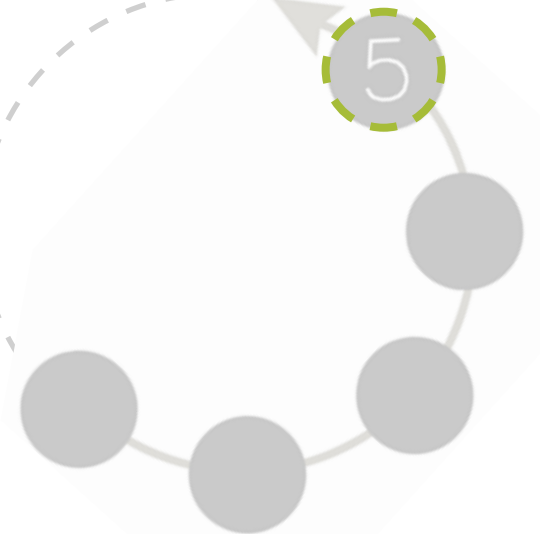
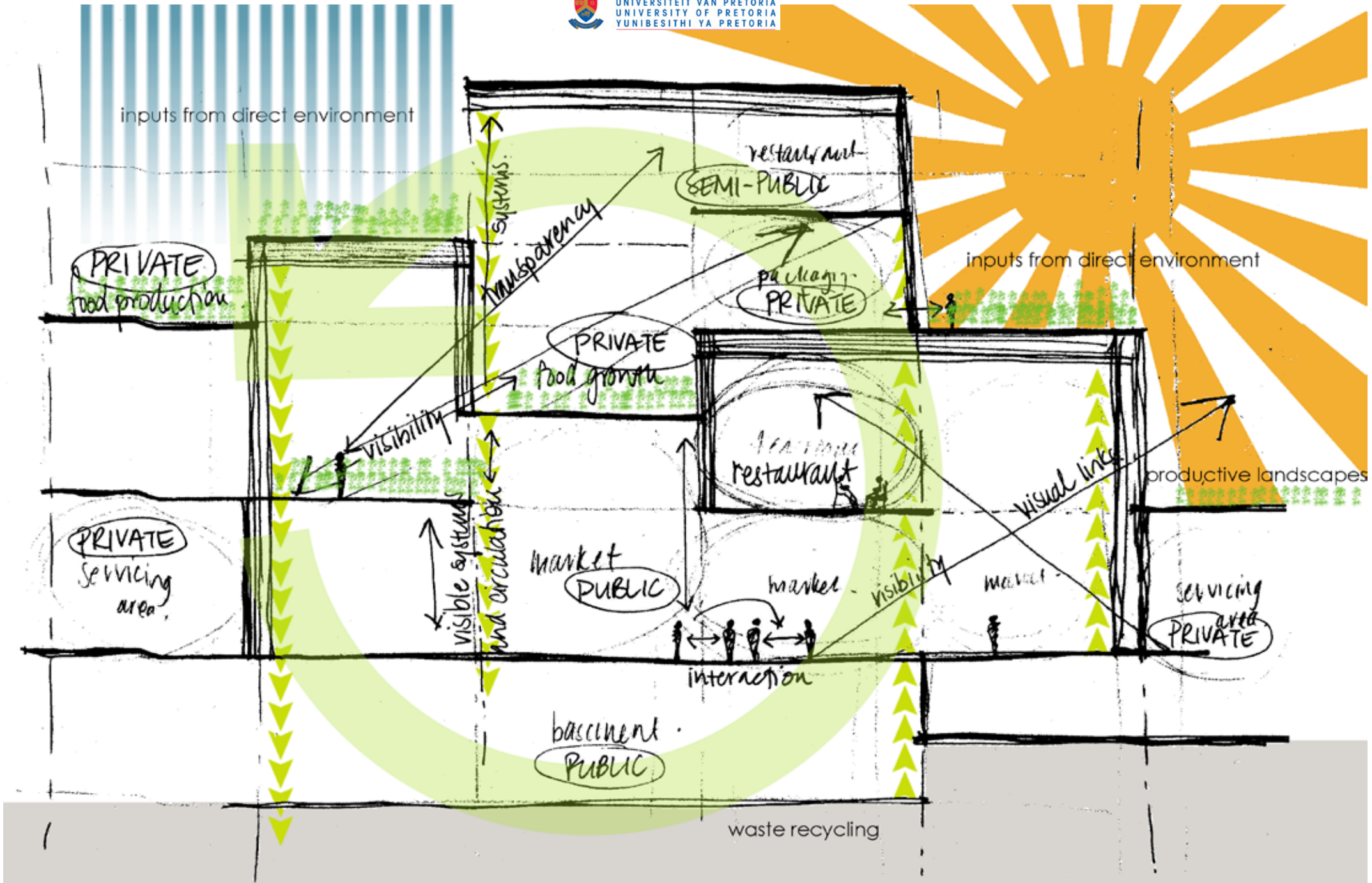




*In this chapter, a final design proposal and the development thereof is discussed, to support design decisions. Spatial and floorplan development are informed by structural design decisions. The structure of this building is the design focus, because of the systemic nature of the project. Building transparency and honesty creates an easily accessible and understandable market. This chapter prepares for the final design as shown in Chapter 7.*

# Design Development





### 5.1. Project Description - A Summary of The Project Aims and Design Proposal

This market platform and park will be an outdoor meeting place and transitional space for commuters, business people and people from every walk of life. Healthier living should be promoted by better food options than the everyday supermarket. The market park creates a 24-hour node, that is also an alternative to the supermarket.

The proposed project will offer a fresh food market that feeds off the hydroponics and urban agriculture in the building and study area, as discussed in Chapter 4. By means of passive surveillance, this will be a precinct with safe outdoor spaces and activity areas.

Fruits and vegetables will be processed and packed within the market building. Added to the freshly grown produce, a bakery, butchery, deli and dairy section complete this as a fresh food stop.

For street vendors and small business owners, an educational facility with classrooms is provided, to be taught on informal trade, entrepreneur skills, hygiene, financial management etc. This initiative will help spread healthier living to more areas in the City of Tshwane.

In the park/courtyard area, ample space and trees create the opportunity for informal market activities. For example the Hazel Food Market can now be held here on Saturdays.

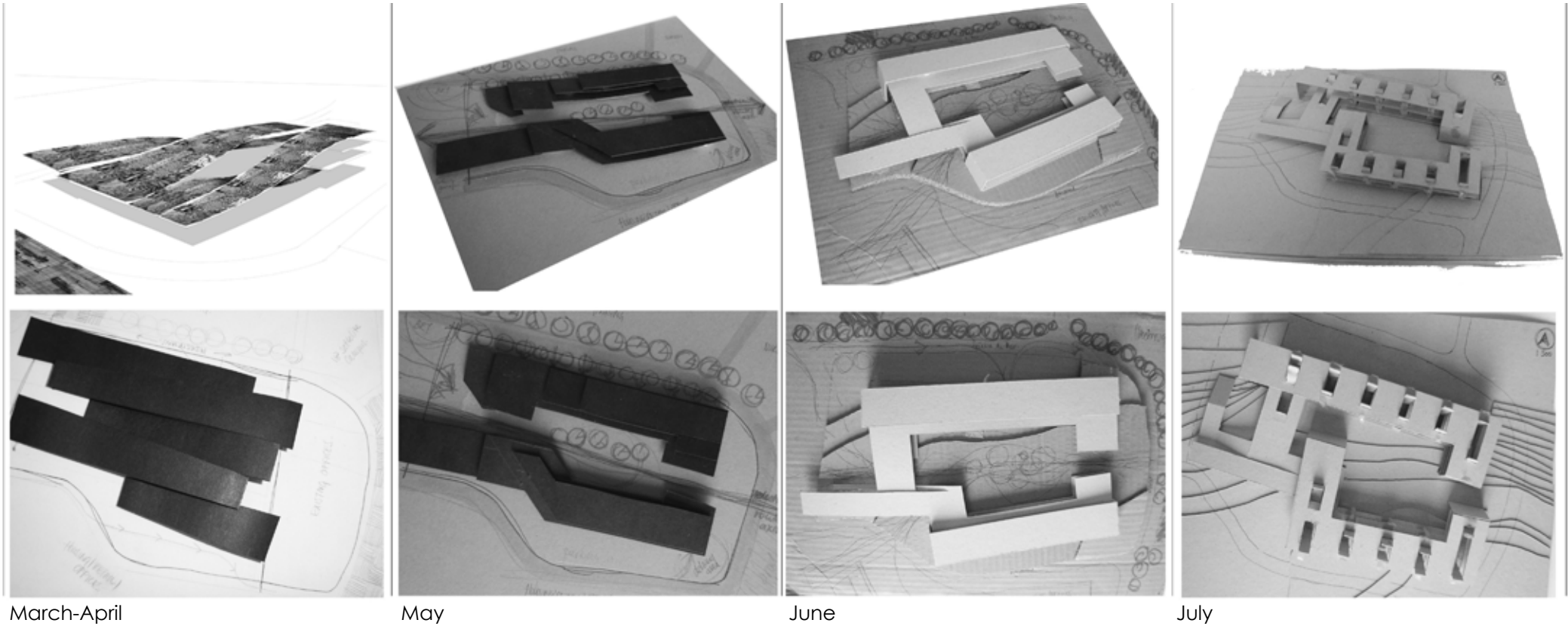
The market and open spaces will be a platform for new relationships to be formed between all people, irrelevant of age, race and income group. A sense of community and ownership will be cultivated. Jobs will be created through the keeping of productive landscapes. This will be an opportunity for all to become entrepreneurs. The market should replace the artificial, impersonal, unsociable supermarket outings with natural, social, personal experiences.

Within the market building: although the market, restaurants and hydroponics will not all be situated on one floor, and should be separated mainly for factors like humidity, a visual link between different functional spaces is very important. This will showcase how this building works as an ecosystem: creating and using waste, generating and using energy, collecting and distributing water, producing, using and selling food.

