The Orchid Cooperative

Revitalizing the Ailing Praxis

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I would like to thank Zhang Ye for agreeing to be my supervisor in this extremely long and ardous journey, my studio mates for keeping us sane week after week of studio sessions, Dad for always accomodating to my schedules, Mum for taking care of my welfare, elfing and replacing my 3D prints. Last but not least, Hayley for sticking by the entire journey with me, helping out with my work as much as possible. This thesis would not have been possible without you all, and it is with much pleasure to close the final chapter of my academic journey.

// Foreword

Orchids - Darwin's fascination, a natural heritage, a national identity, and much more, has a rich evolutionary history and value that is only discussed through its aesthetics and beauty in Singapore's gardens. This thesis probes at an obscure, less discussed topic which we in fact find it a commonplace to be hidden in plain sight - where do our orchids come from?

It was a topic which I only took interest in while investigating the future of agricultural farms in Singapore, and this thesis brings you story of the Orchids' in two parts; first, the past and its heritage, and its future in the second.

Part I

// Preface

The first part of this thesis documents the research into through interviews and site visits, the Orchid business and the industry in Singapore and globally.

This part of the thesis will bring you through the marginalized context of Orchid cultivation and its ailing business in Singapore; the challenges, opportunities and national interests in revitalizing the trade. Focused as a research project, it will then attempt to bring to the table some possible design resolutions. The design intent in this chapter is preliminary, and will be largely revised in Part II.

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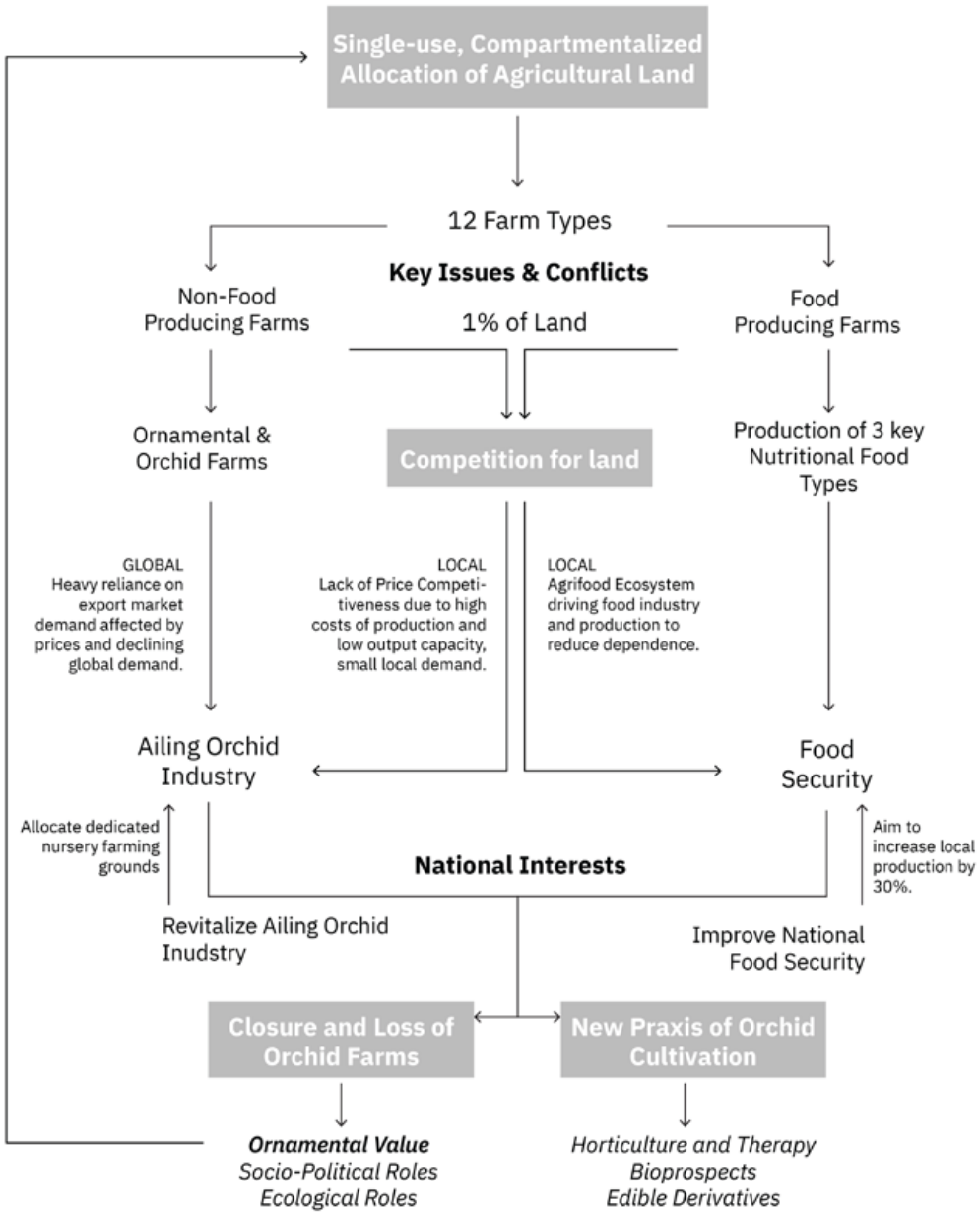
Figure 1. Supercrops! No space for diversity.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LOCAL
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ABSTRACT

Allocating agricultural land resources is crucial in land scarce Singapore; extensively compartmentalized, the praxis of Orchid cultivation is gradually diminishing in the interests of food security. Orchids which once flourished for its single, ornamental value is the very reason for its ailing industry now. Singapore's space constraints and labor costs have driven up the cost of production over the years since the popular cultivation of Orchids as cash crops in 1900s. Heavily dependent on the export market and outcompeted by other nations in cost of production and quantity, Singapore grew her competitive edge on hybridizing novel species of Orchids. As local farms fell into a struggle for survival against rising costs and a matured declining global market, the recent added stresses of expanding food production has forced to local growers to reconsider the sustainability of continuing the traditional models of Orchid cultivation.

Orchids have been less known for its horticulturally therapeutic uses and micro-nutritional content beyond the normative ornamental value, socio-political, and ecological roles in Singapore. In response to the changing nutritional preferences due to greater health awareness and a greying national population, the value chain of Orchid cultivation could be re-evaluated to focus on the human centric wellness in a new praxis of farming. The cooperative could gather the public and communities in need of care through the stages of Orchid Cultivation in pre-harvest therapy and post-harvest development of high value micro-nutritional extracts. Embedding the different stages in activities of the daily life, the cooperative extends into a living lab which invites investors to develop new applications of extracts through ground-up, co-productive initiatives. The new value chain revitalizes the ailing Orchid industry by tapping into its therapeutic uses and nutritional content.

Figure 2. (Facing Page)
Diagram of Thesis Abstract

1

Introduction

The history of Orchids and the praxis of its cultivation can be understood through its economic and social value over many years. Orchids, constituting 10% of all flowering plants in the world are the largest group of flowering plants, with an estimate of up to 22,500 species worldwide (K.M, 2012). Orchids used to be a species extremely abundant in Singapore; as with the tropical rainforest cover (Chin, 2008). Prized for its ornamental value as an exotic species in western culture, they have been actively collected by professional and free-lancers (Chong Jin & Lee, 1989) since 1819.

