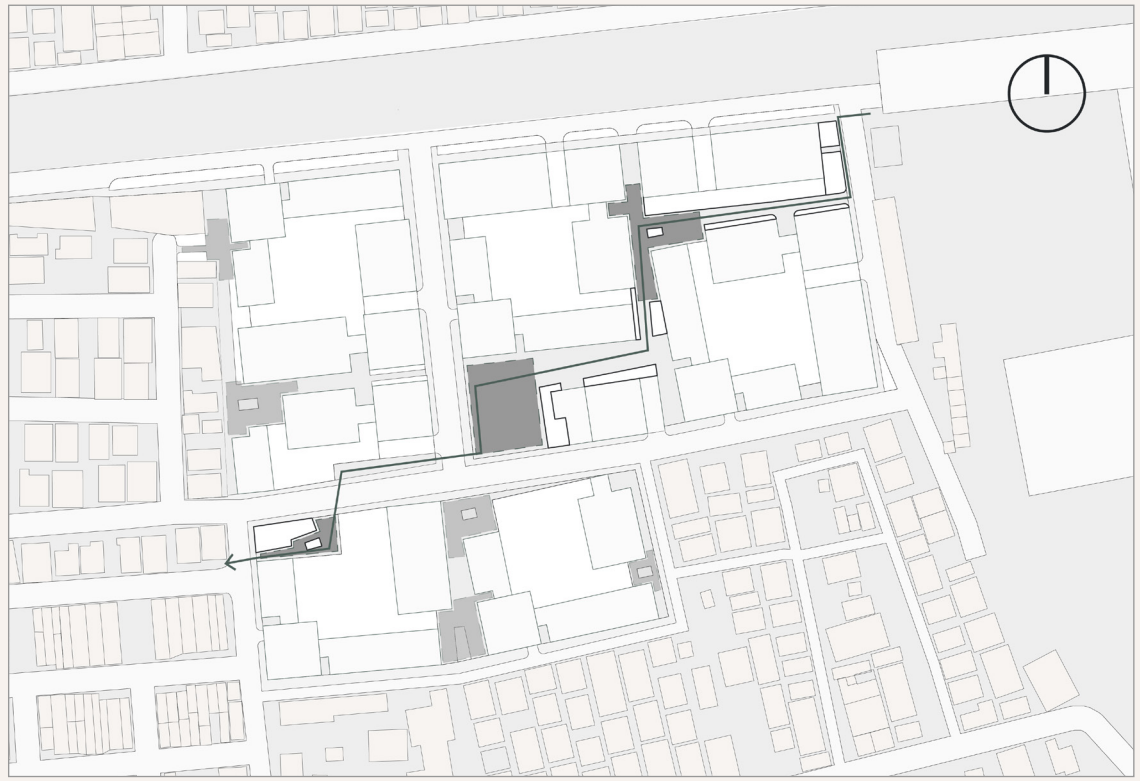


Figure 156. *Public courtyards along the pedestrian roads*

The location of the main pedestrian road is based on the existing route already used by to move through the plot. Because this informal route is already present it shows the importance of the connection from the north- to the westside for the neighborhood. The route is diverted slightly at the north-east corner so it instead of going through the cluster diagonally it goes under that first cluster to then form the rest of that routing to the westside. To emphasise the route the clusters along the route are adapted so that the public space that is created inbetween them keeps alternating between more narrow and more wide open pockets. Small public courtyards are created that attract the walker to move along the route to the next courtyard and allows for interactions and activities. The public courtyards form, together with the square, more public and shared spaces as an alternation of the more closed off courtyards inside the clusters. This way, varying views and accessibility provides diversification of spaces within the urban fabric of the plan.

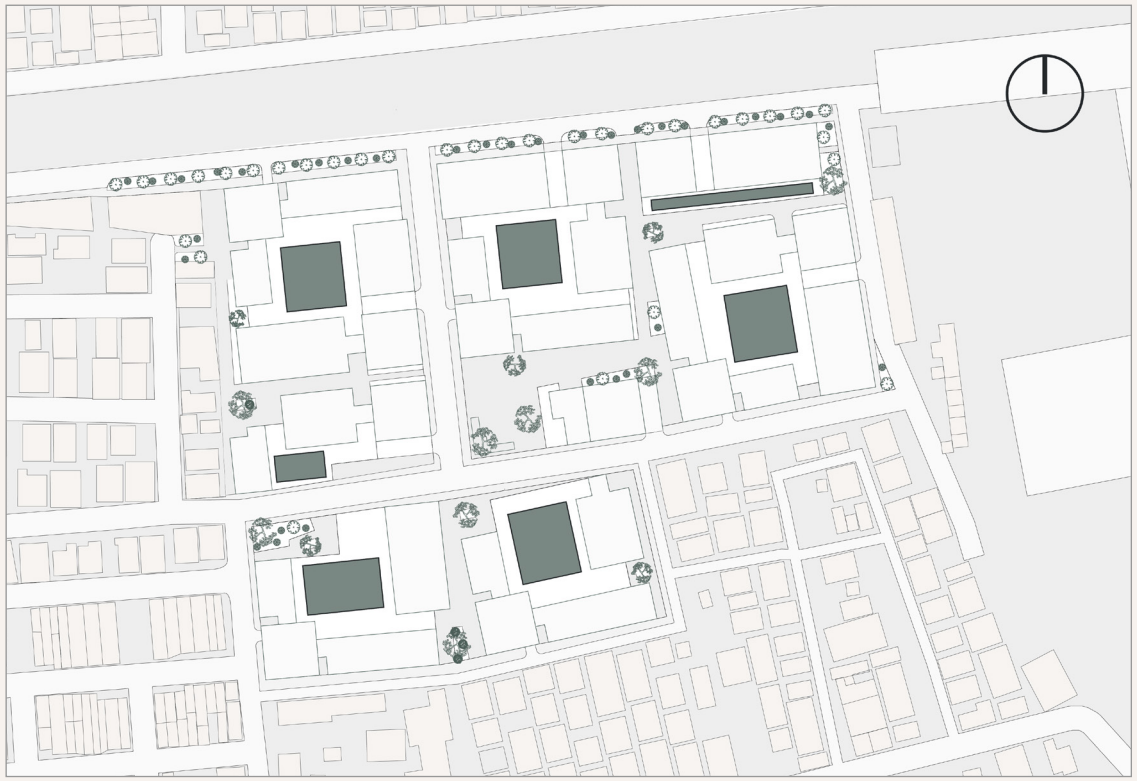


Figure 157. *Green structures of the urban design - scale 1:2500*

By using paving that is not always solid but at times permeable, excess rainwater can be guided to specific points in the plan where it can seep into the ground and add to the local groundwater body. It also makes the public streets more green and strengthens the idea of the CPUL to create continuous green landscapes. In the public spaces, trees and shrubs offer a form of natural bordering while also providing shade. For bordering evergreen shrubs are chosen that maintain their density throughout the seasons to provide year-round seperation. Either trees with a large crown or dense leave structure are chosen to provide shade and protection from external noise pollution.



Figure 158. *Connection of open public spaces*

The dotted arrows on the site plan show the visibility of each public space to the other, which, together with the housing units, provides more eyes on the street and -safety.

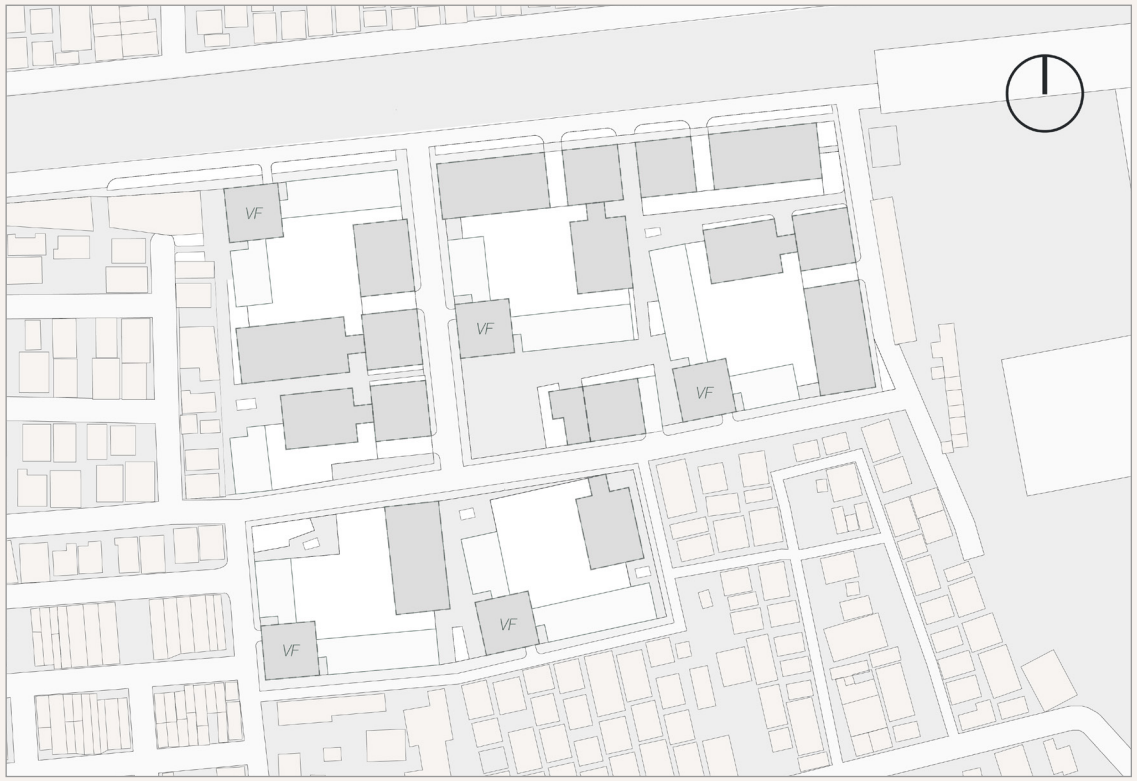
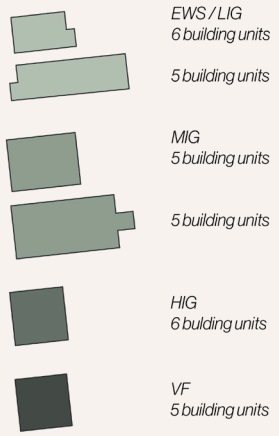


Figure 159. *Amenities that form the public plinths on the groundfloor - scale 1:2500*

The marked buildings show where public functions such as healthcare, daycare, shops and leisure are located on the site and form this public plinth that facing the streets. The places that are not directly adjecent to the main pedestrian roads offer spaces for local startups and companies to locate.



Figure 160. *Typology mix and cluster arrangement within the plot*



The following map underlines the four typologies together with the masterplan as a whole to their characteristics and placement.

Total site area: 32.600 m²
Build footprint: 14.744 m² (VF included)
Build up area: 53.616 m² (69.616 m² with VF buildings included)
Farmable footprint area: 20.160 m²

(actual farmable area dependent on UA type chosen; at least the footprint is returned in farmable area.)

(area for circulation and storage has already been excluded in the calculation.)

GSI: 0,45
FSI: 1,64 / 2,14

Amount of buildings of each typology:
- EWS / LIG = 160 dwelling units
- MIG = 115 dwelling units
- HIG = 48 dwelling units
- VF = 5 building units

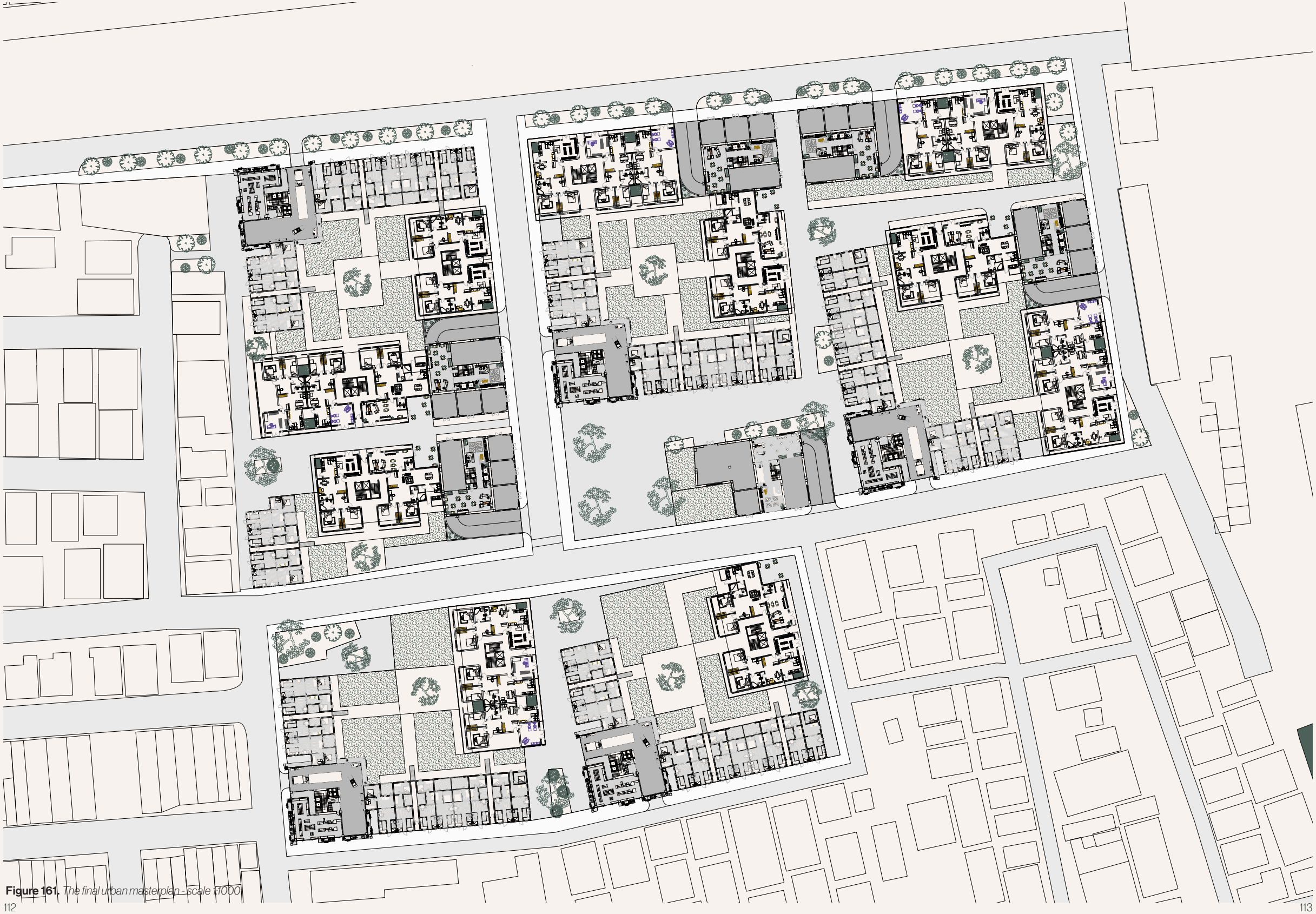


Figure 161. *The final urban masterplan - Scale 1:1000*

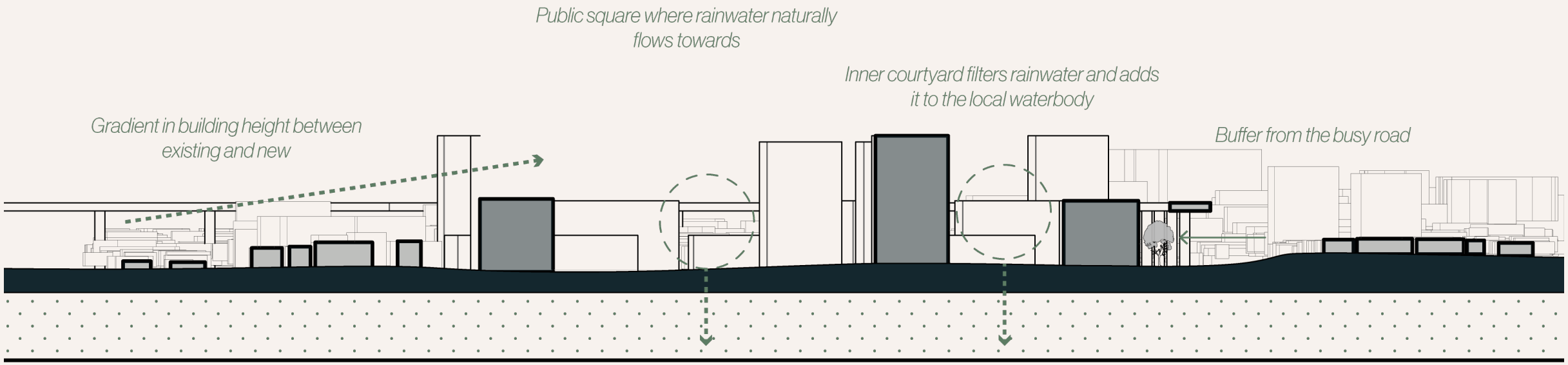


Figure 162. *N-S and E-W urban section showing interactions, the creation of spaces and climate strategies - scale 1:1200*

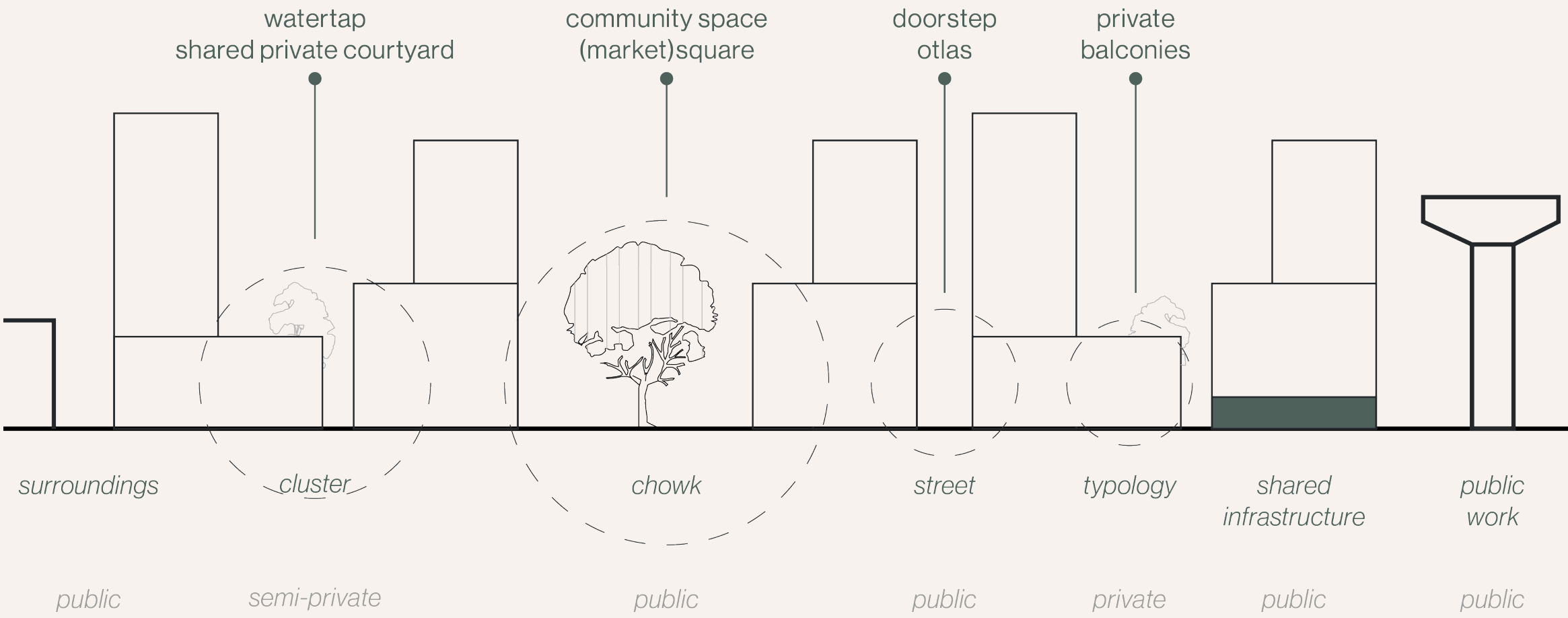


Figure 163. *The scales of public spaces and their privacy level within the urban design*

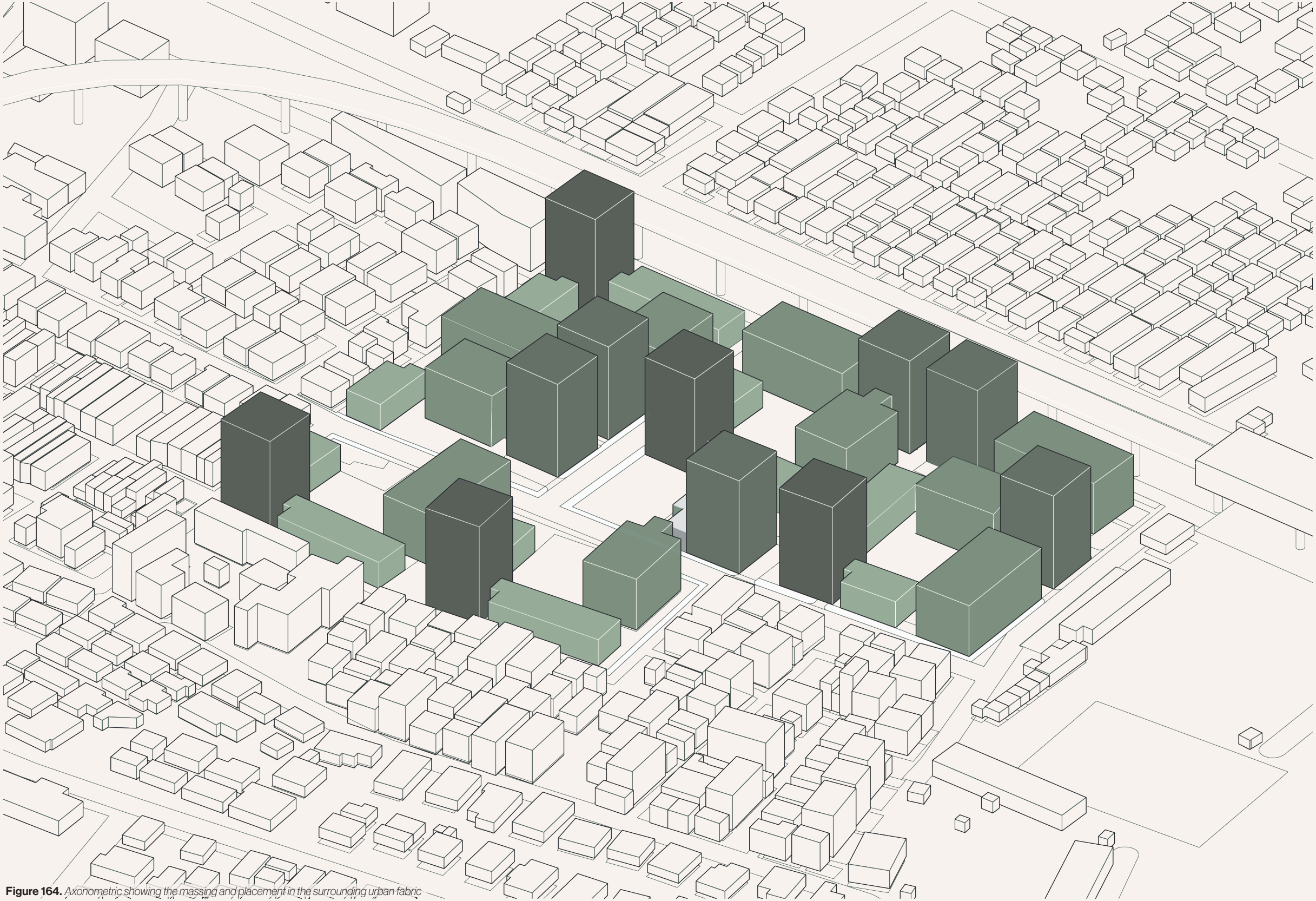


Figure 164. *Axonometric showing the massing and placement in the surrounding urban fabric*

4.2.2 | Cluster

On the cluster scale it is where all four typologies come together; the vertical farm and the lower-income-, middle-income, and high-income housing. The clusters are organised around the vehicular- and pedestrian roads around it. Commercial functions are located on the groundfloors of the middle- and high-income buildings, providing nearby amenities that clusters share and use together.

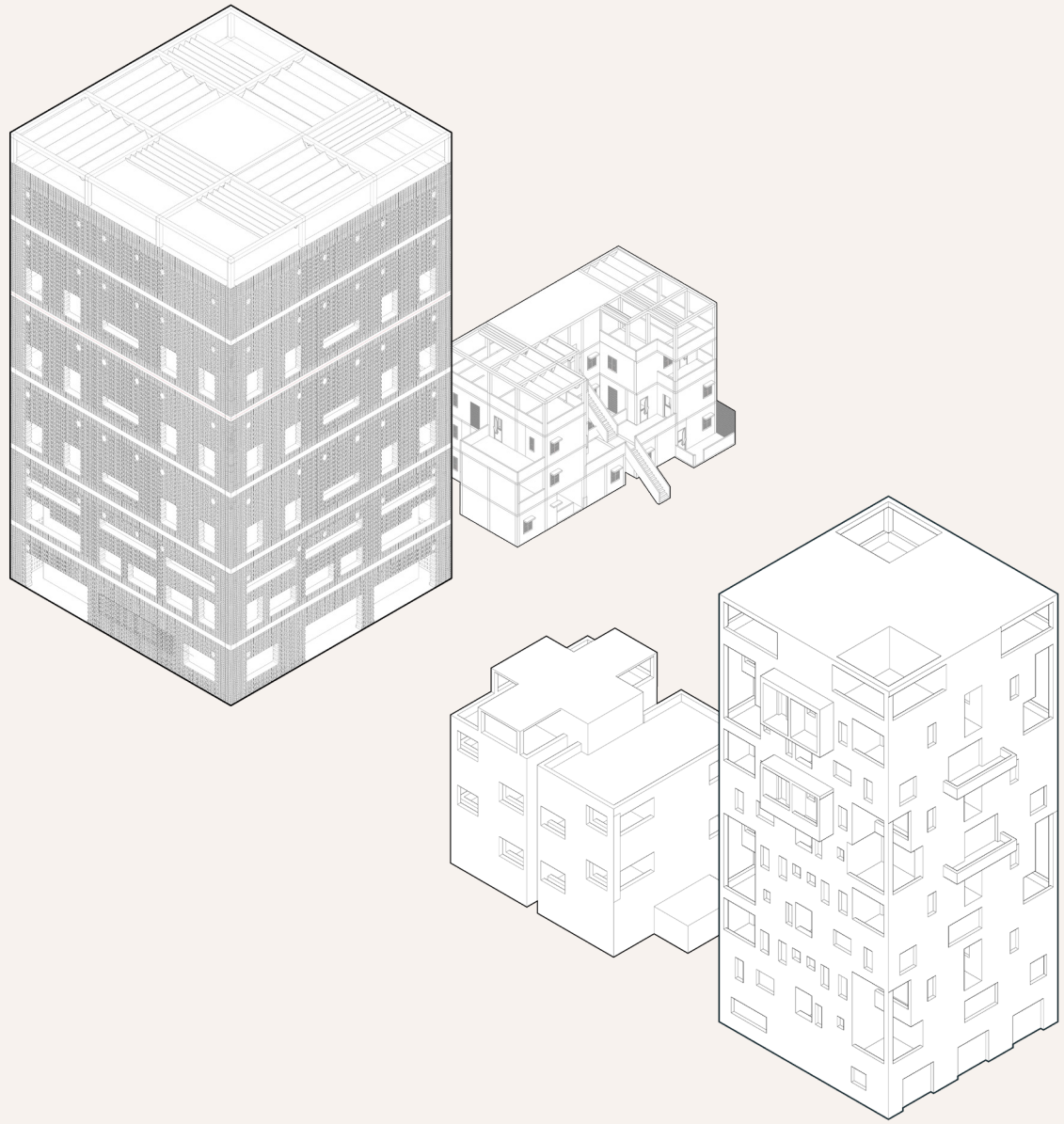
In the heart of the cluster a shared, private courtyard is located. Here the cluster community can come together and it is the place where households rent and sometimes expand their farming plots to practice soil-based agriculture or cattle herding. Each cluster also has an aquifer placed in the courtyard, where excess rainwater can seep into the groundwater body below it more sufficient in a way to prevent flooding and also a more consistent source of water throughout the dryer seasons. The roofs of the lower- and middle-income buildings also become spaces where UA is practiced. The vertical farm forms the commercial and professional side of UA practicing, where soil-less based agriculture produce is aimed to be maximised. This hierarchy of public, semi-public and privace spaces contribute to community formation, security and residential privacy.



Figure 165. *Groundfloorplan cluster*

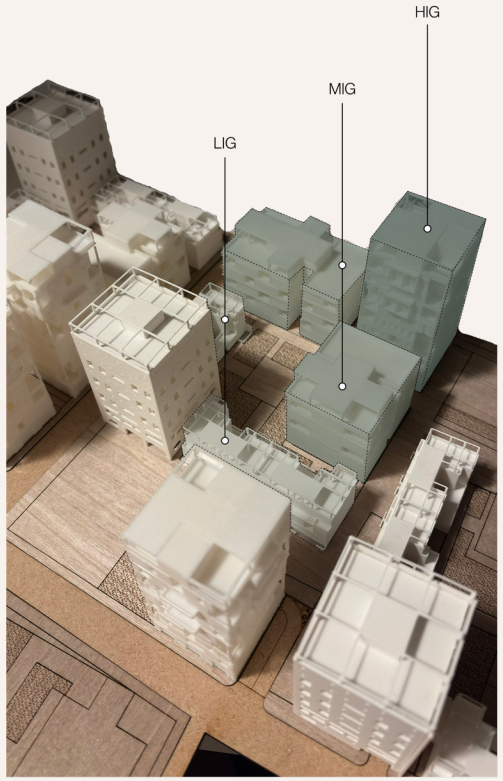
Target groups with their spatial aspirations

Group	m² (excl. outdoor)	Spatial qualities
EWS / LIG	36 - 60	- otla (public and on ground floor only) - wada (private outdoor space) - connection to the street - multifunctional indoor spaces - possibility to expand and grow in time - clear landownership and security/safety - flexible living environment - shared outdoor spaces - shared input UA practices (lower investment costs) - UA as leisure and supplement for cooking - scaling up of UA practices over time
(low and high) MIG	90 - 160	- privacy (only dwellings facing inward the cluster on the groundfloor) - wada (private outdoor space) - multiple bedrooms - elevator - public and private parts of the dwelling are clearly seperated - parking under the building is tried to be provided - kitchen garden - scaling up of UA practices over time - lucrative UA practicing
HIG	200+	- seperate entrance and room for the servant - entrance close to the elevator - multiple large wadas (private outdoor space) - public and private parts of the dwelling are clearly seperated - multiple bedrooms with on-suite bathrooms - parking under the building - kitchen garden (tended by the servant)
VF	- needs to bring back the footprint of the building in multiples of farmable area	- waste management - storage - public plinth of shops and delivery area - food processing - offices and control room - germination and cleaning layer - production floors - environmental control levels - climate installation spaces (water, electricity, ventilation) - storage tanks - soil-less UA practices placement - roof is also farmable area



There are four main typologies that get introduced in the masterplan and in each cluster. Three of them provide housing, while the fourth one introduces a more commercial building; the vertical farm. Each income has their own needs and aspirations which reflect in the qualities of the created spaces and dwellings for each group. Their different qualities are taken into account into the design..

Figure 166. *Massing of the four building typologies*



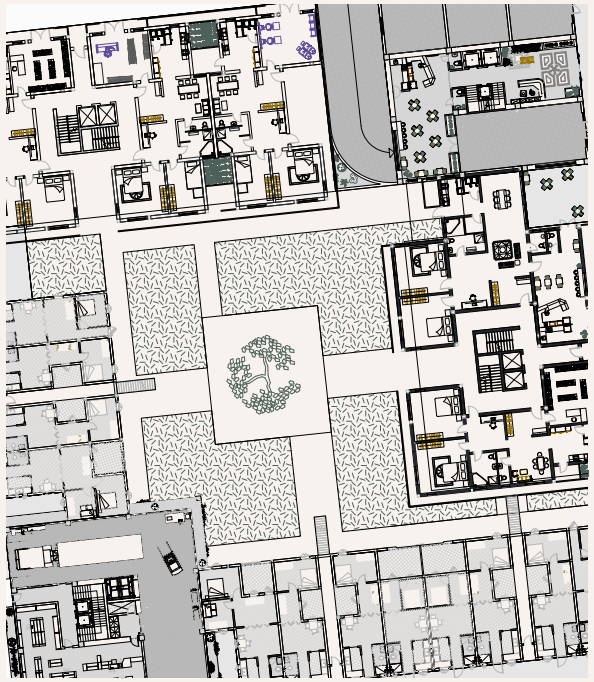
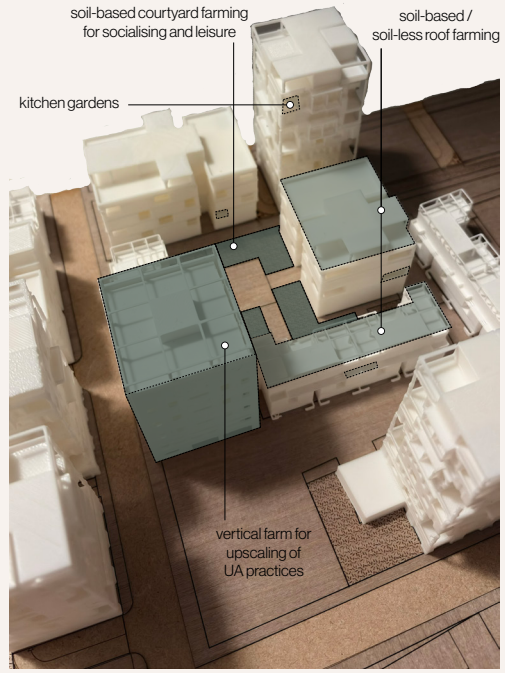


Figure 167. *Social mix within the cluster*

The cluster aims to create a social mix that is unified by the implementation of UA practices on different working scales. The middle-income buildings provide as a transition between the lower- and high-income buildings so they are not placed directly next to eachother. This way on one edge the high- and middle-income are placed and at the opposite the vertical farm with the lower-income buildings.