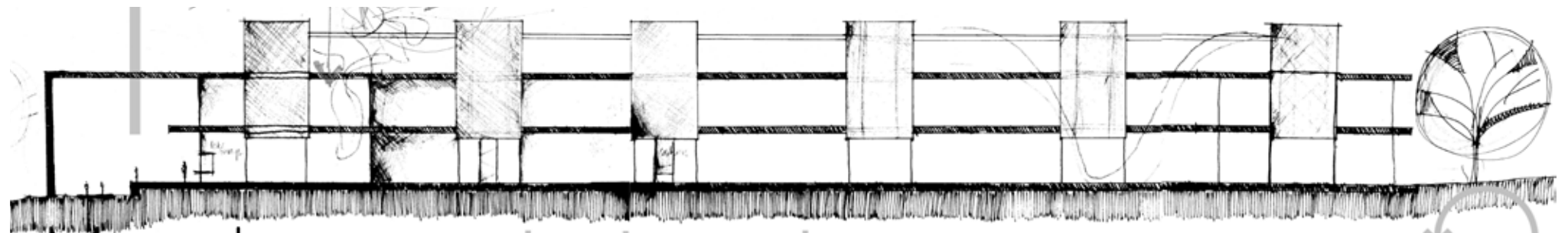
Visibility of systems and circulation within this building is an important design generator.

## 5.2. Development of Building Form

Spatial and form development through working models.



>>73: Conceptual model development.





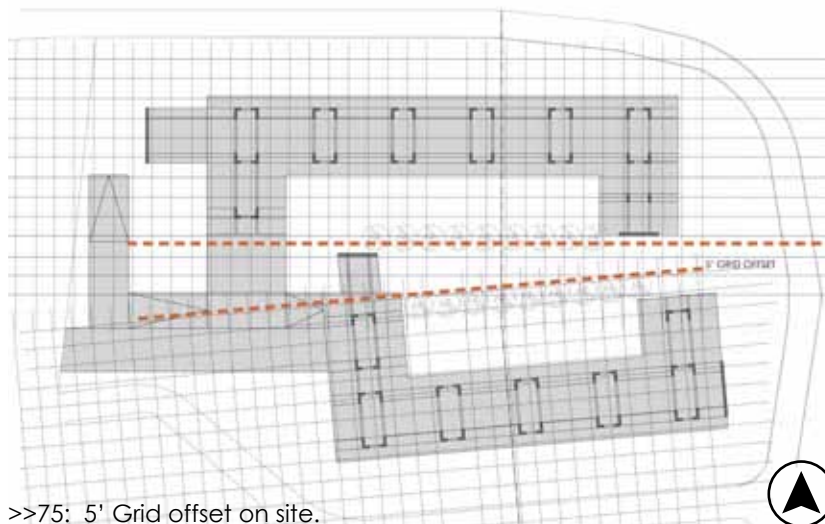
### 5.3. Form Development Around Courtyard

People living and working in the urban environment, especially in the Menlyn area, are confronted with introverted living, as discussed in Chapter 4. Many social and emotional issues can be excluded when the wellbeing of business people are considered, therefore the importance of a life more towards nature, even during office hours.

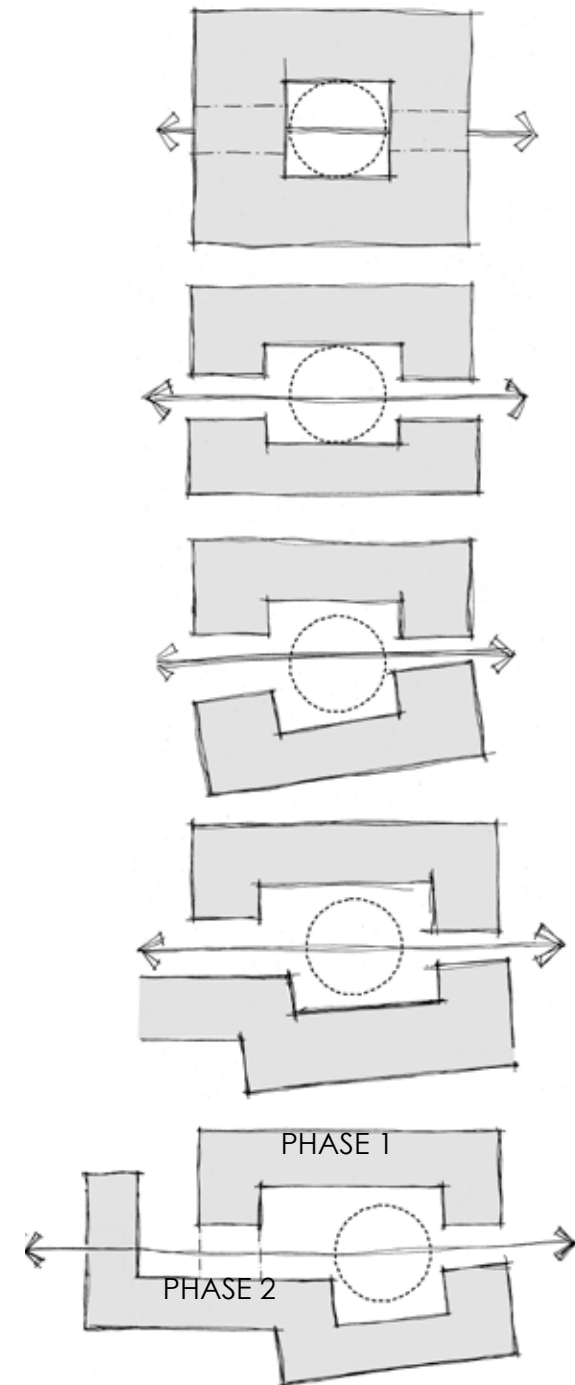
Linking smaller private courtyards with semi-private and larger public courtyards creates a network of social connectedness in the intervention precinct. A public courtyard was the design generator of building form for the market.

The market building will be phased, therefore the northern part forms phase 1. Growth in this precinct will encourage the erection of phase 2.

The next important area on site is where the grid is set off with 5 degrees. This meeting point of the grids is emphasised with trees and building offset as seen on the site plan. The building creates a courtyard space which becomes a public space/park.

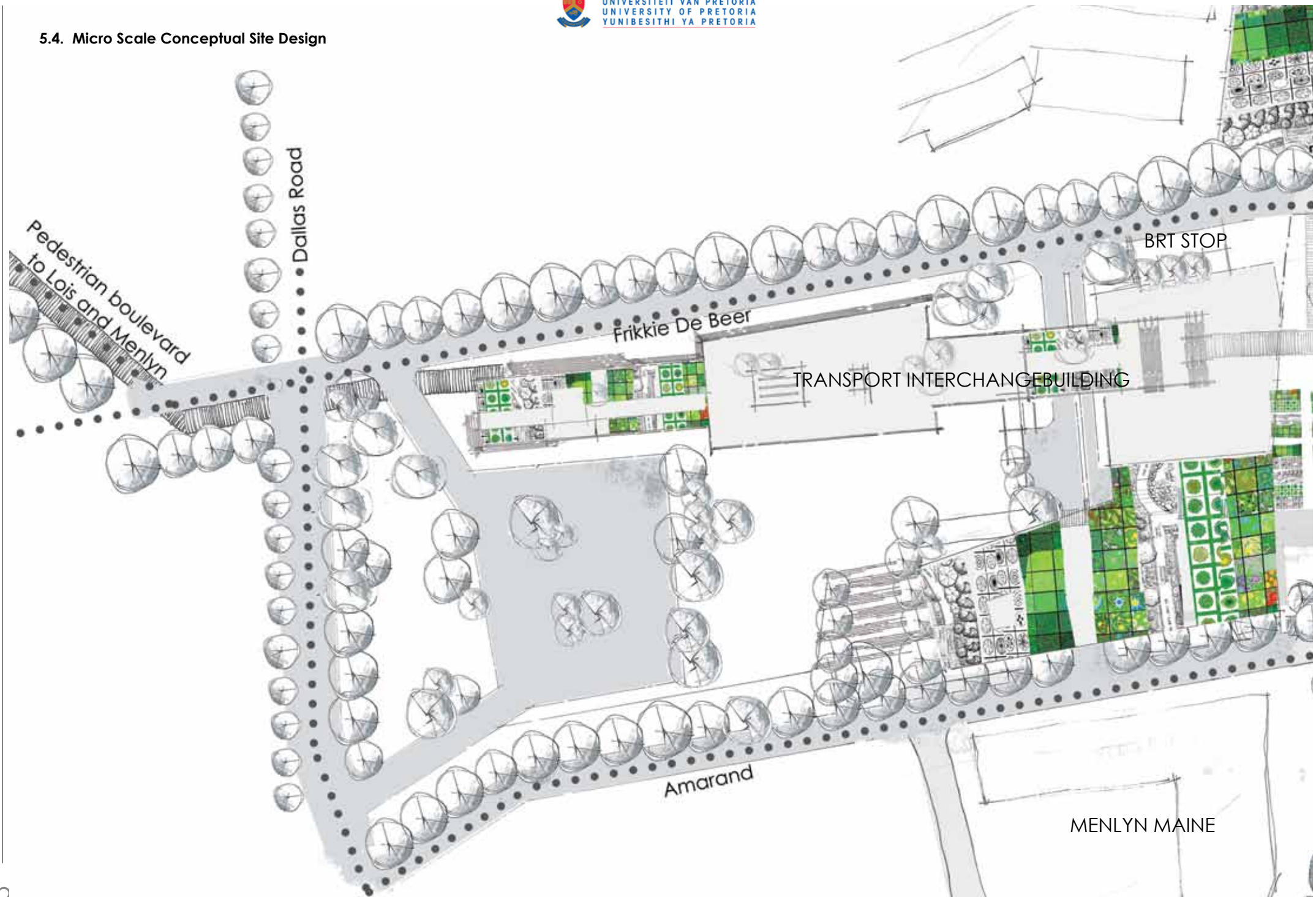


>>75: 5' Grid offset on site.



>>76: Form development diagrams.