The popularity of local Orchid cultivation grew with the recognition of its value beginning from the adoption of Vanda Miss Joaquim as the world's first national hybrid flower in 1891. With the following awards for locally bred hybrid orchids by the Royal Horticultural Society and the nation's privilege to hosting the 4th World Orchid Conference (OSSEA, 2017), the phased out pig farms in 1977 (Begum, 2019) rapidly expanded Orchid cultivation to 359.46ha within 10 years from 71ha (Figure 3), providing jobs and income for many as an ornamental cash crop (Judith, 2013)

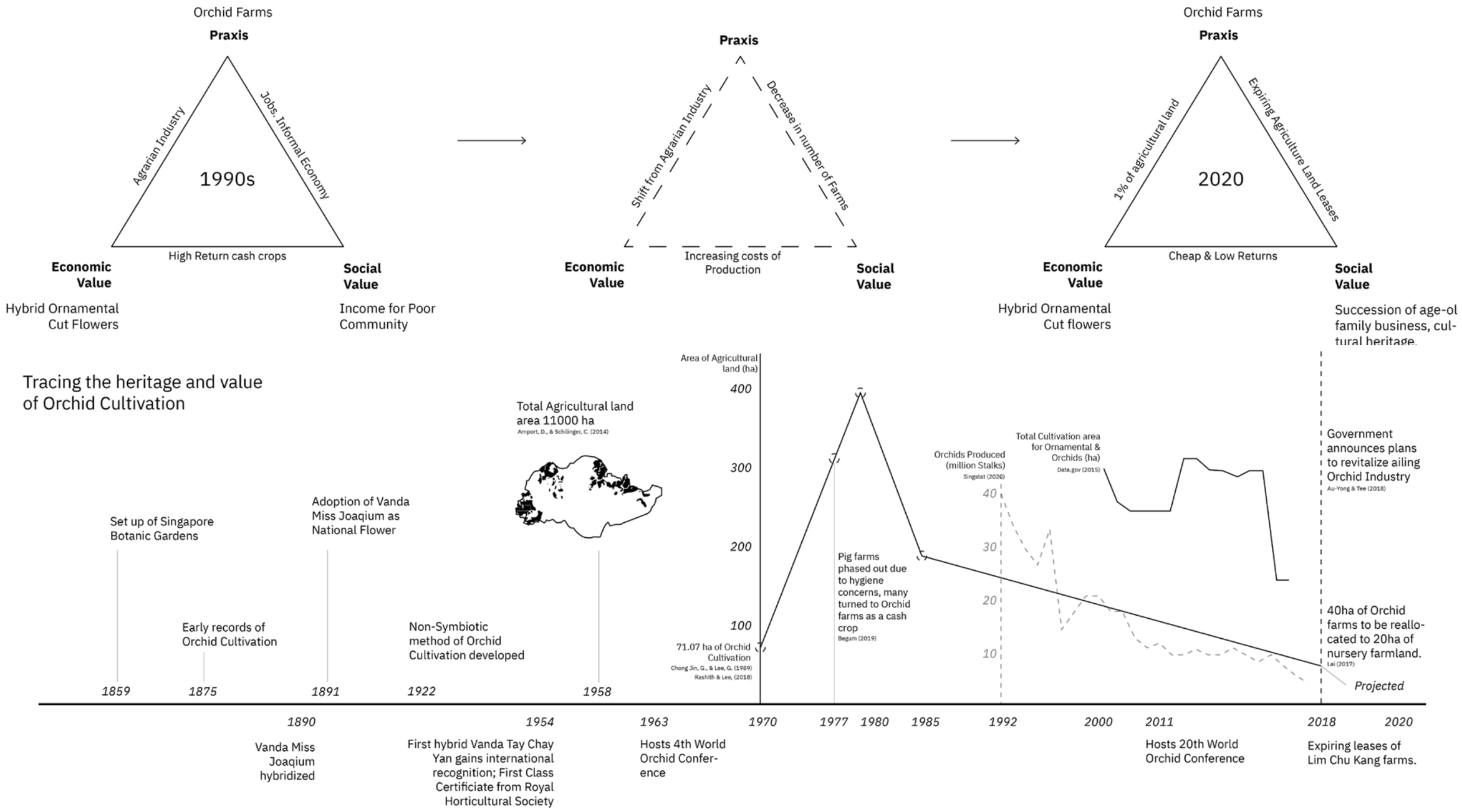
Figure 3. (Facing Page, Folded)
An Evolving Praxis

The expansion was however short-lived as Singapore shifted away from the agrarian industry, limiting the land intensive Orchid cultivation. Locally cultivated Orchids became less price competitive against regional producers as land shrunk by half to 192.10 ha in 1985 (Chong Jin & Lee, 1989) with added labor costs. Cultivation practices expanded into the SIJORI region (Figure 6.) such as Johor with larger agricultural plots (Gasco, 2016) in bid to drive down costs of production. However, as the agricultural grounds shrunk, so did the share of Singapore's orchids in the global export market from 10% in 2012 (Rajeevan, Rao, De, & Pathak, 2019) to 3.9% in 2019, recording negative growths year on year (ITC, 2020). In 2018, approximately 40ha of Orchid farms remain (Rashith & Lee, 2018) as the businesses survive on the personal interests of the farmers' hobby and willingness in continuing the heritage of cultivation.

In response to revitalizing the heritage of Orchid industry, the government promised aid (Au-Yong & Tee, 2018) to the orchid farms in 2018. However, the disconcerted efforts been challenged by the interests of food security in the recent 2030 road map (Tan & Tan, 2020). In fact, the orchid farms have to invest in relocation and technology for production intensification with plans to consolidate all ornamental farms into 100ha of nursery allocated land (Lai, 2017); 20ha designated to Orchid farms. A new economic value and social value is needed to revitalize the ailing Orchid industry as local farms have been struggling to find new models of Orchid cultivation.

The value chain of Orchids has always been structured for efficiency in production of an ornamental commodity. The thesis re-evaluates the current value chain of Orchid cultivation by finding synergies between conflicting stakeholders and the greater wealth of uses that Orchids provide in the pre & post-harvest stages.

An Evolving Praxis



An Evolving Praxis

Figure 3.

2

Thesis Statement

The Orchid Cooperative revitalizes the ailing praxis of orchid cultivation in a land scarce nation for its untapped horticulturally therapeutic and micro-nutritional values. The cooperative re-evaluates the value chain of Orchid production, gathering the communities in need of care and public through the stages of pre-harvest as a therapy and post-harvest development of high value micro-nutritional extracts. Embedding both stages into activities of the daily life, the cooperative further invites investments towards ground-up co-productive initiatives, fostering social interactions in response to the nation's changing nutritional demands, greater dietary health awareness and ageing population.

3

Literature Review

3.1 The Wealth of Orchids

The praxis of Orchid cultivation is closely linked to its social and economic values. The thesis examined in greater detail the wealth of uses that orchids could provide for unmet economic demands and social needs of the nation.

3.1.1 Ecological Roles

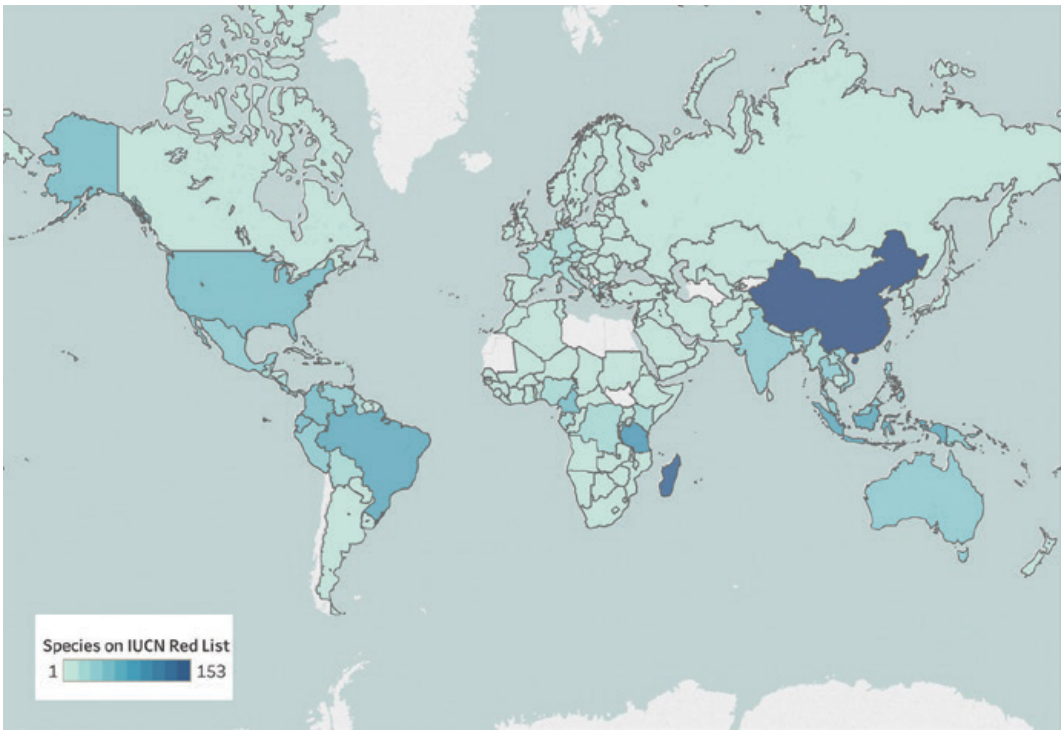


Figure 4. Number of Orchid Taxa assessed for IUCN Red List (Data: IUCN, 2017).