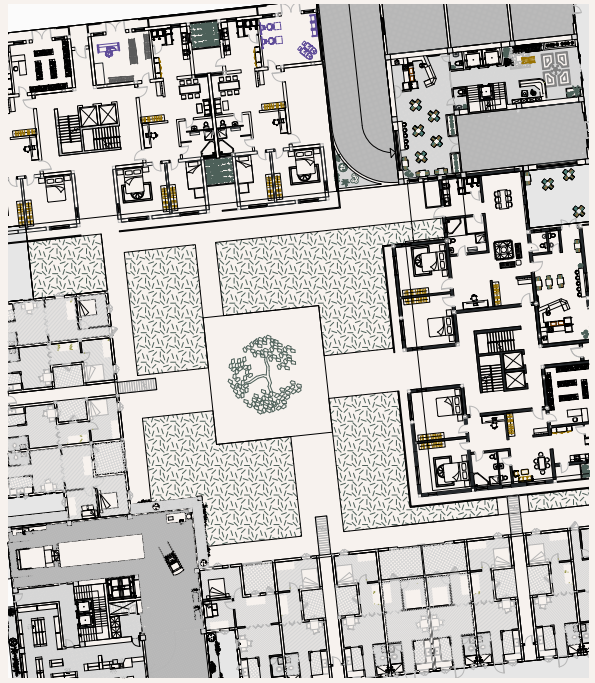


Figure 168. *UA type mix within the cluster*

The different UA types are also mixed together in the cluster. The courtyard provides soil-based agriculture and cattle herding that has the aim to provide and stimulate social interaction and own household consumption and sometimes creating small produce surpluses.

The roof privides space for shared input into either soil-based or soil-less UA practices owned by the household living in the units below it. By investing into soil-less UA practices, highter yields can be achieved and can be stored and sold locally. This way, different groups can also focus on different types or species and afterwards can exchange produce. Polyculture growing is stimulated which where not all the same vegetables or plants are grown everywhere. This system can then be alternated to also provide proper crop rotation, keeping soil quality and practicing varied.

As a bonus, households can privately grow small veggies and herbs in their kitchen garden and/or balcony or terrace. It is also the space where they can incementally expand their dwelling. That is why these spaces are not counted as farmable area within the design since their existence can change and adapt over time.

In the vertical farm it is where productivity and space efficiency are maximised to create high produce surpluses that are sold in the shop on the public groundfloor level. The productive floors implement soil-less UA practices in a controlled indoor climate and acts more as a system that provides the last, largest scale of agriculture that can be practiced within the urban fabric, while also aiming to provide high-density housing.

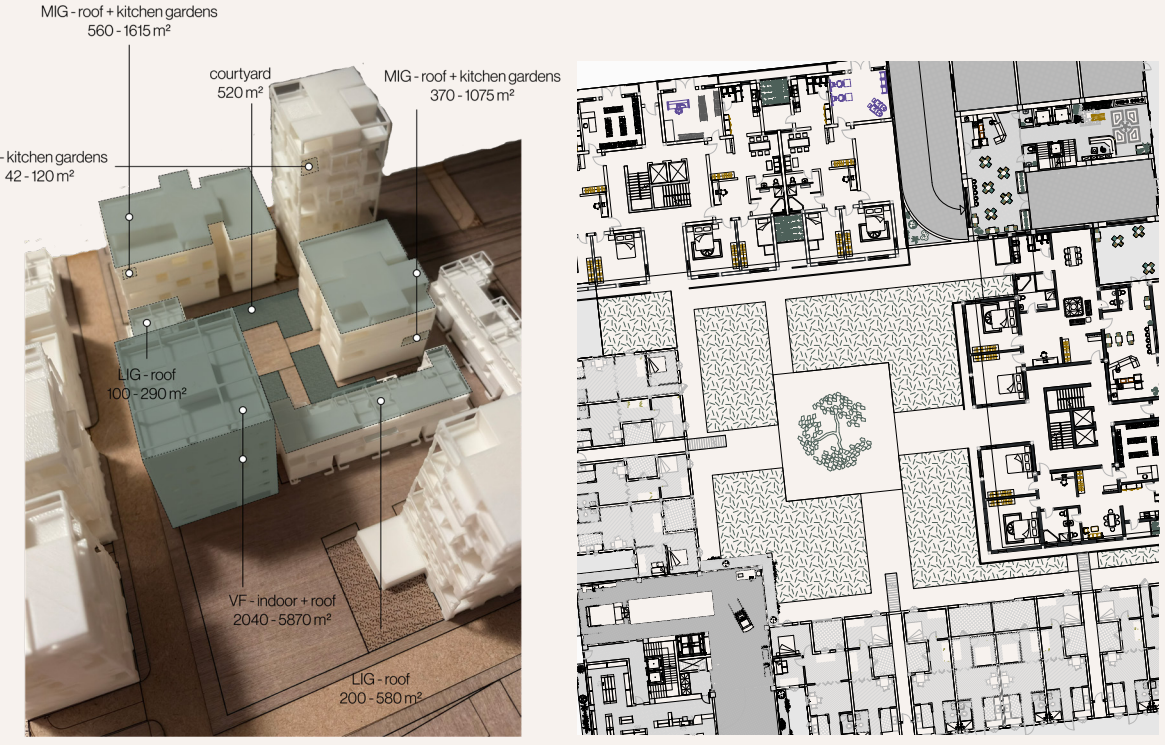


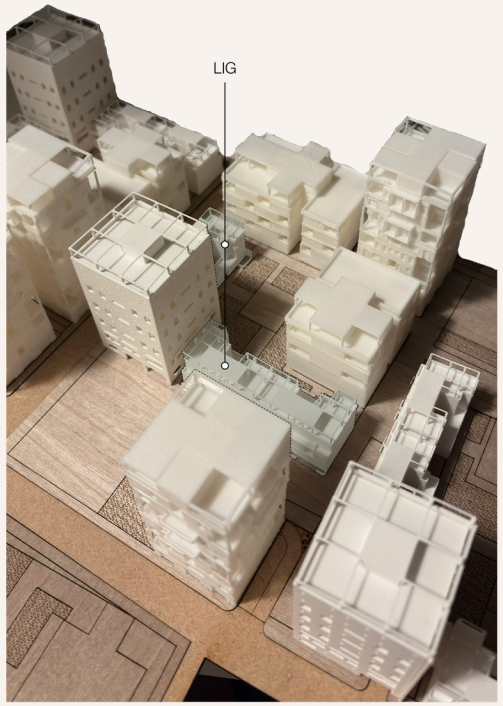
Figure 169. *Farmable area of the cluster*

Farmable area with their produce cultivation for each type of UA within the cluster.



Figure 170. *Public plinths of the cluster that face the street*

In the cluster a mix of functions, UA practices, income groups and typologies are thus introduced. By arranging the vertical farm and lower-income housing,- and the middle- and high-income buildings together, the middle-income buildings and the courtyard become the inbetween space that border the lower-income dwellings from the high-income ones, while still all living within the same cluster. Furthermore, each building is seperated from the other and thus different income-groups are slightly seperated from eachother, while they do still share facilities and amenities with eachother, located on the public plinth at the perimeter of the cluster. The unifying factor of all the income groups lays in the form of the different scales of UA practices that they either share and maintain together or own privately. It stimulates and promotes social interaction and local food production of the different income groups.



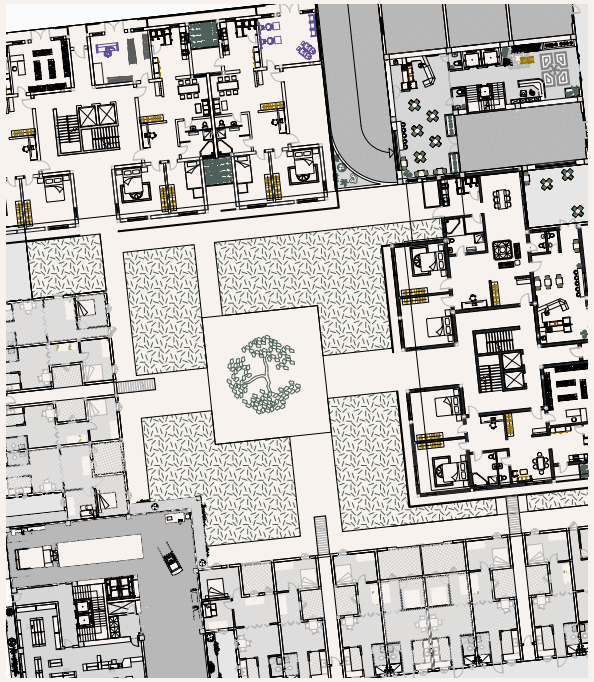
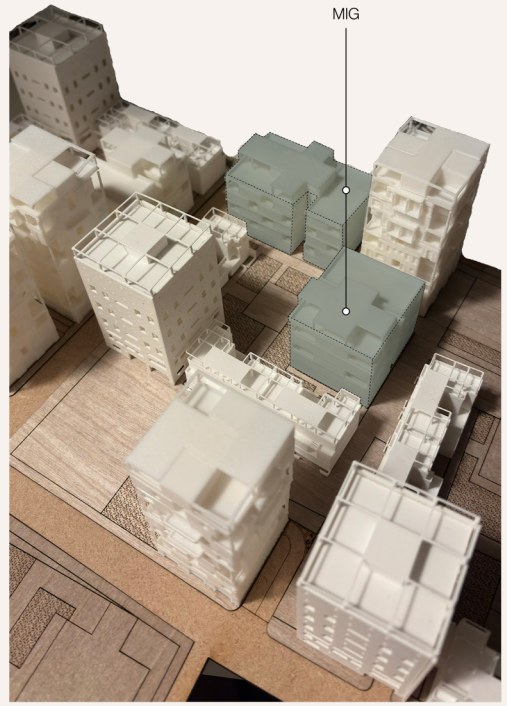


Figure 171. *LIG buildings*

The lower-income buildings are always placed along the two sides of the vertical farm, where there is one building on one side and two on the other. The groundfloor units include an otla facing the public street so that those streets become more activated and thus safe. Each building consists of three levels and either ten or twenty units per building. To keep the construction costs relatively low the units are created within a grid of 3000 x 4200 mm, with slight variations as the dwellings go up in level. Simple and fast construction and material choices become aspects where the design focusses on. The roof is the activated space for shared UA practices.



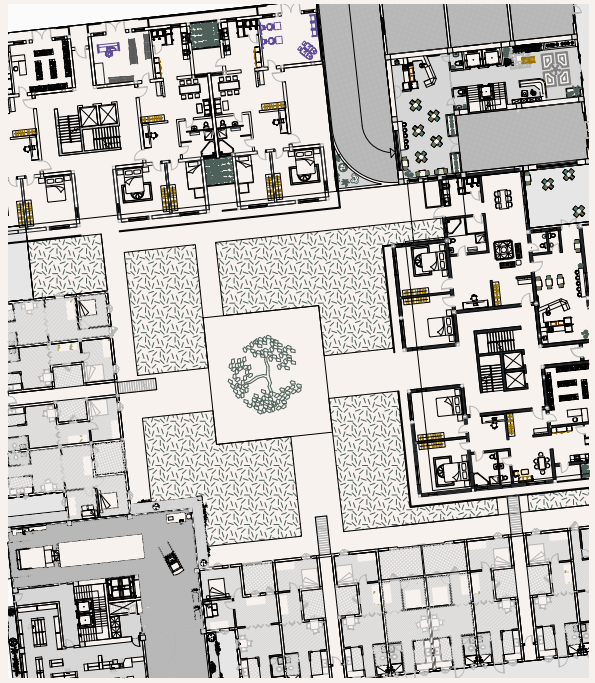
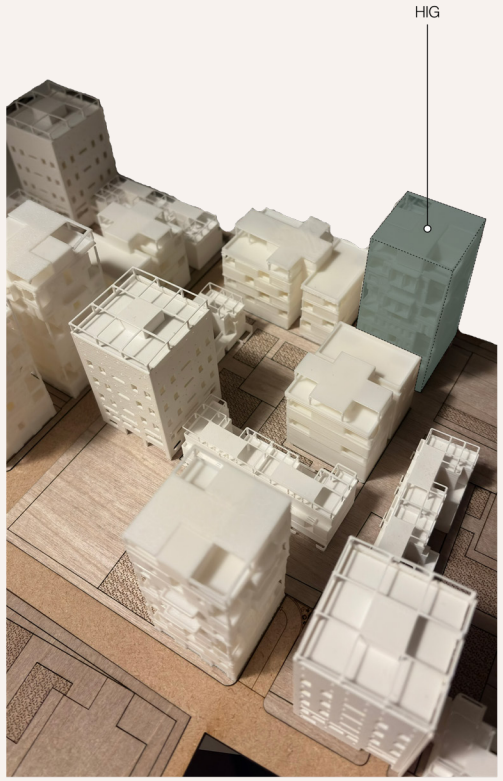


Figure 172. *MIG buildings*

The middle-income buildings are located on the two sides of the high-income tower where again on one there is placed one building and on the other two. They consist of a public groundfloor in combination with dwellings that face the inner courtyard. This public plinth hosts facilities like healthcare, daycare and shops. The four floors above are dwelling spaces. The foor and kitchen gardens become the main (shared) output spaces for the UA practices.

To make the cluster be able to accomodate different gradients of middle-income housing in terms of its size, floors on the second and third floor and the side facing the high-income tower, are half the size of the other units in the building. This creates apartments between the 90 and 160 m^2. Together they either fit fourtien and twentyone units per cluster. These dwelling sizes fall within the aspirations and affordability of the middle-income group and recognises that within the group there are different household types and sizes to cater for.



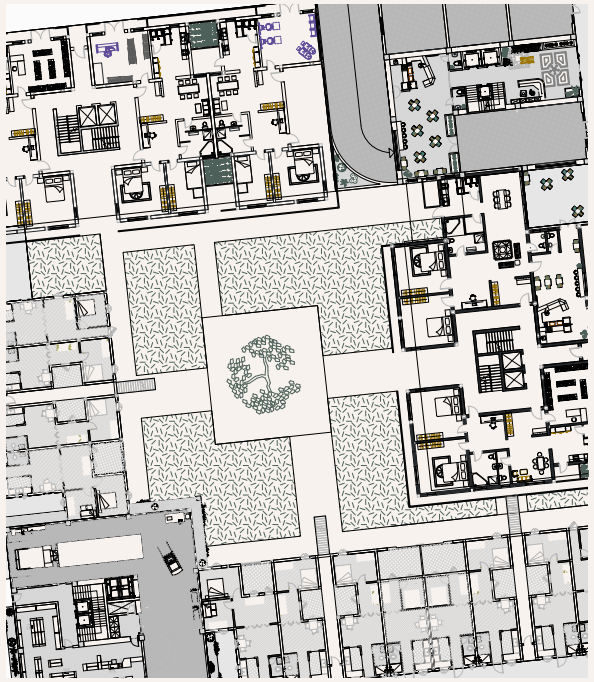
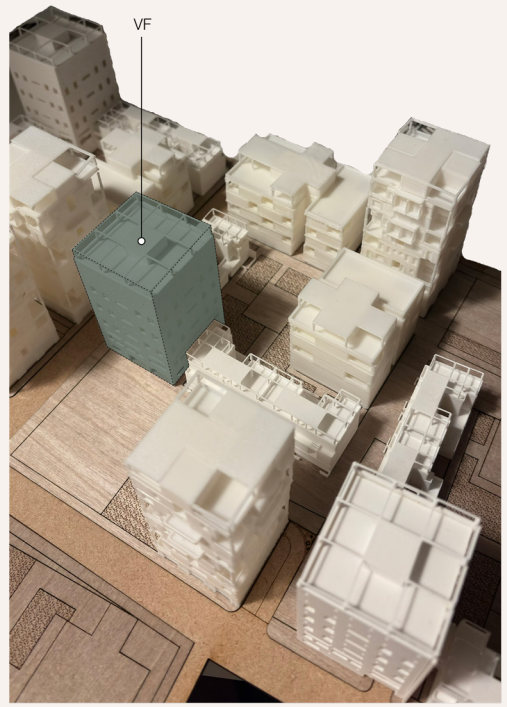


Figure 173. *HIG buildings*



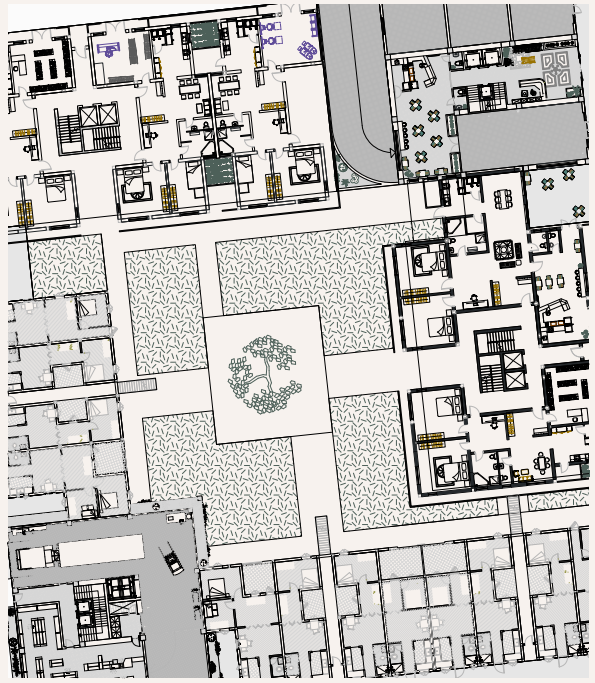


Figure 174. *VF building*

The high-income tower is located at the corner of the cluster, inbetween the two middle-income buildings. They consist of a public groundfloor with facilities like a gym, daycare, healthcare and shops. The entrance to the underground parking is also situated at the side of the tower. The eight floors above are dwellings and where from groundfloor +5 the dwellings get extra outside spaces since surrounding buildings are no longer hindering far sightlines. These dwellings consist of the same layout but become a bit more luxe-rious. This edge of the cluster will always have direct access to a vehicular road and is shielded from direct contact with surrounding lower-income buildings, either existing or newly intoduced. UA practices in this typology are integrated within the dwellings in the form of kitchen gardens. The roof becomes a shared space for the residents used for other activities like a bar or garden.

On the opposite edge of the cluster the vertical farm tower is placed inbetween the two lower-income buildings. This professional building acts like a machine creating UA produce surpluses that feed the cluster back and sell the rest of it in the shop located on the groundfloor. The underground levels of the building harbor storage, installations and waste management. The three floors above groundlevel facilitate support spaces for the production floors such as germination rooms and offices. Depending on the neighborhood demand and or aspiration of the investors/companies either two or three production floors can be build, starting from level four on. The floors themselves are double height (6000mm) so that the farmable area of each floor is expanded more efficiently. Above these floors an environmental control floor is incorporated, regulating further installations and cycles within the building design for it to function properly. The roof also becomes a space for UA practices that gets added to the total farmable area of the building, together with the production floors. The edge of this cluster will also have direct connection to a vehicular road to provide proper logistics with loading- and unloading to and from the building.



Figure 175. *Privacy and security through bordering eyes on the street*



Figure 176. *Cluster courtyard*

To provide further safety and active streets, it is important that the streets are occupied by people on the otlas and by placing commercial and community functions along them to create public plinths. The middle- and high-income households ask for more privacy of their homes, which is why their groundfloor also becomes a public plinth with different amenities and their dwellings are situated behind (middle-income only) and above them (both middle- and high-income).

In the center of the cluster the community has space for activities, socialising, practicing religion and soil-based agriculture practices/cattle herding through the use of a stepped courtyard. For the rest it is up to them to what activities arise in it. Farm plots can be shared and expanded so that the practice can be put out by the households that aspire to do so. Together it provides social cohesion, safety and privacy within the shared space of the cluster.

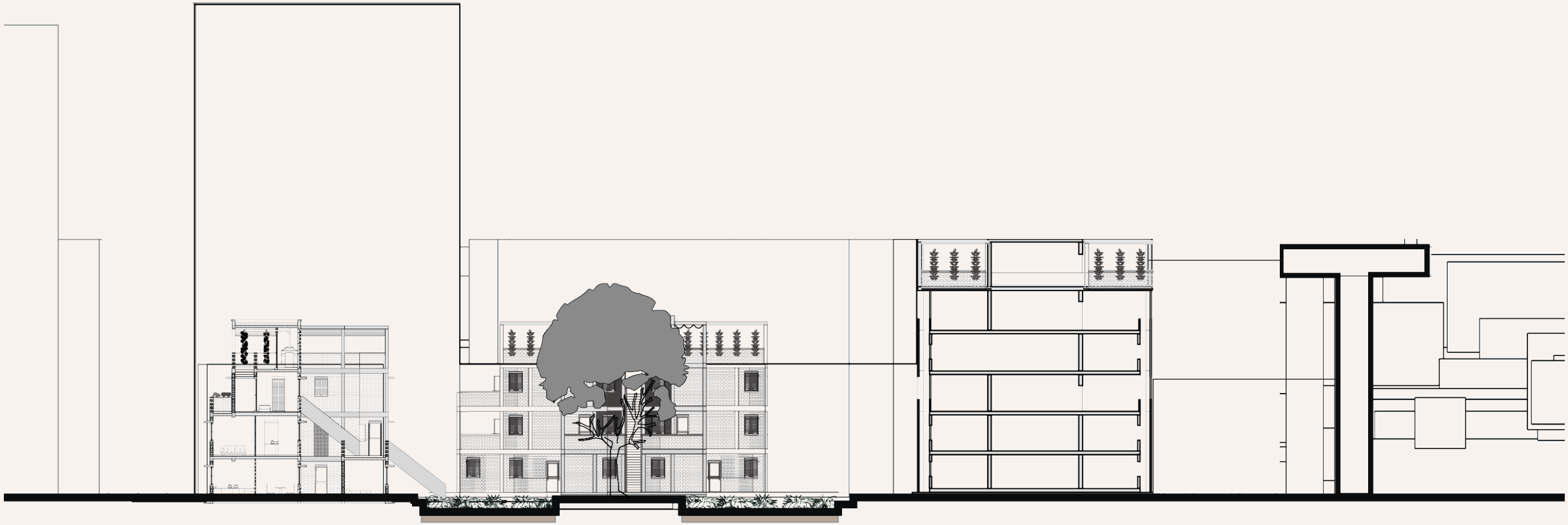
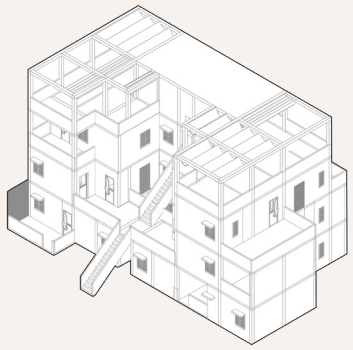


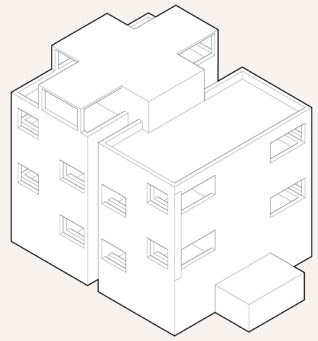
Figure 177. *N-S cluster section showing the interaction of the buildings to the street and the inner courtyard*

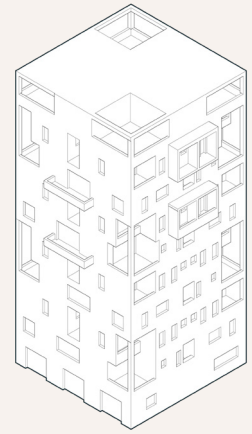
4.2.3 | Typologies

In this section the design outputs of each of the four typologies are brought together. First the lower-income and then the middle- and high-income typologies are layed out. Lastly the vertical farm design is presented.

Circulation of the farmable areas include space for storage and on the residential roofs, stacked beds are calculated with more space between beds so that artificial lighting is not required. Yields per week are an indication and differ between out- and indoor environments.

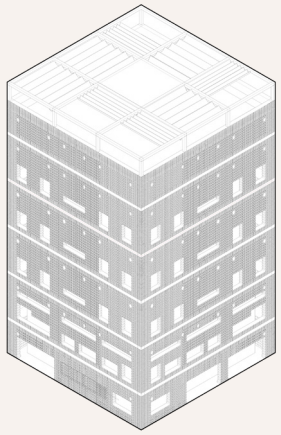






- **Target group:**	low-income / economically weaker section	low middle-income / high middle-income	high-income
- **Type of unit:**	residential	residential	residential
- **Amount of stories:**	3	5	9
- **Floorplan types:**	3 - (plus two variation floorplans)	3 - (plus three variation floorplans)	2
- **Floorplan area:**	30, 40, 45, 50, 55 m^2	- Floorplan area: 90, 105, 120, 160 m^2	254 m^2 (duplex dwellings)
- **Balcony/terrace area:**	0, 2,5, 5, 8, 8,5, 18,5 m^2	- Balcony/terrace area: 18, 20, 30 m^2	5, 12, 17 m^2
- **Circulation:**	through shared staircases	elevator and staircases	elevators and staircases - seperate for the servant
- **Rooms:**	1/2 bedrooms, otla, hall, kitchen, common room, private room, terrace/balcony	- Rooms: 2/3 bedrooms, 2 bathrooms, hall, kitchen, living room, study room	3 bedrooms +1 guest- , 3 en-suite bathrooms, 1 bath room, kitchen, dining-, living-, study-, servant room,
- **Footprint:**	250 m^2 / 500 m^2	475 m^2 / 712 m^2	324 m^2 drawing room, balconies
- **Buildup area:**	445 m^2 / 890 m^2	2025 m^2 / 3040 m^2	2916 m^2
- **FSI**	1, 78	4,26	9
- **Roof area:**	135 m^2 / 202,5 m^2	385 m^2 / 580 m^2	288 m^2
- **Spaces for UA practices:**	roof	roof and kitchen garden - (16, 20 m^2)	kitchen garden - (6,5 m^2)

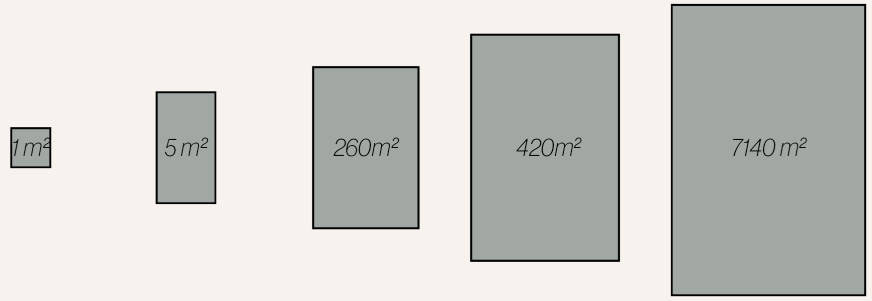
- **Farmable area:**			135 m^2	- (smaller LIG building)		497 m^2	52 m^2
- Circulation area	- 25%		33,75 m^2	- (including storage area)	- 25%	124,25 m^2	- 20% 10,4 m^2
- Area for planters	1 x 101,25		101,25 m^2		1 x 372,75	372,75 m^2	1 x 41,6 41,6 m^2
- Area for stacked beds	2,5 x 101,25		253,125 m^2	- (no artificial lighting - more height between beds)	2,5 x 372,75	931,88 m^2	2,5 x 41,6 104 m^2
- Area for A-frame trellises	2,8 x 101,25		283,50 m^2		2,8 x 372,75	1043,70 m^2	2,8 x 41,6 116,48 m^2
- Area for hydroponic columns	2,88 x 101,25		291,60 m^2		2,88 x 372,75	1073,52 m^2	2,88 x 41,6 119,84 m^2
- **Annual crop yields:**							
- Lettuce				- (3 kg / m^2)	- Lettuce		
- planters	303,75 kg		868 crops		1118,25 kg	3195 crops	124,8 kg 360 crops
- stacked beds	759,375 kg		2170 crops		2795,64 kg	7987 crops	312 kg 888 crops
- A-frame trellises	850,5 kg		2430 crops		3131,10 kg	8946 crops	349,44 kg 1000 crops
- hydroponic columns	874,8 kg		2499 crops		3220 kg	9202 crops	359,52 kg 1024 crops
- Tomatoes				- (8 kg / m^2)	- Tomatoes		
- planters	810 kg		5400 fruits		2982 kg	19.880 fruits	332,8 kg 2216 fruits
- stacked beds	2025 kg		13.500 fruits		7455,04 kg	49.700 fruits	832 kg 5544 fruits
- A-frame trellises	2268 kg		15.120 fruits		8349,60 kg	55.664 fruits	931,84 kg 6216 fruits
- hydroponic columns	2332,8 kg		15.552 fruits		8588,16 kg	57.254 fruits	958,72 kg 6392 fruits
- Bell peppers				- (12 kg / m^2)	- Bell peppers		
- planters	1215 kg		6075 fruits		4473 kg	22.365 fruits	499,2 kg 2496 fruits
- stacked beds	3037,5 kg		15.188 fruits		11.182,56 kg	55.913 fruits	1248 kg 6240 fruits
- A-frame trellises	3402 kg		17.010 fruits		12.524,4 kg	62.622 fruits	1397,76 kg 6992 fruits
- hydroponic columns	3499,2 kg		17.496 fruits		12.882,24 kg	64.411 fruits	1438,08 kg 7192 fruits
- **Yields per household:**							
- lettuce	1,66 / 4,16 / 4,66 / 4,79		crops	- (per week)	5,11 / 12,76 / 14,30 / 14,71	crops	0,86 / 2,13 / 2,40 / 2,45 crops
- tomatoes	10,36 / 25,89 / 29,00 / 29,83		fruits	- (per week)	31,77 / 79,43 / 88,96 / 91,50	fruits	4,35 / 13,29 / 14,90 / 15,32 fruits
- bell peppers	11,65 / 29,13 / 32,62 / 33,55		fruits	- (per week)	35,74 / 89,36 / 100,08 / 102,94	fruits	5,98 / 14,96 / 16,76 / 17,24 fruits



- **Target group:** investors / companies
- **Type of unit:** commercial
- **Amount of stories:** 8
- **Floorplan types:** 6
- **Floorplan area:** 324 m^2
- **Balcony/terrace area:** 0 m^2
- **Circulation:** through staircases and elevators
- **Rooms:** storage, waste management, installations, shop, packaging, offices, control room, food processing, germination room, cleaning room, loading dock, production floors, meeting rooms, environmental control room with installations, bathrooms, changing rooms, cantine.
- **Footprint:** 400 m^2
- **Buildup area:** 3200 m^2
- **FSI** 8
- **Roof area:** 364 m^2
- **Spaces for UA practices:** roof and production floors

- **Farmable area:** 2548 m^2
- Circulation area - 20% 509,60 m^2
- Area for planters 1 x 2038,4 2038,4 m^2
- Area for stacked beds 5 x 2038,4 10.192 m^2
- Area for A-frame trellises 2,8 x 2038,4 5707,52 m^2
- Area for hydroponic columns 2,88 x 2038,4 5870,59 m^2

- **Annual crop yields:**
  - Lettuce - (16 kg / m^2)
    - planters 32.614,40 kg 93.184 crops
    - stacked beds 163.072 kg 465.920 crops
    - A-frame trellises 91.320,32 kg 260.915 crops
    - hydroponic columns 93.929,44 kg 268.370 crops
  - Tomatoes - (3 kg / m^2)
    - planters 6115,20 kg 40.768 fruits
    - stacked beds 30.576 kg 203.840 fruits
    - A-frame trellises 17.122,56 kg 114.150 fruits
    - hydroponic columns 17.611,77 kg 117.412 fruits
  - Bell peppers - (12 kg / m^2)
    - planters 24.460,80 kg 122.304 fruits
    - stacked beds 122.304 kg 611.520 fruits
    - A-frame trellises 68.490,24 kg 342.451 fruits
    - hydroponic columns 70.447,08 kg 352.235 fruits
- **Compared to traditional greenhouse farming:** 400 m^2 - (polyhouse, same footprint)
  - Circulation area - 10% 40 m^2
- **Annual crop yields:**
  - Lettuce & bell peppers - (16 kg / m^2)
    5760 kg - 16.457 crops / 28.800 fruits
  - Tomatoes - (17,5 kg / m^2)
    6300 kg 42.000 fruits



	square meter	parking space	tennis court	basketball court	soccer field
LIG building	100 -290	20 - 58	1	0,5	-
MIG building	375 - 1075	75 - 215	1 - 4	1 - 2,5	-
HIG building	41 - 120	8 - 24	-	-	-
VF	2040 - 5870	408 - 1174	7,5 - 22,5	4,5 - 14	0,8

Figure 178. *Comparison of the farmable area of each cluster*

To make the farmable area of each (smallest version) of the building typologies more tangable, their size is compared to typical floor areas of sports fields. The range of the farmable area is depended on the chosen type of UA that is chosen to be practiced.