### 5.4. Micro Scale Conceptual Site Design







EXISTING HOUSING

EXISTING HOUSING

PHASE 1 MARKET BUILDING

COURTYARD AND  
INFORMAL MARKET  
AREA

PHASE 2 MARKET BUILDING

Amarand

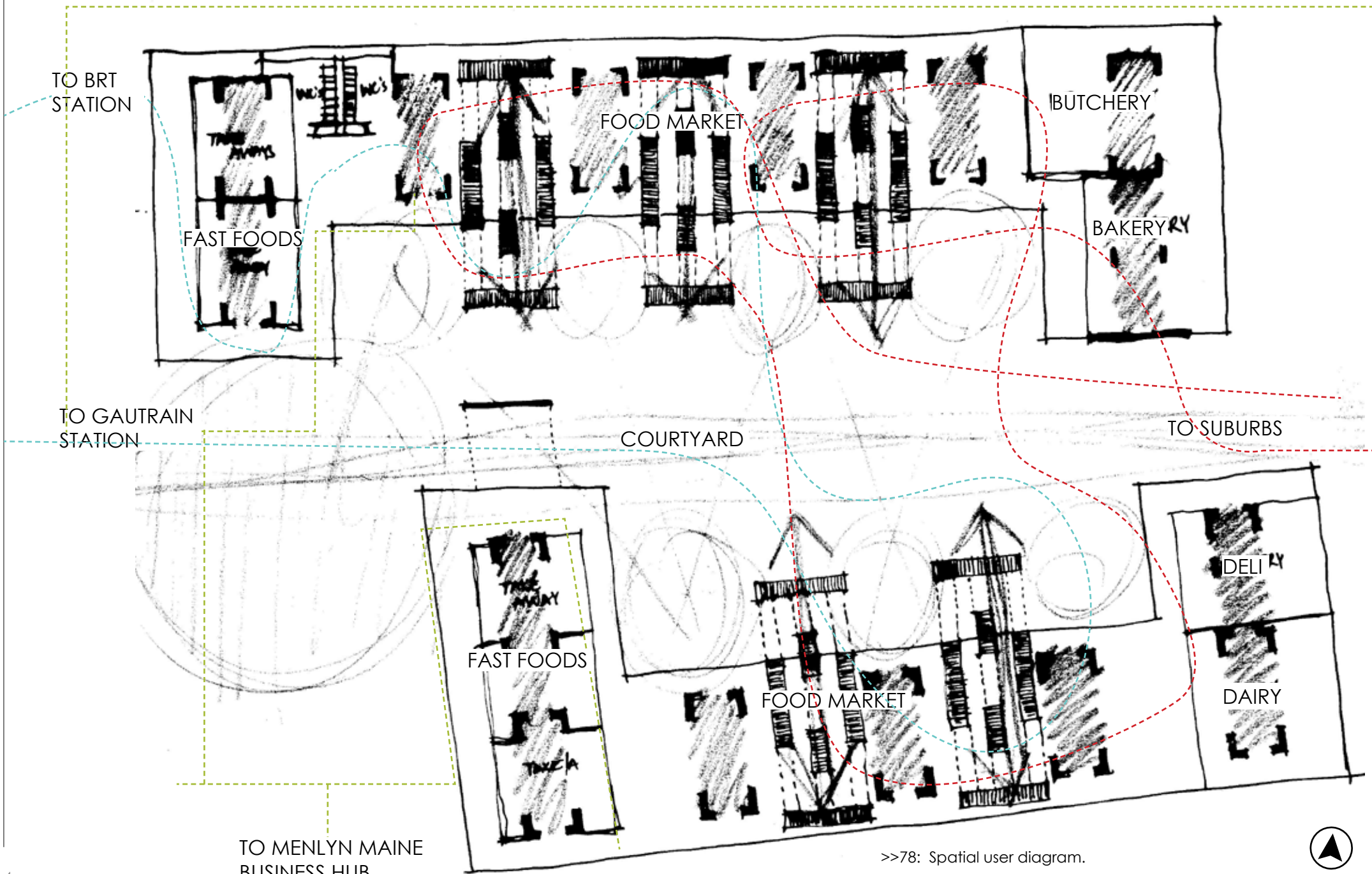
Mercy

Genl. Louis Botha



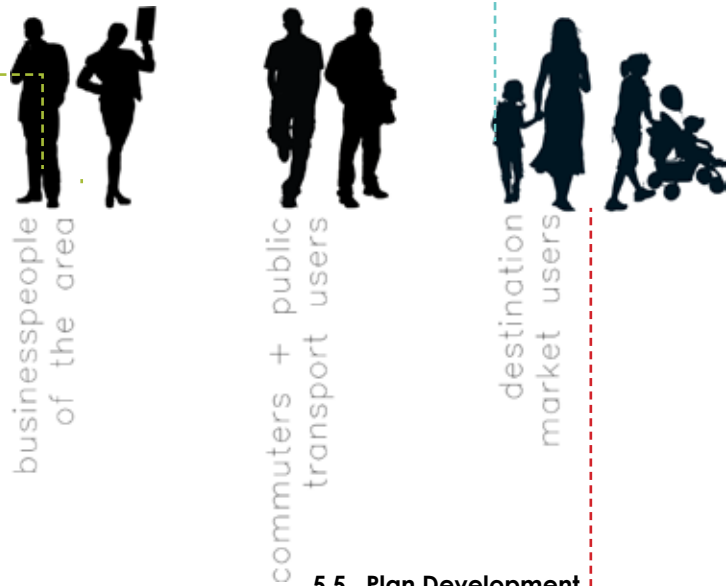
>>77: Conceptual site development plan.





>>78: Spatial user diagram.





**5.5. Plan Development**

To the WESTERN part of the groundfloor, you will find all the take aways and the quick help food zone for the business people from the area, and most importantly the commuters and users of the transport node and taxi rank.

To the EASTERN part of the market close to the parking area, the butchery, bakery, deli and dairy are placed for easy access for those to whom this is a destination, who does daily shopping at the market.

In the CENTRAL part is the market area. By day the market becomes part of the park by being moved outside on a track system, and by night the groundfloor can be locked up. These market stalls creates smaller courtyards within the market, for more intimate gathering spaces. These smaller courtyards are linked to the bigger courtyard and also public courtyards within the precinct.

**BASEMENT FLOOR** - The contours perfectly lends itself to be carved away, creating a basement floor, that is directly accessible and open from the street. This floor houses delivery space, parking, coolrooms, storerooms and recycling depot.

**FIRST FLOOR** - This floor has less pedestrian traffic and houses restaurants, an educational facility for street vendors, packaging and food processing rooms.

**ROOFTOP** - Productive roofscape – the top floor is a vegetated area where fruit and vegetables are grown in monitored areas by using hydroponic systems.

**5.6. Phase 1 Form and Floorplan Development**

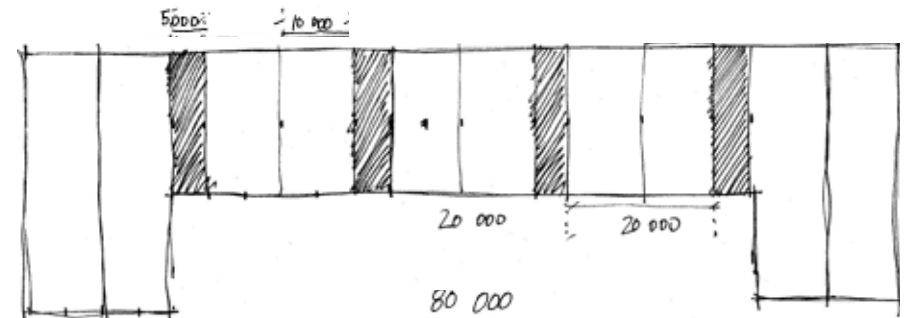
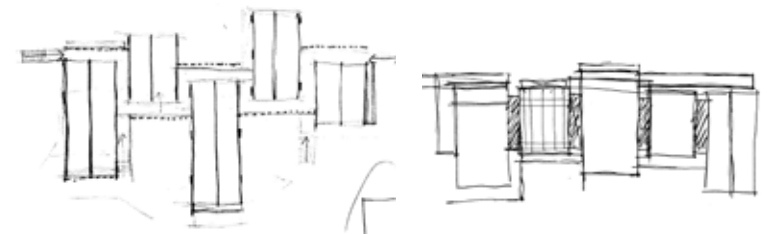
As this market building should work like an organism in producing and using waste and fresh products, an ecosystem, it is very important for the systems to be visible to the general public and building users. Therefore a steel and glass service core box was designed and placed at 20 m intervals. These 5 x 18 m glass boxes house the following functions:

- circulation and movement (stairs and lifts)
- service ducts (hydroponic water circulation, vertical electrical ducts, waste pipes, water circulation)
- ventilation chimneys
- produce service lifts

On the market floor, the service core boxes create a division between different produce sections, although it does not create a barrier, as open and continuous flow on the market floor is very important.

On hydroponic and restaurant floors, the service core boxes become barriers for humidity and access control between public and growth areas, although not a visual barrier.

Between the service core boxes, portal frames are distributed on 10 m intervals, discussed in the detail in section 6.6.



>>79: Floor plan conceptual development.