Orchids are potential ecological indicators to the recovery of a damaged natural environment given its inherent specificity to ecological niches with selective pollinating and mycorrhizal guilds for germination. The lack of wild Orchids in Singapore has been evident of a damaged ecosystem. Constituting more than 70% of the CITES-listed species (Figure 4), it is a heavily poached species of flora that has been facing pressures from of habitat loss (Hinsley, 2018). Highly evolved in adaptation to a wide range of environments, orchids are known to be terrestrial and epiphytic (Yam, Ang, Tay, & Wei Jing, 2016). nParks enlisted help from Orchid farms in the past to cultivate orchids for reintroduction but has discontinued the partnership since the expansion of botanic gardens.

3.1.2 Horticultural Therapy

The concept of horticultural therapy is construed from various theories in relation to nature and its healing powers; from biophilia (Wilson, 2011), to Roger Ulrich's nature's stress reduction capabilities (Ulrich, 1984), and Kaplan's attention restorative hypothesis in restoring cognitive abilities (Johnson, & Bounds, 1989). Recent discovery of improvements in wellness based on biomarkers (nParks, 2018) have also proven the therapeutic potential of horticulture.

Horticultural therapy is a long-term program that employs the help of facilitators to engage with groups of audience in specific profiles. It aims to enhance the quality of life by building social interactions and positive connections through activities enabled by horticulture, encouraging mental and memory stimulation. It belongs to the broader-based programs (Figure 5.) of "Therapeutic Horticulture" which is less individualized, and "Social Horticulture" that forms the most generic suite of activities carried out without any facilitation. Locally, there are about 6 therapeutic gardens, 1,200 community gardens and two medical care centers conducting varying levels of horticulturally related therapy.

Figure 5. The Wealth of Orchids (pp 15)

Orchids fulfil not only the fundamental considerations of flora a therapeutic garden in Color, texture, fragrance, edibility, fauna, and reminiscence (Ng, 2020). Its long biocultural history provides an added dimension of ethnobotanical practices (Singapore Memories, 2020) of deriving treatments in ayurvedic and traditional Chinese medicines, as well as spiritual-religious teachings and symbolisms (Blooms, 2018).

3.1.3 Ornamental Value

Four key Orchid types; Cymbidium, Dendrobium, Phalaenopsis, and Vanda are the most common ornamental commodity. As one of the top exporters of Orchids in the world, the local industry has been dependent on the global market partners for cut flower sales (Floral Daily, 2016) formed by major importing countries such as Australia, Japan and United States (ITC, 2020). However, Singapore's share is minimal compared to major exporting countries such as Thailand due to price competitiveness (Jetro, 2011).

Price of Imported Orchids in Japan (Jetro, 2011)			
Country (Tropical Region)	Singapore	Malaysia	Thailand
SGD Price / KG	14.58	12.46	9.84

Locally, Orchids play an important role in attracting tourists for its ornamental novelty with Changi Airport, Gardens by the Bay and Festivals such as Garden Festival and Chinese New Year forming bulk of the demand. Ornamental novelty remains the key factor for demand in maintaining a global presence

3.1.4 Bioprospects

Figure 5. (Folded Right) The Wealth of Orchids

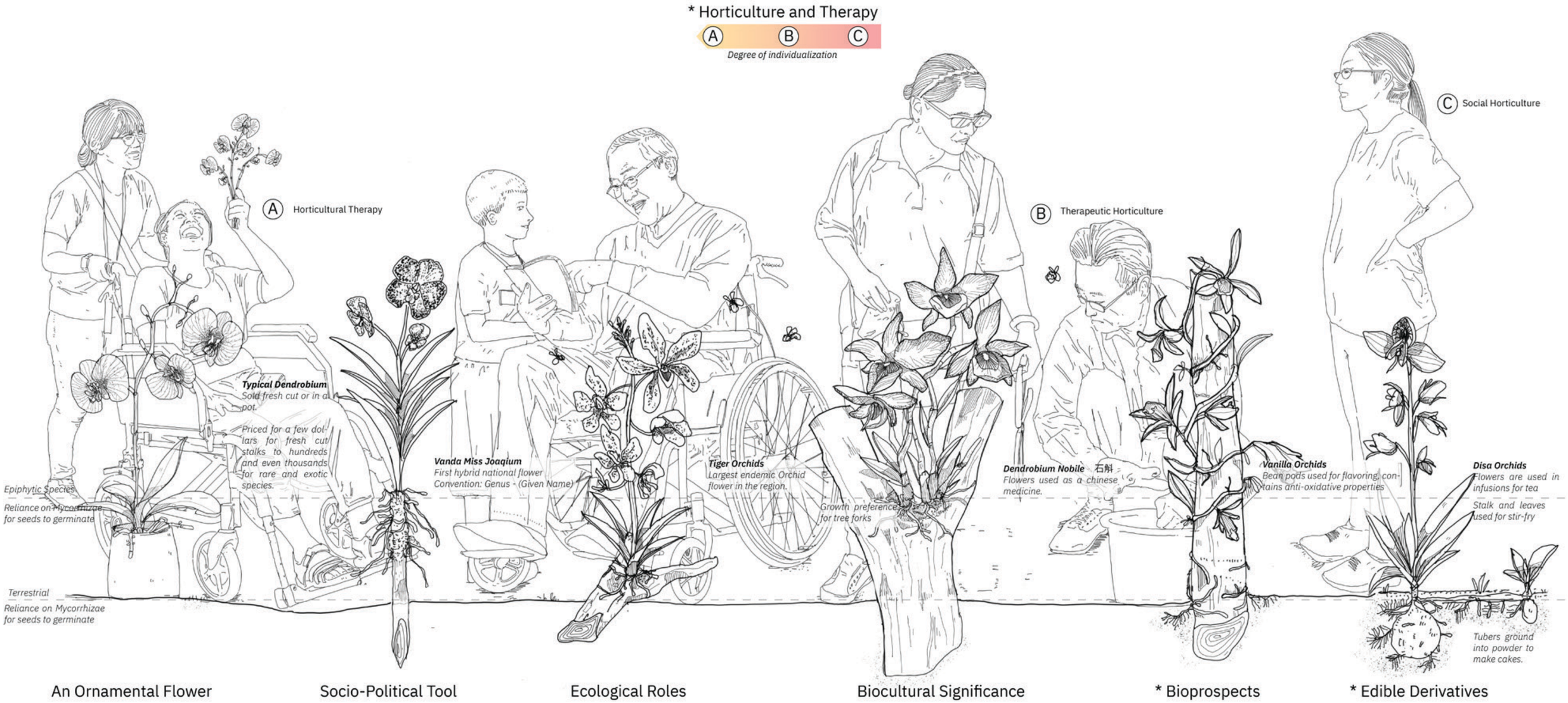
Bioprospecting is the exploration of natural resources for micro and macromolecules, genetic information and biochemicals in applications to pharmaceuticals, nutraceuticals, and cosmetics. Phytochemicals are usually found in the form of phenolics and carotenoids with an array of health benefits found only in specific food types. Orchids are high in alkaloids and flavonoids and phytochemicals, and many medicines, perfumes and cosmetics are derived from it. The extensive studies carried out by Nguyen, et al (2018) showed that the contents of Flavonoid and Anthocyanins in orchids are higher than many vegetables and sweet potatoes from Taiwan. In a separate study carried out identified yellow orchid flowers containing the highest phenolic content of 446.22mgGAE/gdw (Figure 13), comparable to the average blueberry content of 443.6mgGAE/gdw (Nguyen, et al., 2018) and several other commonly found food items (Annex 8.3). By identifying the right Orchids for extraction through methods of cold press, solvent, CO-2 and steam distillation, they could be a source of low-cost phytochemicals (Minh, et al., 2017) for applications in nutrition, flavor, and fragrance (Teng, Ma, Montesclaros, Hulme, & Powell, 2019).