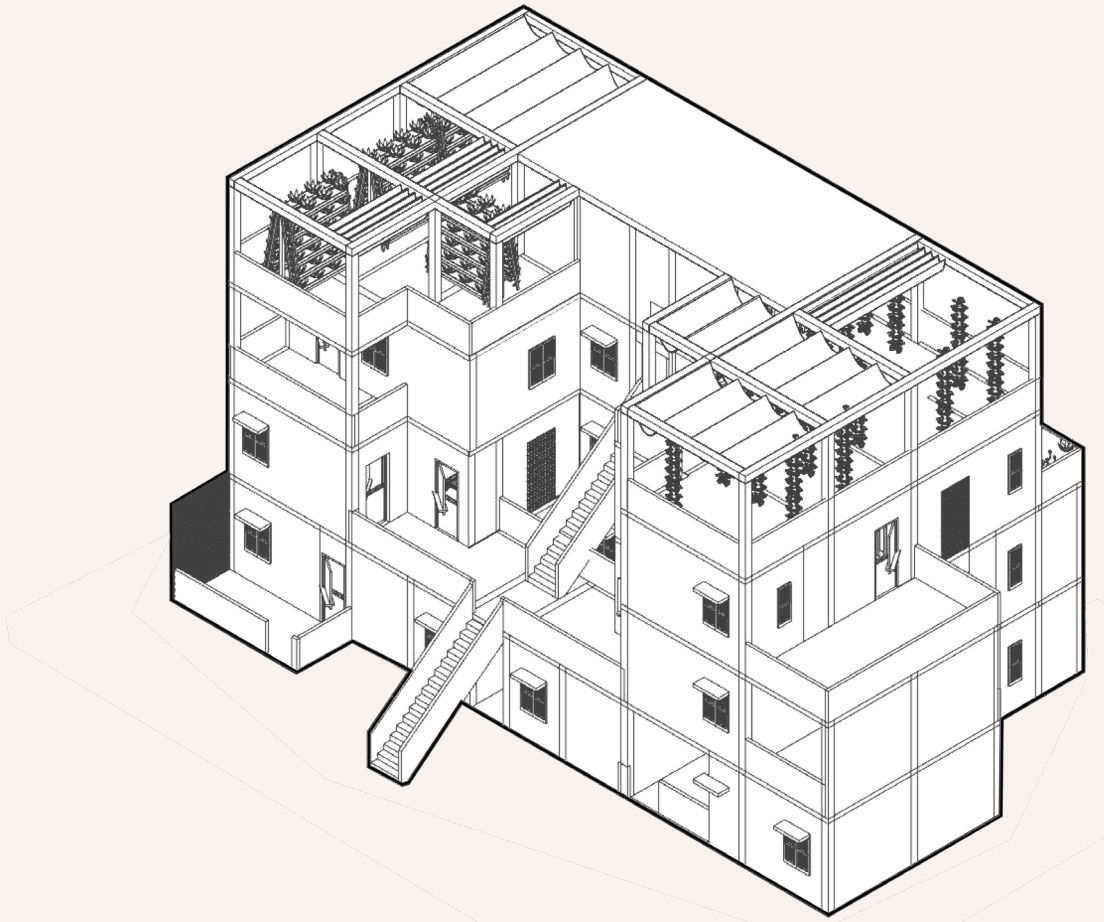
EW / LIG - general layout

The low-income housing typology is defined by a staggering form around a small central courtyard which simultaneously functions as the entrance to the cluster. This way shaded outdoor spaces are created, improving thermal comfort and allowing incremental expansion over time. Each block contains 10 dwellings with four units on the first- and second- and two on the third floor levels. The central circulation is provided by shared staircases. The units are relatively long and narrow in nature, similar to the pollhouses seen in the historical city centre. Using this configuration, each unit has less exterior facades, only on its opposite ends and share the walls on the side with the unit next to them. This way, solar heat gain is minimised, while through the courtyard in the middle each room of the unit still receives sufficient daylight. To promote cross-ventilation through the rooms and to the outside, exterior doors become pivotable windows in the form of dutch doors which can work together with the timber shutters. Each unit has outdoor space, which becomes the households' semi-private area.

The facade buildup consists of a clay brick infill that is supported by a reinforced concrete structural grid of columns and beams. Outside of strategically placed stabilisation walls, allows the framework to variation in layout of openings and walls within each unit. Over time each building block can develop to its own desired and optimal configuration. The balcony/terrace also become spaces where the household can incrementally grow and expand their unit. In its base, these open spaces are designed for them to have a semi-private open space where they for example can hangout or hang their laundry. The groundfloor units include otlas facing the public streets as a means of creating a transition between public and private open spaces.

The roof is the space for joint input into soil-based and soil-less UA practices. On three of the four UA types that can be practiced on the roof, the footprint of the building is brought back in the form of farmable area, minimising its ecological footprint within the site. The roof is insulated and its finish reflective to further prevent solar heat gain from above into the units. On top of that a lightweight timber overhead structure with retractable overhead curtains allow for further shading or providing more sun on the different orientations of the roof as desired. Depending on the activity occuring on the roof it becomes flexible in creating comfortable conditions for it.

In the urban plan, the building is placed in multiple orientations and thus deals with different sun paths and shading each time. By designing the units in a long but narrow form, most of the solar heat gain on each unit is minimised. On each side of the building either the vertical farm or the middle-income building is situated, casting shadow on the lower-income building since both are relatively taller in their volume. Furthermore, depending on how the building is placed in its orientation, different sides of the building do or do not acquire extended concrete window sills above their facade openings, further diversifying each building in the urban fabric. Although unit sizes vary per floor, each floorplan is organised around a consistent service core with a kitchen, toilet and bathroom. Through the use of room dividers and bordering spaces become flexible and support multiple uses throughout the day, enabling residents to adapt rooms for work, living or sleeping as needed.



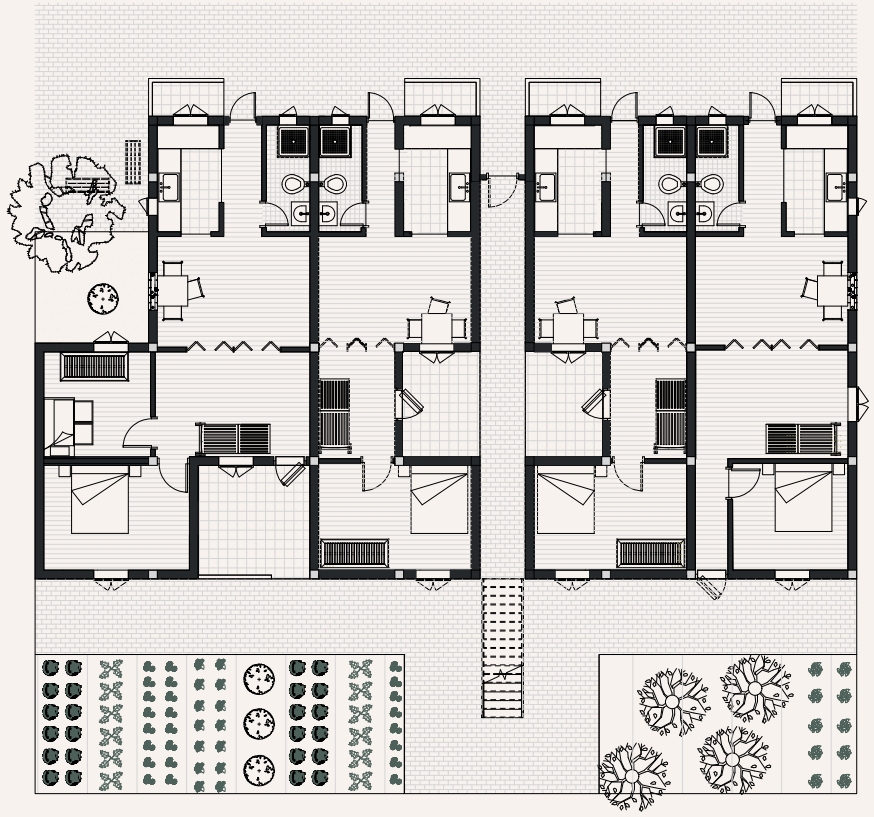


Figure 179. *Groundfloorplan smaller LIG building unit - scale 1:200*

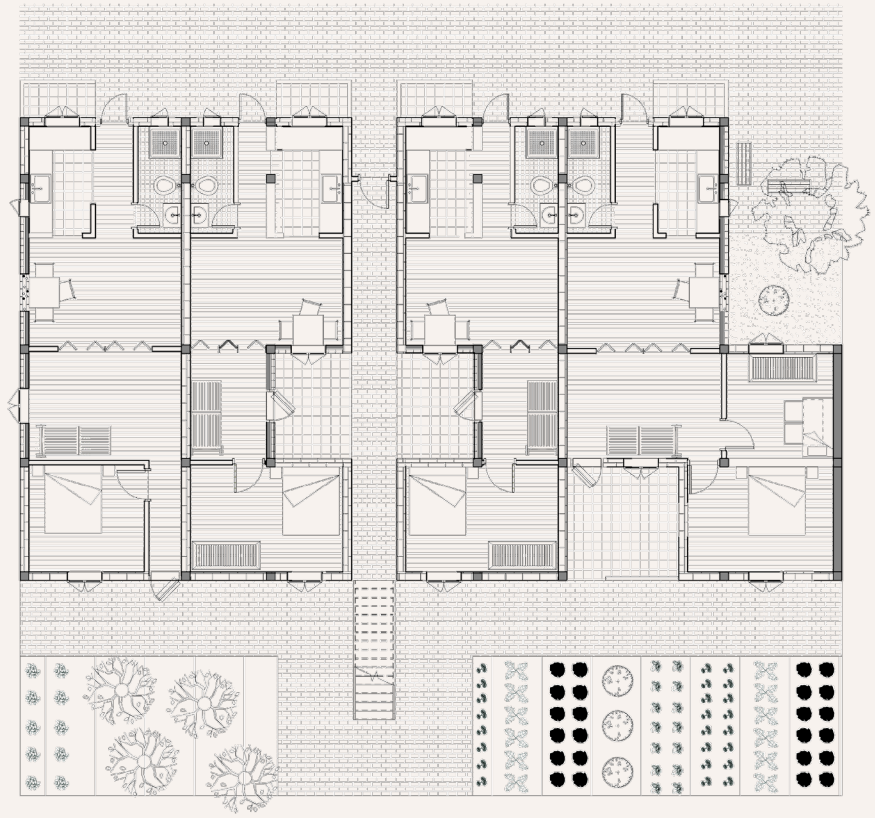
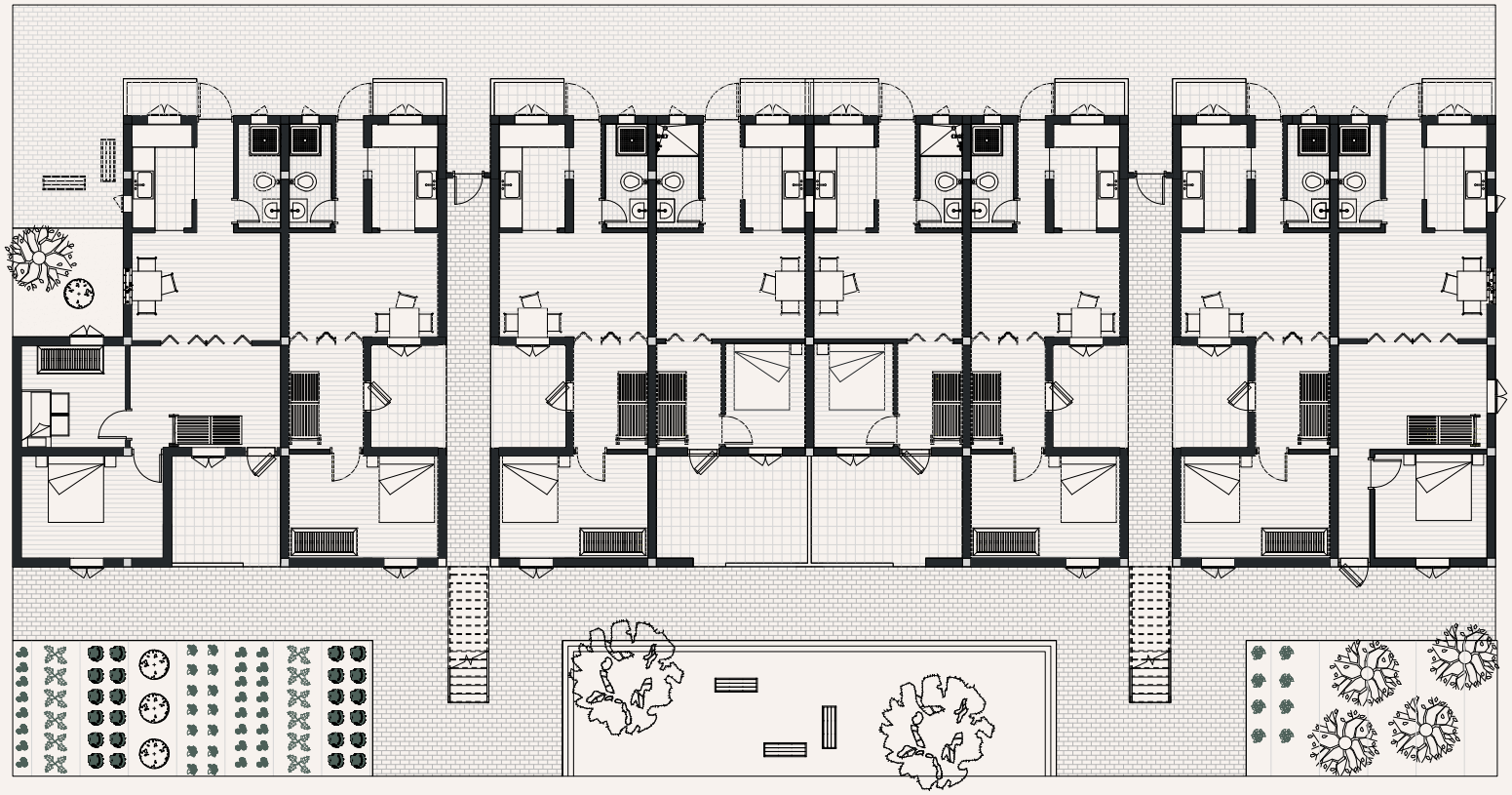


Figure 180. *Groundfloorplan facade buildup smaller LIG building unit - scale 1:200*



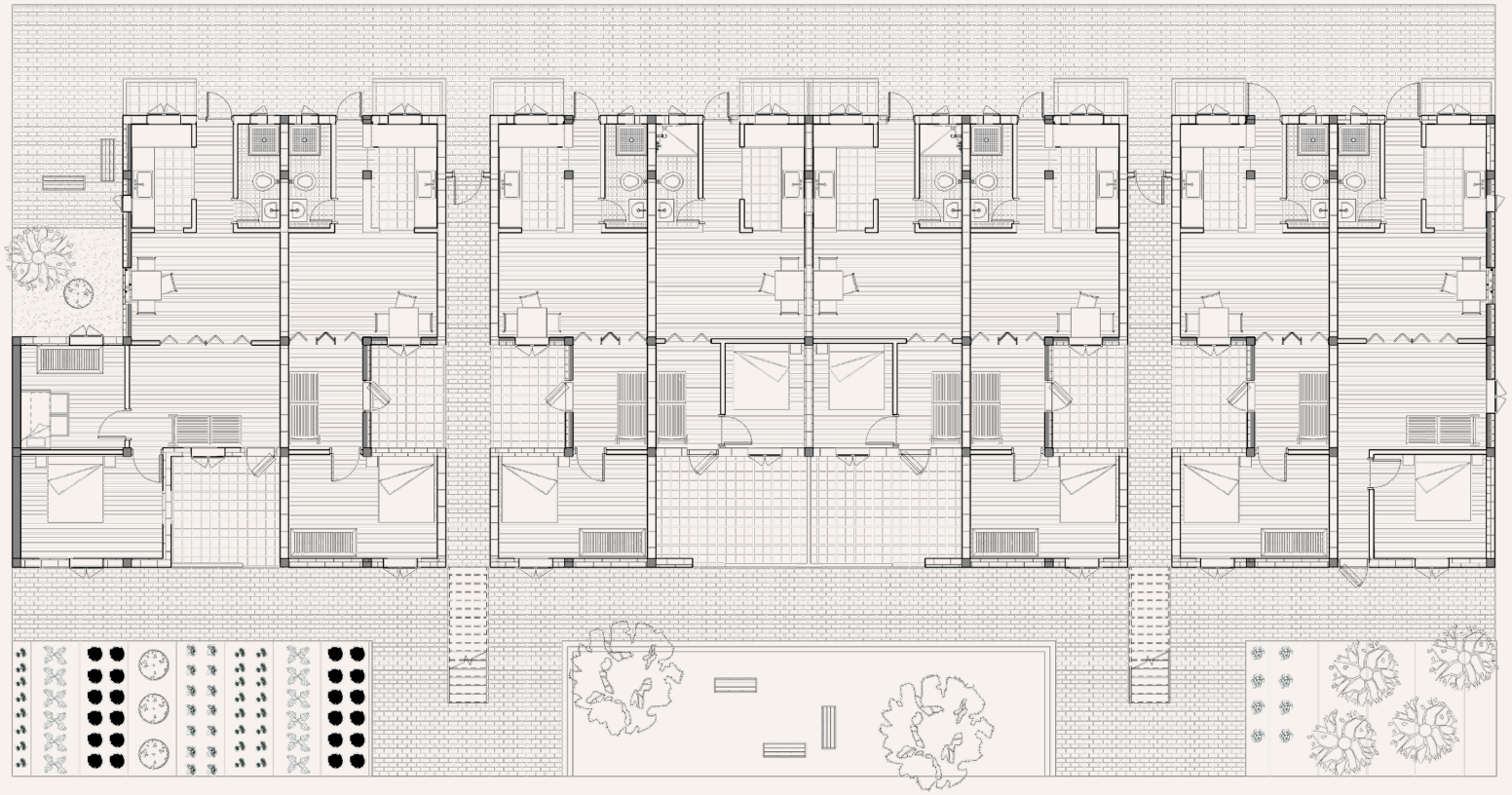


Figure 181. *Groundfloorplan longer LIG building unit - scale 1:200*

Figure 182. *Groundfloorplan facade buildup longer LIG building unit - scale 1:200*

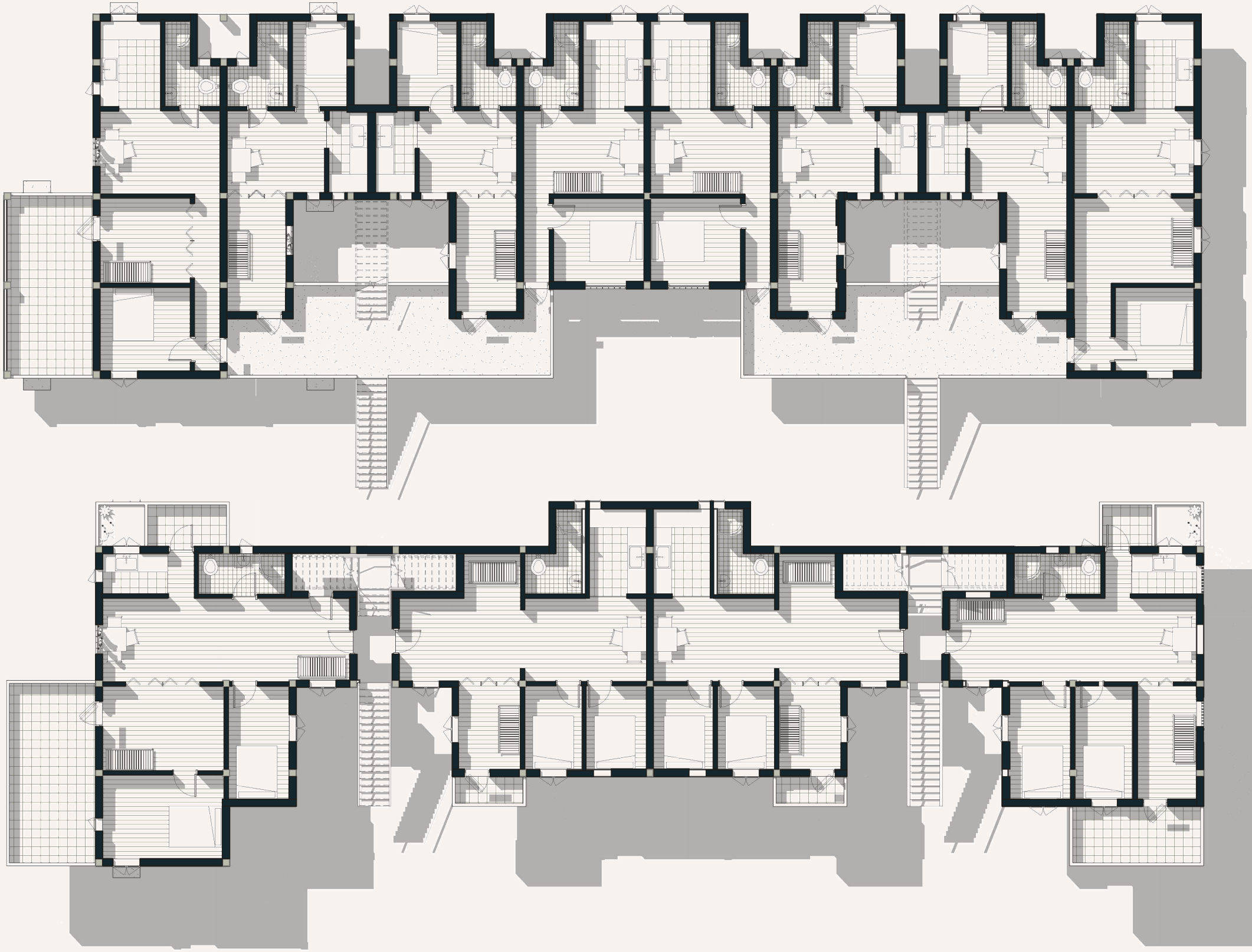


Figure 183. *Firstfloor plan longer building unit (top) - scale 1:150*

Figure 184. *Secondfloor plan longer building unit (bottom) - scale 1:150*

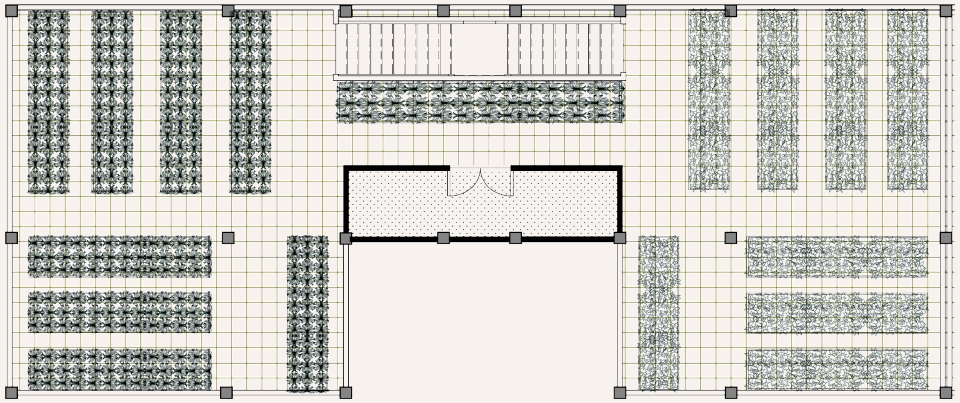


Figure 185. *Possible rooffloor plans smaller building unit (top) - scale 1:150*

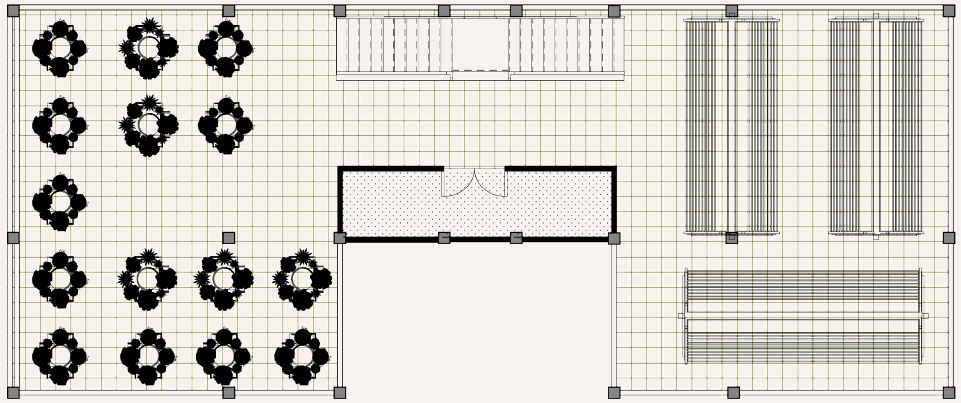


Figure 186. *Possible rooffloor plans longer building unit (bottom) - scale 1:150*

EW / LIG - construction and materiality

The primary structure of the building consists of a reinforced cement concrete (RCC) frame of columns and beams with a clay brick infill. It is a widely used construction method in India and gets used on low- as well as middle- and high-rise buildings. This way a consistent structure of the cluster can be achieved while enabling facade variations through the use of jalis, openings and patterns. Clay brick is locally available and often used material that provides a durable and flexible use in the design. Depending on its use, bordering, shading and ventilation are functions of the infill walls. By using the rat-trap bond air cavities improve the thermal performance of the wall while also allowing space for installations like water pipes to travel through the unit. At the balustrades a hit and miss brick pattern is used that allows airflow through it. The two masonry layers are held together by steel wall ties. To be able to withstand leaning on and bumping into the ballustrade, steel bars secure it directly to the RCC beam below.

The concrete structure is cast on site and provides the grid for the modular system that allows for potential incremental growth of the housing units. The columns, beams and slabs form te primary load-bearing structure, while strategically placed stability walls provide further stabilisation against wind- and earthquake forces. These walls are better in providing lateral stiffness as the columns, beams handle the downward loads and the slabs tie the structure together to form a moment-resisting frame. They are situated on the side walls of the units (that they share) and on some interior walls, so to not prevent future exansion at the ends of each unit. The stabilisation walls are buildup by a 125 mm thick concrete wall (interior), air cavity and a 75 mm thick brick jali infill (exterior). Internal partitions are single layer brick walls used for internal spatial division. Wood is used for window frames, louvers and doors because the material is often used in Indian architecture and it an easy workable material. Furthermore it allows for high durability and lightweight construction. Above the 3 floors of dwellings a light timber construction is located, holding the overhead curtain system.

The colums have a thickness of 230x 230 mm and are 3000 mm high. The beams are 300 mm high and 230 mm wide. The concrete floor has a thickness of 200 mm at its thickest and 150 mm at its thinnest.

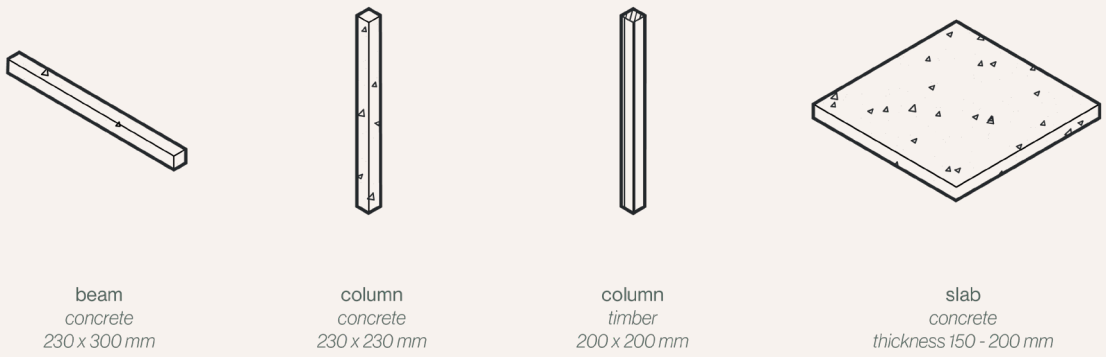
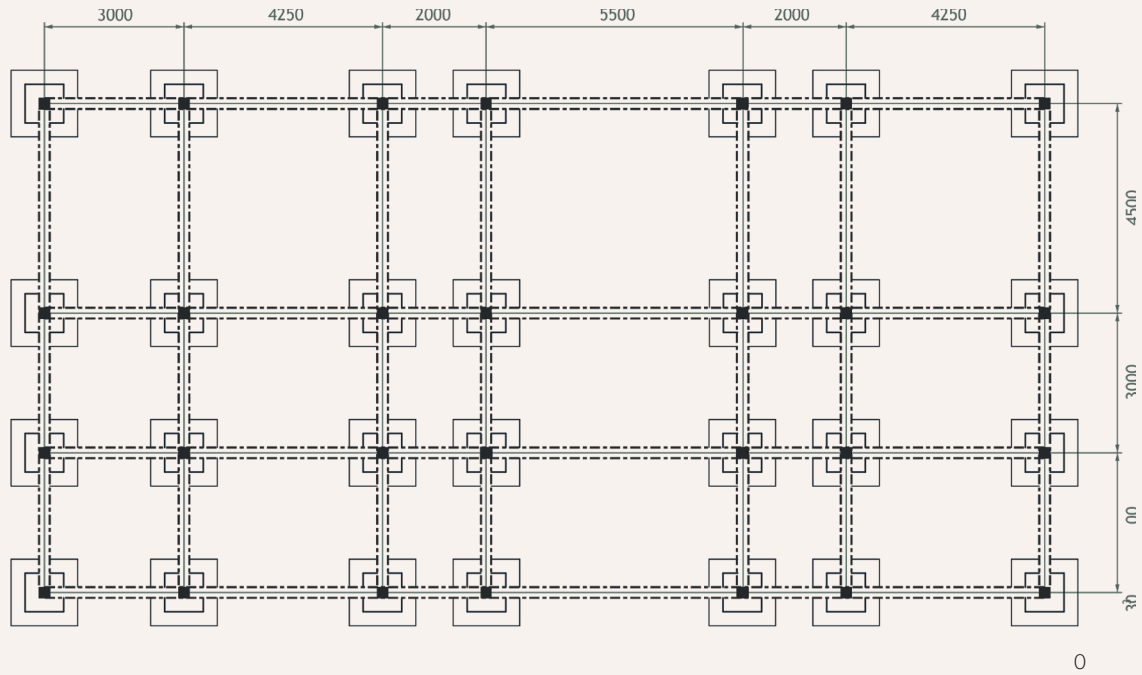


Figure 187. *Construction materiality of the four typology buildings*



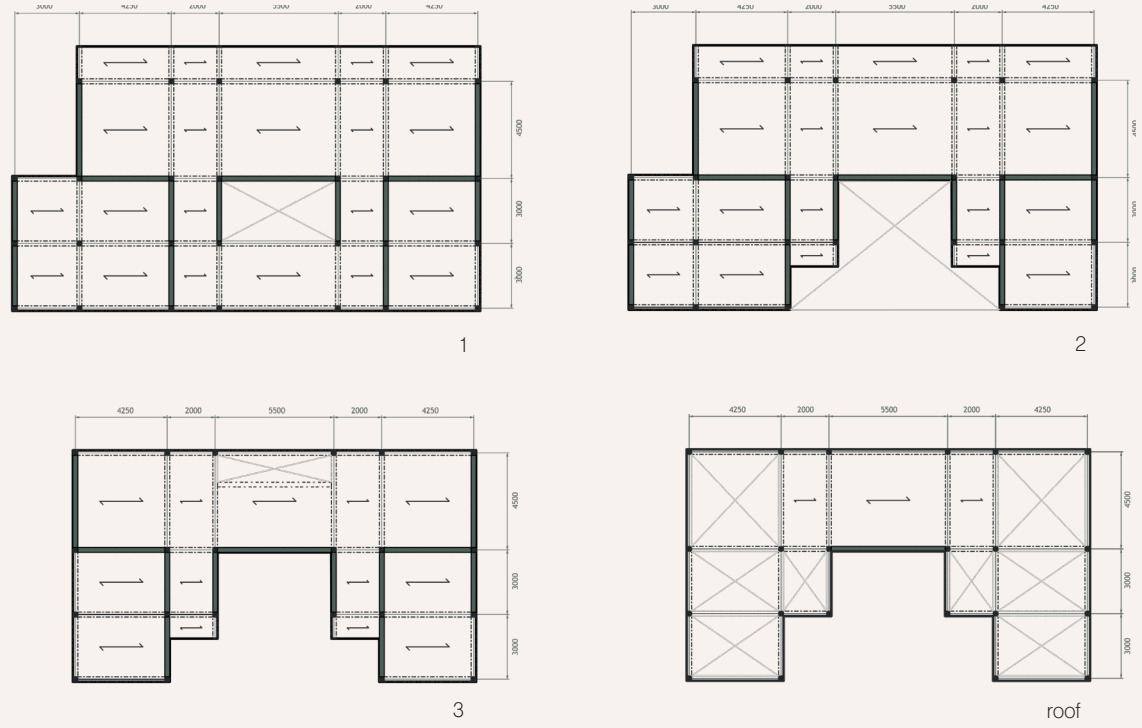


Figure 188. *Foundation-, 1st floor-, second floor-, third floor- and roof construction floorplans (scaled)*

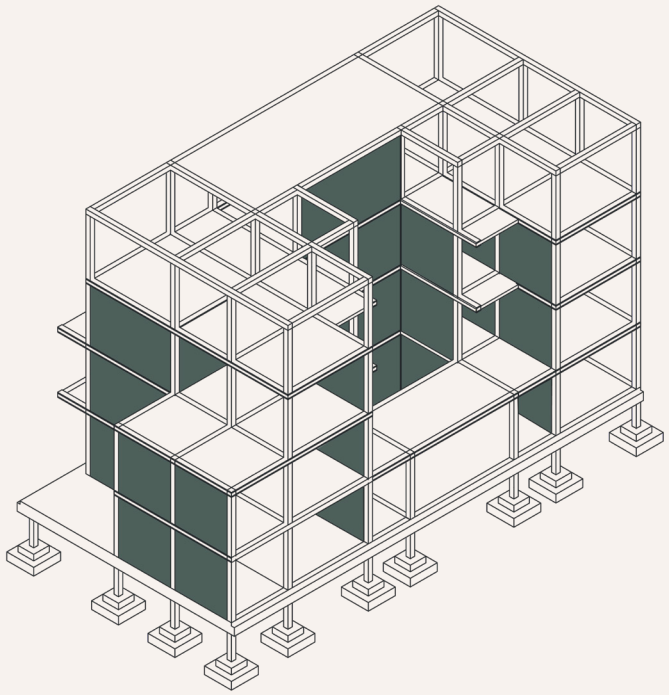


Figure 189. *LIG construction axonometry (stabilisation walls highlighted in green)*