### 5.7. Structural and Spatial Precedent Study

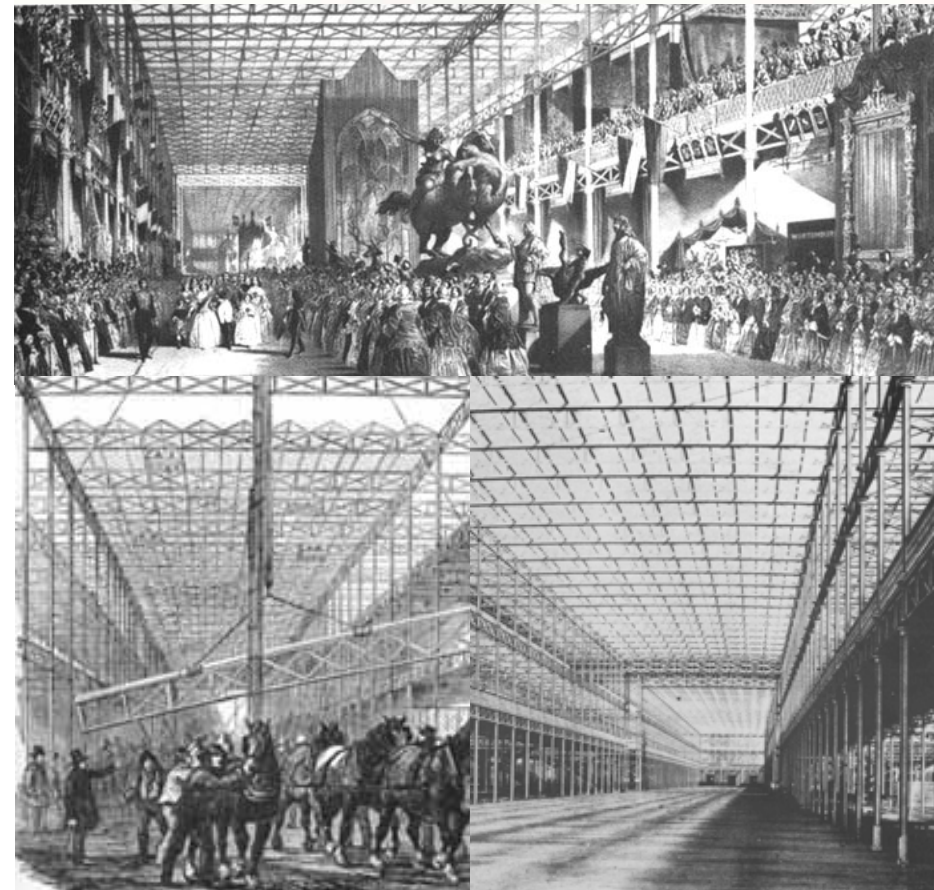
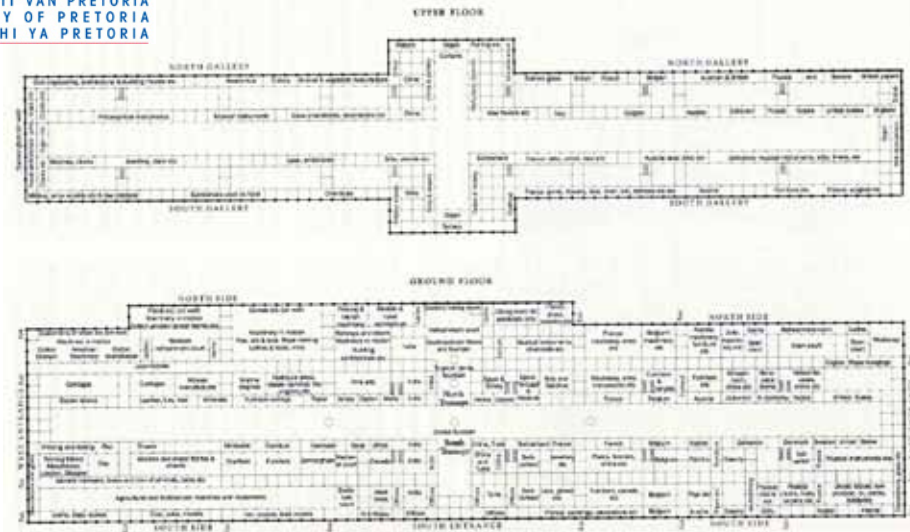
An appropriate building to use as a precedent study regarding structure and spatial qualities, is the **Crystal Palace**, in essence a large greenhouse and exhibition area. I find this example suitable, because a market could be seen as an exhibition of food products, as display is an important aspect of retail.

The Crystal Palace was a cast-iron and glass building originally erected in Hyde Park, London, England, to house the Great Exhibition of 1851. The Crystal Palace's creator, Joseph Paxton, had experimented with glass and iron in the creation of large greenhouses, and had seen something of their strength and durability, knowledge that he applied to the plans for the Great Exhibition building.

The final dimensions were 563 m long by 139 m wide. The building was 41 m high, with 72 000 m<sup>2</sup> on the ground floor alone. The large expanse of overhead glass that serves as the enclosure and lighting systems and gives the building its nickname allowed excessive amounts of light and heat into the exhibition spaces (Rourk, W: 2001)

- It was large enough to accommodate tens of thousands of exhibitors and visitors.
- It fostered the orderly display of exhibits.
- It could be manufactured and assembled in a timely manner.
- It clearly demonstrated the nation's industrial and manufacturing competence.
- Lastly, the Crystal Palace was a departure from the past and a vision of the future.

*Ventilation:* The Crystal Palace's large expanses of glass turned sunlight into heat necessitating an extensive system of louvres for cooling and ventilation. The louvres are located in the top 1 m of the wall panels on each floor and the bottom 1,5 m of the wall panels on the ground floor.



>>80: The Crystal Palace Floor Plan and structural design.

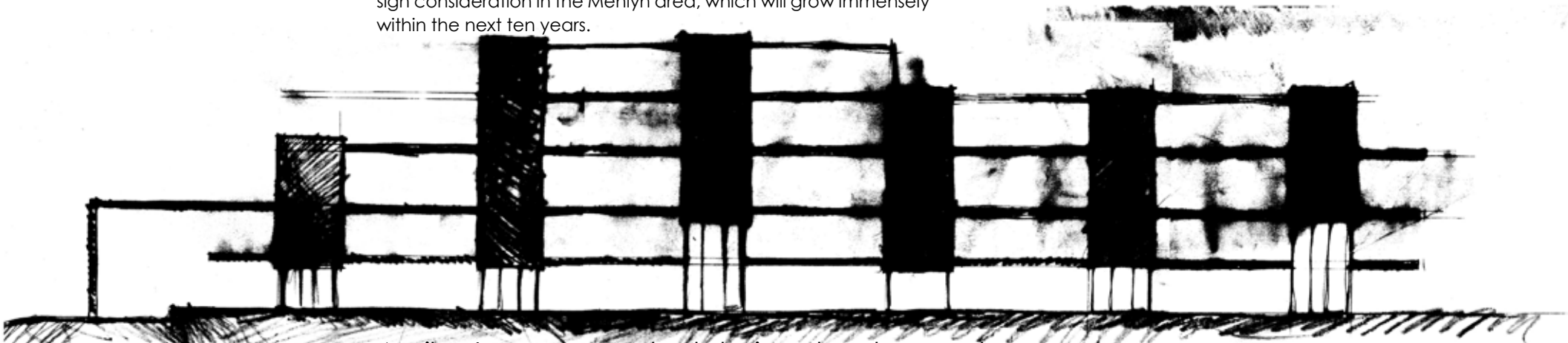


## 5.8. Structural Development

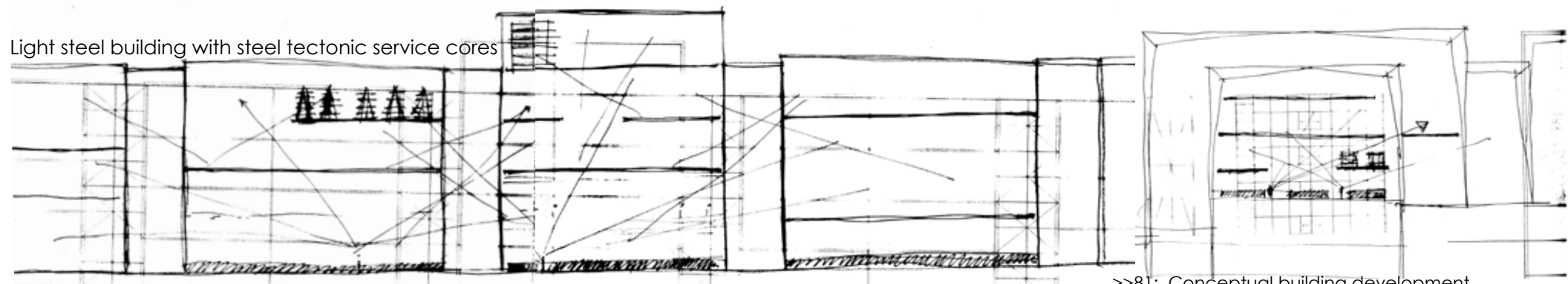
When the design started developing from a conceptual idea into a building, it seemed as if a concrete structure should be the best solution to the design problems. In the process of designing this structure, I realised that the concrete structure was very heavy and dark, opposite to the light and open feel the market should have. Experimenting with steel became much more festive and seemed to be a better choice for the structure of this market.

Designing with steel offers the opportunity for architectural expression, as well as structural versatility and adaptability. Designing a steel structure for this market building was decided on after a few advantages was evident. At first, the modular nature of its parts, that is adaptable to growth, an important design consideration in the Menlyn area, which will grow immensely within the next ten years.

The second most important design need was to have open market floors without too many columns blocking the way. Steel has a very large span capability, which makes it a highly advantageous material. The reuse of elements or components by unbolting provides for adaptability in the future, when next phases of the market building will be erected.



April - June conceptual design development Concrete building with steel tectonic service cores



Light steel building with steel tectonic service cores

The architectural function of steel is that of slenderness and lightness, which became important in the design process of this building. A building that has a light and festive feel to it was required to house a successful market. Architecturally, steel has many advantages. The lightness was accentuated by openings in steel portal frames, and using slender tubular sections as tension members. Expressively designed steel connections brings the complete design together to a refined whole. By exposing the structure of this building, the idea of transparency and honesty is achieved. The repetition of structural elements, e.g. portal frames, creates a rhythm and harmony throughout the building. Diagonal bracing is used for structural stability between the portal frames, but also for visual expression of the structure.

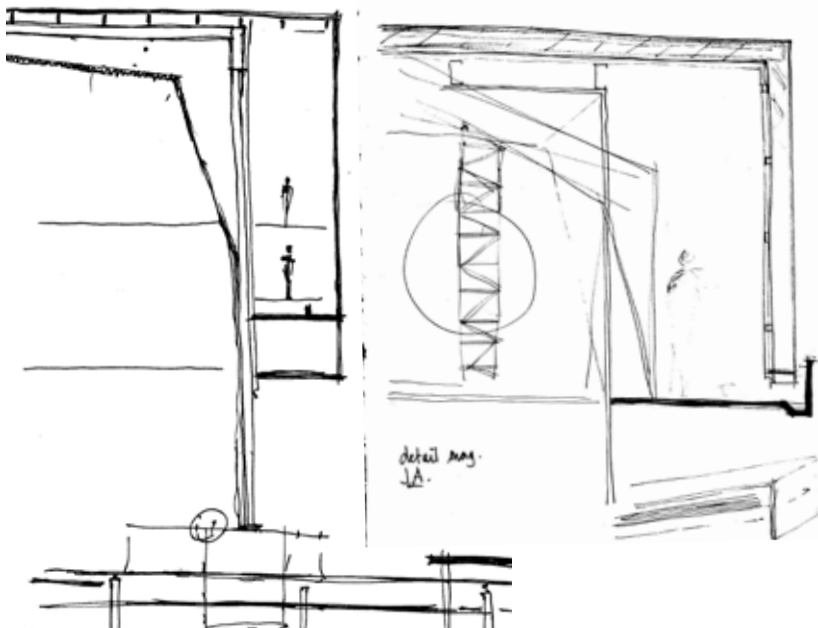
Portal frame structures were first developed in the 1960's and have now become very common in structural spans of 20 – 60 m. (Trebilcock, 2004:31) Portal frames are generally fabricated from hot-rolled steel sections and normally braced in the orthogonal direction. In their general application, portal frames provide little opportunity for expression, but with detail design, these elements

can become something beautiful and enlightened. In the market building, a tapered portal frame is used, with tubular steel lattices as tension members. In its common application, the portal frame structure doesn't support multi-storey buildings, but rather large barns and storage buildings. For this building design the best option was to implement suspended floors, hung from the portal frame itself. A few options were explored in terms of the structural and material choices that should be made, including a steel grid structure or steel trusses as flooring supports. These options were both space limiting and thus inappropriate. Lightweight concrete floors were the best choice, because of its thin floor depth.