3.1.5 Edible Derivatives

Edible flowers have been scientifically explored as a research in EU by ANTEA (2020), aiming to deepen the understanding of nutraceuticals and uses of flora beyond its ornamental quality. Traditionally, Orchids have been harvested for its edibles in across other countries in the world. In turkey as ice creams and salep, Europe as Vanilla, Zambia as Chikanda, Bhutan as olachtoto; stir-fried vegetable dish and tea (Singh, Kishore, Kumar, & Singh, 2016). In Singapore, orchids have been frequently used as a botanical infuse for alcohols such as tiger beer (Raguaraman, 2020) and Tanglin Gin (Bowers, 2018).

3.1.6 Socio-Political Values

The power of the botanic object as a state ideological apparatus (Alperstein, 2018) has demonstrated the practice of hybridization using Singapore's natural heritage that grew to become a manifest of Singapore's identity that is both locally and globally sculpted. The collection of hybrid Orchids in the National Orchid Garden forms a tangible living memory, exhibiting Singapore's cultural heritage and milestones. To date, the micropropagation and microbiology lab has bred 630 species (Zaccheus, u.d.), naming after socio-political events in three categories: VIP, Celebrity and Heritage. Hybridized orchids are strictly use for exhibition and not commercial uses.



Wealth of Orchids

Figure 5.

Ornamental and orchid farms located in Sungei Tengah and Lim Chu Kang will be heavily affected by the restructuring of agricultural land. While some farms have expanded to the SIJORI region to increase production capacity, it does not resolve the issue of the global decline demand for orchids and the limited local demand. The restructuring of farming grounds will only expedite the ailing industry.

Loss of Orchid and Ornamental Farms

Figure 6.

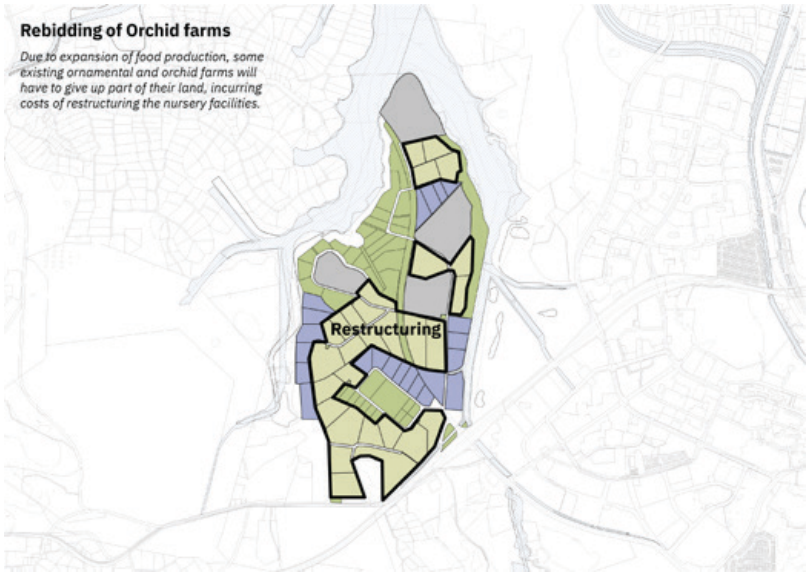


Figure 7. Future Sungei Tengah parcels affected by land restructuring.

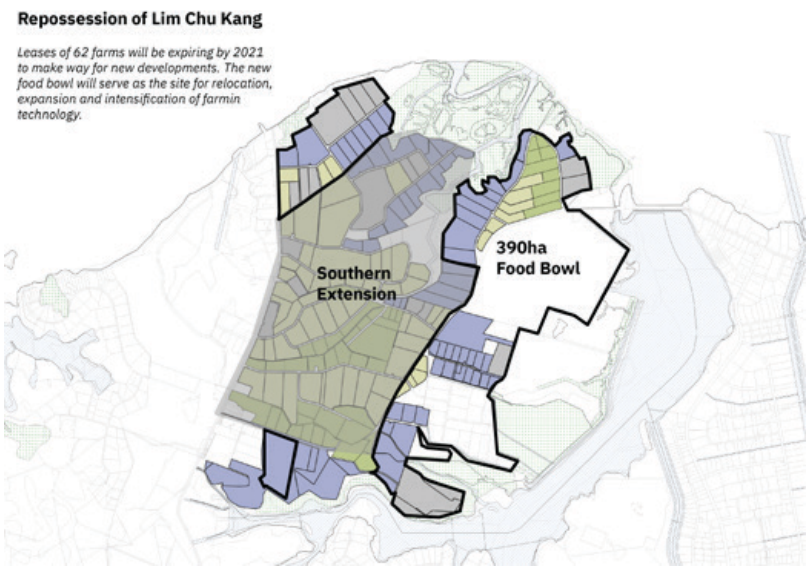


Figure 8. Future Lim Chu Kang parcels affected by land restructuring.

3.2 Loss of Orchid Farms from Expanding Food Production

The total agricultural land in Singapore has been shrinking over the years (Annex 8.1) due to urbanization and land scarcity. Working towards the goal efficient land use, it is the nation's goal to contain all farm grounds within 1% of the total land area (SFA, 2020). The agricultural farms in Singapore are diverse and compartmentalized; up top 12 different types of farms can be found, with Orchid and ornamental farming occupying the largest share of land (Annex 8.1).

The food security roadmap outlines the aims to increase local production of the nation's nutrition to 30% by 2030 from the current 10%. While food farms; vegetable farms, are slated to expand into the Lim Chu Kang food bowl, the leases of non-food farms will be expiring by 2021 (Tan & Boh, 2017) to make way for other developments (Figures 6, 7 & 8). Orchid farms will be relocated into 20ha of designated tranches within a larger 100ha of undefined ornamental nursery agricultural land. As a result, the total ornamental orchid farming grounds will be cut by half from 40ha as part a more efficient land allocation for food crop production (Lai, 2017).

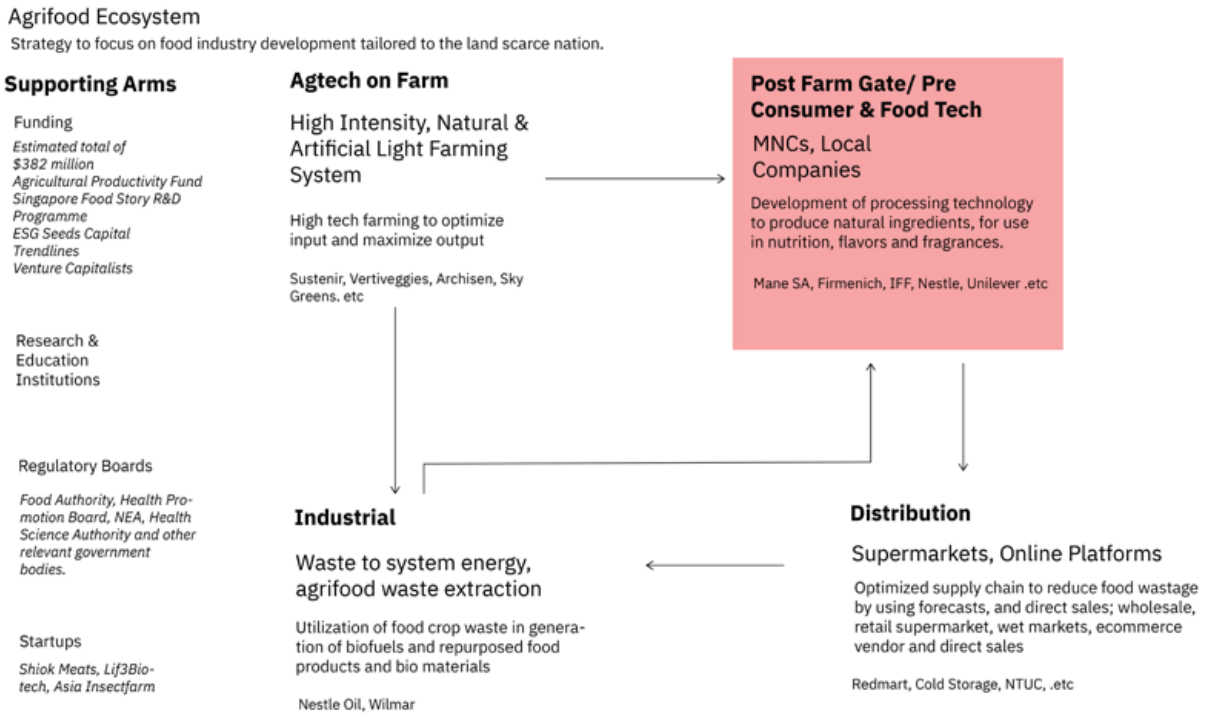


Figure 9. (Above) Agrifood Ecosystem

3.3 Agri Food Ecosystem: Shift to Food Processing

Recognizing the issue of land scarcity in Singapore, the agri-food ecosystem emphasizes on the importance of food processing industry in a land scarce country, which is a potential avenue for the wealth of Orchid uses to find value in.