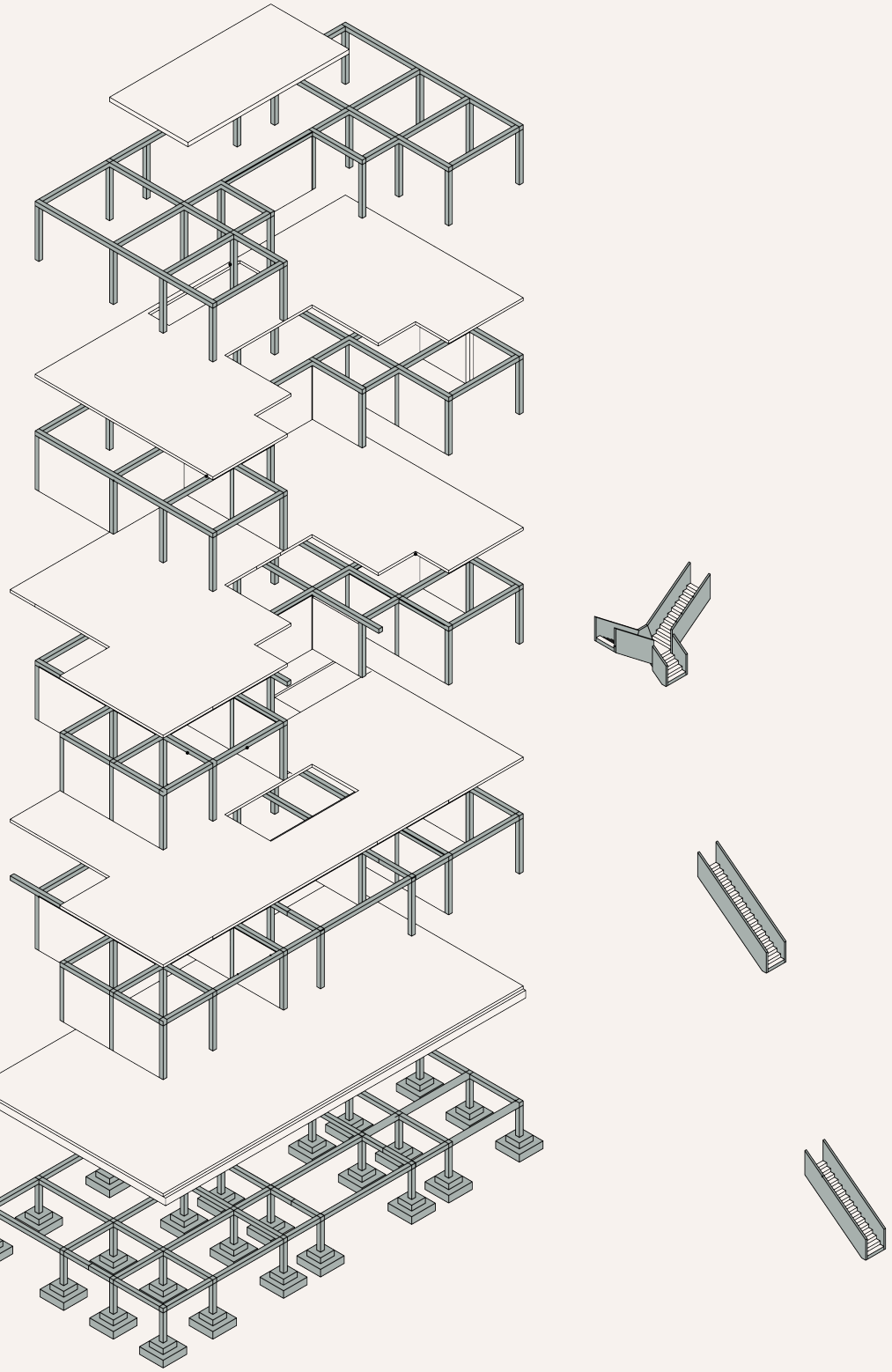


Figure 190. *LIG exploded construction axonometry (beams and columns highlighted in green)*



Figure 191. *Facade fragment and -elevation 1:20 (scaled to 1:70)*

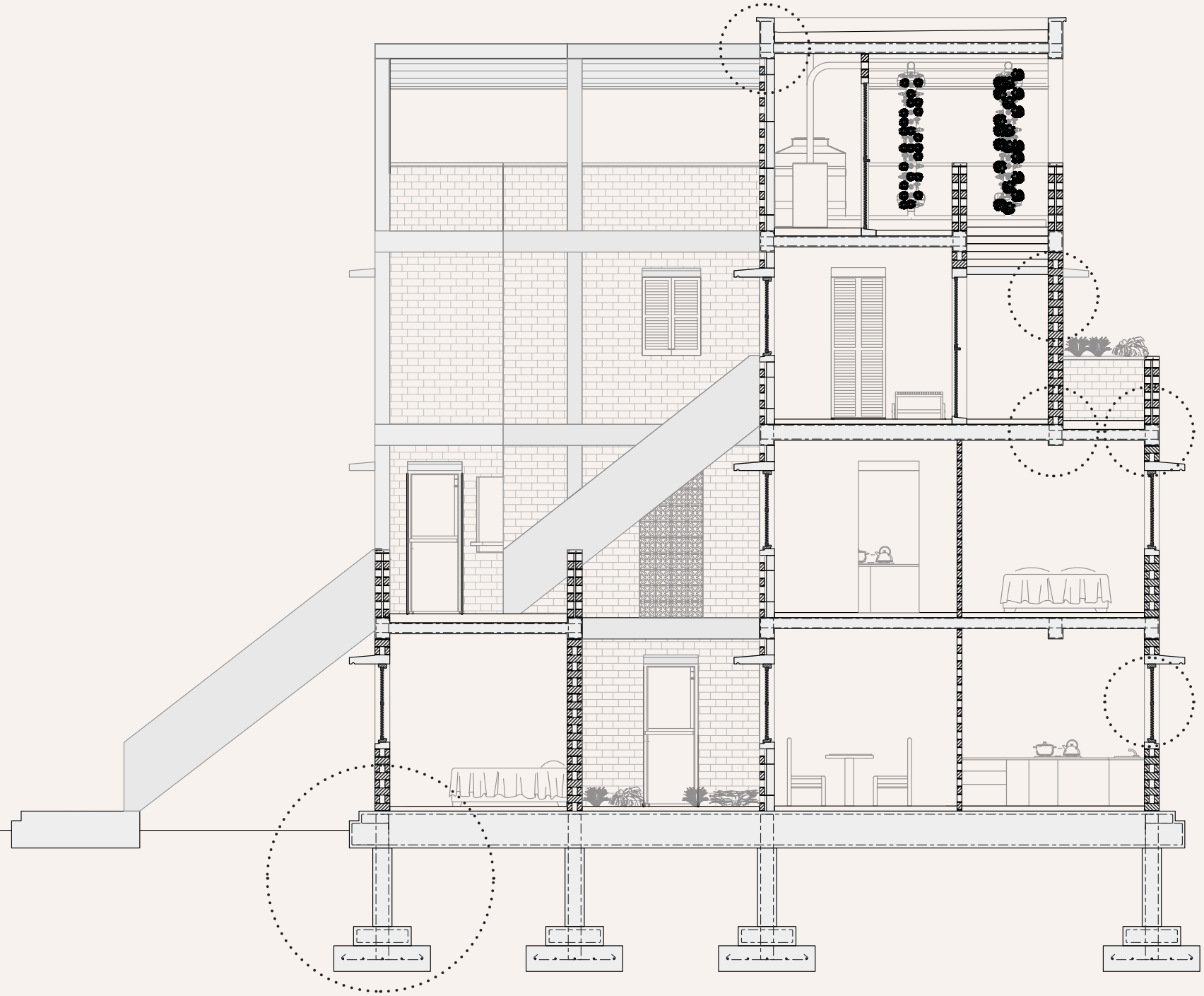


Figure 192. *Technical facade section 1:20 (scaled to 1:70)*

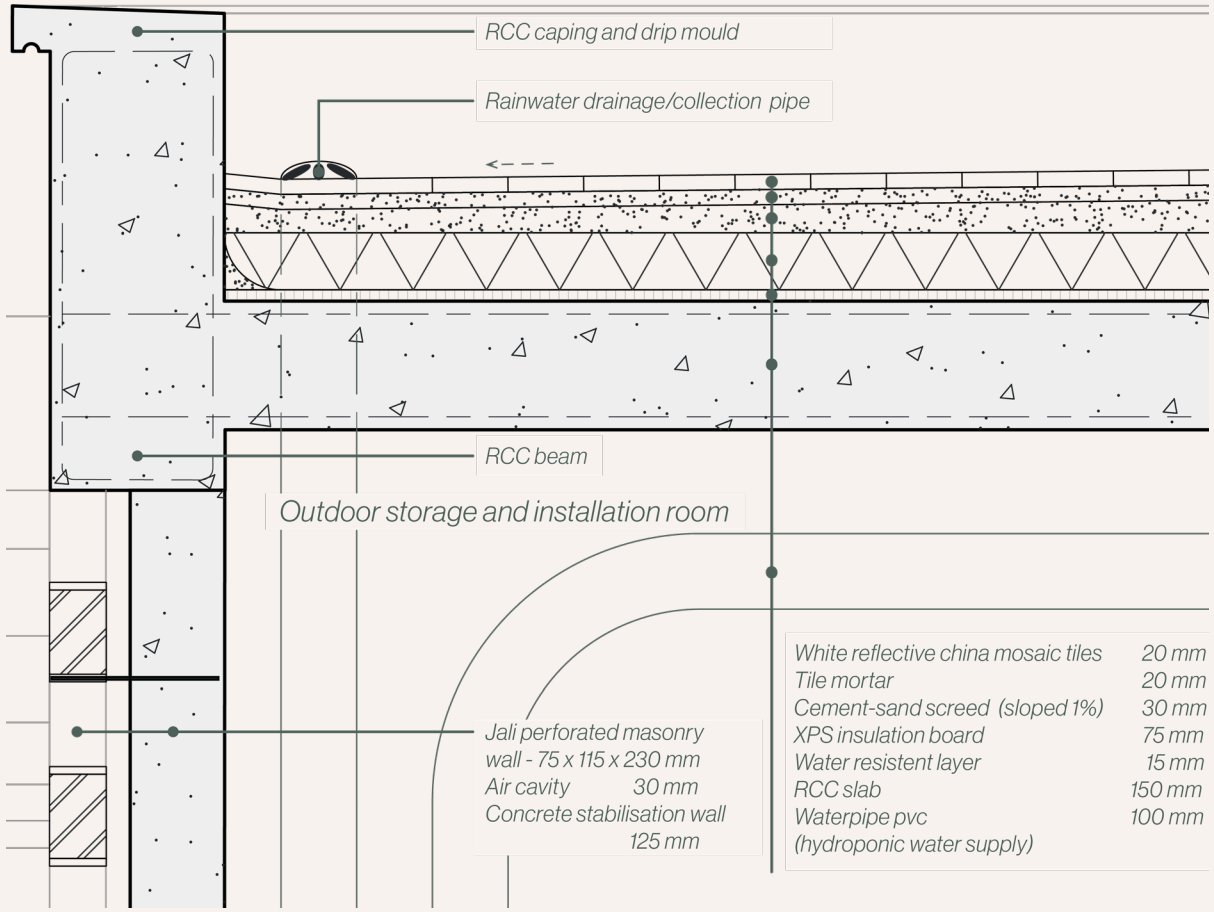


Figure 193. *Roof detail 1:5 (scaled to 1:10)*

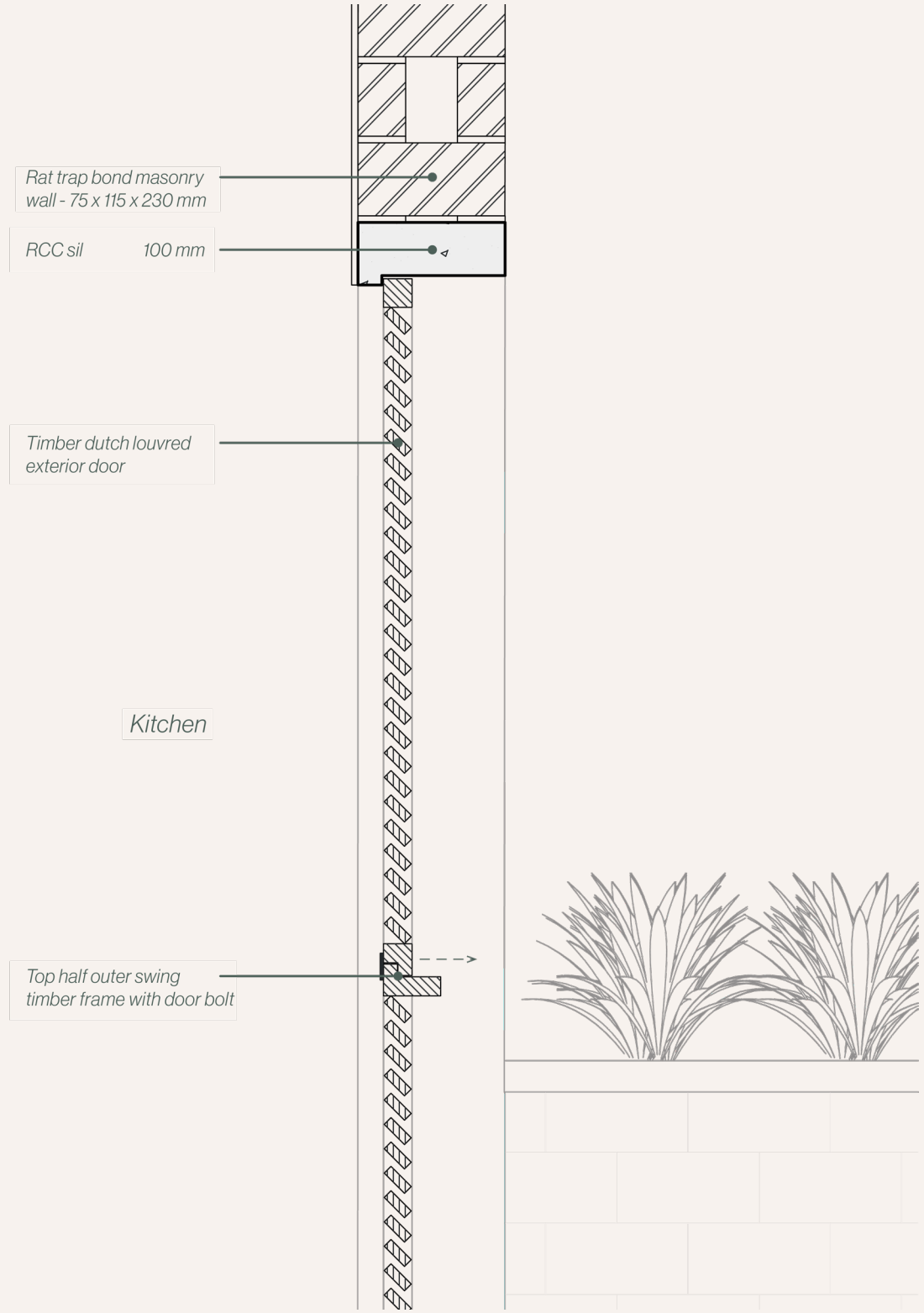


Figure 194. *Dutch door detail (top) 1:5 (scaled to 1:10)*

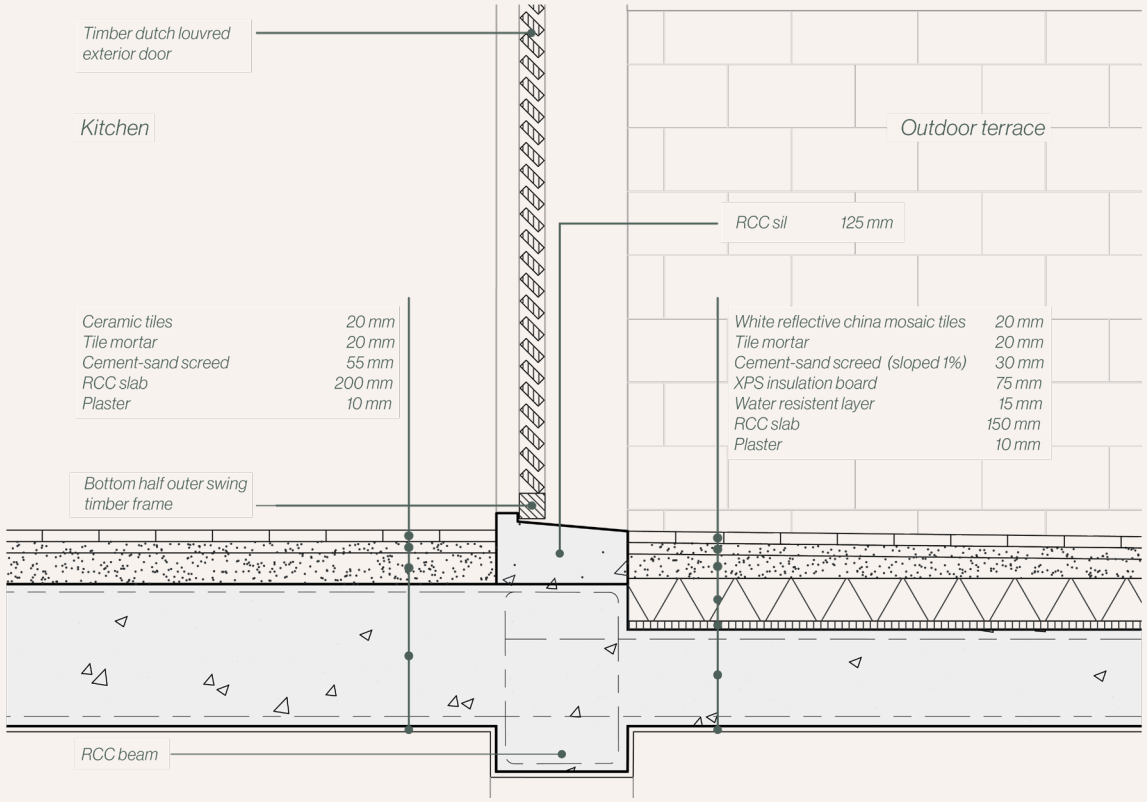


Figure 195. *Indoor / balcony detail 1:5 (scaled to 1:13,33)*

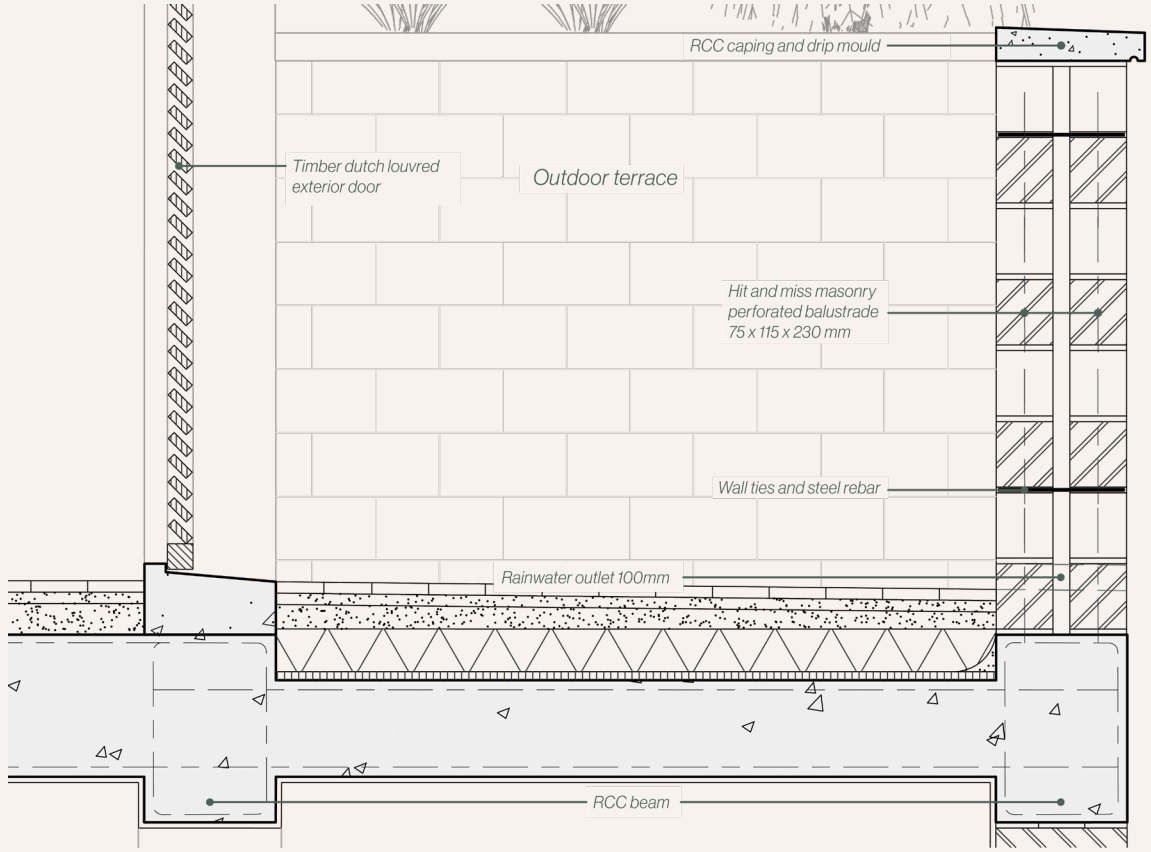


Figure 196. *Balcony detail 1:5 (scaled to 1:13,33)*

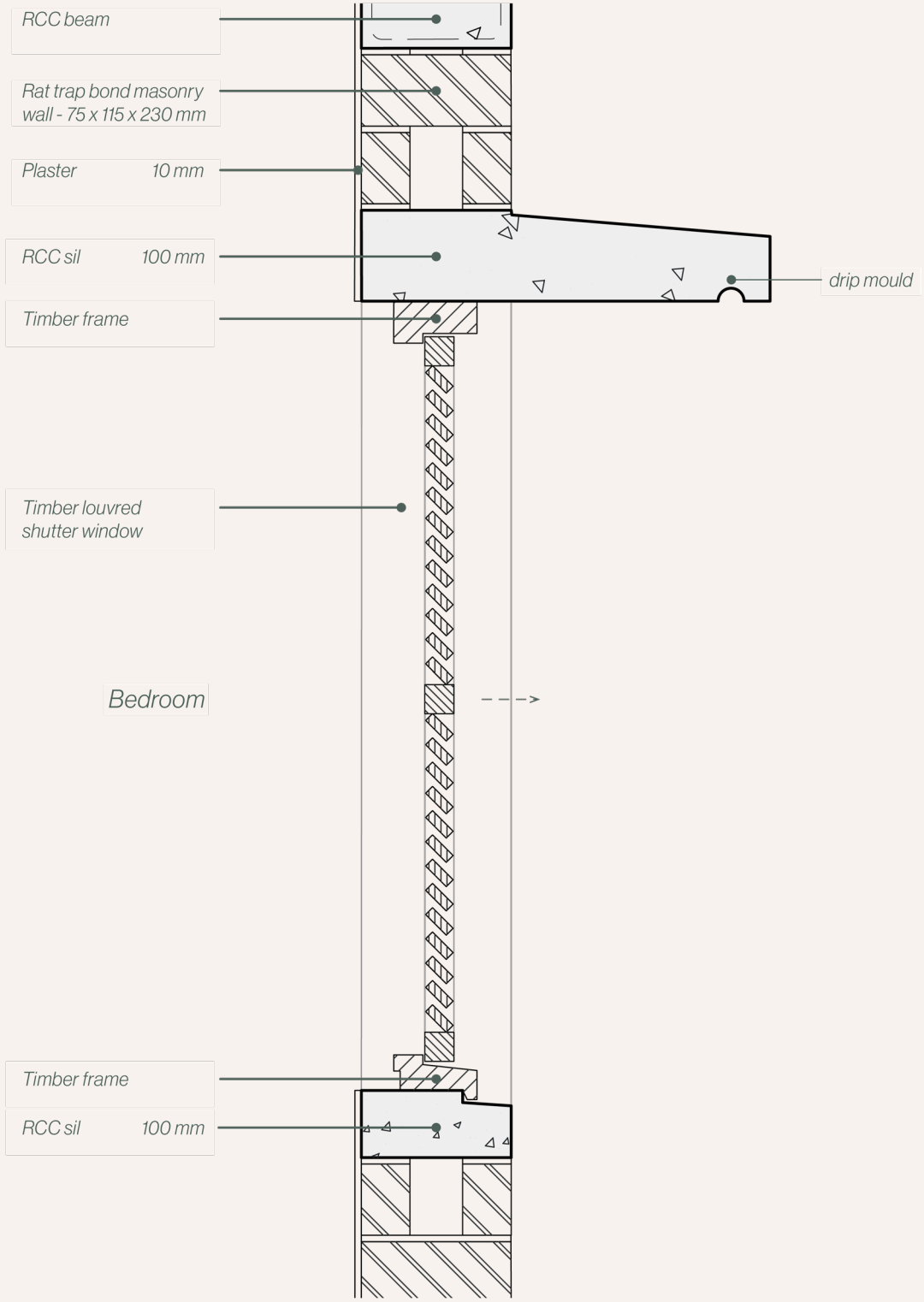


Figure 197. *Shutter window detail 1:5 (scaled to 1:10)*

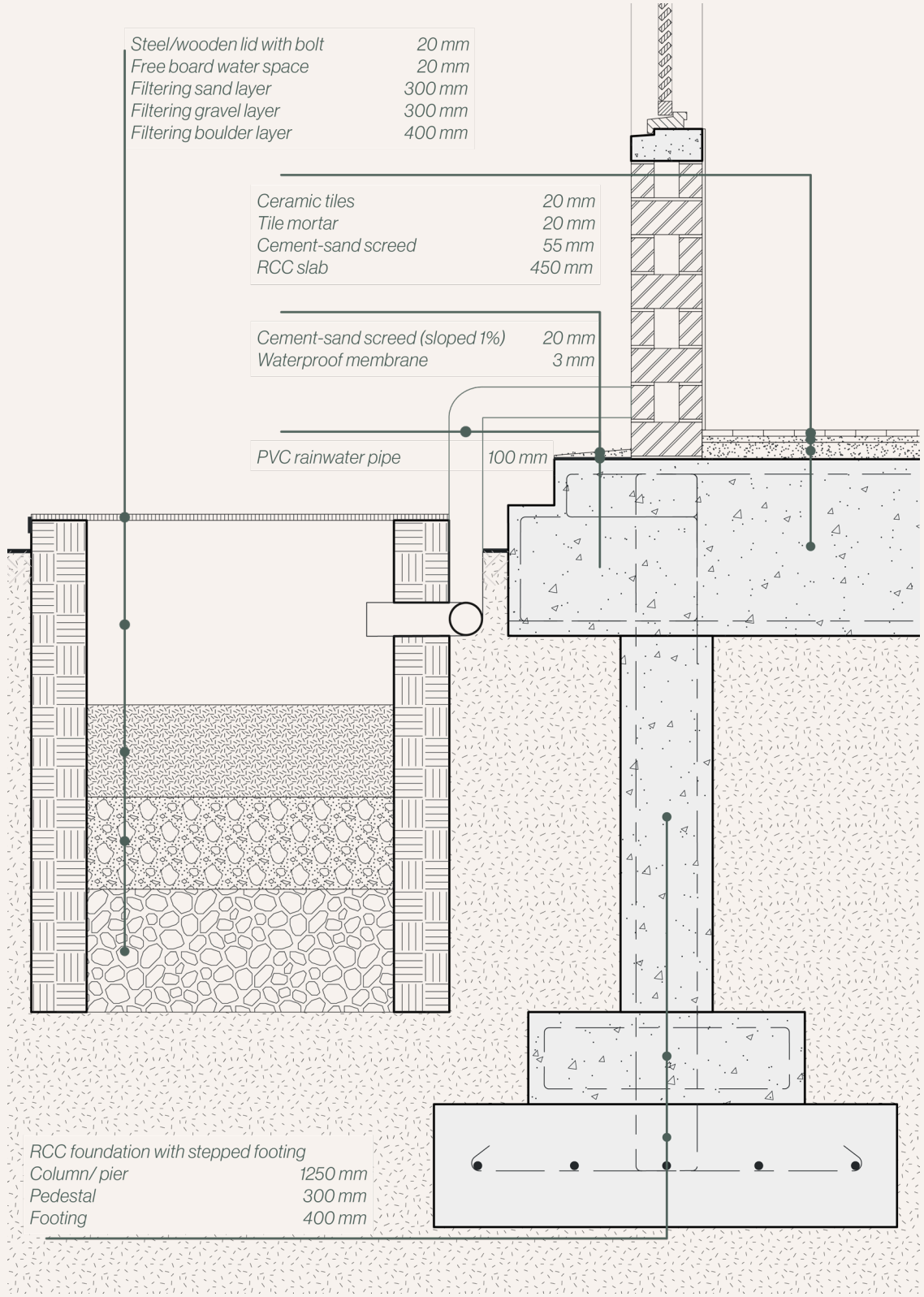


Figure 198. *Foundation with recharge pit detail 1:5 (scaled to 1:20)*

EW / LIG - climate design

The following design strategies address the hot-arid climate of Ahmedabad and aim to improve thermal comfort. Openings on multiple facades promote cross-ventilation, while concrete sills provide additional solar shading. The staggered building typology increases shading on both facades and outdoor spaces and the absence of pavement along the east and west facades reduces heat gain.
Each floor contains four units with shared walls, reducing exposure to facades. The shared open stairwell also acts as an air shaft, supporting natural ventilation.
The cavity wall construction enhances thermal performance by creating a shaded inner wall protected by the outer clay brick. Parts of the facade use jali (perforated brickwork), combining an open outer layer with a half-brick inner wall. These openings allow ventialtion in the inner layer while maintaining privacy and enabling stack ventilation and night flushing.
The RCC frame with brick infill provides thermal mass, helping to stabilize indoor temperatures by absorbing and slowly releasing heat. On the roof, white reflective mosaic tiles reflect solar radiation, reducing heat absorption. A rooftop water tank draws from underground storage and supplies water pressure to the building system.