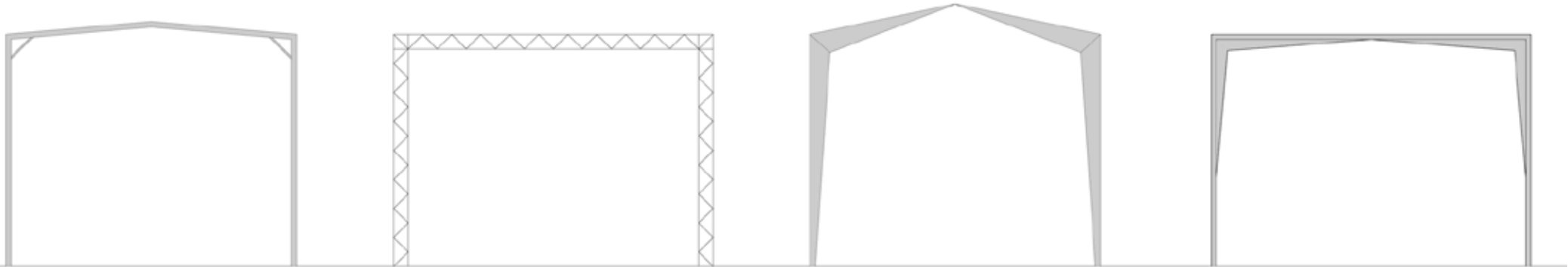
### Suspended lightweight concrete floors

There is quite a few lightweight concrete flooring slab systems that could be used in this design, of which the best was SVF flat slab system. These floor slabs will be suspended from the portal frame with 25 mm diameter galvanised steel cables, fixed to the concrete slabs with a conic anchor. Large span concrete flat-slab systems with internal spherical void formers (SVF) can be successfully designed in accordance with SANS 10100-1 (SABS 2000).

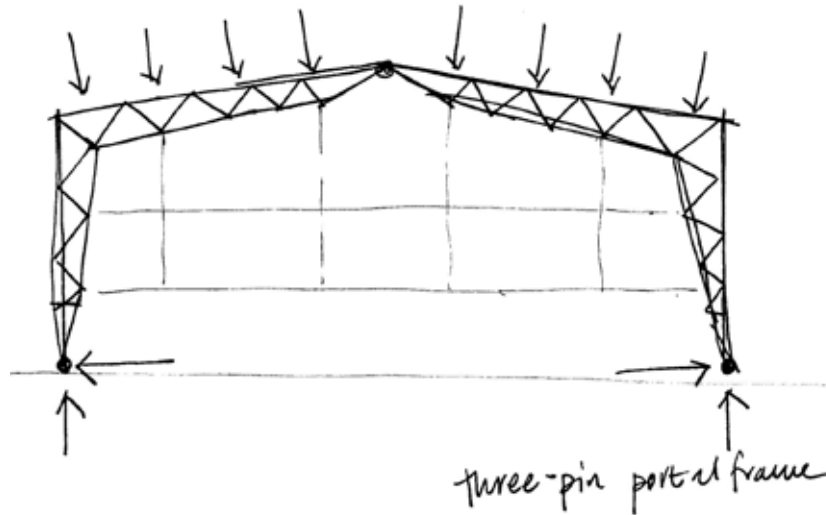
Suspended floors ensure that this market can grow with the precinct by adding floors, or moving the portal frames upwards by adding to the height of basement concrete columns.



“PORTAL: A structural framework consisting of columns and beams supported by two columns to which it is connected with sufficient rigidity to hold unchanged the original angles between the intersecting members”.



>>83: Portal frame typologies.



**Three-pin portal frames:**

The three-pin portal frame is incomparably the most common type. It is stable against horizontal forces in its own plane and statically determinate, which means that the moment distribution is not affected by uneven subsidence of the foundations or by unforeseen deformations in joints and connections. Further, the three-pin frame is hinged into the foundations, which simplifies their basic construction. In poor soil conditions the horizontal reactions at the supports can be taken up by tension members between the foundations (within or under the slab). The load on the substrate is then principally vertical.



>>84: Portal frame design development.

>>85: Final Portal frame design.



## 5.9. Factors of Influence in Successful Market Design

### 5.9.1. Location

#### a) Location of Population Movement Generators

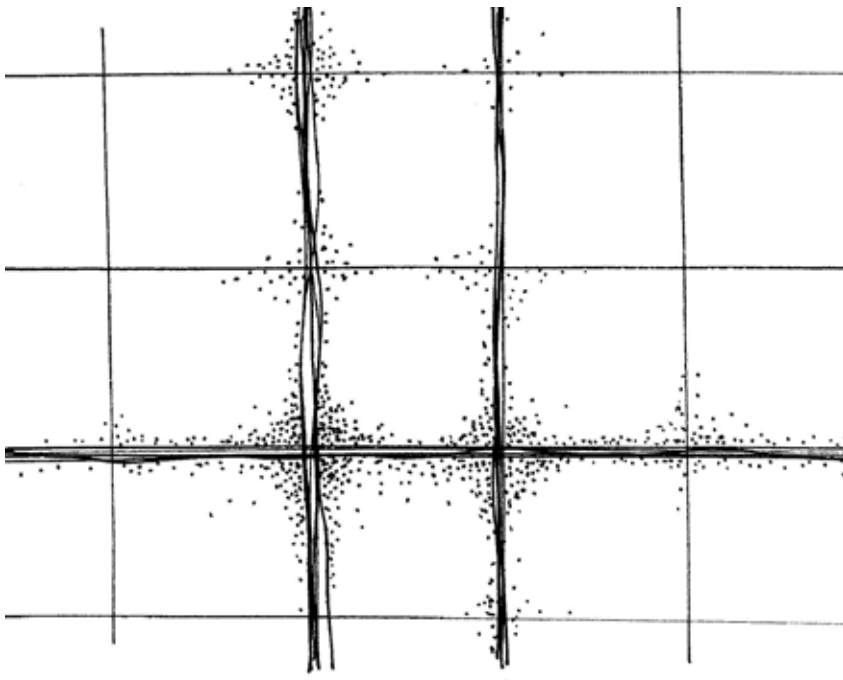
Markets are extremely sensitive to flows and concentrations of pedestrians and traffic – the most successful locations are therefore in close proximity to larger generators of population movement. (Dewar, 1990: 23) The proposed new market building will be located next to the new Menlyn intermodal transport interchange, housing the new Gautrain station. This public transport node will attract thousands of users. Another generative node of movement would be the new Menlyn Maine development, providing 44 000 m<sup>2</sup> new retail space, 143 000 m<sup>2</sup> new office space and 100 000m<sup>2</sup> new residential space within the precinct. The development team foresee an extra 20 000 people using this precinct, on a daily basis. (Bowen, 2011)

#### b) Sources of Supply

The second most important factor of determining the location of a market is the siting in relation to other sources of supply. In this instance, the market is located close to newly introduced productive landscapes, and the hydroponic component of the market building.

#### c) Location of Consumers

From a planning point of view, a third factor which should influence decisions on market location is the need to serve the city's consumers as equitably as possible. Given that the Menlyn intermodal transport interchange would house a taxi rank, Bus Rapid Transit, Tshwane Bus system and Gautrain, people of all walks of life would meet here. This site is therefore perfectly located to serve urban citizens equally.