The ecosystem aims to propel Singapore to becoming a one-stop food innovation hub, “Food Industry 4.0” that could create new livelihoods and value of intellectual property export to the region and beyond (Teng, Ma, Montesclaros, Hulme, & Powell, 2019). The regulatory boards have amalgamated into a collective authority as an effort to discover potential synergy and benefits across different value chains (MTI, 2019).

Five core components are responsible for the distribution and direct production of agrifood products; Agtech On-Farm, Distribution, Post-farmgate & Preconsumer Sector, Foodtech and Industrial, constitutes to the fundamental structure of the Agri-food ecosystem (Figure 9). Supporting components such as incubators, accelerators, regulatory boards, educational bodies and investors further diversifies the actors participating in the decentralized ecosystem to derive greater opportunity for collaboration (Teng, Ma, Montesclaros, Hulme, & Powell, 2019).

Amidst the increase in demand for protein and impact of climate change due to livestock rearing, the development of alternative protein has been propelled into a trend of discovering more sources of food through plants as a healthier and sustainable substitute. Development of plant, insect-based protein and cellular agriculture has become an opportunity for Singapore to address future concerns of food security regarding imported proteins. Singapore Food and Biotechnology Innovation (SIFBI, 2020) arms further adds to the importance of developing and identifying food that is safer and more nutritious for the Asian diet.

3.4 Changing Nutritional Demands

The food production paradigm has shifted towards a more ecologically and scientifically driven paradigms of food production and consumption (Lang & Heasman, 2015) since the global food crisis in 2008. Globally, people have started to opposed the productionist approach in addressing the relationship between food and health. The greater awareness towards environment has changed the consumption patterns of meat, as people turn to alternative plant-based protein to avoid the ecologically damaging effects of rearing livestock. Food has also grown to become more functional, tailoring nutrition to different lifestyle needs (Barnett, 2014), bioengineered and processed to maximize output efficiency and health benefits while limiting ecological impacts. While conventional modes of food production remain in the form of high-tech farming, the greater acceptance towards unconventional approaches to nutrition has experienced a shift in demand and this signifies a major role of Singapore's Agrifood Ecosystem.

Singapore is facing a change in the nation's nutritional demands. In a recent survey (Yong, 2020), 2 in 5 Singaporeans have been reported to be on a flexitarian diet with general health reasons being the biggest concern with the growing persistence of diet related diseases (HPB, 2014). The nation's key sources of nutritional demand; leafy vegetables, fishes and egg, has been based on demand and production feasibility (Amport & Schilinger, 2014) limited by land scarcity and production technology. It is crucial to understand that dietary requirements are different across ages (Lee, 2011) and dietary health still remains one of the key concerns for population health (MOH, 2016).

By 2050, the aged population in Singapore is projected to make up half of the entire nation's population (En, 2017). Facilities for aged care are underway, with targets for 10,000 homecare places, 6,200 daycare places and 17,000 beds in nursing homes by the end of 2020 (Khalik & Rashith, 2018). The aged population brings a new set of health issues faced by the nation, and in response has brought more attention to developing a multi-faceted approach towards long term care to improve the population health; aiming to reduce medical interventions by forming partnerships across different communities and sectors. Burgeoned by the increasing geriatric nutrition demand (EDB, 2016) and the cornerstone of medical nutrition in chronic disease management (Chek, 2008), the growth in long-term care needs also brings a suite of dietary requirements and regimes limited by medical conditions and physical edibility.

The nation needs to be prepared for the change in nutritional demands on the institutional and community level. Concerns have been raised in the funding appropriated by the government that has been focused on developing long term care facilities instead of social programs (Basu, 2017), given the strong Confucian principle leading the culture of ageing-in-place away from the reach of institutional care facilities (ADB, 2020).

4

Research Approach

Ground Research with Local Cultivators

The review of existing strategies brings the research to further examine the value chain of orchids in the pre- and post-harvest stages in the farms. Ground up investigation was conducted in detail with the local orchid farmers, researcher of nParks and potential partners in the food biotechnology companies in Singapore. The conversations in person, through phone calls and emails were carried out to understand the perceptions and struggles of the ailing orchid industry and the efficacy of policies implemented for the ornamental agricultural sector.

Figure 9.1 (Right) Interview with Yikzhuan Orchids

5

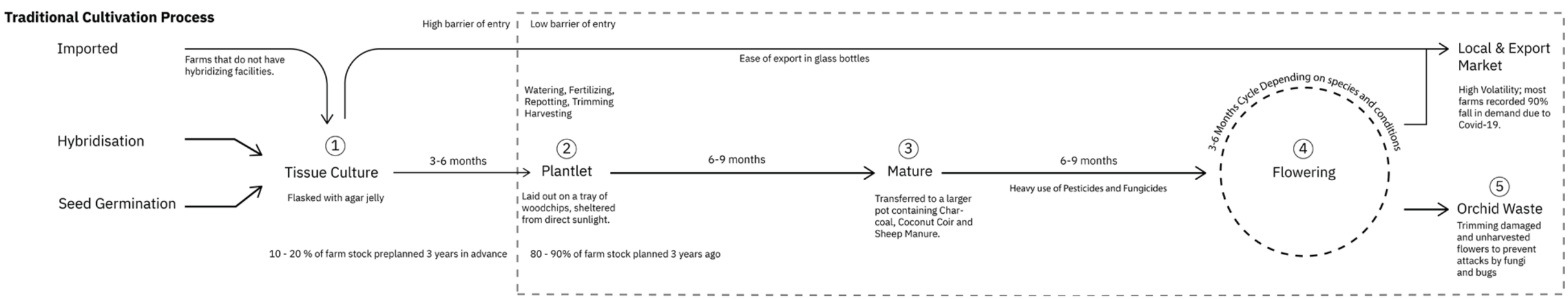
Research Outcomes

5.1 Orchid Cultivation: A Capital and Land Intensive Process

Orchid is a high capital, land intensive investment due to the long harvest cycles up to 3 years (Figure 11), and the need for a controlled environment to ensure consistent flowering cycles. Potted in an aerated medium; charcoal, coconut coir and wood chips, the plant often needs repotting in different phases of growth and requires sufficient sunlight and constant fertilizing. While being extensively treated with pesticides, surplus of flower blooms must be harvested to protect the plant from pest attacks. Given all the investment in efforts and costs, a local grower revealed that only 5%-10% of its total 200,000 holding capacity is supplying the local market. With the local harvests sold in bulk at an extremely low price of 8-10 cents per stalk to businesses, local growers have indicated minimal profit margins for their businesses.

Figure 10. (Right)
Toh Gardens Orchid Farm Site Visit

Figure 11. (Back of Page)
Orchid Cultivation Process



Orchid Cultivation Process

Figure 11.

5.2 Lack of Continued Goverment Support

While some farmers have managed to find alternative uses in collaboration with educational institutions and craftsmen, the programs were short term commitments. Hybridizing new orchids is limited to larger farms such as Woon Leng Orchids with the capacity to sustain the technology, allowing them to profit from the novel factor prized in locally and globally. A smaller farm has noted the lack of continued support from government to revitalize the ailing industry in 2018, halting the progress of developing intensive farming solutions and hybridizing new orchids as an ornamental commodity. In addition, the lease of orchid and ornamental tranches are priced at a premium of 6 times (Figure 12.) to food agricultural tranches, and with the comparatively shorter leases of 10 years compared to the existing expiring tranches, the agricultural model imposed by the government is unsustainable for their survival.

The news to relocate and develop intensive farming to meet minimum production levels even against a declining demand in a successful bid for re-allocation adds even higher capital costs of renovation that local farms are unable to sustain. While some growers have expressed disinterest in continuing, Orchid farms struggling to stay afloat must restructure the traditional models of cultivation or risk losing the business entirely.