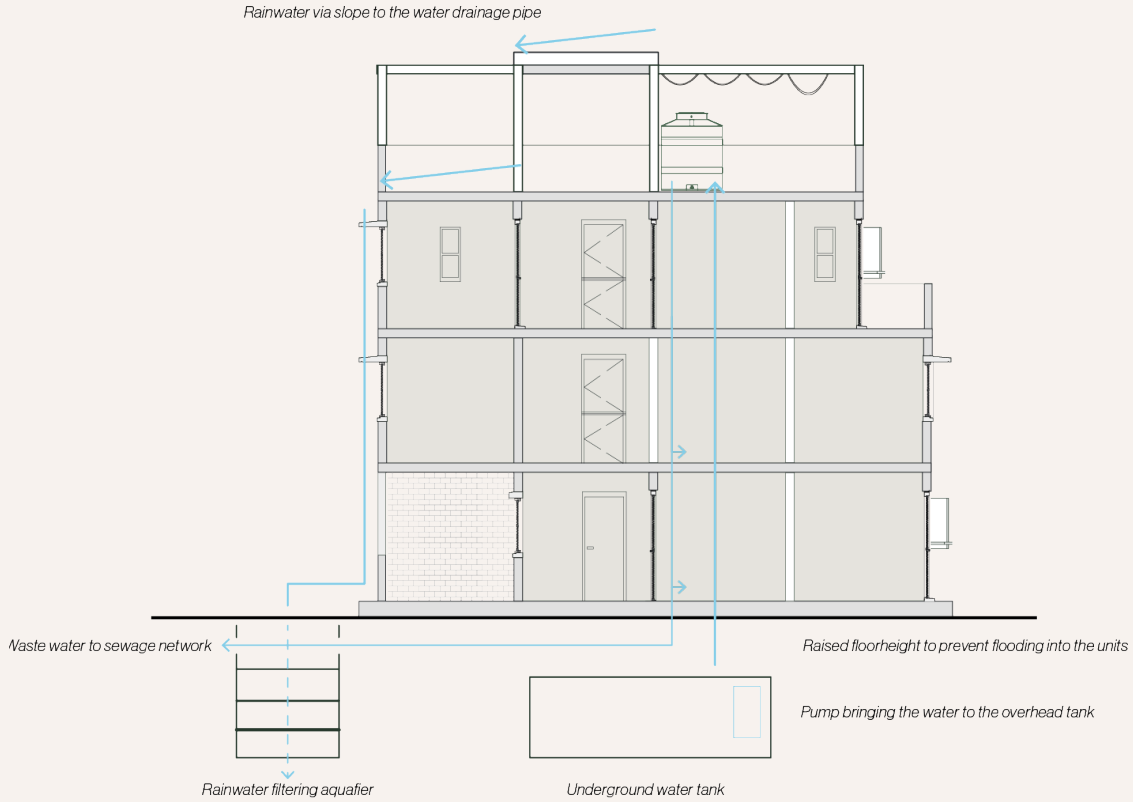
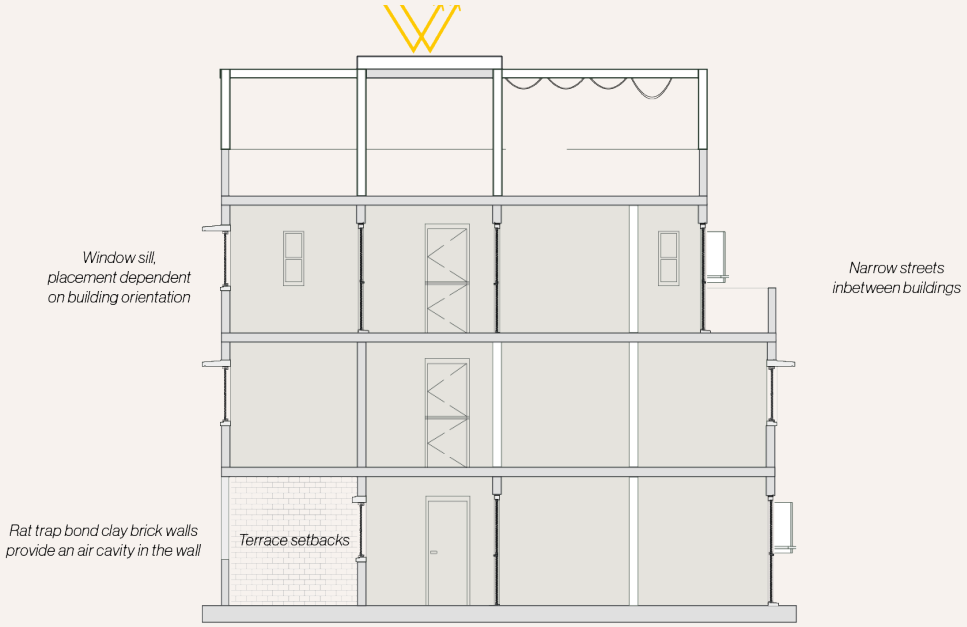


Figure 199. *Water management climate section*



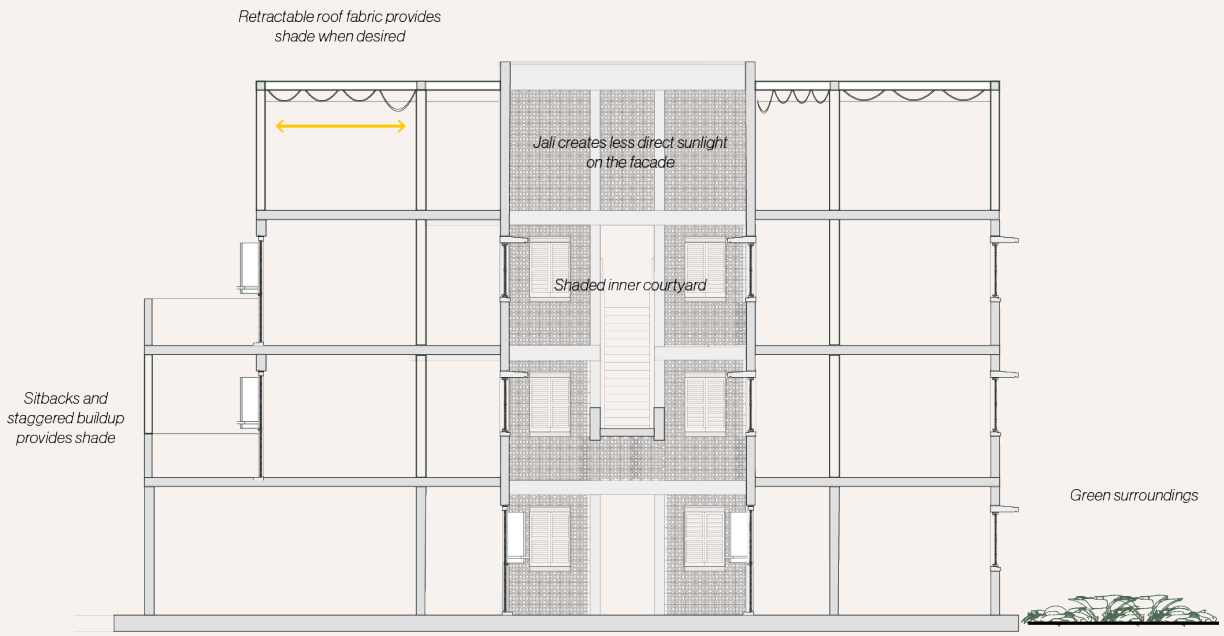
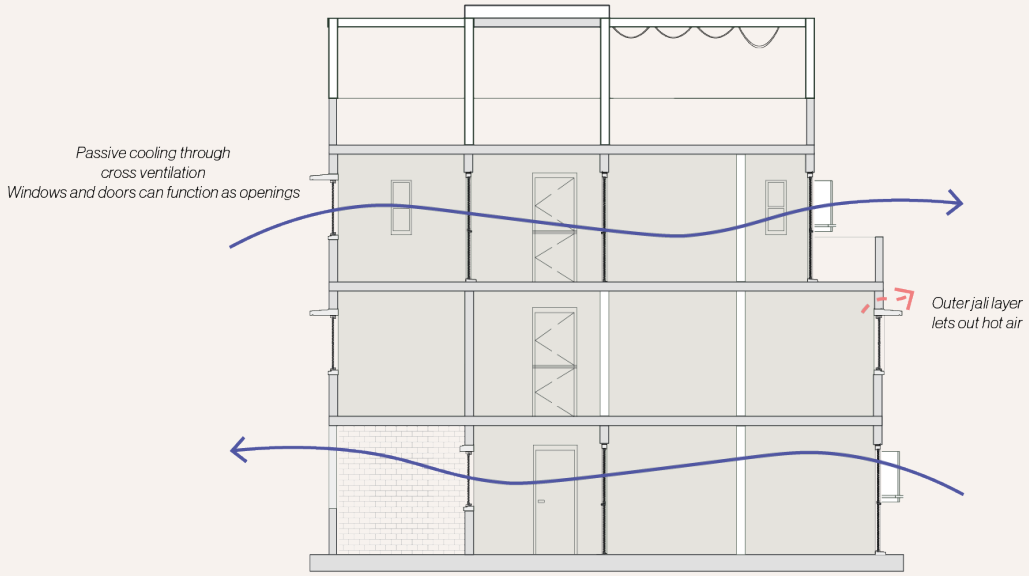


Figure 200. *Thermal comfort climate sections*



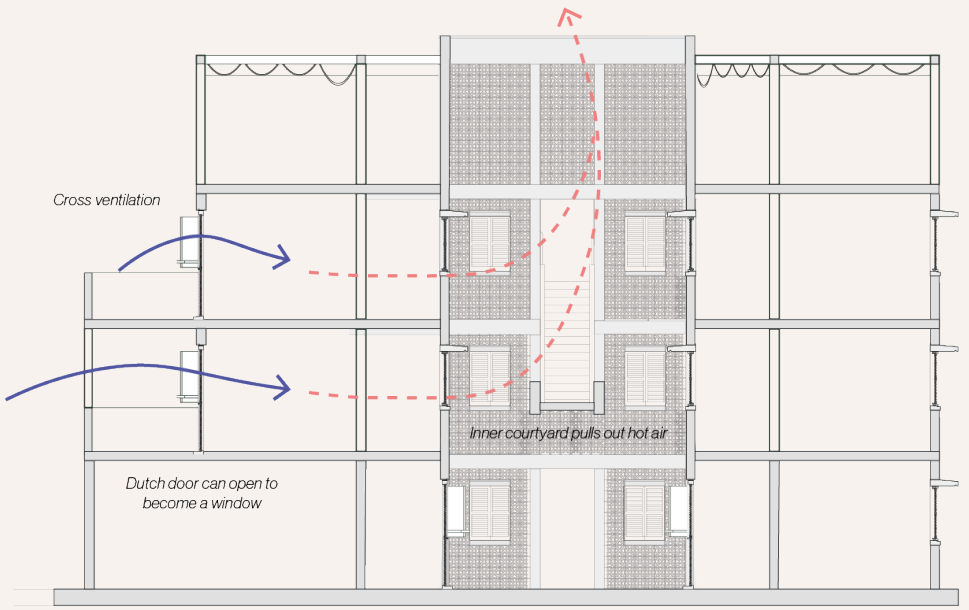


Figure 201. *Natural ventilation climate sections*

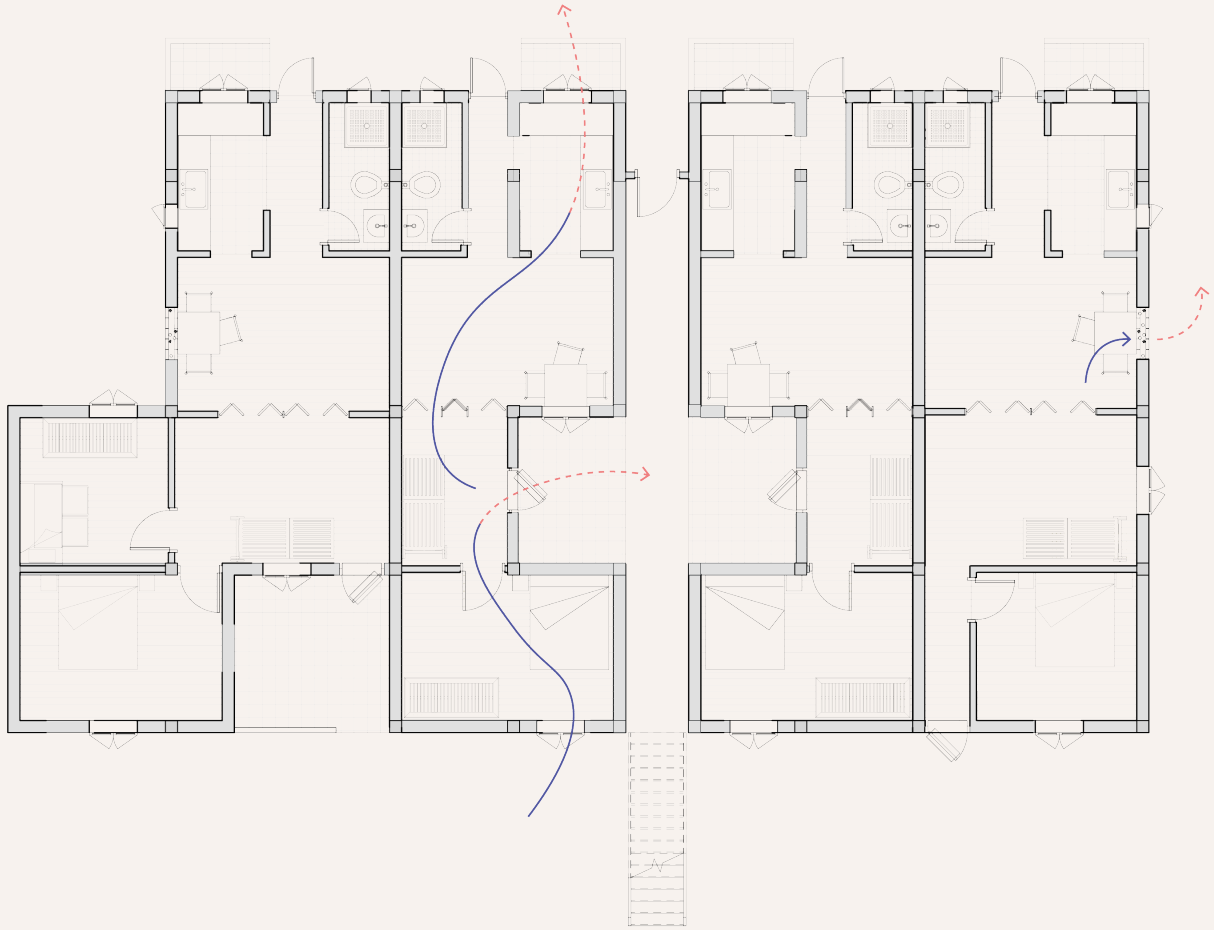


Figure 202. *Natural ventilation climate floorplan*



Figure 203. *Daylight penetration climate floorplan*

MIG - general layout

The middle-income housing typology consists of two bedrooms, a separate toilet, a separate shower, a living area, a kitchen and shaded outdoor spaces on two sides of the dwelling. At ground floor level, along the street-facing side, an active public plinth is provided. On this outer facade the entrance to the elevator and stairs are located as well and it is the main way households enter their dwelling. It is these households alone that also have access to the inner courtyard that they share with the rest of the cluster. Above the groundfloor level four storeys of dwellings are located. On the roof shared UA practices take place for the residents living in that MIG building.

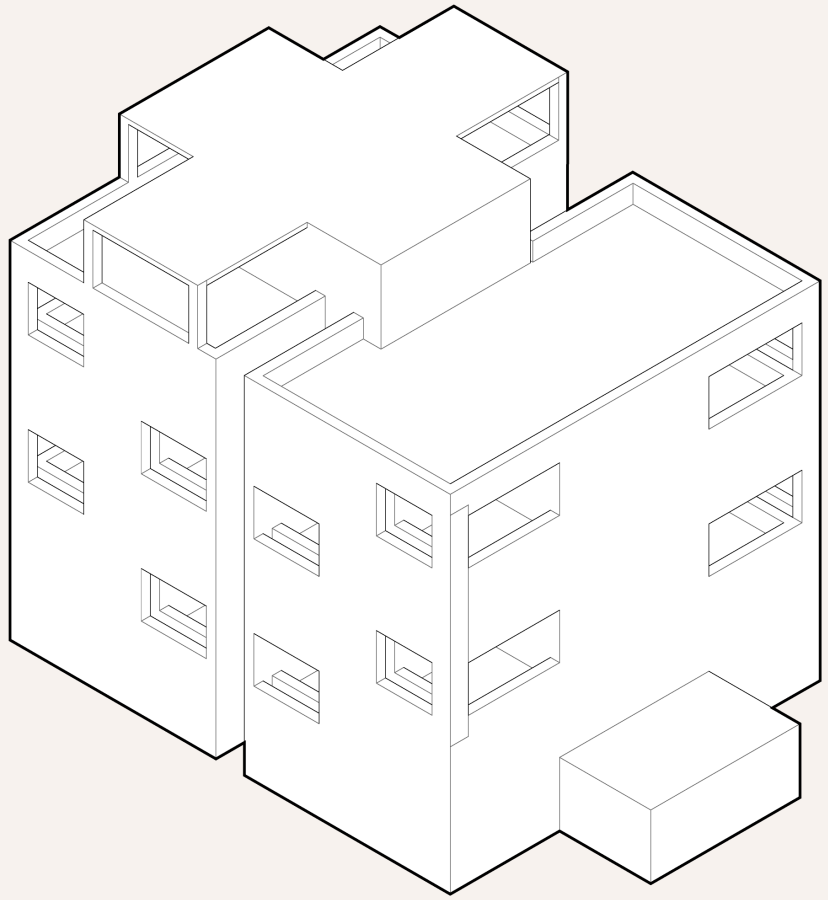




Figure 204. *Groundfloor plan longer MIG building unit - scale 1:200*

HIG - general layout
For the higher middle-income and high-income groups, spacious apartment units are designed. The plans typically include generous outside spaces, en-suite bathrooms, a dedicated servant entrance, utility spaces adjacent to the kitchen and a central circulation core with lifts. Within each unit, a clear separation is made between service, social, and private zones through the use of two dwelling layers above eachother.
This spatial organisation is also expressed at the building scale. The ground floor features an active public plinth. Above this level, the dwelling floors are located.

In addition, these income groups are provided with underground parking facilities. with the entrance being next to the building.The towers are wrapped by a secondary skin of perforated jali screens, acting as a climatic and spatial buffer. This layer filters sunlight, reduces heat gain and improves thermal comfort while allowing natural ventilation to continue across the facade. At the same time, the jali introduces a dynamic visual rhythm and enhances privacy.

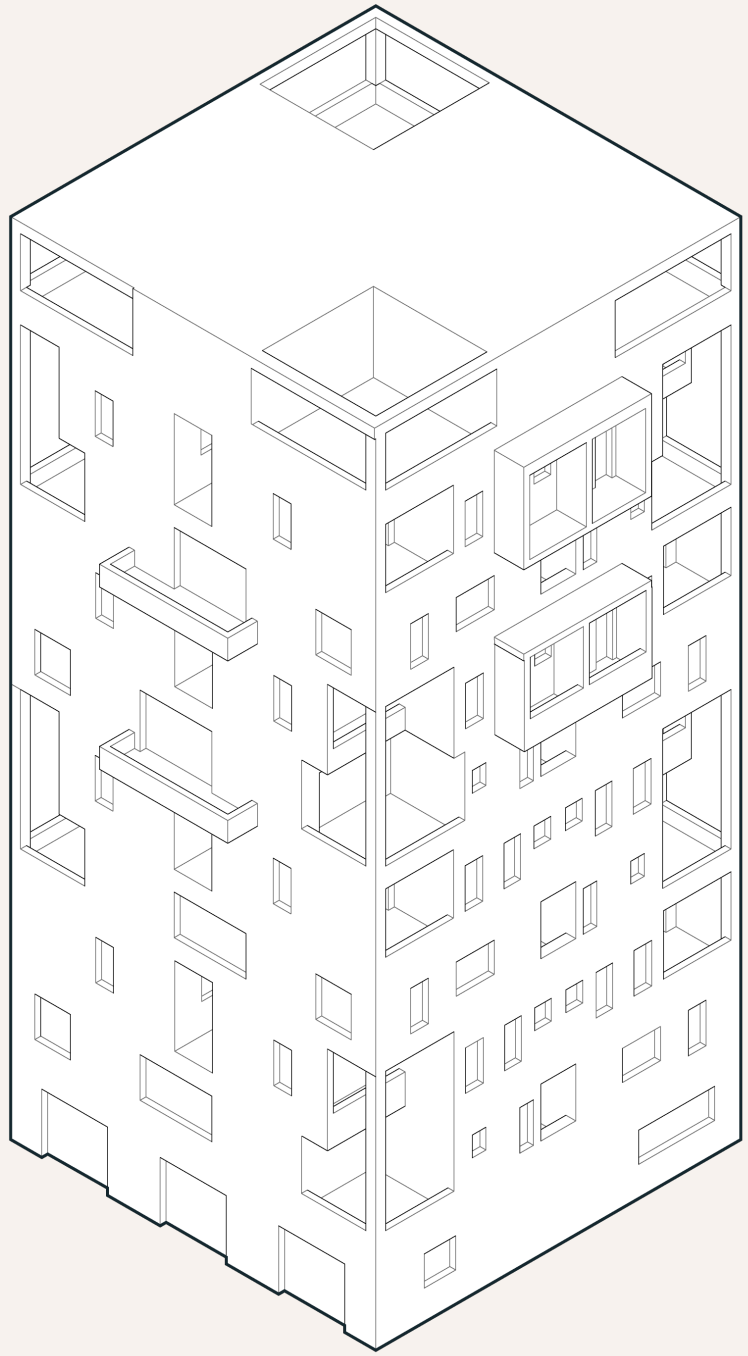




Figure 205. *Groundfloorplan HIG building unit - scale 1:200*

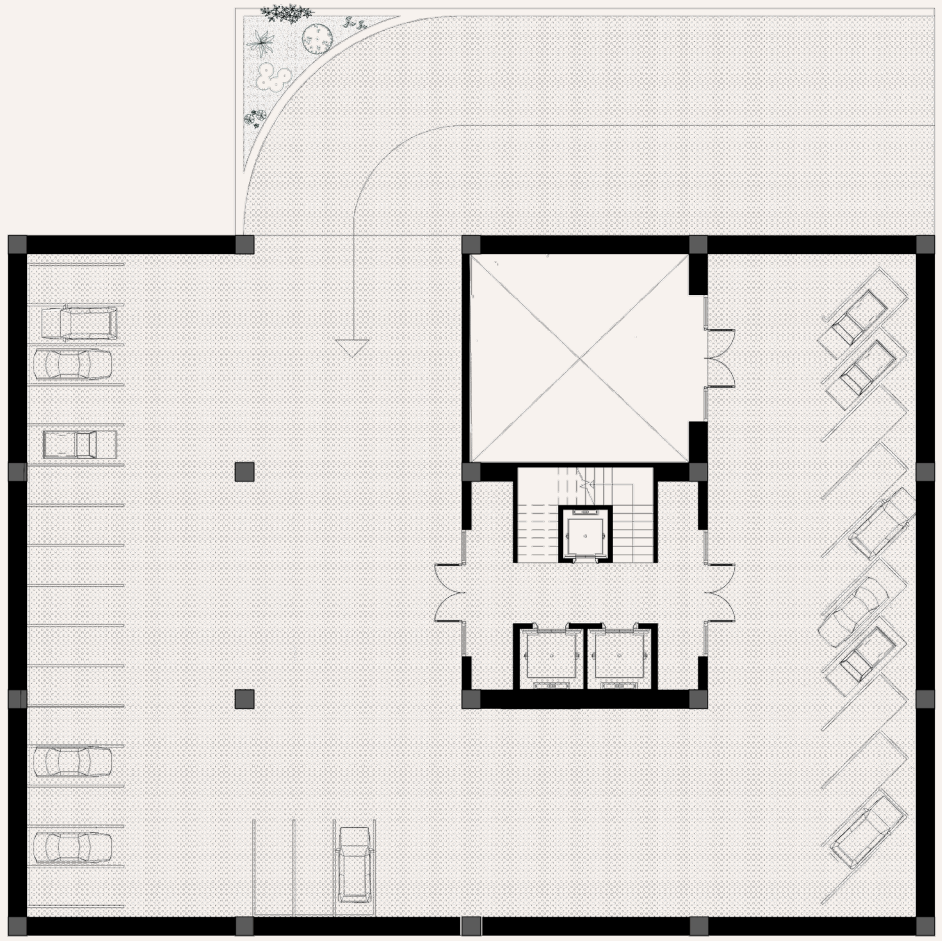
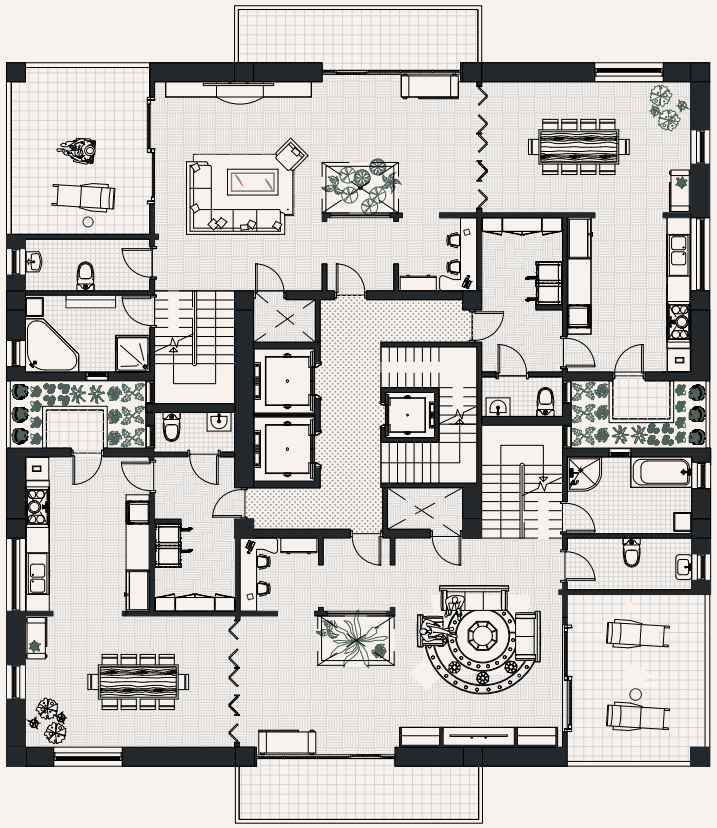


Figure 206. *Underground parking floorplan HIG building unit - scale 1:200*



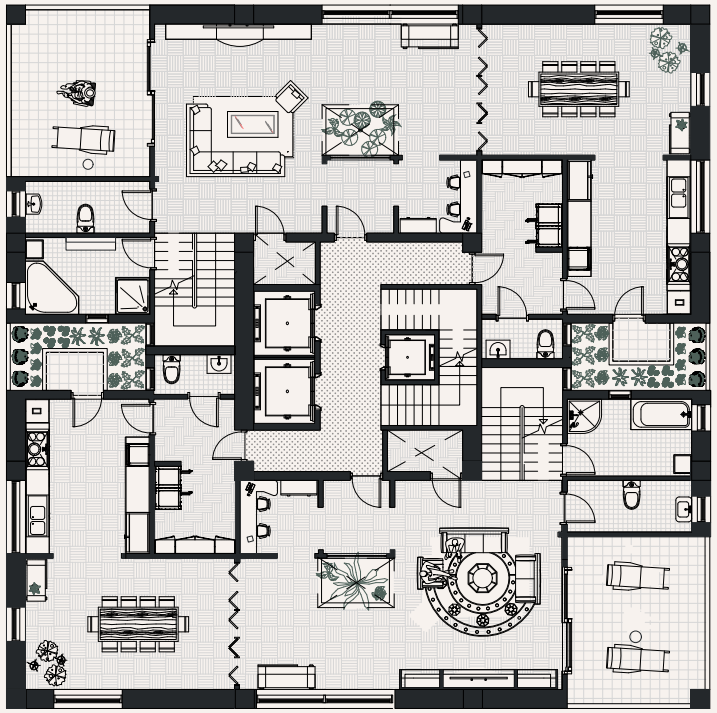
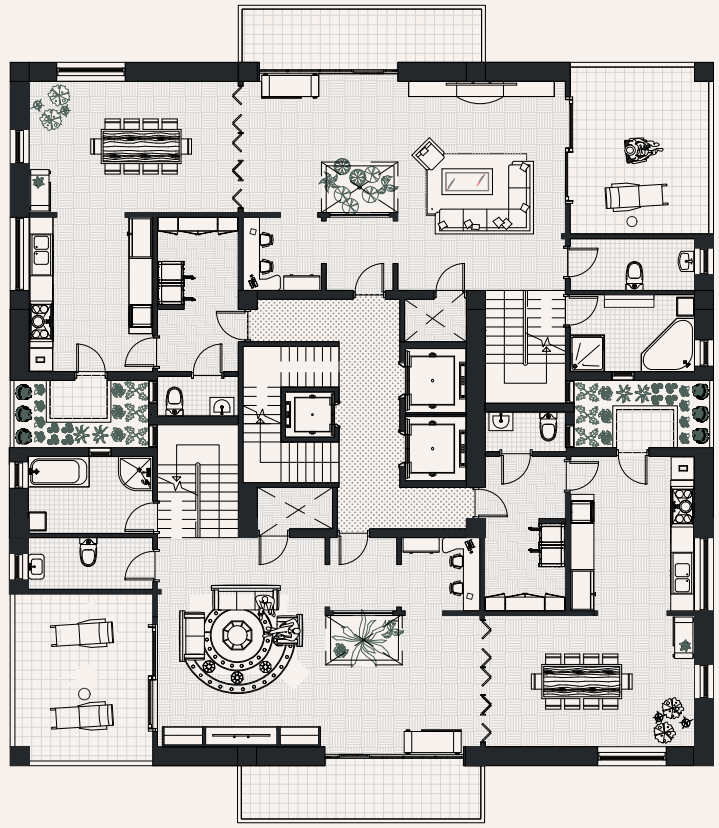


Figure 207. *Firstfloorplan duplex dwellings HIG level 2-5 (bottom) and level 6-9 (top) - scale 1:200*



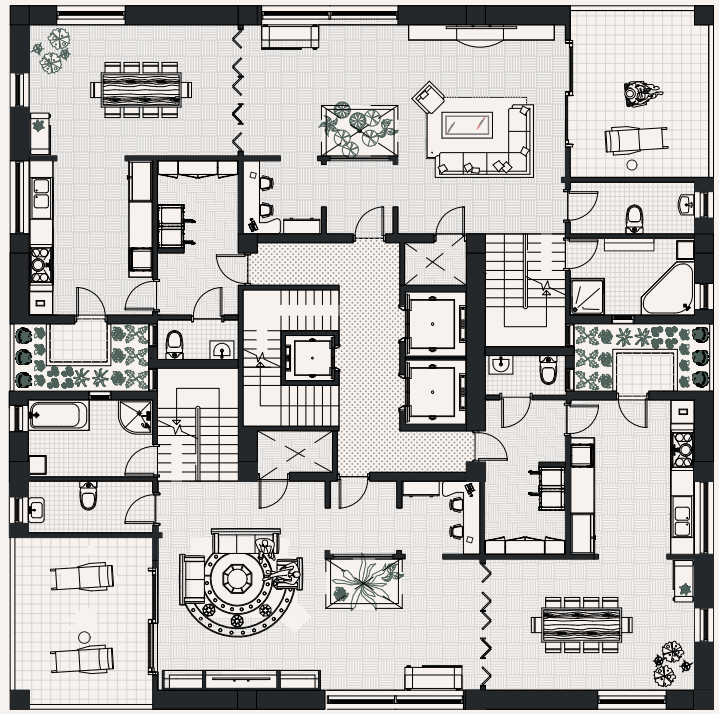
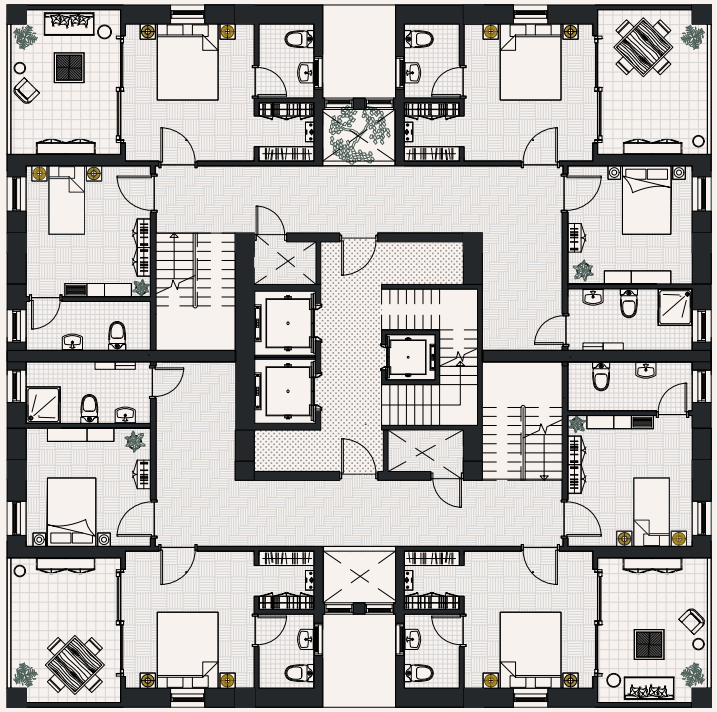


Figure 208. *Mirrored firstfloorplan duplex dwellings HIG level 2-5 (bottom) and level 6-9 (top) - scale 1:200*



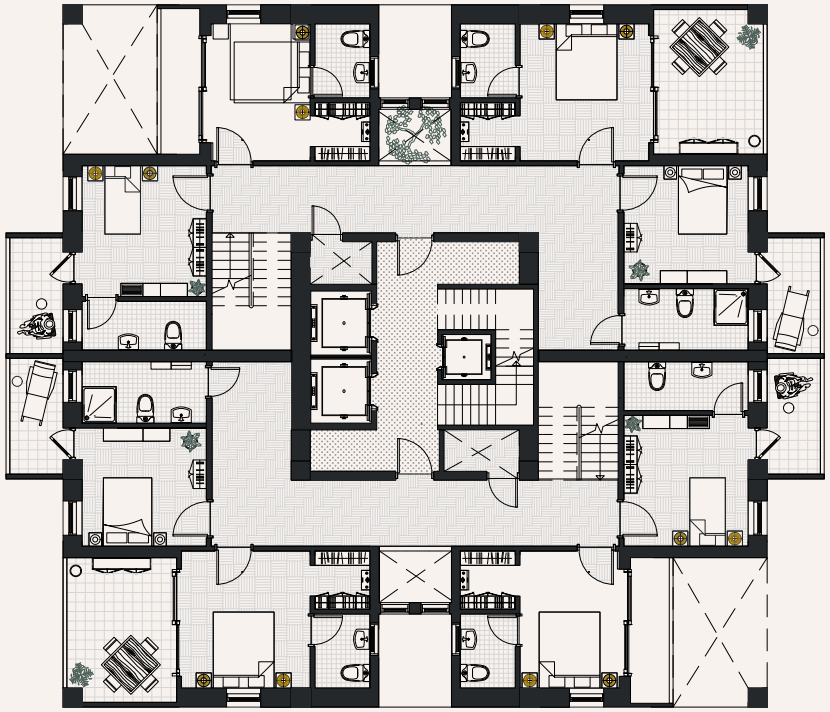
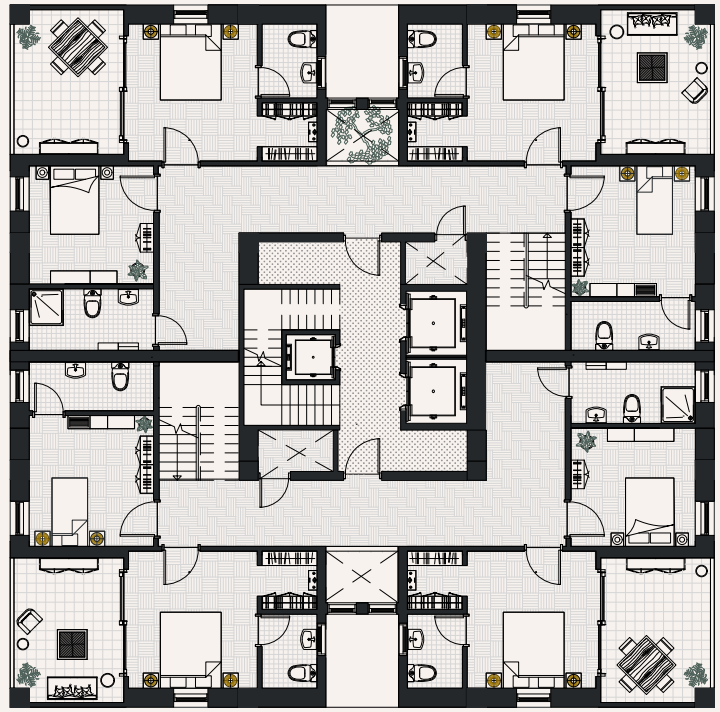


Figure 209. *Secondfloor plan duplex dwellings HIG level 2-5 (bottom) and level 6-9 (top) - scale 1:200*