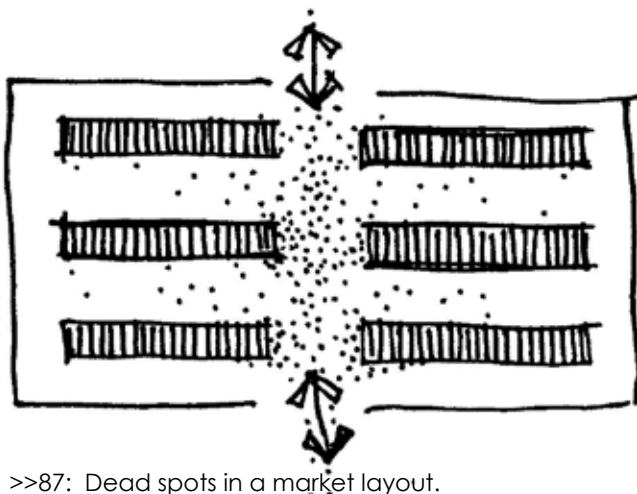
## 5.9.2. Market Layout

### a) Spatial Marginalisation

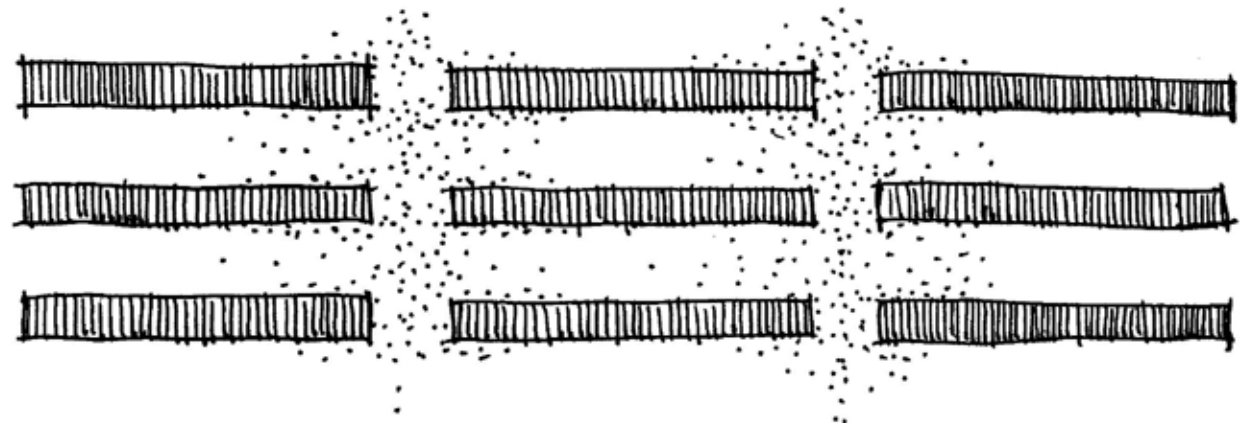
This might be the most common problem directly related to physical layout. Abandoned, unused and low profitable stalls, mainly because they are avoided by customers for some or other reason. This happens when stalls are not exposed to sufficient flows of pedestrian movement. The most optimal market place is created when intense flows are diffused across the entire trading area, and where 'edge' or 'cul-de-sac' conditions are minimised. Dead spots should be avoided in the market area. Smaller stalls or stalls that are not a destination should be placed en-route to destination areas such as fruit and vegetables or meat and dairy products. These stronger elements draw customers through the market, creating a continuous flow and 'buzz'. In shopper behaviour, it is known that people seek to reduce energy expenditure when searching for products. The most direct movement channels are the ones that draw energy in their pattern of search. (Dewar, 1990:42) Another important factor in the successful layout of a market is visibility or visual contact. The tendency to which certain parts of a market are used is strongly related to the degree to which it is visually observable from other parts of the market. Vertical separation between functions can break the flow and dynamics of the market, thus openness and visual connectedness are of utmost importance.

Dead spots are the result of the following layout conditions:

- non-contiguous or fragmented market form
- small formal shops having to compete with informal markets
- in the middle of excessively long, unbroken stall runs
- non-selling sides of stalls



>>87: Dead spots in a market layout.



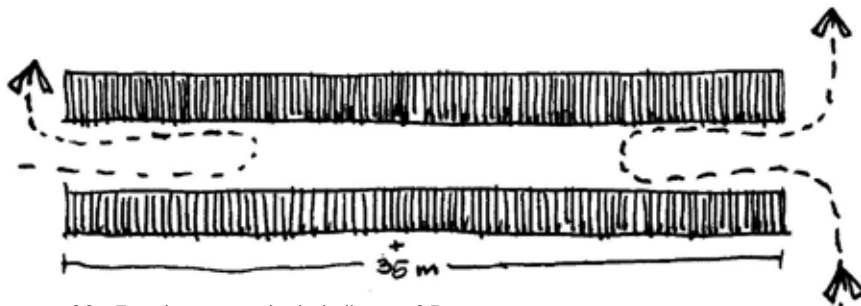
>>88: Dead spots in too long stall runs.

b) **Length of Selling Runs**

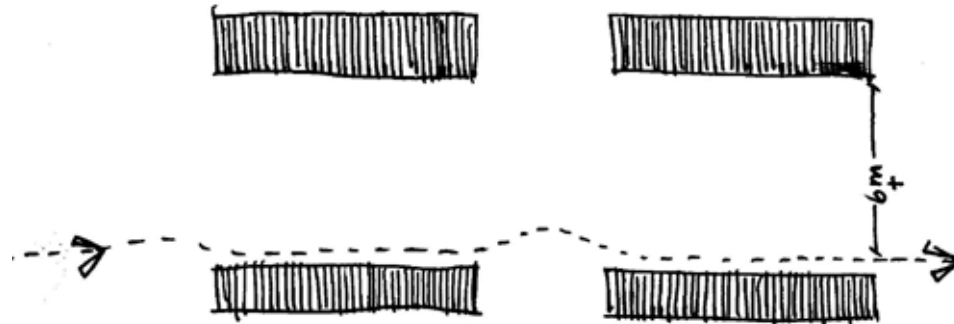
Market performance is significantly affected by the length of unbroken stall runs of adjacent sides. Unbroken runs must be long enough to facilitate comparative buying and to generate a strong sense of vibrancy and activity. When the runs are too short, activity levels are scattered, and when the runs are too long the ability of users to switch between runs are impaired, and selection gets restricted. As discussed previously, lengthy runs create dead spots to the middle. Therefore runs will be avoided. Observing market and shopper behaviour shows that an optimum run length would be between 18 m and 25 m. Stalls should never be longer than 35 m or shorter than 10 m. (Dewar, 1990:52)

c) **Width of Circulation Space**

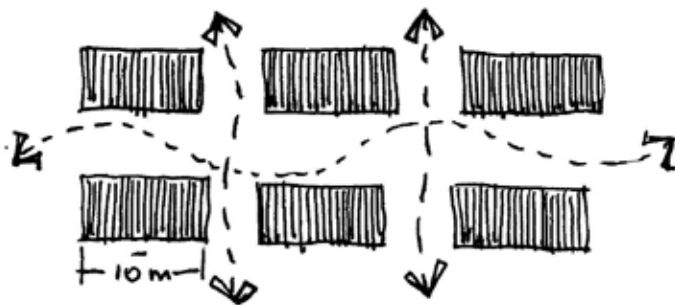
The best situation would be if shoppers could engage in both sides of the circulation channel in the process of product selection and comparison. A clue of the perfect channel width range can be derived from the layouts of informal and spontaneous markets. These conditions show that a width of 1,5 m is optimal for pedestrian movement and shopping. A design issue is how to create the possibility of expanding the volumes of spaces with changing intensities of pedestrian flow over different times of the day or week. By creating expanded circulation areas or knuckles at intersections and movement spaces, congestion can be minimised.



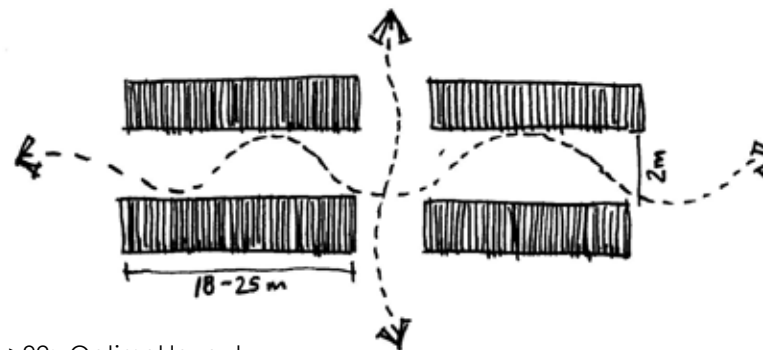
>>89: Too long market stall runs 35m +.



>>91: Market runs too wide apart 6m+.



>>90: Too short market stall runs 10m -.



>>92: Optimal layout.



### 5.9.3. Market Infrastructure

- a) *Cleanable floor surface.*  
Fresh produce easily gets trampled into the floor, therefore floors should not be very porous and easily cleaned with water.
- b) *Water.*  
For regular cleaning, washing of produce and drinking.
- c) *Electricity.*  
Preparation of food, fridges and freezers and lights.
- d) *Public toilet facilities.*
- e) *Shelter for informal market in park area.*  
The type of shelter is affected by:
  - 1) climate
  - 2) urban context
  - 3) environmental impact
  - 4) market permanence
  - 5) cost

In this instance large trees would be appropriate for providing shelter at the informal or spontaneous market in the landscape.
- f) *Selling and display areas.*
- g) *Storage.*  
Storage in this market will be provided for in the basement cold store, accessed through goods lifts and staircases.
- h) *Cleaning and garbage removal.*  
Wet waste areas will be allocated close to heavy vehicle delivery and collection area.

### 5.10. Cash System

The market will be a cash free area, for safety and planning reasons, also this will be the way forward with intelligent systems like smart cards. Congestions will be minimised at peak hours, making the shopping experience as pleasurable as possible.

Each customer buys a smart card once, and afterwards loads value via electronic transfer, debit order or cash payment at one of the three cashiers or vending machines in the market. Each stall owner, restaurant or take away shop will have a wireless device where the card will be swiped so the payment can be made for items bought. This will be an easy and effective system. Gautrain commuters will be able to use the Gautrain Gold card to buy at the market, as each commuter should have one to be able to travel. This is also a smart card on which you can top up value to use for train and bus rides.

Drop safes will be situated at each cashier and cash will be collected by an independent cash collection service, at least twice daily.



>>93: Smart card system.

### 5.11. Hydroponics

Hydroponics is a way of growing plant life without soil, only by using water and mineral nutrient solutions. Terrestrial greenery can be planted and grown with its roots in the solution of mineral nutrients or in other mediums such as mineral wool or gravel.

According to Despommier, D.(2005), the advantages of hydroponic farming include:

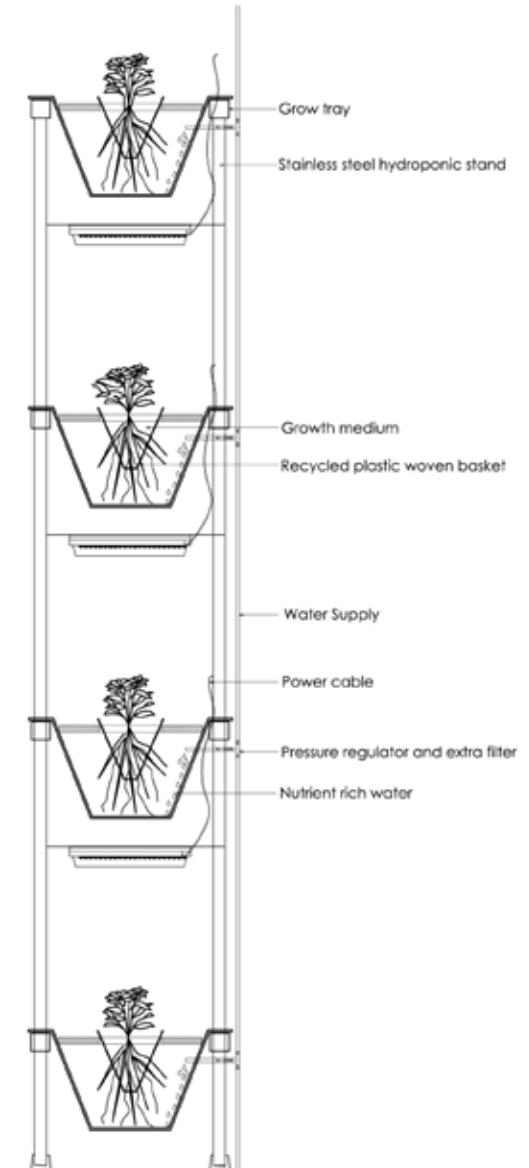
- year-round crop production
- the elimination of agricultural runoff
- significantly reduced use of fossil fuels (farm machines and transport of crops)
- the use of abandoned or unused properties
- no weather-related crop failures
- the possibility of sustainability for urban centres
- the conversion of black and gray water to drinking water
- adding energy back to the grid via methane generation
- creating new urban employment opportunities
- reducing the risk of infection from agents transmitted at the agricultural interface
- returning farmland to nature, helping to restore ecosystem functions and services
- controlling vermin by using restaurant waste for methane generation

Upon many, a decision was taken to use mainly three ways of hydroponic food production. A short discussion on each follow:

1) Nutrient film technique: This system has a continuous nutrient solution flow, which does away with timers for the submersible pump. This solution is slowly pumped into the grow tray, often or usually a tubular element, which then flows over the plant roots, whereafter the remaining water returns to the reservoir. Typically there is no growing medium, other than air, used in this system. The plant is normally supported in a little basket, and the roots dangle down into the solution.