Figure 12. (Bottom of Folded Page) Struggles of Local Orchid Farms

Figure 13. (Back, Folded Page) Orchid Micronutritional benchmark and Participant Capacity

5.3 In Search of a New Praxis

Figure 14. (Back, Folded Page) A New Praxis

The efforts in restructuring the model of Orchid cultivation by the farmers (Figure 12) could be directed towards renewed value propositions for social and economic value (Figure 14).

In response to the changing nutritional demands, the post-harvest value chain of Orchids is captured as a high value, low-cost extract for micro-nutrition. With an estimated harvest of 4 flowers per micro-nutritional serving, it could provide nutrition for up to 15,000 people per day based on the total excess holding capacity of 200,000pots (Figure 13). The extracts could be developed with the expanding agri-food ecosystem, leveraging on the food processing sector to develop value added fragrance and flavor applications.

The pre-harvest value chain of orchids extends the opportunity to leverage on horticultural therapy, gathering participants from the community with long term care needs and the public in the process of Orchid cultivation. Embedding the principles of horticultural therapy, common activities could be derived to foster interactions and better population health.

Tapping into the increase in demand for long term care needs, the projected loss of 20ha of Orchid farms can be redirected into community and open spaces near the targeted stakeholders. With the capacity of supporting up to 15,000 participants per day, it complements the nation's target of expanding the long-term care facilities by 2020; introducing 16,200 care places and 17,000 nursing home beds. The increase in demand can be further extended to the untapped 20ha of Orchid farms remaining in the designated agricultural plots.

The lease expiry of farms has long been due since 2017, delayed till 2019 and coming as a surprise to many in 2020. While some farms welcome the move, some the smaller orchid farmers that do not have the capital nor plans struggle to cope. Local orchid and ornamental farms have reflected the need to find a re-evaluate the value proposition of current farming models which are unsustainable in Singapore's agricultural sector.

1. Land Premium

Paying 650% land premium* compared to produce farms.

Orchid & Ornamental Farms

$6, 037.86 /ha/month

Vegetable Farms

$935.25 / ha / month

2. Cost of Relocation & Production Intensification

Consolidation of Orchid farms in 20ha of allocated tranches, all farms are required to rebid.

Need to relocate → Heavy relocation costs Rebuilding from scratch

Lim Chu Kang

Need to Restructure → Cost of new technology

Sungei Tengah

Unable to bid successfully → Major losses incurred from clearing stock of holding capacity.

Cost of clearing and rebuilding the existing systems

To bid successfully, the proposals have to meet minimum productivity levels.

Due to smaller 1-2ha tranches compared to current 3ha tranche sizes.the orchid farms have to intensify due to smaller land area.

3. Competitive & Weakening global demand

Weakening global demand and outcompeted by regional Orchid producers.

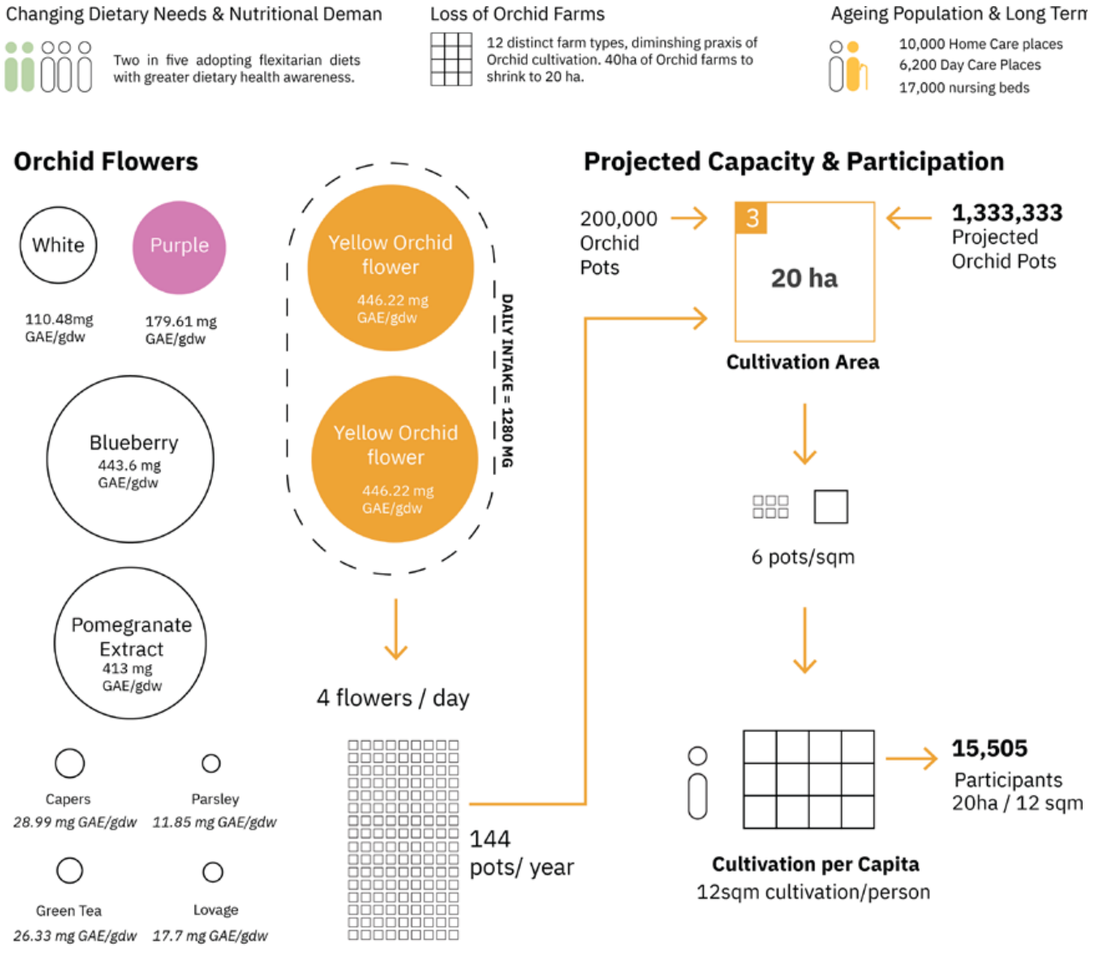
Japan's Imported Orchids
Singapore share: 1.1%
$14.58 per kg

Malaysia share: 8.1%
$12.46 per kg

Thailand: 60.8%
$9.84 per kg

3. Small Local Demand

A local orchid farm revealed that of the 200,000 holding capacity, only 5-10% is used to meet the local demand.



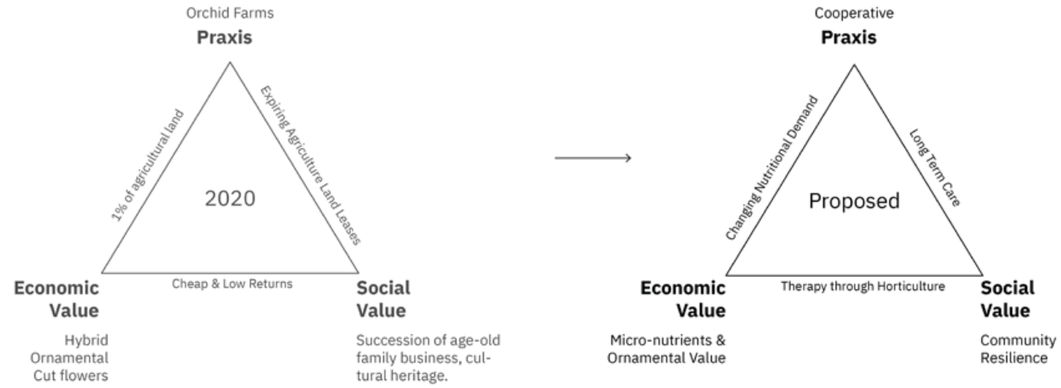


Figure 13. (Left) Orchid Micronutritional benchmark and Participant Capacity

Figure 14. (Above) The Future Praxis

6

Contribution to Knowledge

Praxis of a Cooperative

The praxis of an Orchid Cooperative frees up agricultural land available for the expansion of food production, promoting a multi-use community space that integrates with green and open spaces. This serves as a critique against the conventional single-use master-planning of compartmentalized green and agricultural spaces, promoting the sharing of land as a common pool resource crucial for a land scarce nation.