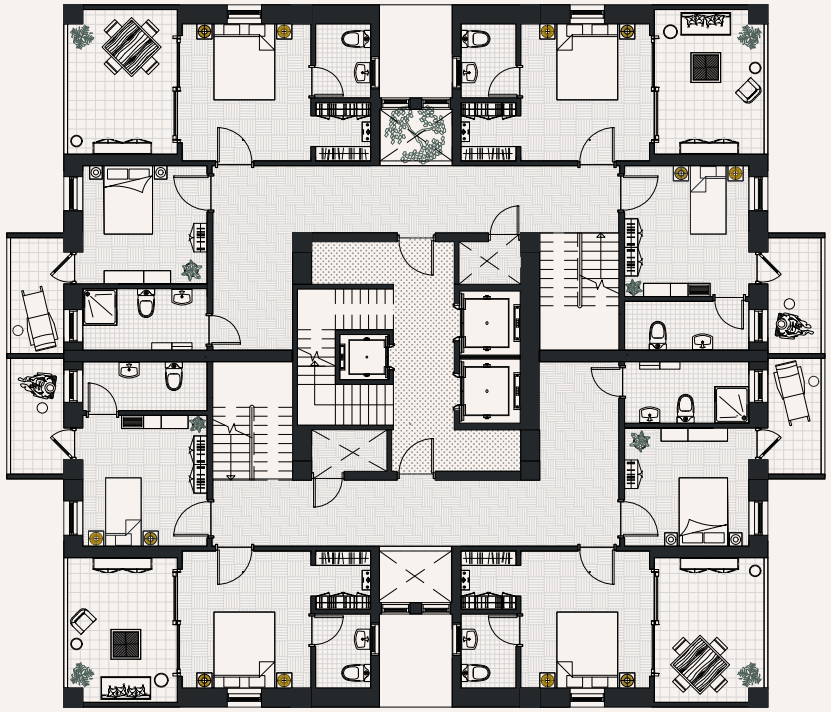
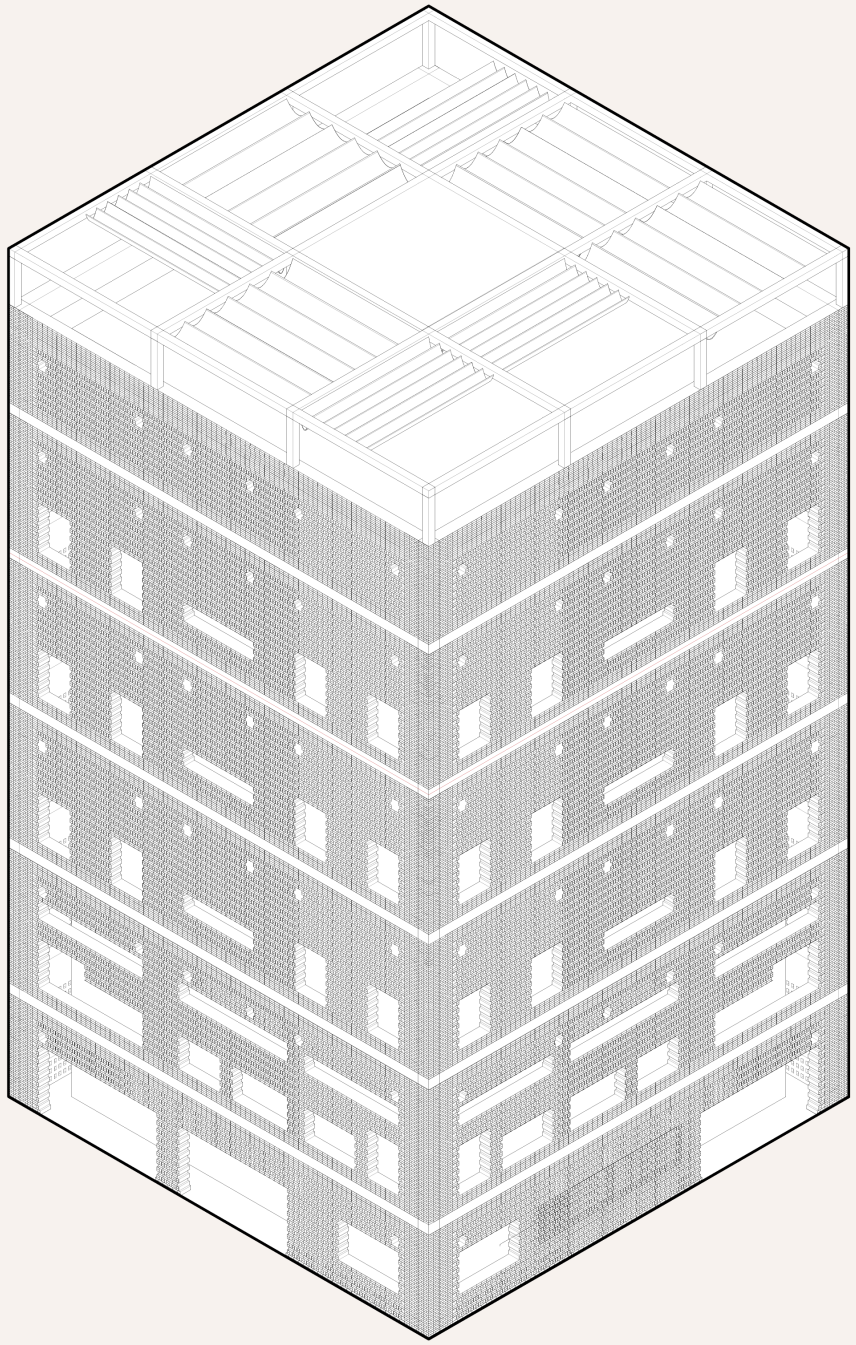


Figure 210. *Mirrored secondfloor plan duplex dwellings HIG level 2-5 (bottom) and level 6-9 (top) - scale 1:200*

VF - general layout
The vertical farm combines climate-responsive architecture with controlled-environment agriculture to enable efficient, local food production in the hot semi-arid climate. A double-skin jali facade reduces direct solar exposure and heat gain while drawing on traditional Indian architectural principles.

The floorplans are organised around an efficient logistical sequence connecting cultivation, harvesting, processing, storage and distribution, while separating agricultural operations from public circulation. Integrated climate-control systems regulate temperature, humidity and air circulation, while energy-efficient LED lighting provides crop-specific light conditions. Water management strategies, including efficient irrigation, recirculation and potential rainwater harvesting, aim to minimise resource consumption.

At ground level, a publicly accessible plinth with a produce shop connects the farm to the surrounding community, creating a direct link between food production and consumption. Together, these strategies establish a resource-efficient, locally integrated urban farming facility adapted to Ahmedabad's climatic conditions.



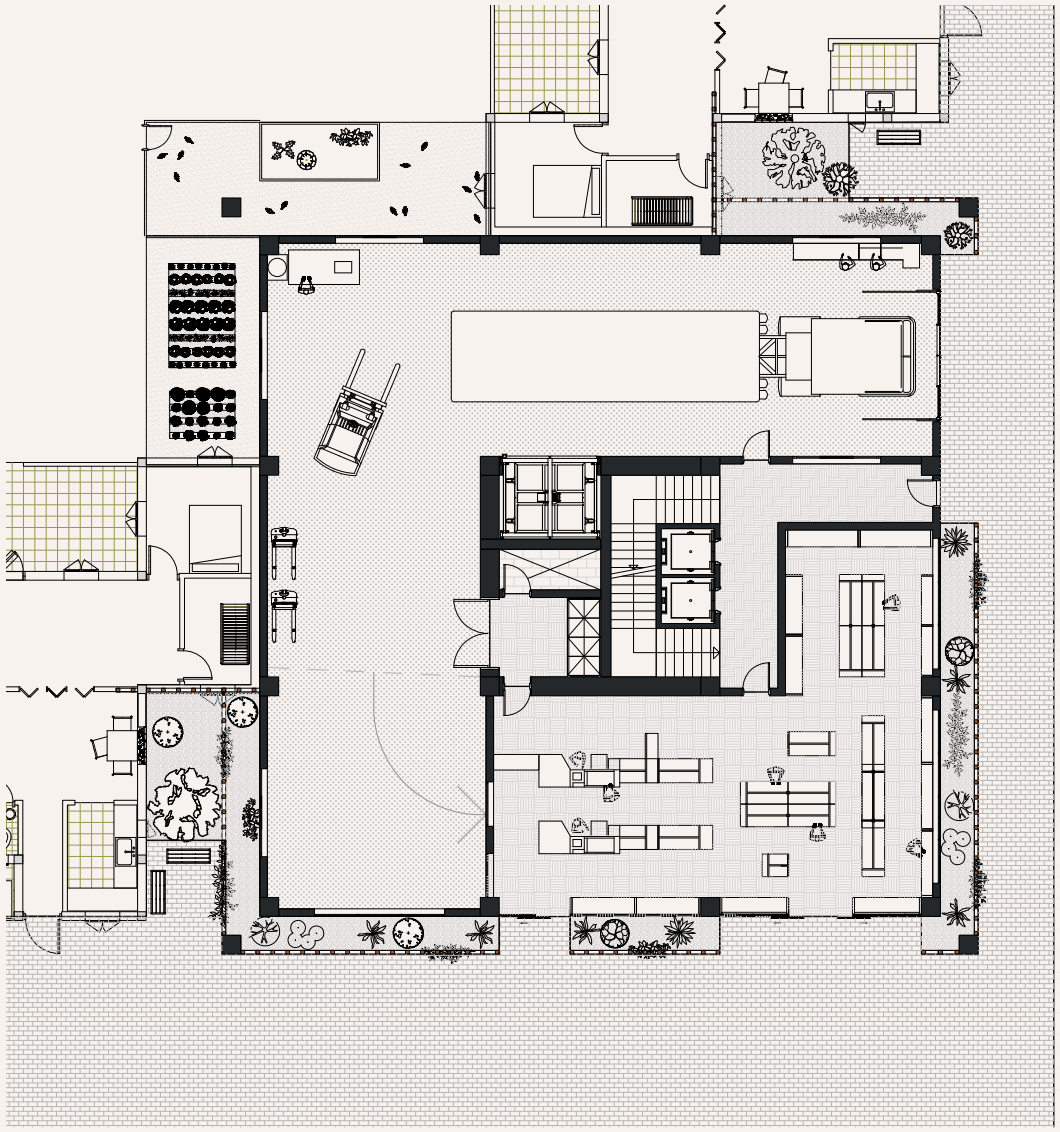


Figure 211. *Groundfloorplan VF building unit - scale 1:200*

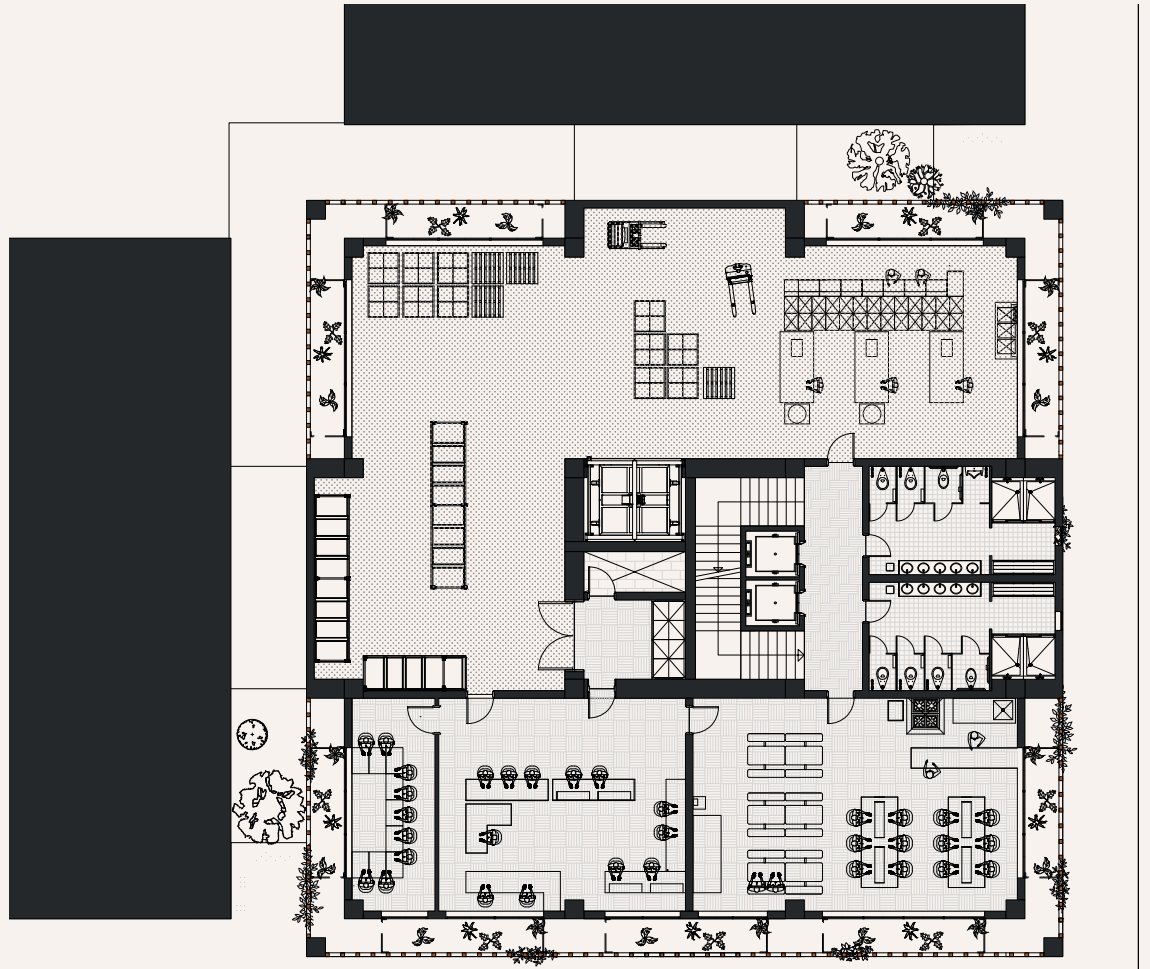


Figure 212. *Firstfloor plan VF building unit - scale 1:200*

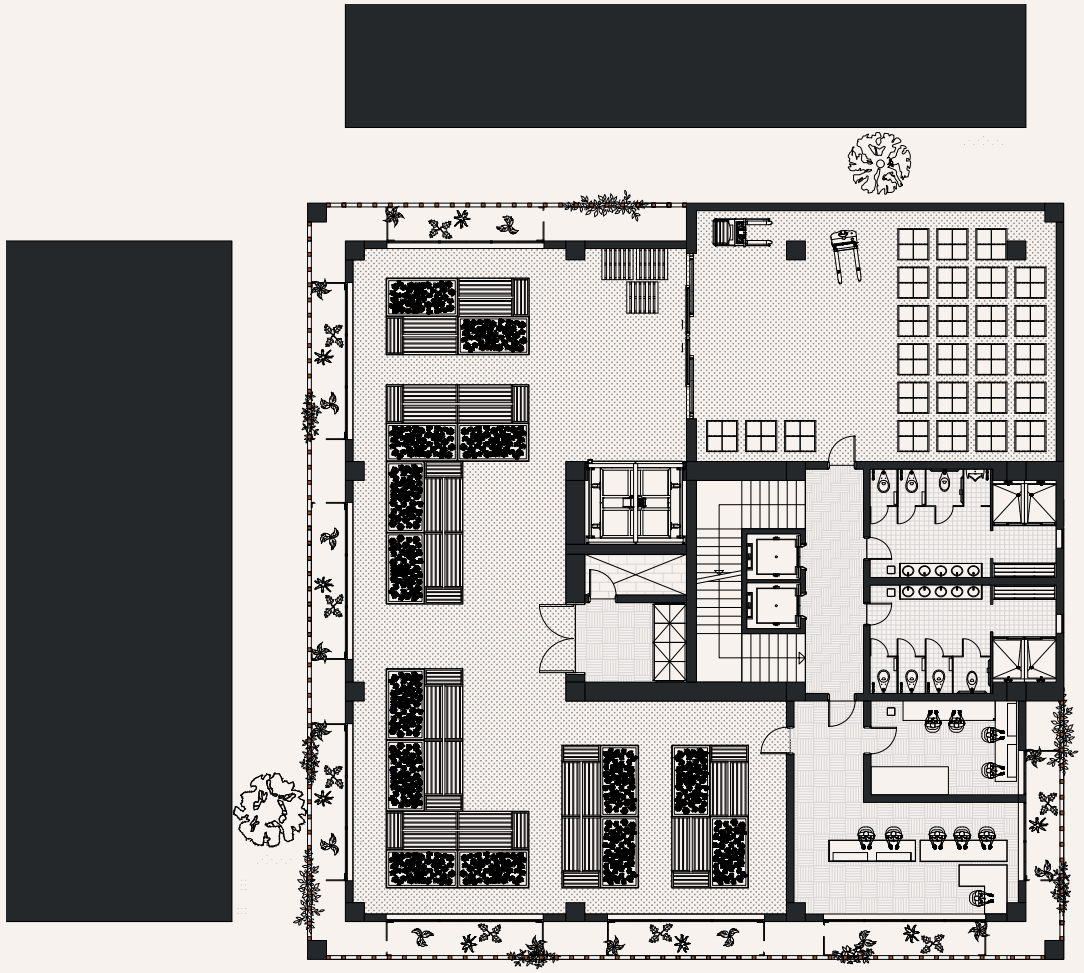


Figure 213. *Secondfloor plan VF building unit - scale 1:200*

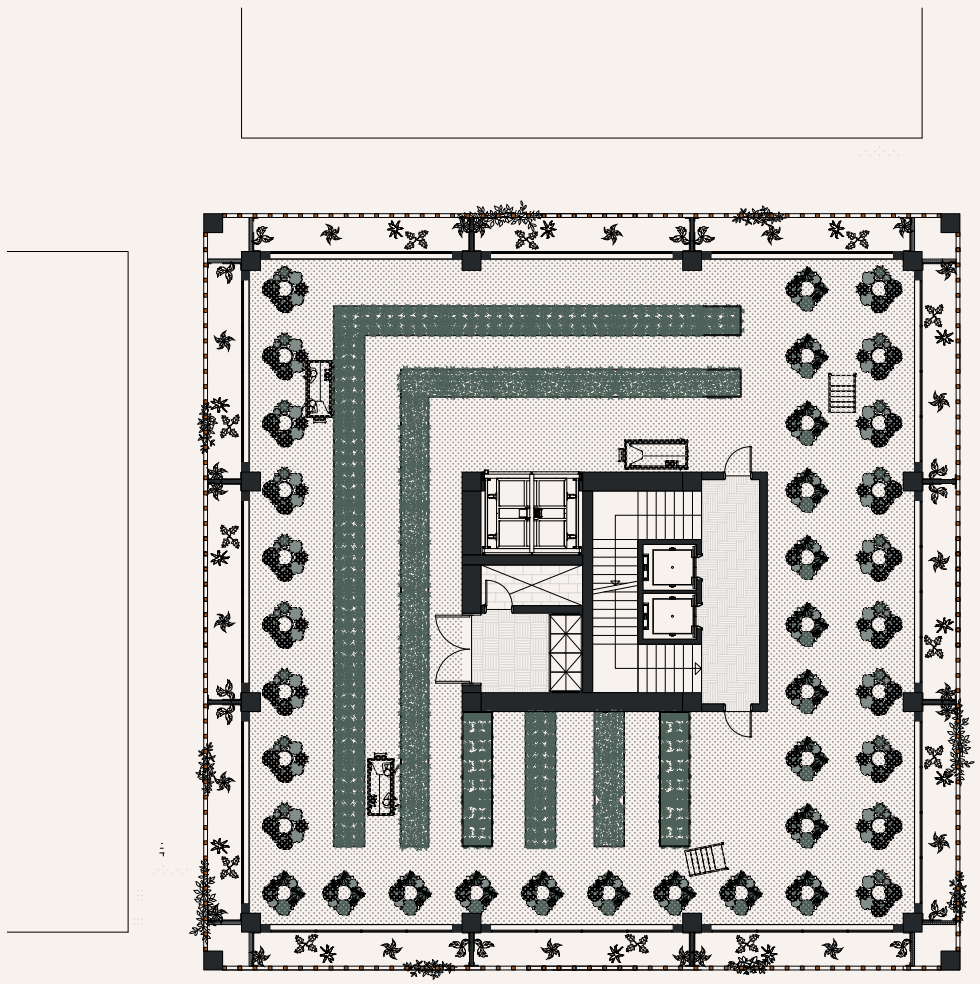
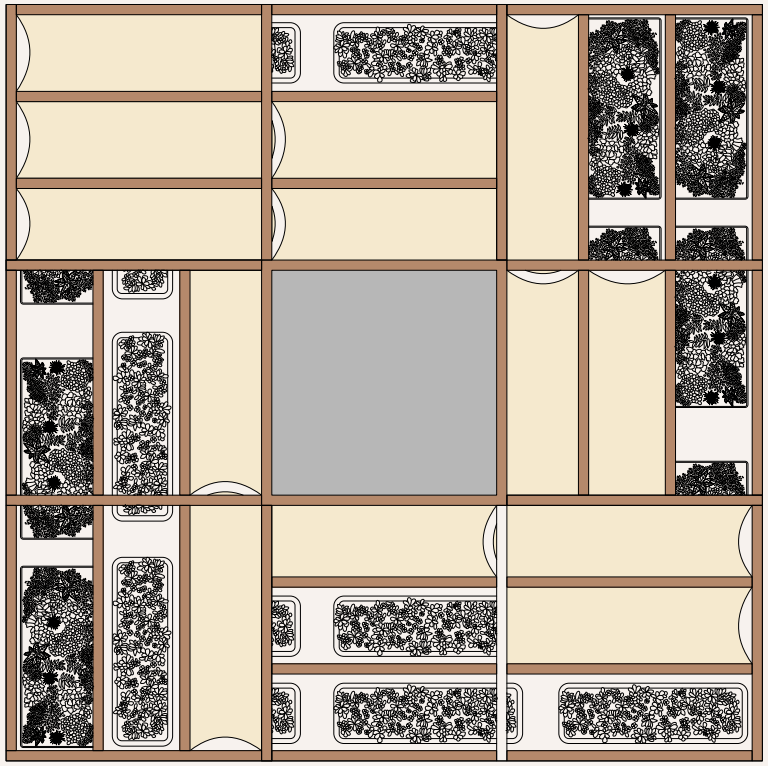


Figure 214. *Thirdfloor plan (production floors) VF building unit - scale 1:200*



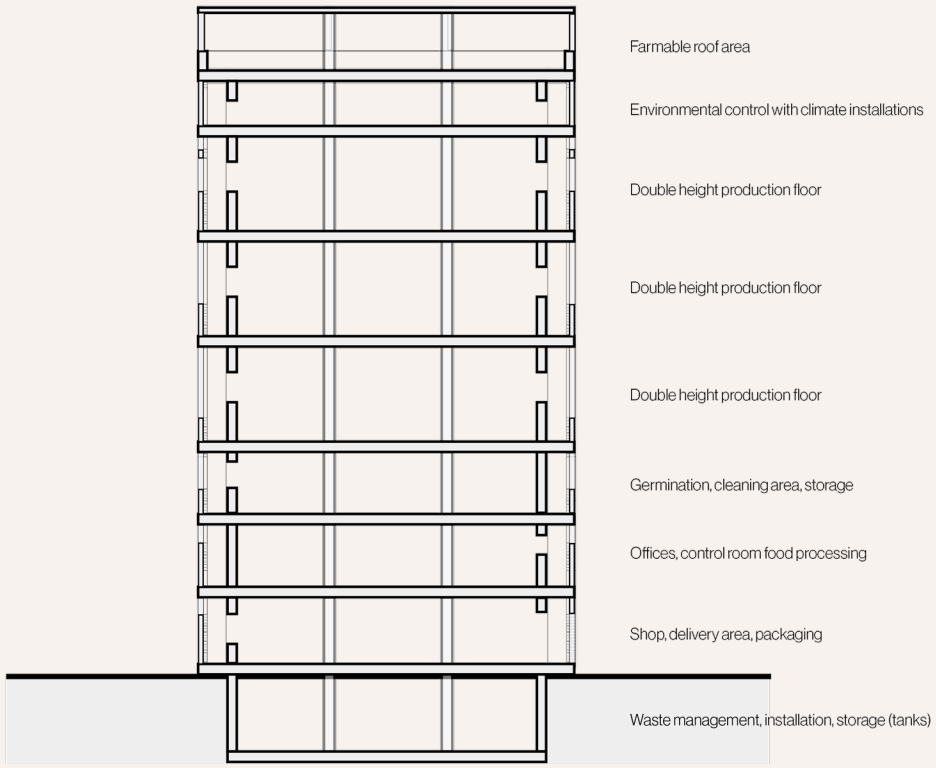
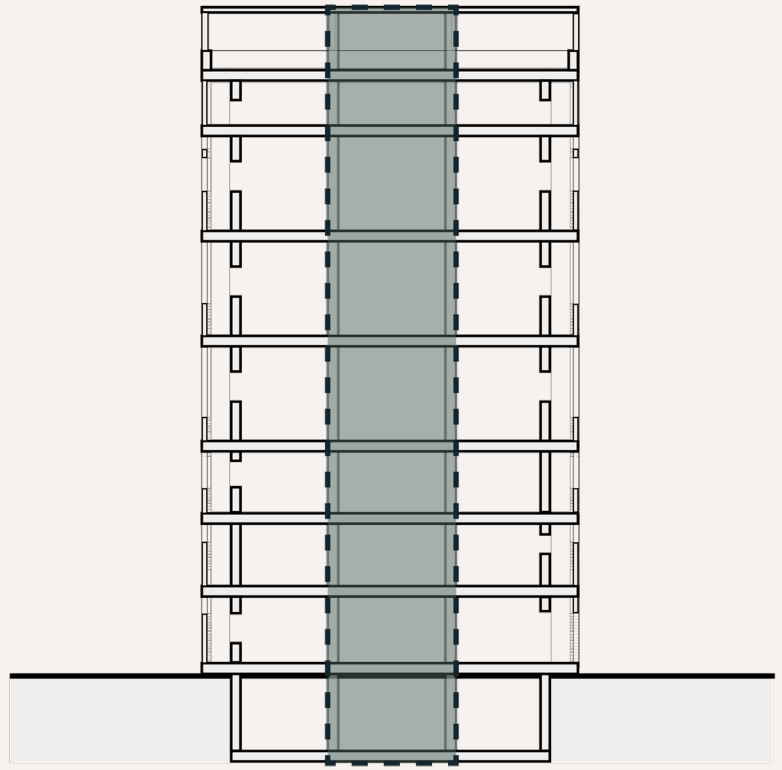


Figure 215. *Rooffloor plan VF building unit - scale 1:200*



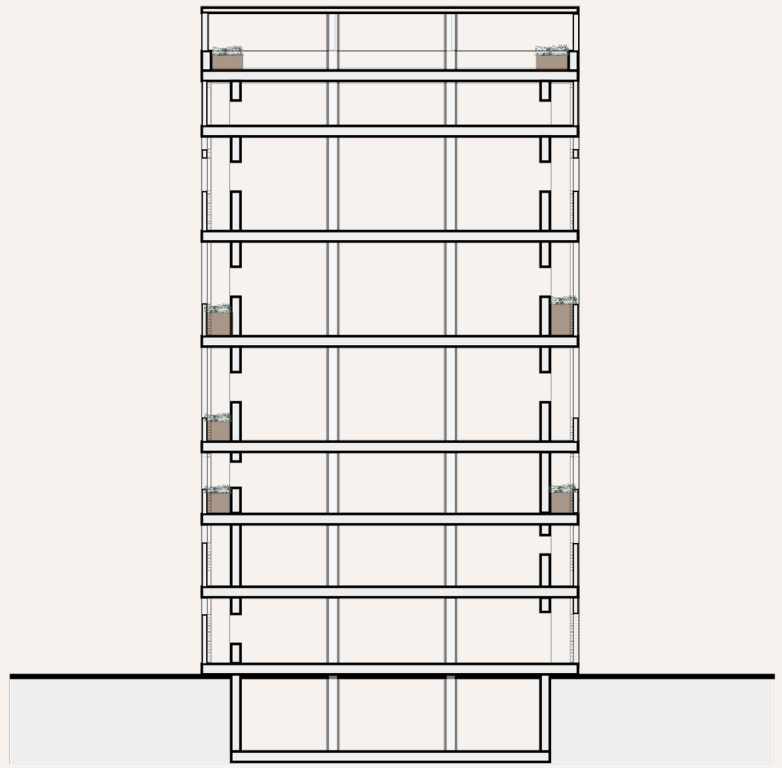
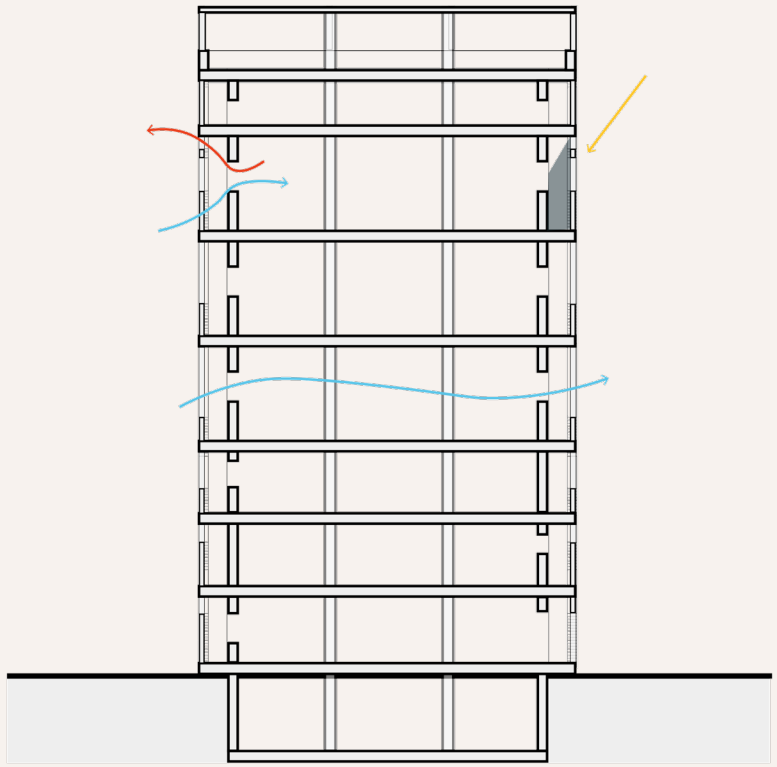


Figure 216. *VF leveldivision, -circulation core and productive second-skin facade*



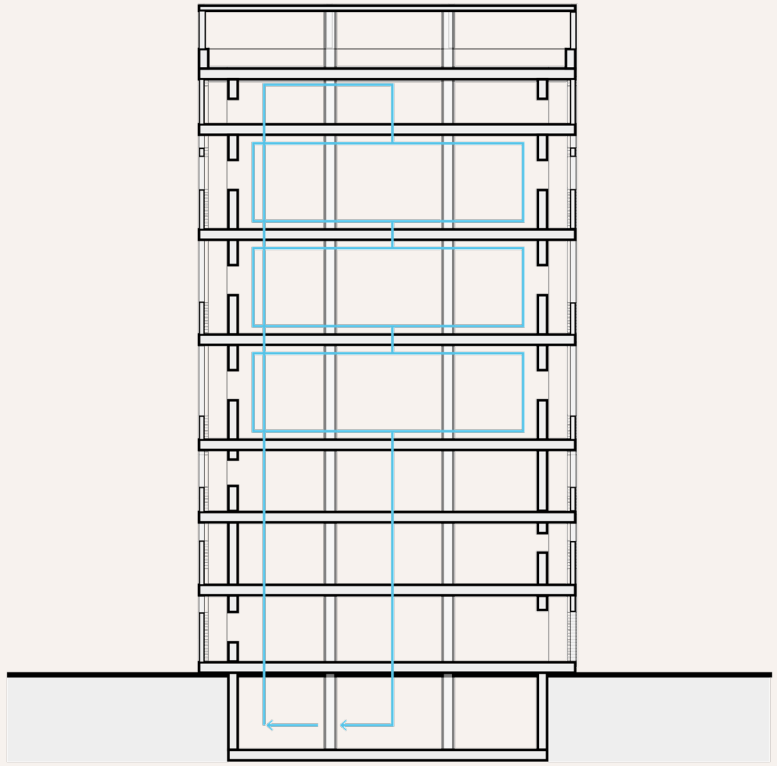
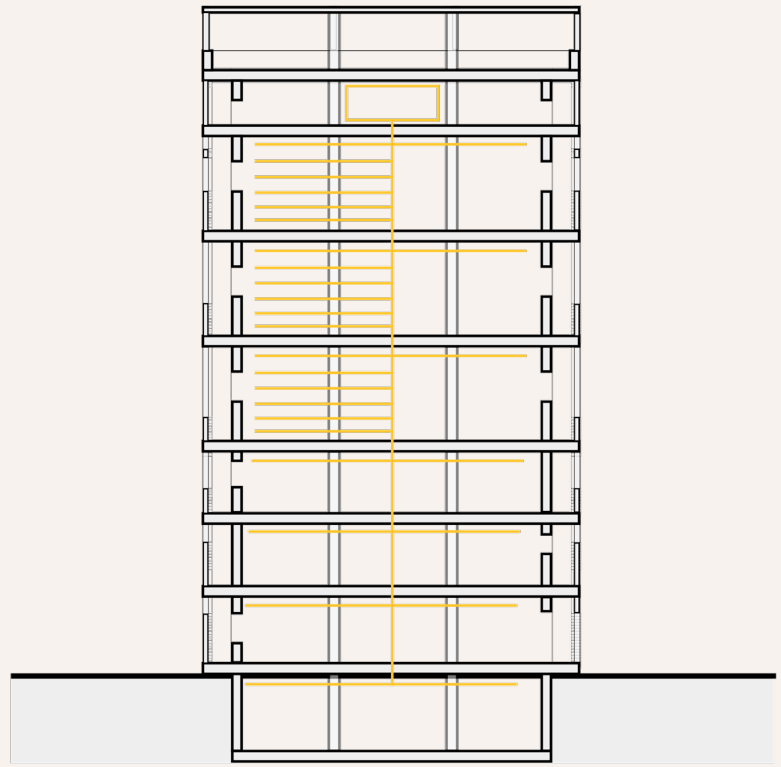


Figure 217. *VF ventilation, - shading and water circulation*



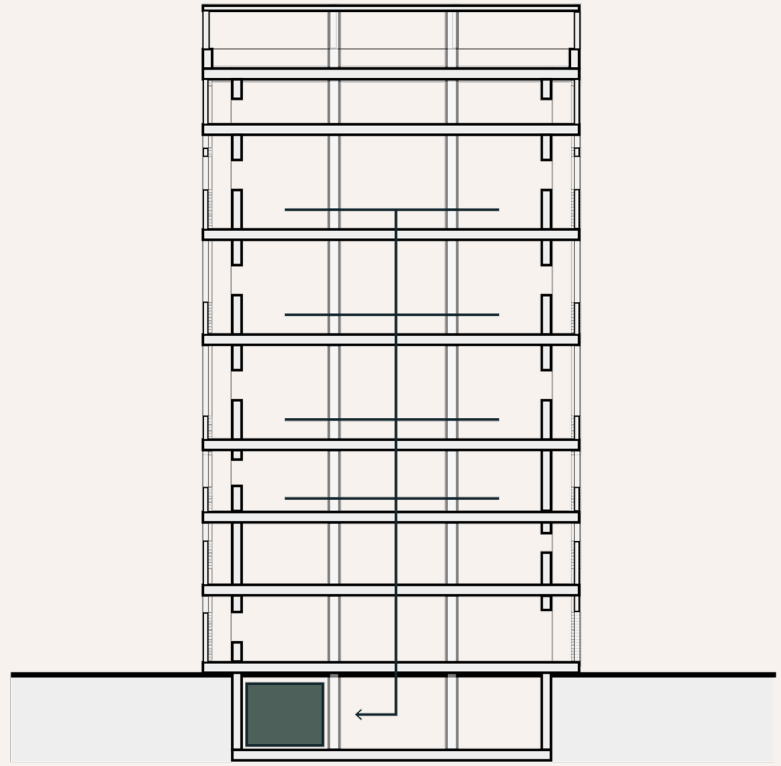


Figure 218. *VF electicity- and waste management*

4.2.4 | Managerial strategy and feasability

Since this project proposes housing for different types of households with sometimes low and insecure incomes, the feasibility of the project is a crucial consideration. Therefore, architectural and spatial strategies are needed to operate under conditions of tenure insecurity and limited resources.