2) Omega carousel hydroponic systems: This is a system based on hydroponics that consists out of a few rotating cylinders made of stainless steel, that houses about 3 000 plants each. These cylinders rotate around LED light sources, and still get five times more food per watt than conventional farming does.

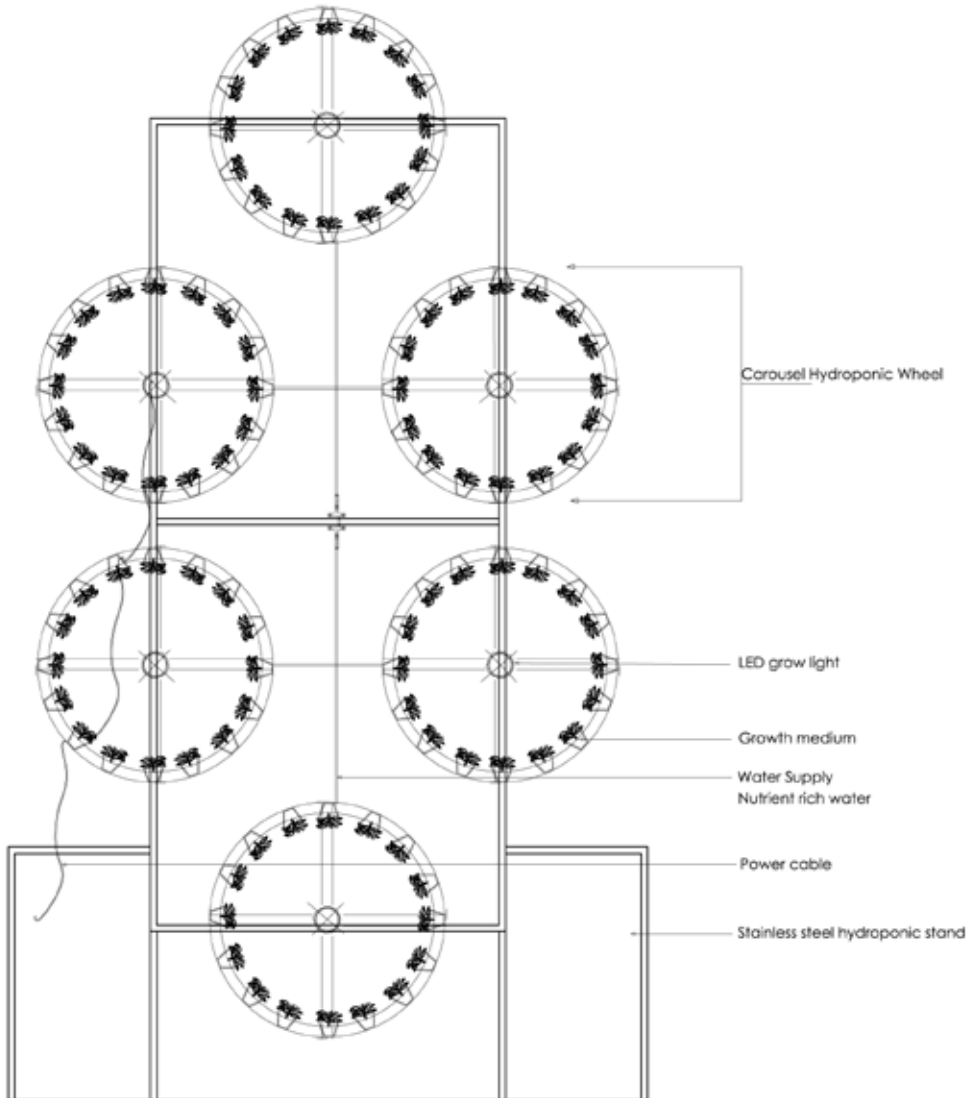
3) Aquaponics: It is the grouping of aquaculture and the above-mentioned system called hydroponics. Fish and plants are grown simultaneously in one integrated, soil free system, called aquaponics. The waste produced by the fish, provides a source of food for the greenery, and the greenery form a natural water filter for the habitat of the fish. Harmless, fresh, organic fruits and vegetables are produced by the system of aquaponics. (Hydroponics and organics, 2010 & Simplyhydro, 2010)



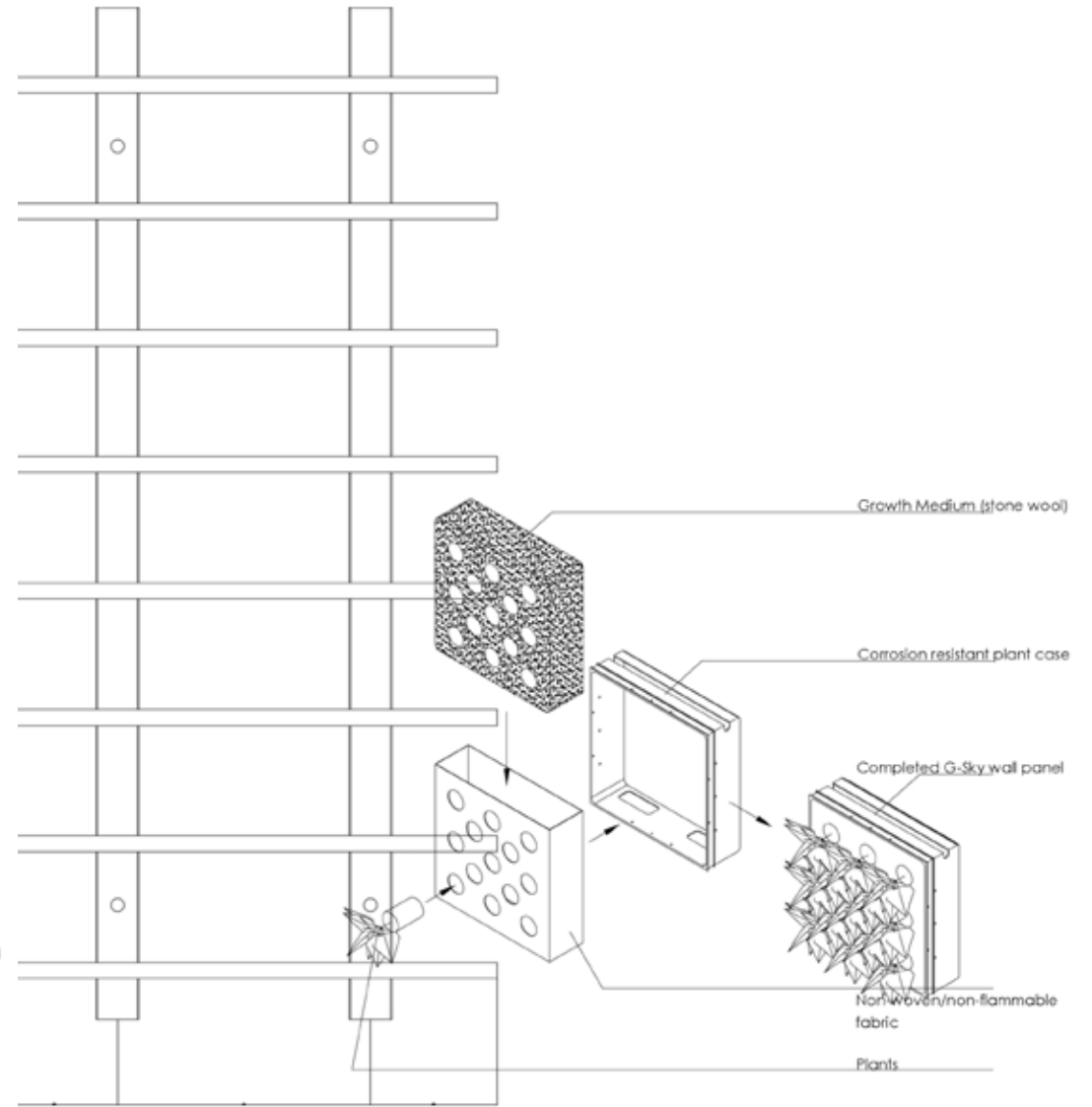
>>94: Nutrient film trays



>>97: Collage of urban farming and hydroponic typologies.



>>95: Omega carousel wheel.



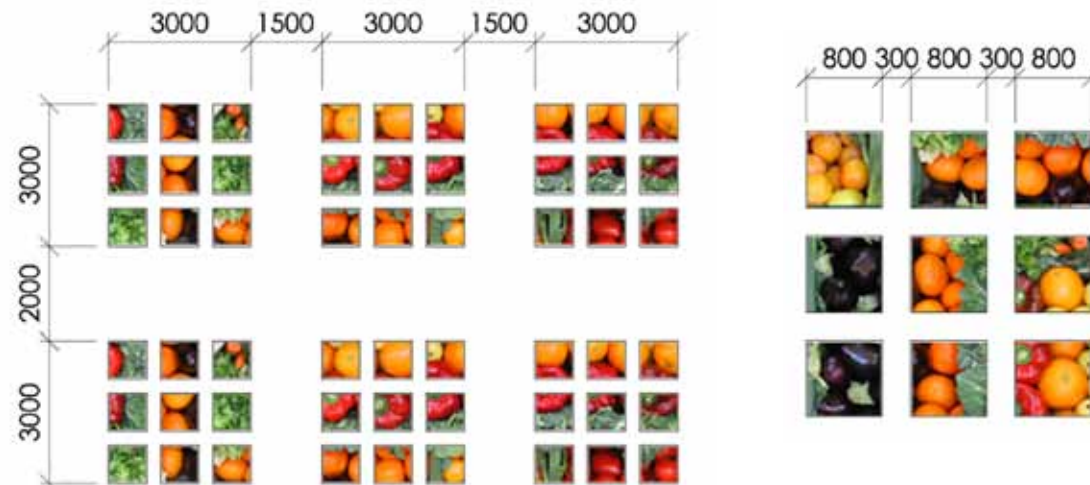
>>96: Green wall construction.