The social value of Orchids overcomes the status quo of a continued heritage of Singapore to being realized for its value in building wellness and community resilience of the ageing population. Horticultural therapy has been a proven treatment and science where practice is at its infancy in Singapore given the limited community spaces integrated into medical centers and the lack of training. While Orchids have not been listed as one of the flowers for therapeutic gardens, its wealth of uses proposes novel ways of value adding to the programs of horticultural therapy.

The economic value of Orchids will be radically re-evaluated in its post-harvest value chain as a low-cost source of high value micronutrient extract, fueling the development of the nation's "Food 4.0" with the existing Orchid holding capacity, expanding the nation's expertise of Orchid hybridization beyond a socio-political tool. New species of Orchids could be hybridized for nutrition, creating value in intellectual property that can be exported to other countries. This reinforces Singapore's technologically driven strategy while constituting a more equitable allocation of resources in revitalizing the ailing orchid industry.

7

Design Intent

7.1 The Orchid Living Lab

Figure 15. (Folded Right) System of The Cooperative

The praxis of cultivation could be relocated into green and community spaces to engage the locals (Figure 15). By breaking down the value chain, new demand can be generated through the wealth of Orchid in response to the needs and interests of the key institutional stakeholders, the local governing healthcare, food, and environmental bodies.Anchored by three core programs necessary to a long-term care patient's routine; Clinic, Multi-Faith, and Medical Labs, clusters of programs are developed as an extension of sub programs. The cultivation of Orchid as therapy through horticulture is embedded in the activities facilitated by unique clusters through an interdependent relationship.

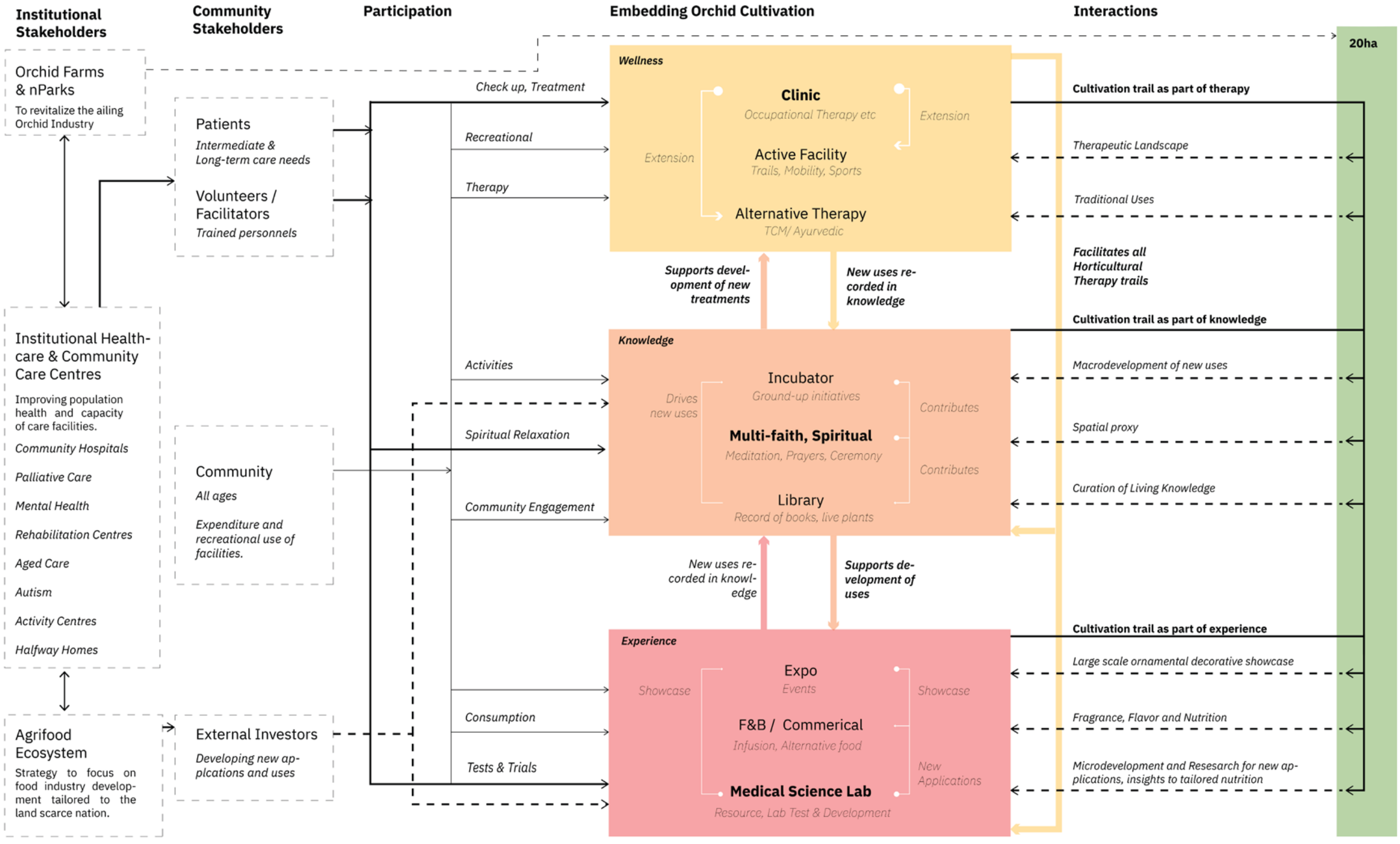
a. Wellness cluster incorporates and facilitates all facets of horticultural therapy as trails into the knowledge and experience cluster.

b. Knowledge cluster stores and collects information of orchid uses as a living repository for the experience and wellness clusters.

c. The Experience cluster showcases the uses of Orchids, bringing in innovation and investments to the facility in developing new uses in the knowledge and wellness clusters.

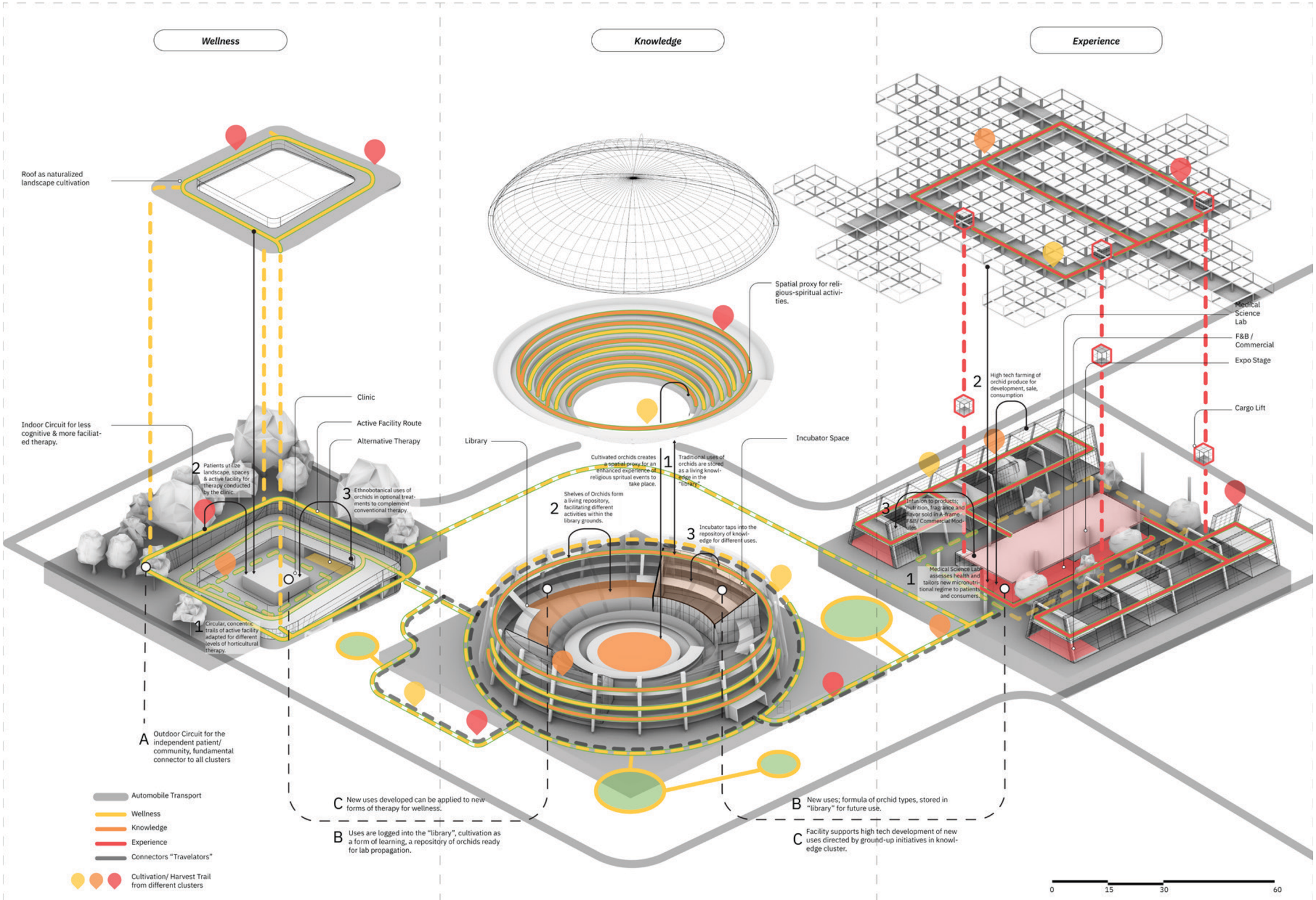
Community stakeholders are invited to participate in the activities across clusters through "trails" that promotes interactions through activities embedded with cultivation processes. New uses and applications are further developed through activities hosted within the facilities, co-producing new spaces with stakeholder and community engagement. Orchids are trimmed regularly before the attack by fungus and insects. The waste is then used to develop new uses in the post-farm gate food industry, deriving nutrition, fragrances and flavors.