The aim of the project is to use a repeatable framework that is adaptable to accommodate different users. Using a repeatable cluster system reduces construction complexity and costs. Since many construction workers live on site, the use local labour can be easily implemented. Phased development reduces risk and allows current residents to relocate on site.

Cross-subsidisation is explored through shared infrastructure and clusters of mixed income groups, combining EWS and low-income migrant households with middle-income- and high-income residents within the same building cluster. This reduces the costs per unit for the lower-income groups. While this increases the financial feasibility, it also creates the challenge of avoiding segregation. For the project to succeed the different needs of the socio-econimc groups need to be fulfilled. However, it is still of importance that the mixed income groups share facilities and collective space to support interaction and create a socially integrated neighborhood.

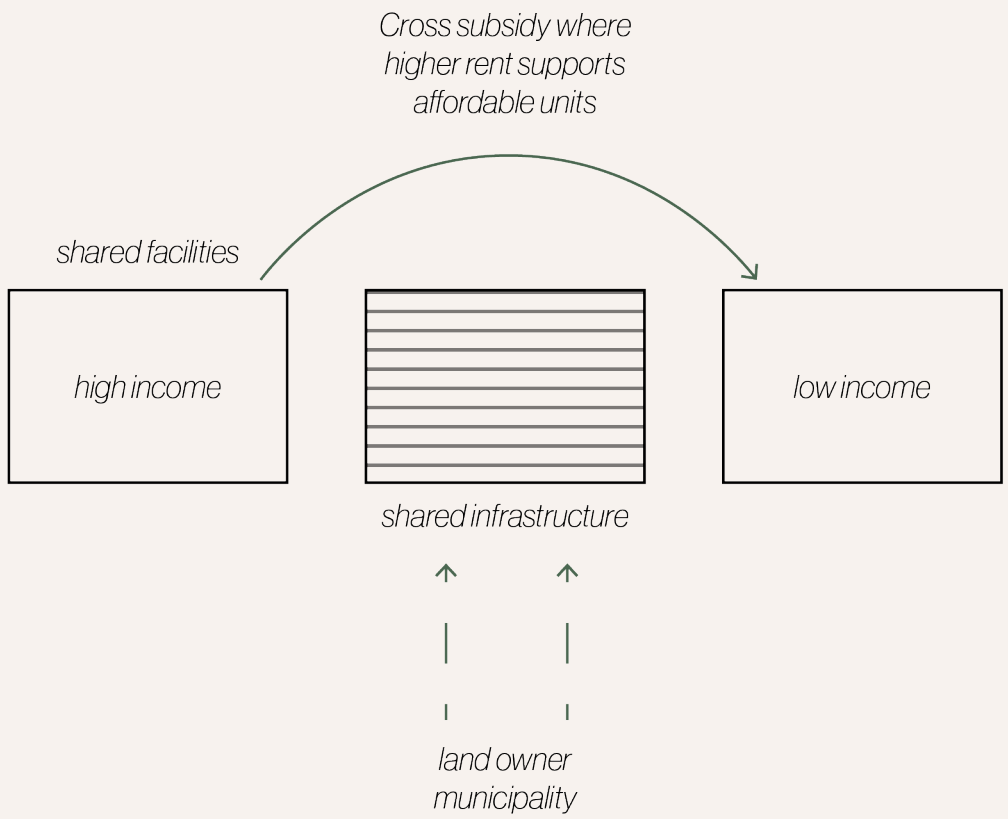


Figure 219. *Housing development strategey*

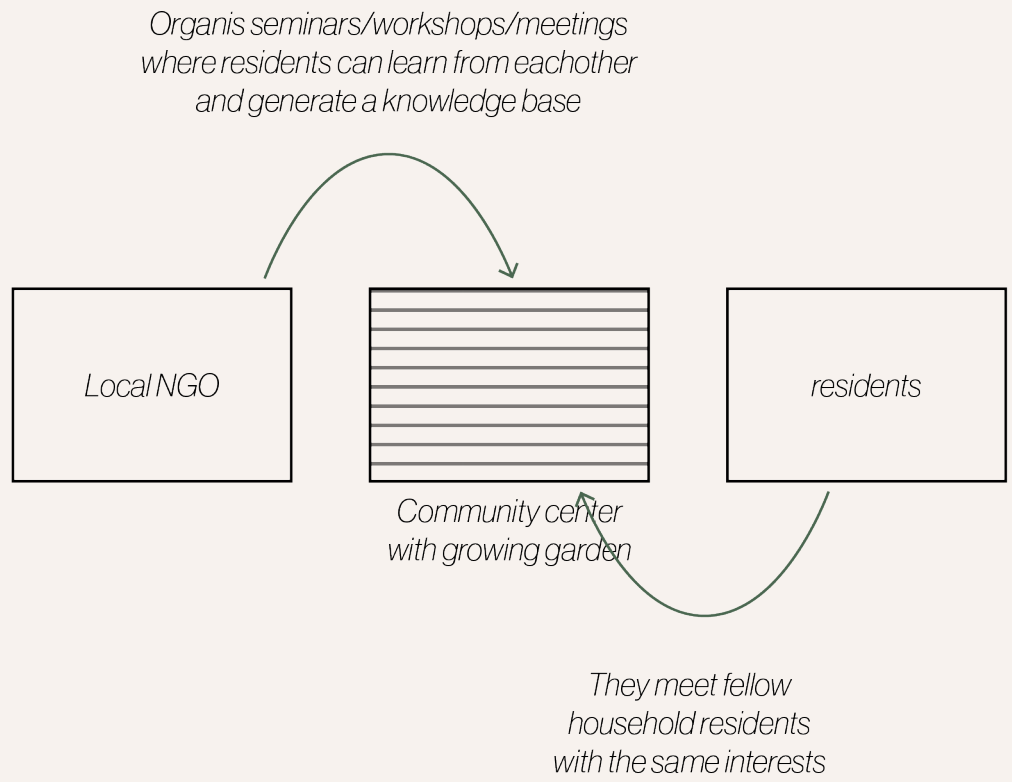


Figure 220. *UA engagement and long-term participation strategy*

The managerial strategy focuses further on creating initial engagement in UA through education, awareness and accessible community activities with help of a local NGO (non-government-organisation). They encourage residents to become involved in practicing UA and helping them with the basic knowledge needed. Long-term participation is sustained through shared responsibilities, community working, knowledge exchange and benefits such as locally produced harvests. This creates a continuous cycle in which active participation strengthens community involvement and ensures the long-term participation of UA.

By offering different types of UA practices, households always have a choice in what parts they want to be involved which makes the practice voluntary and can be seen more as a way of combining production with socialising, leisure and livelihood support.

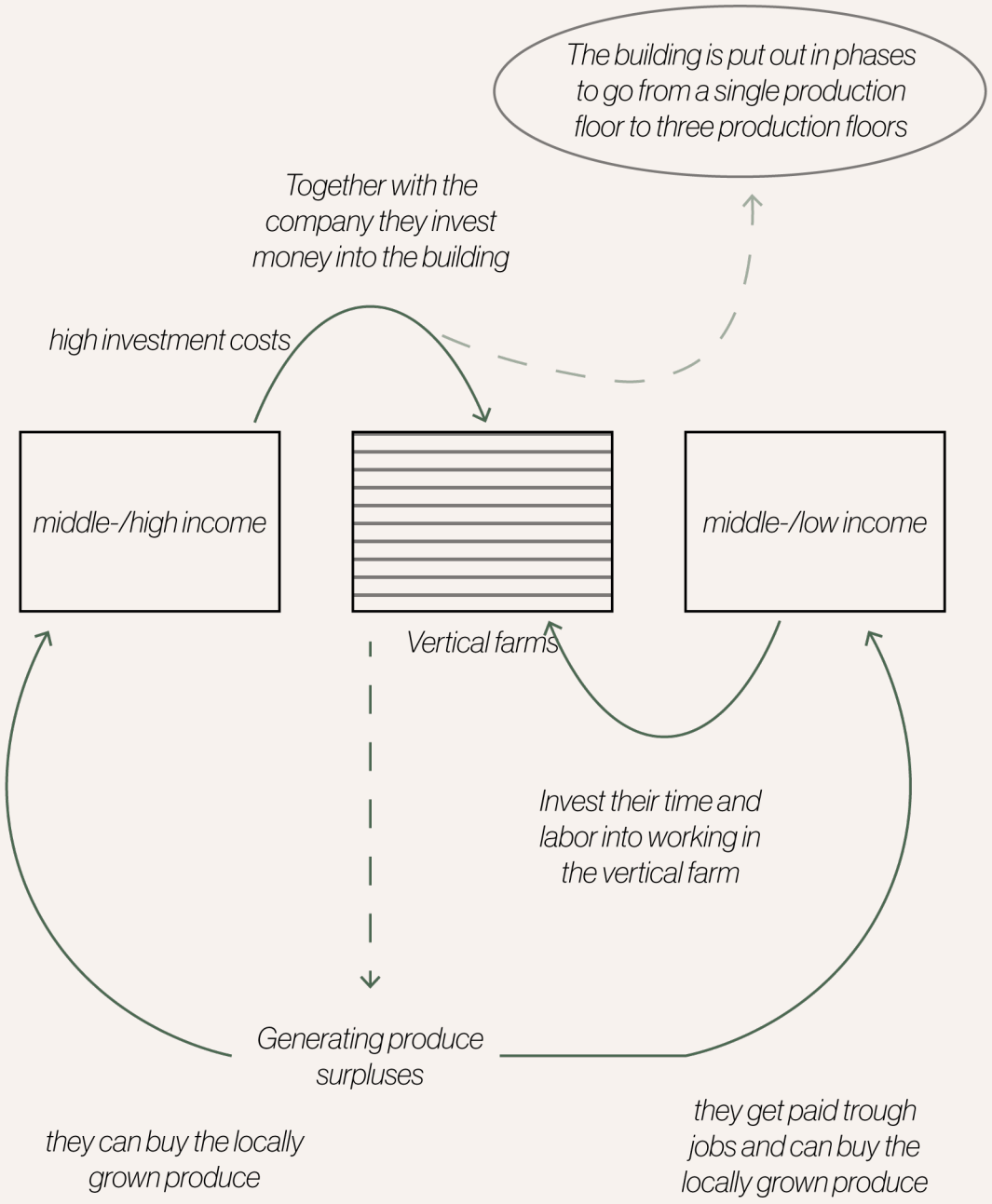


Figure 221. *Vertical farm phasing- and implementation strategy*

The vertical farm's managerial strategy is based on a phasing of building levels. The investment of the company and the high-income households allows for the construction and build of the supporting floors and one production floor. As time goes on and the building starts generating produce and income, the building can expand to up to three production floors. Meanwhile the low- and middle-income households contribute to the process by working in the vertical farm on the different function levels. The main output is freshly grown, local produce that all the households then can buy and use.

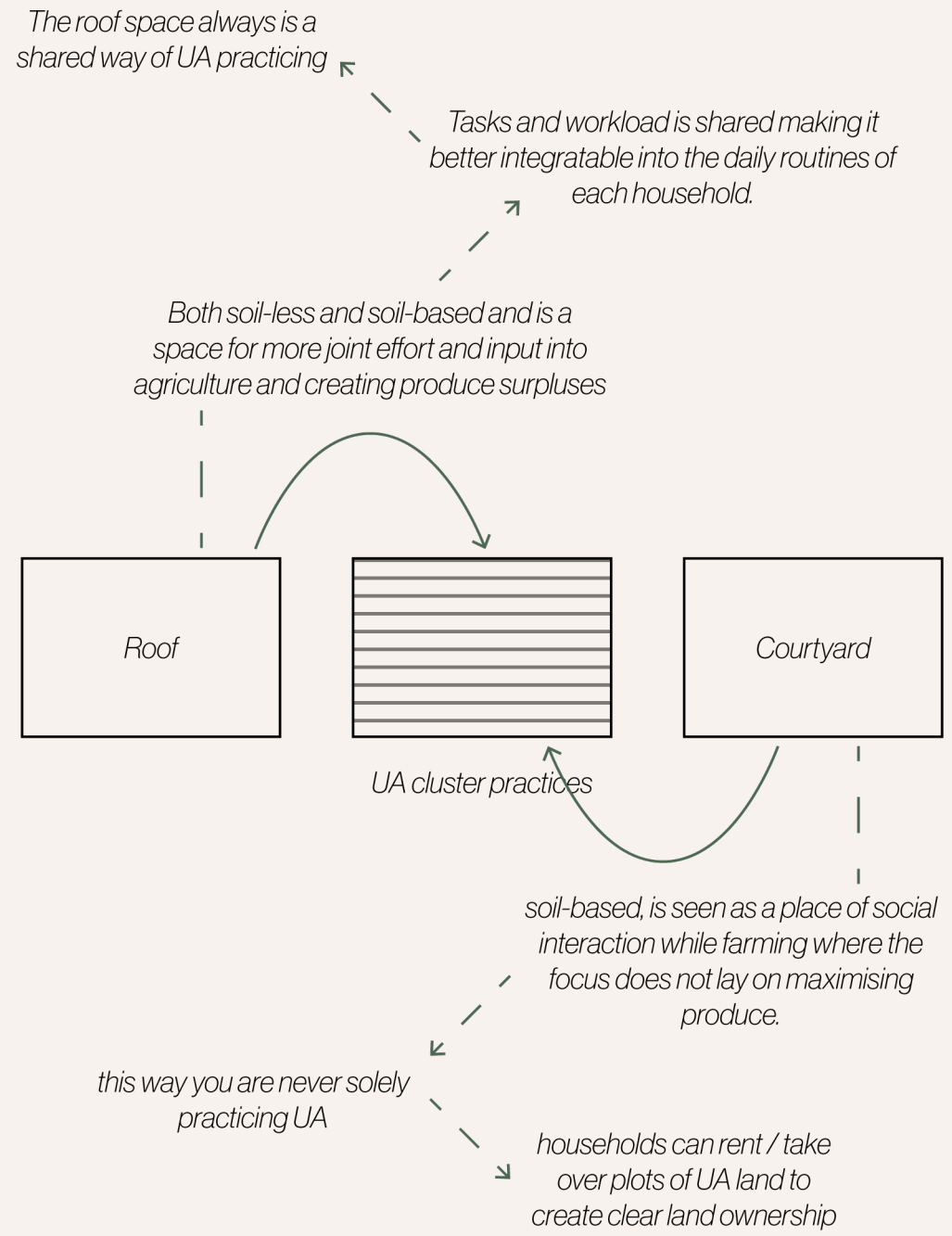


Figure 222. *UA cluster implementation strategy*

On the cluster scale UA is practiced on the roof and the inner courtyard. Both serve different forms of scale and end goal. While on the roof a shared input is brought by the households living under it, on the courtyard the soil-based practice services also a more social activity practiced for leisure. Here the aim is not necessarily to maximise produce, while on the roof shared investment in for example hydroponic towers is possible as a way to indeed multiply the farmable area that is provided through the design. Both spaces do provide clear ownership of it to ensure they feel responsible and entitled to use them.

Phasing

In phase 1 of the project, the base cluster gets build together with one extra unit of each typology and the public marketsquare. This way the HIG can cross-subsidise the low-income housing units and all UA types can be started in their practice. The marketsquare is tied to the community center to give the NGO the space to start creating this knowledge exchange and practice in the UA sector. The vertical farm and square become the spaces where the investment costs are earned back in time and awareness on the practice starts to spread. The phase is connected to the busy nothern road to pull visitors along the public plinth- and vertical farm shops. Feedback on the arrangement and layout of the farmable areas (courtyard, terrace, roof) by the residents can inform minor design alerations for the clusters build in the next phases.



The second phase serves as the addition of another typical cluster where now both vertical farms can expand gradually over time. Meanwhile phase three of the project also starts construction to fully complete that section of the project. Again feedback on UA practicing can be taken into account in bettering their functioning within the project.

The last phase holds the final two clusters of low- and middle income dwellings, which with the cross-subsidisation of the already build HIG towers, can be completed to finalise the whole masterplan. The connection of the project to its surroundings and existing buildings is fully accomplished and the last two vertical farms are build..

Figure 223. *Masterplan phasing strategy*

Chapter 05

Conclusion and Outlook

5.1 Conclusion

This research explores how low-input urban agriculture can be integrated into low-rise, high-density worker housing in Rajiv Nagar, Ahmedabad, to support everyday livelihoods, strengthen local food systems and improve environmental and social quality. It investigates how spatial organisation, infrastructure and everyday practices can create opportunities for domestic life, food production, education and income generation. Through design principles and spatial typologies across the dwelling, cluster and urban scales, the research demonstrates how productive landscapes can become an integral part of the housing fabric.

The findings show that urban agriculture can build on existing daily practices and the use of shared spaces and open fields. By transforming underused areas into productive landscapes, cultivation can support food production, additional income, informal learning and social interaction. However, limited space, inadequate infrastructure and a lack of shared facilities currently restrict this potential. The adaptability and resourcefulness of residents highlight the importance of building on existing practices rather than introducing entirely new ways of living.

Social infrastructure and climate responsiveness are equally important. Shared growing spaces can function as places for cultivation, knowledge exchange and community activities, while strategies such as shading, water management, ventilation and appropriate material choices can improve growing conditions and outdoor comfort. Integrating these elements into a connected network of productive, public and collective spaces can strengthen the relationship between housing, livelihoods and community life.

Ultimately, the research argues that urban agriculture should be understood not simply as a means of increasing food production, but as a spatial strategy for supporting livelihoods, food security, social interaction and environmental resilience. By integrating productive landscapes into housing across multiple scales, the proposed framework offers an approach that can inform future housing developments in Ahmedabad and other rapidly urbanising cities facing similar challenges.

5.2 Recommendations

Future housing developments should approach urban agriculture as an integral and adaptable component of the residential environment rather than as an isolated function. Productive spaces should be incorporated across multiple scales, from individual dwellings and shared courtyards to the wider urban structure, creating a connected network of growing opportunities. Housing should provide flexible spatial conditions that allow residents to appropriate, modify and expand productive spaces in response to changing household needs and cultivation practices. Rather than prescribing fixed programmes, architecture should support incremental development and build on the existing adaptability and resourcefulness of residents.

Furthermore, urban agriculture should be supported by an integrated system of social and productive infrastructure. Accessible water supplies, rainwater collection, composting facilities, storage and shared growing spaces are essential for supporting low-input cultivation. These should be combined with facilities for education, childcare and community activities, allowing productive landscapes to become places for knowledge exchange, social interaction and economic opportunities. Community participation in the planning and management of these spaces is equally important to ensure that they respond to local needs and remain viable over time.

Climate responsiveness should be considered a fundamental design principle. Strategies such as shading, cross-ventilation, water management and appropriate material choices should be integrated from the beginning to improve growing conditions and thermal comfort. This can increase the usability of productive and collective spaces while supporting environmental resilience in Ahmedabad's hot climate.

Finally, urban agriculture should be understood as a spatial strategy that connects domestic life with collective activities and the wider urban environment. By linking individual growing spaces with shared productive landscapes and public infrastructure, housing can support both household cultivation and collective food production. Rather than introducing a rigid system, the aim should be to establish a flexible framework that enables urban agriculture to develop over time, strengthening local food systems, supporting livelihoods and contributing to more resilient neighbourhoods.

5.3 | Reflection

While this research provides a spatial and design-oriented understanding of housing in informal settlements, several limitations should be acknowledged. The study focuses solely on Rajiv Nagar in Ahmedabad, limiting the generalisability of its findings to other contexts. Comparing different types of informal settlements, particularly those with more established semi-pucca housing structures, could provide a broader understanding of the proposed approach.

Data collection was also limited to two site visits. More extensive fieldwork, including in-depth interviews, observations throughout the day and night, and fewer language barriers, could have provided a deeper understanding of residents' needs and everyday practices. Involving residents throughout the design process would have further strengthened the proposals through direct feedback and participatory testing.

Furthermore, the research primarily addresses spatial and architectural aspects, while broader issues such as land tenure, financial feasibility, water availability, governance and long-term maintenance remain unexplored. These factors are particularly important for the successful implementation of urban agriculture in informal settlements. As the design proposals remain conceptual, their actual social, economic and productive impact has not been tested in practice.

Looking back on the project, one of the most important lessons was that urban agriculture should not be understood solely as a productive system. Its value lies equally in the social interactions, cultural traditions, environmental benefits and spatial qualities it generates. The research also highlighted that providing growing spaces alone is insufficient; their success depends on accessibility, infrastructure, available resources and community participation.

As someone who grew up in an agricultural environment, this research broadened my understanding of agriculture from a predominantly rural practice into a potential component of urban life. It shifted my perspective on housing from an individual dwelling towards a connected system of domestic, productive, social and ecological spaces. Ultimately, the project strengthened my belief that architecture can help reconnect food production, communities and the built environment, creating more resilient ways of living.



Appendix

Appendix

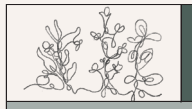
Ahmedabad plant database

Ahmedabad plant database
Listed in order of: grasses, herbs, vegetables, horticulture, climbers, shrubs, trees



Grasses

Name	Family	Common name	Main purpose	Mature footprint (m)	Spacing (m)	Water requirement	Sun/shade
Alloteropsis cimicina L. Stapf	Poaceae	Bug seed grass	Fodder	0,4 × 0,6	0,8	Low - tolerates seasonally dry	Full sun
Elytrophorous spicatus Wild.A. Camus	Poaceae	Spikegrass	Grass cover	0,3 × 0,5	0,6	High - prefers wet soil	Full sun
Oryza rufipogon Griff	Poaceae	Wild rice	Animal Culinary	0,3 × 0,5	0,5	High - prefers wet soil	Full sun
Pennisetum spp	Poaceae	Fountain grass	Fodder	0,6 × 1,0	1,1	Moderate	Full sun
Fimbristylis spp	Cyperaceae	Fimbry	Soil water management	0,2 × 0,4	0,4	Moderate - tolerates seasonally dry	Partial shade



Herbs

To fully grow the herbs in outside conditions, the below footprint and spacing is advised.The footprint of the listed herbs can be significantly scaled down when they are grown inside in pots or planters.

Name	Family	Common name	Main purpose	Mature footprint (m)	Spacing (m)	Water requirement	Sun/shade
Agenolaema marantifolia Blume	Araceae	Aglaonema	Ornamental	0,4 × 0,4	0,4	Moderate	Indirect/shade
Agenolaema simplex Blume	Araceae	Aglaonema	Ornamental	0,4 × 0,4	0,4	Moderate	Indirect/shade
Aloe barbadense Mill	Liliaceae	Aloe vera	Medicinal	0,5 × 0,5	0,5	Low	Partial shade
Aloe aristata Haw.	Xanthorrhoeaceae	Lace aloe	Ornamental	0,3 × 0,3	0,3	Low	Partial shade
Alysicarpus spp	Fabaceae	Alyce clover	Fodder	0,3 × 0,3	0,3	Low	Full sun
Caladium bicolor Aiton Vent	Araceae	Heart of Jesus	Ornamental	0,4 × 0,4	0,4	High	Partial shade
Caladium esculentum Vent	Araceae	Elephant ear	Culinary	0,8 × 0,8	0,8	High	Partial shade
Caladium hertulanum Bridsey	Araceae	Caladium	Ornamental	0,4 × 0,4	0,4	High	Partial shade
Cannabis sativa L.	Cannabaceae	Cannabis	Medicinal	1,0 × 1,0	1	Moderate	Full sun
Eriocaulon eleanorae Fyson	Eriocaulaceae	Pipewort	Ornamental	0,2 × 0,2	0,2	High	Partial shade
Murdania nudiflora L	Commelinaceae	Dewflower	Medicinal	0,3 × 0,3	0,3	High	Partial shade
Panacratium triflorum Roxb	Amaryllidaceae	Forest spider lily	Medicinal	0,3 × 0,3	0,3	Low	Full sun
Phyllanthus virgatus G.Forst.	Euphorbiceaes	Slender leaflflower	Medicinal	0,3 × 0,3	0,3	Moderate	Full sun
Zornia gibbosa Span.	Fabaceae	Zornia	Fodder	0,3 × 0,3	0,3	Low	Full sun
Capsicum annum L.	Solanaceae	Chili pepper	Culinary	0,4 × 0,4	0,4	Moderate	Full sun
Impatiens balsamina L. var. coccinea	Balsaminaceae	Garden balsam	Ornamental	0,3 × 0,3	0,3	Moderate	Partial shade
Canna indica L.	Cannaceae	Indian shot	Ornamental	0,8 × 0,8	0,8	Moderate	Partial shade
Argemone mexicana L.	Papaveraceae	Mexican poppy	Medicinal	0,5 × 0,5	0,5	Low	Full sun
Tribulus terrestris L.	Zygophyllaceae	Puncture vine	Medicinal	1,2 × 1,2	1	Low	Full sun
Eclipta alba L. Hassk	Asteraceae	False daisy	Medicinal - hair problems	0,6 × 0,6	0,5	High	Partial shade
Vinca rosea L.	Apocynaceae	Madagascar periwinkle	Medicinal	0,4 × 0,4	0,4	Low	Partial shade
Ocimum sanctum L.	Lamiaceae	Holy basil	Medicinal - fever	0,6 × 0,6	0,5	Moderate	Full sun
Ocimum basilicum L.	Lamiaceae	Sweet basil	Culinary	0,4 × 0,4	0,4	Moderate	Full sun
Ocimum gratissimum	Lamiaceae	Clove basil	Medicinal - typhoid	1,0 × 1,0	0,8	Moderate	Partial shade
Achyranthes aspera L.	Amaranthaceae	Prickly chaff flower	Medicinal	0,5 × 0,5	0,4	Low	Full sun
Aloe vera L.	Liliaceae	Aloe vera	Cosmetic	0,5 × 0,5	0,5	Low	Partial shade
Datura inoxia	Solanaceae	Moonflower	Medicinal - Asthma	1,0 × 1,0	0,8	Moderate	Full sun
Ricinus communis	Euphorbiceaes	Castor bean	Medicinal - abdominal disease	1,2 × 1,2	1	Moderate	Full sun
Grangea maderaspatana	Asteraceae	Madras fleabane	Medicinal - boils	0,4 × 0,4	0,3	Low	Full sun
Solanum surattense	Solanaceae	Yellow-berried nightshade	Medicinal - bronchitis	0,6 × 0,6	0,5	Low	Full sun
Echinops echinatus	Asteraceae	Indian globe thistle	Medicinal - cough	0,5 × 0,5	0,4	Low	Full sun
Argemone mexicana	Papaveraceae	Mexican poppy	Medicinal - eczema	0,5 × 0,5	0,5	Low	Full sun
Andrographis paniculata	Acanthaceae	Green chiretta	Medicinal - fever	0,4 × 0,4	0,3	Moderate	Partial shade
Enicostema hyssopifolium	Gentianaceae	Indian whitehead	Medicinal - fever	0,3 × 0,3	0,3	Low	Full sun
Blumea eriantha	Asteraceae	Blumea	Medicinal - headache	0,6 × 0,6	0,5	Low	Full sun
Blumea eriantha	Asteraceae	Blumea	Medicinal - headache	0,6 × 0,6	0,5	Low	Full sun
Celosia argentea	Amaranthaceae	Silver cockscomb	Medicinal - kidney stone	0,4 × 0,4	0,3	Moderate	Full sun
Launaea sarmentosa	Asteraceae	Beach lettuce	Medicinal - piles	0,5 × 0,5	0,4	Low	Full sun
Datura metel	Solanaceae	Devil's trumpet	Medicinal - skin disease	1,0 × 1,0	0,8	Moderate	Full sun
Curcuma longa	Zingiberaceae	Turmeric	Medicinal - skin disease	0,5 × 0,5	0,4	Moderate	Partial shade
Abelmoschus moschatus	Malvaceae	Musk mallow	Medicinal - snake bite	0,8 × 0,8	0,6	Moderate	Full sun
Coriandrum sativum	Apiaceae	Coriander	Culinary	0,25 × 0,25	0,2	Moderate	Full sun
Mentha spicata	Lamiaceae	Spearmint	Culinary	0,4 x 0,4	0,4	High	Partial shade
Trigonella foenum-graecum	Fabaceae	Fenugreek	Culinary	0,25 × 0,25	0,2	Moderate	Full sun
Murraya koenigii	Rutaceae	Curry leaf	Culinary	2,5 × 2,5	2	Moderate	Full sun
Zingiber officinale	Zingiberaceae	Ginger	Culinary	0,4 x 0,4	0,4	High	Partial shade
Cuminum cyminum	Apiaceae	Cumin	Culinary	0,25 x 0,25	0,2	Low–moderate	Full sun
Foeniculum vulgare	Apiaceae	Fennel	Culinary	0,6 × 0,6	0,5	Moderate	Full sun
Trachyspermum ammi	Apiaceae	Carom	Culinary	0,4 x 0,4	0,3	Low–moderate	Full sun
Anethum graveolens	Apiaceae	Dill	Culinary	0,4 x 0,4	0,3	Moderate	Full sun
Brassica juncea	Brassicaceae	Indian mustard	Culinary	0,4 x 0,4	0,3	Moderate	Full sun
Cymbopogon citratus	Poaceae	Lemongrass	Culinary	1,0 × 1,0	0,8	Moderate	Full sun
Allium sativum	Amaryllidaceae	Garlic	Culinary	0,2 × 0,2	0,15	Moderate	Full sun
Allium cepa	Amaryllidaceae	Onion	Culinary	0,2 × 0,2	0,15	Moderate	Full sun
Trigonella corniculata	Fabaceae	Kasuri methi	Culinary	0,3 × 0,3	0,25	Moderate	Full sun
Petroselinum crispum	Apiaceae	Parsley	Culinary	0,3 × 0,3	0,25	Moderate	Partial shade
Lepidium sativum	Brassicaceae	Garden cress	Culinary	0,2 × 0,2	0,15	Moderate	Full sun

Vegetables

For vegetables it is important that crop rotation is taken into account to maintain soil vertility. Certain species named in the list below are often only suitable for certain seasons throughout the year and thus can contribute to a rotation scheme.

Name	Family	Common name	Main purpose	Mature footprint (m)	Spacing (m)	Water requirement	Sun/shade
Solanum lycopersicum	Solanaceae	Tomato	Culinary	0,60 × 0,60	0,6	Moderate	Full sun
Solanum melongena	Solanaceae	Eggplant	Culinary	0,75 × 0,75	0,6	Moderate	Full sun
Abelmoschus esculentus	Malvaceae	Okra	Culinary	0,60 × 0,60	0,45	Moderate	Full sun
Cucumis sativus	Cucurbitaceae	Cucumber	Culinary	1,50 × 1,00	0,75	High	Full sun
Lagenaria siceraria	Cucurbitaceae	Bottle gourd	Culinary	2,00 × 2,00	1,5	High	Full sun
Momordica charantia	Cucurbitaceae	Bitter melon	Culinary	2,00 × 1,50	1,5	High	Full sun
Raphanus sativus	Brassicaceae	Radish	Culinary	0,20 × 0,20	0,15	Moderate	Full sun
Daucus carota	Apiaceae	Carrot	Culinary	0,20 × 0,20	0,1	Moderate	Full sun
Brassica oleracea var. capitata	Brassicaceae	Cabbage	Culinary	0,45 × 0,45	0,45	Moderate	Full sun
Brassica oleracea var. botrytis	Brassicaceae	Cauliflower	Culinary	0,45 × 0,45	0,45	Moderate	Full sun
Pisum sativum	Fabaceae	Garden pea	Culinary	0,50 × 0,30	0,3	Moderate	Full sun
Phaseolus vulgaris	Fabaceae	French bean	Culinary	0,45 × 0,30	0,3	Moderate	Full sun
Lablab purpureus	Fabaceae	Hyacinth bean	Culinary	2,00 × 1,00	1	Moderate	Full sun
Vigna unguiculata	Fabaceae	Yardlong bean	Culinary	1,50 × 0,60	0,6	Moderate	Full sun
Vigna radiata	Fabaceae	Mung bean	Culinary	0,40 × 0,30	0,3	Moderate	Full sun
Spinacia oleracea	Amaranthaceae	Spinach	Culinary	0,30 × 0,30	0,2	Moderate	Partial shade
Amaranthus tricolor	Amaranthaceae	Amaranth	Culinary	0,40 × 0,30	0,25	Moderate	Full sun
Beta vulgaris	Amaranthaceae	Beetroot	Culinary	0,30 × 0,30	0,2	Moderate	Full sun
Brassica rapa	Brassicaceae	Turnip	Culinary	0,30 × 0,30	0,2	Moderate	Full sun
Cucurbita maxima	Cucurbitaceae	Pumpkin	Culinary	3,00 × 3,00	2	High	Full sun
Cucurbita moschata	Cucurbitaceae	Butternut squash	Culinary	2,50 × 2,50	1,5	High	Full sun
Luffa acutangula	Cucurbitaceae	Ridge gourd	Culinary	2,00 × 1,50	1,5	High	Full sun
Luffa cylindrica	Cucurbitaceae	Sponge gourd	Culinary	2,00 × 1,50	1,5	High	Full sun
Citrullus lanatus	Cucurbitaceae	Watermelon	Culinary	2,50 × 2,50	1,5	High	Full sun
Cucumis melo	Cucurbitaceae	Muskmelon	Culinary	1,50 × 1,00	1	Moderate	Full sun
Capsicum annuum	Solanaceae	Bell pepper	Culinary	0,50 × 0,50	0,45	Moderate	Full sun
Solanum tuberosum	Solanaceae	Potato	Culinary	0,50 × 0,30	0,3	Moderate	Full sun
Zea mays	Poaceae	Sweet corn	Culinary	0,40 × 0,30	0,3	Moderate	Full sun
Colocasia esculenta	Araceae	Taro	Culinary	0,80 × 0,80	0,6	High	Partial shade
Ipomoea aquatica	Convolvulaceae	Water spinach	Culinary	0,50 × 0,50	0,3	Very high	Partial shade

Horticulture

To fully grow the ornamental plants in outside conditions, the below footprint and spacing is advised.The footprint of the listed horticulture can be significantly scaled down when they are grown inside in pots or planters.