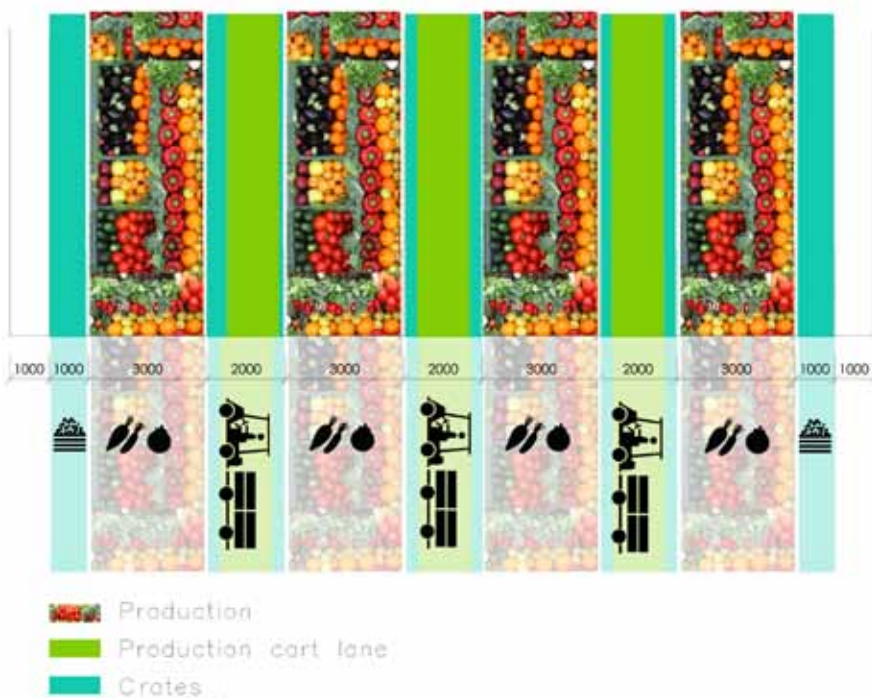
### 5.12. Productive Landscapes

As discussed earlier in Chapter 2, open spaces in the area will be utilised to produce fruit and vegetables. These areas will be let out as allotment gardens to individuals or institutions, and on the site itself gardening boxes will be built, that also serves as seating. The productive landscapes will be watered with rainwater that is collected from rooftops, and fertilised with compost created from market and building waste.

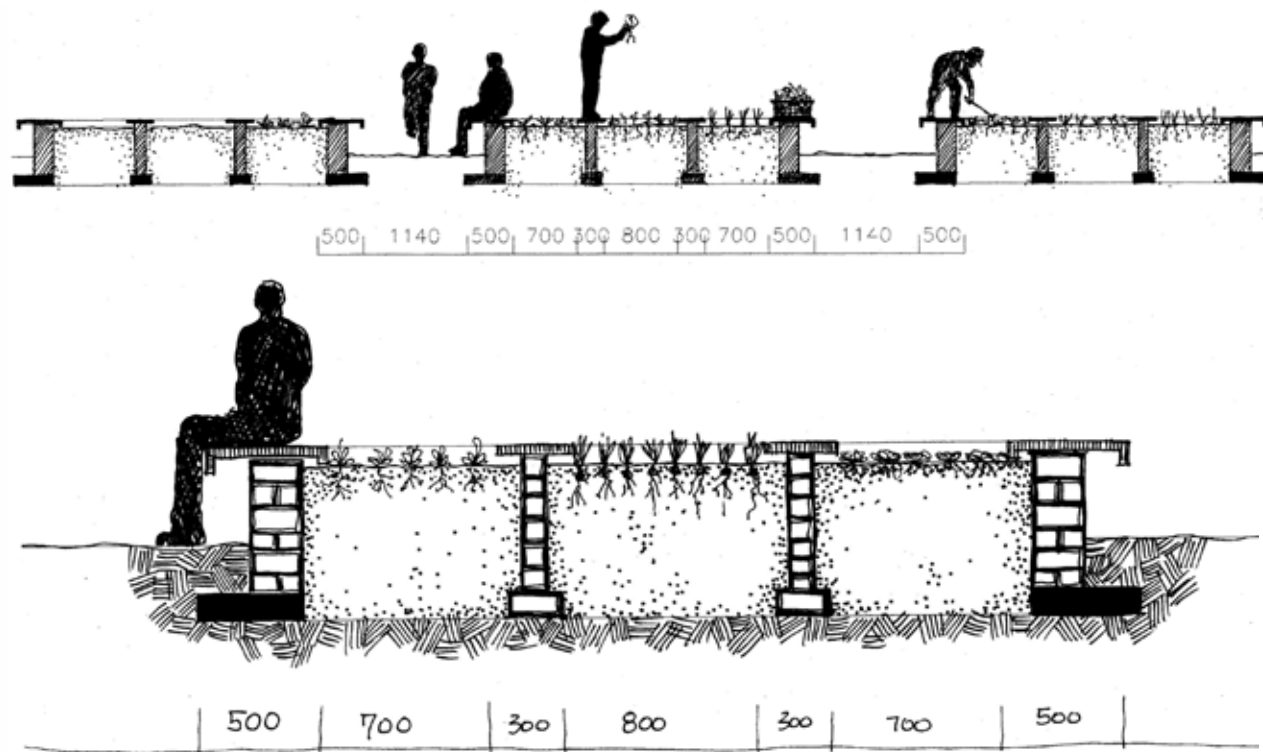
See image below for a layout plan of productive landscapes lanes and zoning. These will be the landscape layouts for the larger areas of open land, in the area and on the market site. The gardening boxes are placed closer to the building where public surveillance is possible from the market itself, to protect the produce from being stolen, as this is a reality today.



>>99: Gardening boxes layout



>>98: Productive landscape lane allocation



>>100: Gardening box design



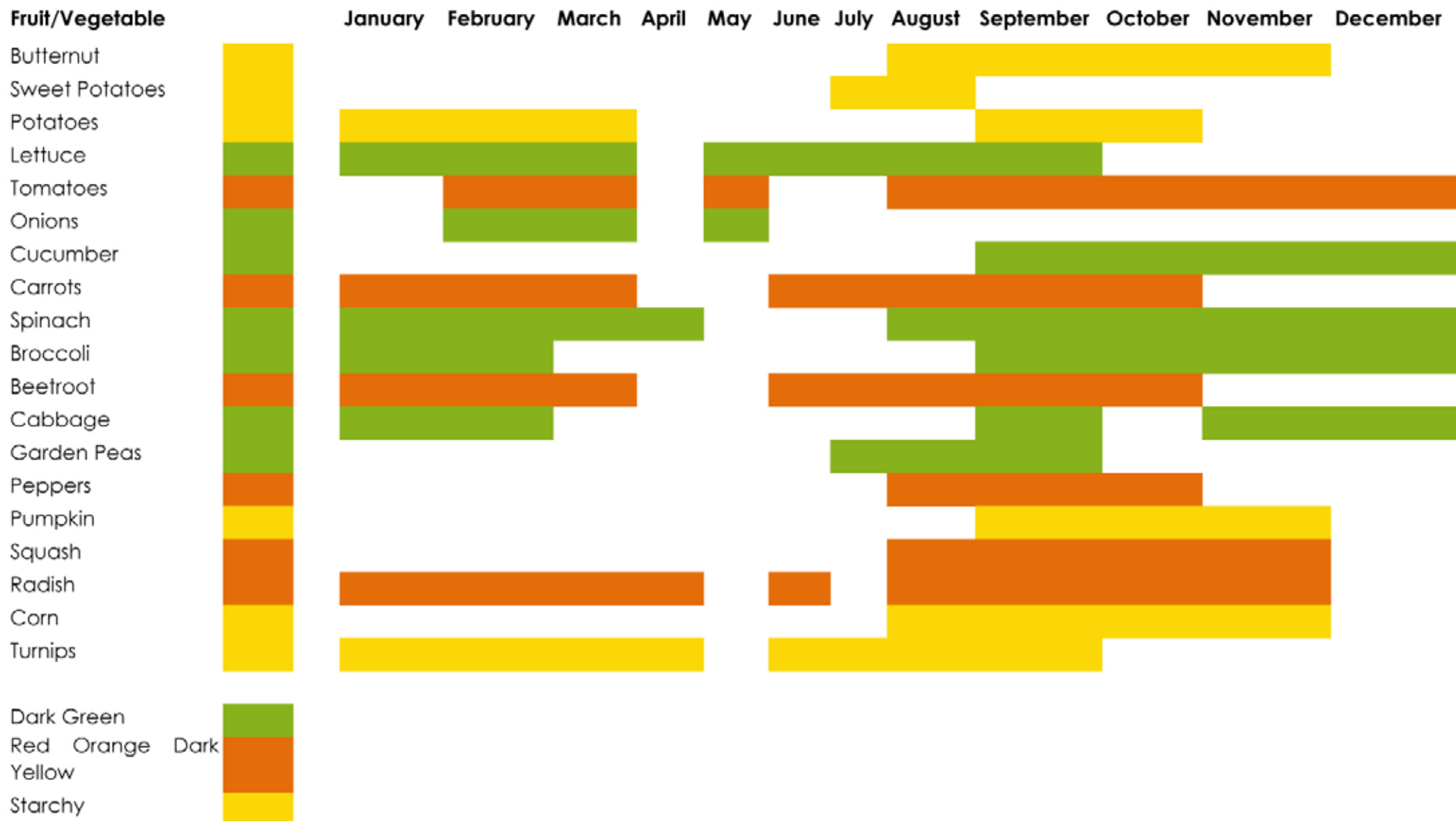


Table 4: Monthly growth of produce groups