Name	Family	Common name	Main purpose	Mature footprint (m)	Spacing (m)	Water requirement	Sun/shade
Zinnia elegans	Asteraceae	Common zinnia	Ornamental	0,30 × 0,30	0,3	Moderate	Full sun
Tagetes erecta	Asteraceae	African marigold	Ornamental	0,40 × 0,40	0,3	Moderate	Full sun
Tagetes patula	Asteraceae	French marigold	Ornamental	0,25 × 0,25	0,25	Moderate	Full sun
Cosmos sulphureus	Asteraceae	Yellow cosmos	Ornamental	0,50 × 0,40	0,4	Low–moderate	Full sun
Cosmos bipinnatus	Asteraceae	Garden cosmos	Ornamental	0,50 × 0,40	0,4	Low–moderate	Full sun
Gomphrena globosa	Amaranthaceae	Globe amaranth	Ornamental	0,30 × 0,30	0,25	Low–moderate	Full sun
Portulaca grandiflora	Portulacaceae	Moss rose	Ornamental	0,25 × 0,25	0,2	Low	Full sun
Petunia × atkinsiana	Solanaceae	Garden petunia	Ornamental	0,30 × 0,30	0,25	Moderate	Full sun
Antirrhinum majus	Plantaginaceae	Snapdragon	Ornamental	0,30 × 0,25	0,25	Moderate	Full sun
Calendula officinalis	Asteraceae	Pot marigold	Ornamental	0,30 × 0,30	0,25	Moderate	Partial shade
Dianthus chinensis	Caryophyllaceae	China pink	Ornamental	0,25 × 0,25	0,2	Moderate	Full sun
Ageratum houstonianum	Asteraceae	Flossflower	Ornamental	0,25 × 0,25	0,2	Moderate	Partial shade
Salvia splendens	Lamiaceae	Scarlet sage	Ornamental	0,35 × 0,35	0,3	Moderate	Partial shade
Torenia fournieri	Linderniaceae	Wishbone flower	Ornamental	0,25 × 0,25	0,2	Moderate-high	Partial shade
Impatiens walleriana	Balsaminaceae	Busy Lizzie	Ornamental	0,30 × 0,30	0,25	High	Partial shade
Ruellia simplex	Acanthaceae	Mexican petunia	Ornamental	0,60 × 0,60	0,45	Moderate	Partial shade
Crossandra infundibuliformis	Acanthaceae	Firecracker flower	Ornamental	0,50 × 0,50	0,4	Moderate-high	Partial shade
Pentas lanceolata	Rubiaceae	Egyptian starcluster	Ornamental	0,50 × 0,50	0,4	Moderate	Partial shade
Gerbera jamesonii	Asteraceae	Gerbera	Ornamental	0,30 × 0,30	0,3	Moderate	Partial shade
Dahlia pinnata	Asteraceae	Garden dahlia	Ornamental	0,60 × 0,60	0,5	Moderate	Full sun
Chrysanthemum × morifolium	Asteraceae	Chrysanthemum	Ornamental	0,40 × 0,40	0,3	Moderate	Full sun
Gladiolus × hortulanus	Iridaceae	Gladiolus	Ornamental	0,25 × 0,25	0,2	Moderate	Full sun
Agave amica	Asparagaceae	Tuberose	Ornamental	0,30 × 0,30	0,25	Moderate	Full sun
Hemerocallis fulva	Asphodelaceae	Daylily	Ornamental	0,60 × 0,60	0,45	Moderate	Partial shade
Strelitzia reginae	Strelitziaceae	Bird of paradise	Ornamental	1,20 × 1,20	1	Moderate	Partial shade
Caladium bicolor	Araceae	Heart of Jesus	Ornamental	0,40 × 0,40	0,3	High	Partial shade
Caladium × hortulanum	Araceae	Caladium	Ornamental	0,40 × 0,40	0,3	High	Partial shade
Dieffenbachia seguine	Araceae	Dumb cane	Ornamental	0,80 × 0,80	0,6	Moderate-high	Partial shade
Aglaonema commutatum	Araceae	Chinese evergreen	Ornamental	0,60 × 0,60	0,45	Moderate	Partial shade
Cordyline fruticosa	Asparagaceae	Ti plant	Ornamental	0,80 × 0,60	0,6	Moderate	Partial shade
Rhoeo spathacea	Commelinaceae	Oyster plant	Ornamental	0,40 × 0,40	0,3	Moderate	Partial shade
Coleus scutellarioides	Lamiaceae	Coleus	Ornamental	0,40 × 0,40	0,3	Moderate	Partial shade
Begonia semperflorens	Begoniaceae	Wax begonia	Ornamental	0,25 × 0,25	0,2	Moderate	Partial shade
Begonia rex	Begoniaceae	Rex begonia	Ornamental	0,35 × 0,35	0,3	Moderate	Partial shade
Fittonia albivenis	Acanthaceae	Nerve plant	Ornamental	0,25 × 0,25	0,2	High	Partial shade
Peperomia obtusifolia	Piperaceae	Baby rubber plant	Ornamental	0,35 × 0,35	0,3	Low–moderate	Partial shade

Climbers

Name	Family	Common name	Main purpose	Mature footprint (m)	Spacing (m)	Water requirement	Sun/shade
Cardiospermum halicacabum L.	Sapindaceae	Balloon vine	Medicinal	2,0 × 1,5	1	Moderate	Partial shade
Cissus quadrangularis L	Vitacea	Veldt grape	Medicinal	1,5 × 1,0	1	Low–moderate	Full sun
Desmodium scorpiurus Sw.Desv.	Fabaceae	Tick-trefoil	Fodder	1,0 × 0,60	0,6	Moderate	Full sun
Dioscorea alata L.	Dioscoreaceae	Purple yam	Culinary	3,0 × 1,0	1	High	Partial shade
Operculina turpethum L.Silva Manso	Convolvulaceae	Indian jalap	Medicinal	3,0 × 1,5	1,5	Moderate	Full sun
Passifloria foetida L	Passifloraceae	Stinking passionflower	Ornamental	2,5 × 1,5	1,5	Moderate	Full sun
Pentatropis capensis L.f.Bullock	Asclepiadaceae	Purple milkweed	Medicinal	2,0 × 1,0	1	Low–moderate	Full sun
Piper longum L	Piperaceae	Long pepper	Culinary	1,0 × 1,0	1,5	Moderate	Partial shade
Piper betle L.	Piperaceae	Betel vine	Culinary	2,0 × 1,0	0,75	High	Partial shade
Miptage benghalensis L. Kurz.	Malphigiaceae	Helicopter flower	Ornamental	4,0 × 3,0	1	High	Partial shade
Quisqualis indica L.	Combretaceae	Rangoon creeper	Ornamental	5,0 × 3,0	2,5	Moderate	Partial shade
Jasminum multiflorum Burm. f. Andr.	Oleaceae	Downy jasmine	Ornamental	2,5 × 2,0	2,5	Moderate	Full sun
Jaquemontia violacea Choisy	Convolvulaceae	Violet skyflower	Ornamental	2,5 × 1,5	1,5	Moderate	Partial shade
Bougainvillea spectabilis Willd.	Nyctaginaceae	Bougainvillea	Ornamental	5,0 × 3,0	1,5	Moderate	Full sun
Antigonon leptopus Hk. & Arn.	Polygonaceae	Coral vine	Ornamental	4,0 × 2,0	2,5	Low–moderate	Full sun
Cissampelos pareira	Menispermaceae	Velvetleaf	Medicinal - asthma	2,5 × 1,5	2	Moderate	Full sun
Oxystelma secamone	Apocynaceae	Milky vine	Medicinal - abdominal disease	3,0 × 1,5	1,5	Moderate	Partial shade
Combretum ovalifolium	Combretaceae	Oval-leaved combretum	Medicinal - bone fracture	4,0 × 2,5	1,5	Moderate	Full sun
Maerua oblongifolia	Capparaceae	Desert caper	Medicinal - cough	3,0 × 2,0	2	Moderate	Full sun
Gymnema sylvestris	Apocynaceae	Gymnema	Medicinal - diabetes	3,0 × 1,5	2	Low	Full sun
Asparagus racemosus	Asparagaceae	Shatavari	Medicinal - diabetes, dysentery, gastric troubles	2,0 × 1,0	1,5	Moderate	Partial shade
Cocculus hirsutus	Menispermaceae	Broom creeper	Medicinal - eye complaints	3,0 × 2,0	1	Moderate	Partial shade
Leptadenia reticulata	Apocynaceae	Jivanti	Medicinal - eye complaints	3,0 × 1,5	1,5	Moderate	Partial shade
Luffa echinata	Cucurbitaceae	Bristly luffa	Medicinal - intestinal worms, skin disease	3,0 × 2,0	1,5	Moderate	Full sun
Luffa cylindrica	Cucurbitaceae	Sponge gourd	Medicinal - jaundice	3,0 × 2,0	1,5	High	Full sun
Abrus precatorius	Fabaceae	Rosary pea	Medicinal - leukoderma, arthritis, eczema	4,0 × 2,0	1,5	High	Full sun
Hemidesmus indicus	Apocynaceae	Indian sarsaparilla	Medicinal - leukoderma	2,0 × 1,0	2	Moderate	Partial shade
Pergularia daemia	Apocynaceae	Trellis-vine	Medicinal - ring worm	3,0 × 1,5	1	Moderate	Partial shade
Mucuna prurita	Fabaceae	Velvet bean	Medicinal - scorpion bite	4,0 × 2,0	2	Moderate	Full sun
Celastrus paniculatus	Celastraceae	Intellect tree	Medicinal - skin disease	5,0 × 3,0	2,5	Moderate	Partial shade
Pueraria tuberosa	Fabaceae	Indian kudzu	Medicinal - swelling	4,0 × 2,0	2	Moderate	Partial shade

Shrubs

Name	Family	Common name	Main purpose	Mature footprint (m)	Spacing (m)	Water requirement	Sun/shade
Agave Americana	Agavaceae	Century plant	Bordering	2,0 × 2,0	2	Low	Full sun
Agave capensis gentry	Agavaceae	Cape agave	Ornamental	1,5 × 1,5	1,5	Low	Full sun
Agave joe hoak	Asparagaceae	Joe Hoak agave	Ornamental	1,0 × 1,0	1	Low	Partial shade
Agave sisalana perrive	Agavaceae	Sisal	Fibre production	2,0 × 2,0	2	Low	Full sun
Agave angustifolia var. angustifolia	Asparagaceae	Caribbean agave	Bordering	1,5 × 1,5	1,5	Low	Full sun
Agave desmettiana Jacobi	Asparagaceae	Smooth agave	Ornamental	1,5 × 1,5	1,5	Low	Partial shade
Agave victoriae reginae T. Moore	Asparagaceae	Queen Victoria agave	Ornamental	0,6 × 0,6	0,6	Low	Partial shade
Agave xylonacantha sal m- Dyck	Asparagaceae	Saw-leaf agave	Bordering	1,2 × 1,2	1,2	Low	Full sun
Allamanda blanchetii A.DC	Apocynaceae	Purple allamanda	Ornamental	2,0 × 2,0	1,5	Moderate	Full sun
Allamanda cathartica L.	Apocynaceae	Golden trumpet	Ornamental	2,5 × 2,0	2	Moderate	Full sun
Alluaudia procera Drake Drake	Didiereaceae	Madagascar ocotillo	Ornamental	2,0 × 2,0	2	Low	Full sun
Aloe perryi Baker	Asparagaceae	Socotra aloe	Medicinal	0,8 × 0,8	0,8	Low	Full sun
Aralia chinensis L	Araliaceae	Chinese aralia	Ornamental	2,0 × 2,0	2	Moderate	Partial shade
Aralia racemosa L	Araliaceae	American spikenard	Medicinal	1,5 × 1,5	1,5	Moderate	Partial shade
Aralia fruticosa Sesse & Moc.	Araliaceae	Shrubby aralia	Ornamental	1,5 × 1,5	1,5	Moderate	Partial shade
Carallum crenulata wall.	Asclepiadaceae	Caralluma	Medicinal	0,5 × 0,5	0,5	Low	Full sun
Cereus jamacaru DC.	Cactaceae	Queen of the night cactus	Ornamental	2,0 × 2,0	2	Low	Full sun
Desmodium gangeticum L DC	Fabaceae	Three-flowered beggarweed	Medicinal	1,0 × 1,0	1	Moderate	Partial shade
Mammilaria longimam ma DC.	Cactaceae	Finger cactus	Ornamental	0,3 × 0,3	0,3	Low	Partial shade
Opuntia elatior Mill	Cactaceae	Red-flowered prickly pear	Bordering	2,0 × 2,0	2	Low	Full sun
Opuntia ficus	Cactaceae	Indian fig cactus	Fruit production	3,0 × 3,0	3	Low	Full sun
Opuntia cylindrical Lam.DC.	Cactaceae	Pencil cactus	Bordering	1,5 × 1,5	1,5	Low	Full sun
Opuntia falcate Ekman & Werderm.	Cactaceae	Prickly pear	Bordering	1,5 × 1,5	1,5	Low	Full sun
Opuntia Microdasys Lehm.Pfeiff	Cactaceae	Bunny ears cactus	Ornamental	0,8 × 0,8	0,8	Low	Full sun
Opuntia tunicate Lehm.Pfeiff.	Cactaceae	Woolly jointed cactus	Bordering	1,5 × 1,5	1,5	Low	Full sun
Pachypodium spp	Apocynaceae	Madagascar palm	Ornamental	1,5 × 1,5	1,5	Low	Full sun
Pachypodium lamerei Drake	Apocynacea	Madagascar palm	Ornamental	2,0 × 2,0	2	Low	Full sun
Pandanaus odorifera Forssk. Kuntze	Pandanaceae	Screw pine	Bordering	3,0 × 3,0	3	Moderate	Full sun
Pentas lanceolata Forssk.Deflers	Rubiaceae	Egyptian starcluster	Ornamental	0,8 × 0,8	0,8	Moderate	Partial shade
Yucca aloifolia Linn	Agavaceae	Spanish bayonet	Bordering	2,0 × 2,0	2	Low	Full sun
Yucca pineahele	Asparagaceae	Pineahele yucca	Ornamental	1,5 × 1,5	1,5	Low	Full sun
Yucca silverae	Asparagaceae	Silver yucca	Ornamental	1,5 × 1,5	1,5	Low	Full sun
Cicer arietinum L.	Papilionaceae	Chickpea	Food production	0,5 × 0,4	0,3	Moderate	Full sun
Morus alba L.	Moraceae	White mulberry	Fruit production	8,0 × 8,0	6	Moderate	Full sun
Hibiscus rosa-sinensis L.	Malvaceae	Chinese hibiscus	Ornamental	2,0 × 2,0	1,5	Moderate	Full sun
Caesalpinia pulcherrima L. Swartz	Caesalpinaceae	Peacock flower	Ornamental	3,0 × 3,0	2,5	Low–moderate	Full sun
Ixora parviflora Vahl.	Rubiaceae	Small-flowered ixora	Ornamental	2,0 × 2,0	1,5	Moderate	Partial shade
Ixora coccinea L.	Rubiaceae	Jungle geranium	Ornamental	1,5 × 1,5	1,2	Moderate	Partial shade
Nerium indicum Mill.	Apocynaceae	Oleander	Ornamental	2,5 × 2,5	2	Low–moderate	Full sun
Duranta plumeri Jacq.	Verbenaceae	Golden dewdrop	Bordering	2,5 × 2,5	1,5	Moderate	Full sun
Rauvolfia serpentina L.	Apocynaceae	Indian snakeroot	Medicinal	1,0 × 1,0	1	Moderate	Partial shade
Calotropis procera Ait R. Br.	Asclepiadaceae	Apple of Sodom	Medicinal	3,0 × 3,0	2,5	Low	Full sun
Withania somnifera L. Dunal	Solanaceae	Ashwagandha	Medicinal	1,0 × 1,0	1	Low–moderate	Full sun
Adhatoda vasica L. Nees	Acanthaceae	Malabar nut	Medicinal	2,0 × 2,0	1,5	Moderate	Partial shade
Calotropis gigantea	Apocynaceae	Giant milkweed	Medicinal - asthma, wound	3,0 × 3,0	2,5	Low	Full sun
Calotropis procera	Apocynaceae	Apple of Sodom	Medicinal - asthma, cough, colic complaints, arthritis	3,0 × 3,0	2,5	Low	Full sun
Justicia adhatoda	Acanthaceae	Malabar nut	Medicinal - asthma	2,0 × 2,0	1,5	Moderate	Partial shade
Punica granatum	Lythraceae	Pomegranate	Medicinal - abdominal disease	4,0 × 4,0	3,5	Moderate	Full sun

Cajanus cajan	Fabaceae	Pigeon pea	Medicinal - bone fracture	1,5 × 1,5	1	Low–moderate	Full sun
Tabernaemontana undulata	Apocynaceae	Wavy-leaved pinwheel flower	Medicinal - cough, syphilis	2,0 × 2,0	1,5	Moderate	Partial shade
Vitex negundo	Lamiaceae	Chinese chaste tree	Medicinal - cholera	3,0 × 3,0	2,5	Low–moderate	Full sun
Senna italica	Fabaceae	Italian senna	Medicinal - constipation	1,0 × 1,0	0,8	Low	Full sun
Cassia auriculata	Fabaceae	Tanner's cassia	Medicinal - diarrhea, earache, fever	2,0 × 2,0	1,5	Low	Full sun
Helicteres isora	Malvaceae	Indian screw tree	Medicinal - diarrhea, dysentery, earache, stomach ache	3,0 × 3,0	2,5	Low–moderate	Full sun
Ziziphus nummularia	Rhamnaceae	Wild jujube	Medicinal - diarrhea	2,0 × 2,0	1,5	Low	Full sun
Vitex trifolia	Lamiaceae	Simpleleaf chaste tree	Medicinal - earache, fever, headache, wound	2,0 × 2,0	1,5	Low–moderate	Full sun
Solanum surattense	Solanaceae	Yellow-berried nightshade	Medicinal - hepatic problems	0,8 × 0,8	0,6	Low–moderate	Full sun
Maytenus emarginata	Celastraceae	Thorny staff tree	Medicinal - jaundice	3,0 × 3,0	2,5	Low	Full sun
Capparis trifoliata	Capparaceae	Three-leaved caper	Medicinal - migraine	2,0 × 2,0	1,5	Low	Full sun
Morinda tomentosa	Rubiaceae	Indian mulberry	Medicinal - skin disease	4,0 × 4,0	3	Moderate	Full sun
Salvadora persica	Salvadoraceae	Toothbrush tree	Medicinal - skin disease	4,0 × 4,0	3	Low	Full sun
Carissa carandas	Apocynaceae	Bengal currant	Medicinal - stomach ache	2,0 × 2,0	1,5	Low–moderate	Full sun
Celastrus paniculatus	Celastraceae	Intellect tree	Medicinal - swelling	4,0 × 3,0	2,5	Moderate	Partial shade
Calotropis gigantea	Apocynaceae	Giant milkweed	Medicinal - wound	3,0 × 3,0	2,5	Low	Full sun

Trees

Name	Family	Common name	Main purpose	Mature footprint (m)	Spacing (m)	Water requirement	Sun/shade
Araucaria columnaris Forsk. Hook	Araucariaceae	Cook pine	Ornamental	5 × 3	5	Moderate	Full sun
Bahunia acuminata L.	Caesalpiniaceae	Dwarf white bauhinia	Ornamental	2 × 2	2	Moderate	Partial shade
Bauhinia tomentosa L	Caesalpiniaceae	Yellow bell orchid tree	Ornamental	3 × 3	3	Moderate	Full sun
Careya arborea Roxb.	Lecythidaceae	Wild guava	Medicinal	8 × 8	8	Moderate	Full sun
Cassia grandis L	Caesalpiniaceae	Pink shower tree	Ornamental	10 × 8	8	Moderate	Full sun
Cassia javanica L	Caesalpiniaceae	Java cassia	Ornamental	10 × 8	8	Moderate	Full sun
Cassia roxburghii DC	Caesalpiniaceae	Roxburgh's cassia	Ornamental	8 × 6	6	Moderate	Full sun
Ficus elastica Roxb. Ex Honem	Moraceae	Rubber tree	Ornamental	10 × 8	8	Moderate	Partial shade
Jacaranda mimosifolia D. Don	Bignoniaceae	Blue jacaranda	Ornamental	10 × 8	8	Moderate	Full sun
Mallotus philippensis Lam.Mull. Arg.	Eurphorbiaceae	Kamala tree	Medicinal	8 × 6	6	Moderate	Full sun
Platycladus orienalis L.Franco	Cupressaceae	Oriental arborvitae	Ornamental	4 × 3	3	Low–moderate	Full sun
Annona squamosa L.	Annonaceae	Sugar apple	Fruit production	5 × 5	5	Moderate	Full sun
Limonia acidissima L.	Rutaceae	Wood apple	Fruit production	8 × 8	8	Low–moderate	Full sun
Mangifera indica L.	Anacardiaceae	Mango	Fruit production	12 × 10	10	Moderate	Full sun
Moringa oleifera Lam.	Moringaceae	Drumstick tree	Food production	5 × 4	4	Low–moderate	Full sun
Tamarindus indica L.	Caesalpiniaceae	Tamarind	Fruit production	15 × 12	12	Low–moderate	Full sun
Terminalia catappa L.	Combretaceae	Tropical almond	Shade	15 × 12	12	Moderate	Full sun
Eugenia jambolana Lam.	Myrtaceae	Java plum	Fruit production	12 × 10	10	Moderate	Full sun
Punica granatum L.	Punicaceae	Pomegranate	Fruit production	4 × 4	4	Moderate	Full sun
Carica papaya L.	Caricaceae	Papaya	Fruit production	3 × 3	2.5	High	Full sun
Achras zapota L.	Sapotaceae	Sapodilla	Fruit production	10 × 8	8	Moderate	Full sun
Kigelia pinnata Jacq. DC.	Bignoniaceae	Sausage tree	Ornamental	12 × 10	10	Moderate	Full sun
Cocos nucifera L.	Palmaceae	Coconut palm	Food production	7 × 7	7	High	Full sun
Phoenix sylvestris L. Roxb.	Palmaceae	Wild date palm	Food production	6 × 4	5	Low–moderate	Full sun
Bauhinia purpurea L.	Caesalpinaceae	Purple orchid tree	Ornamental	8 × 6	6	Moderate	Full sun
Cassia fistula L.	Caesalpinaceae	Golden shower tree	Ornamental	8 × 6	6	Low–moderate	Full sun
Cassia nodosa L.	Caesalpinaceae	Pink cassia	Ornamental	10 × 8	8	Moderate	Full sun
Delonix regia Raf.	Caesalpinaceae	Royal poinciana	Shade	12 × 12	10	Moderate	Full sun
Albizia lebbeck L. Bth.	Caesalpinaceae	Woman's tongue tree	Shade	15 × 12	12	Low–moderate	Full sun
Callistemon lanceolatus DC.	Myrtaceae	Crimson bottlebrush	Ornamental	5 × 4	4	Moderate	Full sun
Plumeria rubra L.	Apocynaceae	Red frangipani	Ornamental	6 × 5	5	Low–moderate	Full sun
Polyalthia longifolia Sonn Thw.	Annonaceae	False ashoka	Ornamental	5 × 2	2.5	Moderate	Full sun
Azadirachta indica A. Juss	Meliaceae	Neem	Medicinal	12 × 10	10	Low	Full sun
Butea monosperma Lam Taub	Papilionaceae	Flame of the forest	Ornamental	10 × 8	8	Low–moderate	Full sun
Pongamia pinnata L. Pierre	Papilionaceae	Indian beech	Shade	12 × 10	10	Low–moderate	Full sun
Terminalia chebula Retz.	Combretaceae	Chebulic myrobalan	Medicinal	12 × 8	8	Moderate	Full sun
Vitex negundo L.	Verbenaceae	Chinese chaste tree	Medicinal	4 × 4	4	Low–moderate	Full sun
Emblica officinalis Gaertner	Euphorbiaceae	Indian gooseberry	Medicinal	8 × 8	8	Low–moderate	Full sun
Ficus religiosa L.	Moraceae	Sacred fig	Shade	20 × 15	15	Moderate	Full sun
Butea monosperma	Fabaceae	Flame of the forest	Medicinal - diarrhea, dysentery, intestinal worms, stomach ache, urticaria	10 × 8	8	Low–moderate	Full sun
Terminalia bellirica	Combretaceae	Beleric myrobalan	Medicinal - abdominal pain, cough, constipation, piles	15 × 12	12	Moderate	Full sun
Balanites aegyptiaca	Zygophyllaceae	Desert date	Medicinal - abdominal pain	8 × 6	6	Low	Full sun
Holarrhena antidysenterica	Apocynaceae	Conessi tree	Medicinal - bronchitis, fever	5 × 4	4	Low–moderate	Partial shade
Aegle marmelos	Rutaceae	Bael	Medicinal - asthma, cholera, constipation, diarrhea, tetanus	8 × 6	6	Low–moderate	Full sun
Bauhinia racemosa	Fabaceae	Bidi-leaf tree	Medicinal - asthma, cough, diarrhea, dysentery, leukorrhea	5 × 4	4	Low–moderate	Full sun
Ficus racemosa	Moraceae	Cluster fig	Medicinal - asthma, diabetes, kidney stone, mumps	15 × 12	12	Moderate	Full sun
Oroxylum indicum	Bignoniaceae	Indian trumpet tree	Medicinal - asthma, jaundice, urinary disorders	10 × 6	6	Moderate	Partial shade
Boswellia serrata	Burseraceae	Indian frankincense	Medicinal - asthma, body pain, mouth ulcer, arthritis	8 × 6	6	Low	Full sun
Azadirachta indica	Meliaceae	Neem	Medicinal - cholera	12 × 10	10	Low	Full sun
Madhuca indica	Sapotaceae	Mahua	Medicinal - arthritis, skin disease, bone fracture	15 × 12	12	Low–moderate	Full sun
Delonix elata	Fabaceae	Creamy-white gul mohur	Medicinal - bone fracture	10 × 8	8	Low–moderate	Full sun
Tamarindus indica	Fabaceae	Tamarind	Medicinal - bone fracture, scorpion bite	15 × 12	12	Low–moderate	Full sun
Terminalia chebula	Combretaceae	Chebulic myrobalan	Medicinal - diarrhea, constipation, skin disease	12 × 8	8	Moderate	Full sun
Terminalia arjuna	Combretaceae	Arjun tree	Medicinal - bronchitis, diabetes, heart attack	15 × 10	10	Moderate–high	Full sun
Ailanthus excelsa	Simaroubaceae	Tree of heaven	Medicinal - cough, fever, hysteria	15 × 8	8	Low–moderate	Full sun
Careya arborea	Lecythidaceae	Wild guava	Medicinal - cough	8 × 8	8	Moderate	Full sun
Syzygium cumini	Myrtaceae	Java plum	Medicinal - vomiting, diabetes, diarrhea, scorpion bite, skin disease	15 × 12	12	Moderate	Full sun
Moringa oleifera	Moringaceae	Drumstick tree	Medicinal - earache, arthritis, urinary disorders	5 × 4	4	Low–moderate	Full sun
Azadirachta indica	Meliaceae	Neem	Medicinal - cholera, eczema	12 × 10	10	Low	Full sun
Terminalia crenulata	Combretaceae	Crocodile bark tree	Medicinal - diarrhea, dysentery	15 × 10	10	Low–moderate	Full sun
Adansonia digitata	Malvaceae	African baobab	Medicinal - dysentery, indigestion	15 × 15	12	Low	Full sun
Cassia fistula	Fabaceae	Golden shower tree	Medicinal - diarrhea, fever, hysteria	8 × 6	6	Low–moderate	Full sun
Sesbania grandiflora	Fabaceae	Hummingbird tree	Medicinal - fever, night blindness	6 × 4	4	Moderate–high	Full sun
Mitragyna parvifolia	Rubiaceae	Kaim tree	Medicinal - fever	12 × 10	10	Moderate	Full sun
Diospyros melanoxylon	Ebenaceae	Coromandel ebony	Medicinal - dysentery	10 × 8	8	Low–moderate	Full sun
Anogeissus sericea	Combretaceae	Gum ghatti tree	Medicinal - fever	8 × 6	6	Low	Full sun
Sterculia urens	Malvaceae	Gum karaya tree	Medicinal - gonorrhoea, syphilis	10 × 8	8	Low	Full sun
Annona squamosa	Annonaceae	Sugar apple	Medicinal - hair problems	5 × 5	5	Moderate	Full sun
Cordia dichotoma	Boraginaceae	Fragrant manjack	Medicinal - mouth ulcer	8 × 6	6	Low–moderate	Full sun
Acacia chundra	Fabaceae	Red cutch tree	Medicinal - mouth ulcer, wound	8 × 6	6	Low	Full sun
Moringa concanensis	Moringaceae	Konkan drumstick tree	Medicinal - intestinal worms, jaundice, arthritis	5 × 4	4	Low	Full sun
Vachellia nilotica	Fabaceae	Gum arabic tree	Medicinal - mouth ulcer	10 × 8	8	Low	Full sun
Ziziphus mauritiana	Rhamnaceae	Indian jujube	Medicinal - scorpion bite	8 × 8	6	Low	Full sun
Adina cordifolia	Rubiaceae	Haldu tree	Medicinal - fever	15 × 10	10	Moderate	Full sun
Gmelina arborea	Lamiaceae	White teak	Medicinal - skin disease, snake bite	15 × 10	10	Moderate	Full sun
Buchanania lanzan	Anacardiaceae	Chironji tree	Medicinal - skin disease	10 × 8	8	Low–moderate	Full sun
Alangium salvifolium	Cornaceae	Sage-leaved alangium	Medicinal - arthritis	6 × 5	5	Low–moderate	Partial shade
Erythrina variegata	Fabaceae	Indian coral tree	Medicinal - swelling, tooth ache, wound	12 × 10	10	Moderate	Full sun
Wrightia tinctoria	Apocynaceae	Pala indigo tree	Medicinal - swelling	8 × 6	6	Low–moderate	Full sun
Anogeissus latifolia	Combretaceae	Axlewood tree	Medicinal - swelling, fever	15 × 10	10	Low–moderate	Full sun

Low-input UA practices with their characteristics, working scale and requirements

Type of UA	Soil-based / Soil-less	Working scale	Placement	Footprint (m)
Herbs	*soil-based / soil-less*	*typology*	*interior*	*1 x 1*
Vegetables	*soil-based / soil-less*	*typology, cluster, urban*	*roof, balcony, facade, plot,*	*1 x 1*
Plant horticulture	*soil-based / soil-less*	*typology, cluster, urban*	*interior, facade, roof, balcony, plot, communal, urban*	*1 x 1*
Climbers	*soil-based / soil-less*	*typology, urban*	*facade, urban*	*1 x 2*
Shrubs	*soil-based*	*typology, cluster, urban*	*roof, balcony, plot, communal, urban, professional*	*1 x 2*
Small tree	*soil-based*	*typology, cluster, urban*	*plot, communal, urban, professional*	*3 x 3*
Tree	*soil-based*	*typology, cluster, urban*	*plot, communal, urban, professional*	*4 x 5*
Cow	*soil-based*	*cluster, urban*	*communal, professional*	*4 x 5*
Goat	*soil-based*	*cluster, urban*	*communal, professional*	*3 x 6*
Chicken	*soil-based*	*typology, cluster, urban*	*roof, balcony, plot, communal, professional*	*1 x 2*
Fish pond	*soil-less*	*typology*	*plot*	*4 x 4*
Fish tank	*soil-less*	*typology*	*interior, balcony*	*1 x 1*
Bees	*soil-based*	*cluster*	*communal*	*2 x 4*
Vertical drum	*soil-less*	*urban*	*professional*	*1 x 1*
Vertical column	*soil-less*	*typology, urban*	*roof, balcony, professional*	*1 x 1*
A-frame trellis	*soil-less*	*typology, urban*	*roof, balcony, professional*	*1 x 2*
Stacked beds	*soil-less*	*typology, urban*	*roof, balcony, professional*	*1 x 2*
Aquaponics	*soil-less*	*typology, urban*	*interior, balcony, roof, professional*	*1 x 2*

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