In response to meeting changing nutritional demands, and the highly diverse and specific needs of the long term care community, the new products can be used to tailor to their nutritional needs. High value products in cosmetics and supplements can be further developed for profit to fund the facility. Ultimately, the technology and new Orchids hybridized for extraction purposes can be sold as an intellectual property regionally and globally.



System of the Cooperative

Figure 15.



Micro-Macro Scales of Typological Relationships

Figure 17.

7.2 Typological Principles

Based on calculations (Figure 13), approximately 38.7ha of clear movement space will be required (Figure 16), in which the 20ha of Orchid cultivation area has to be either integrated or built on as a second layer based on the degrees of productivity and engagement.

The three clusters take on unique typologies with the key principles of engagement-productivity and way-finding for differing degrees of participant cognitive and mobility abiliites. Within each discrete cluster is a set of programs that establishes a micro-relationship which scales up into a macro-level engagement across the clusters through cultivation trails.

Trails are formed by digitally geolocated orchids (Figure 17), engaging participants of varying abilities and aims to move through different clusters according to a schedule. The trails become the basis on which interactions are forged, a crucial aspect to conditioning better population health and a successful horticultural therapy.

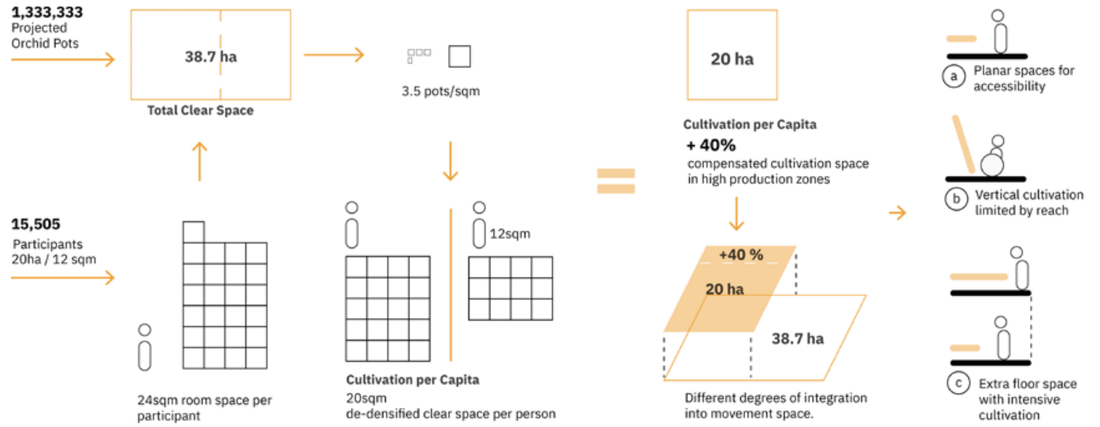


Figure 16. (Right Folded) Spatial Re-scaling & Typo-gological Principles.

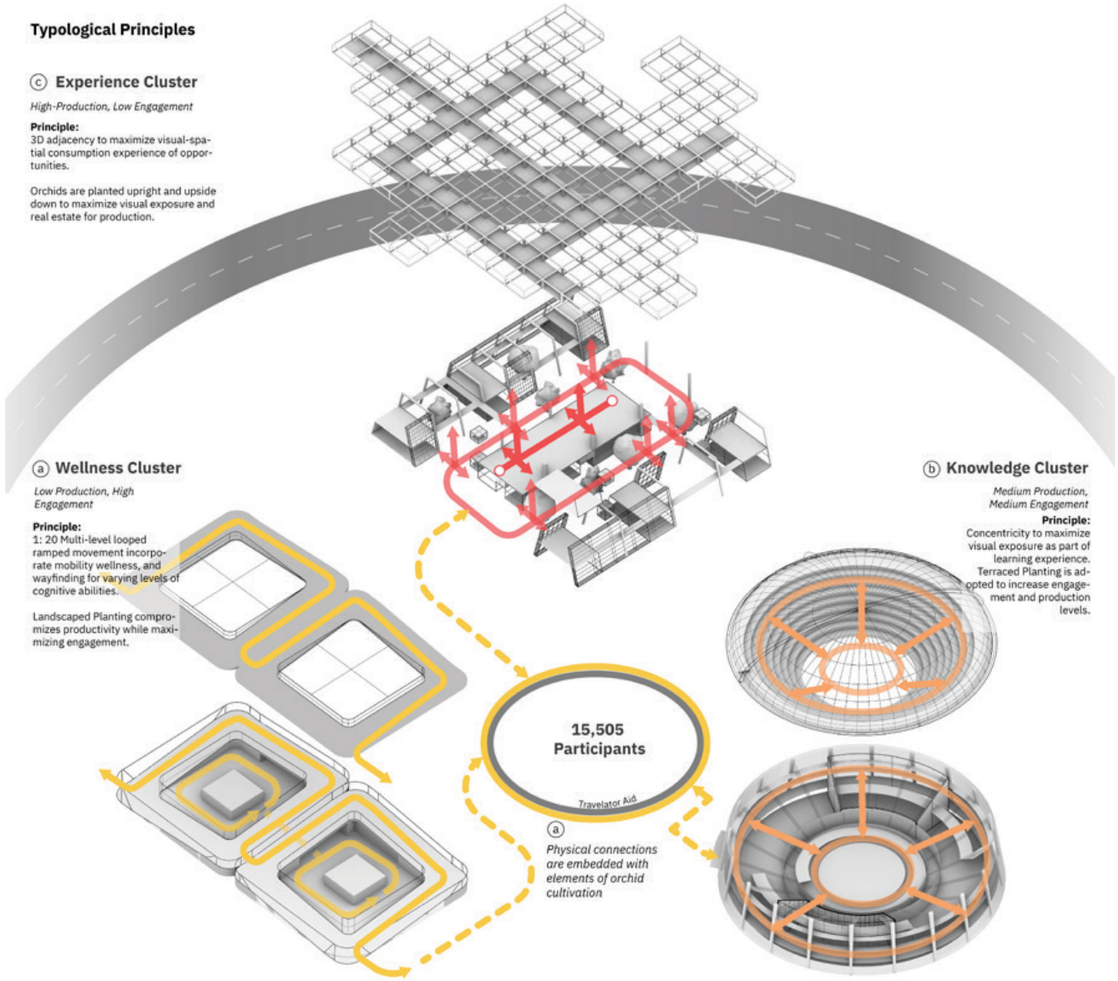
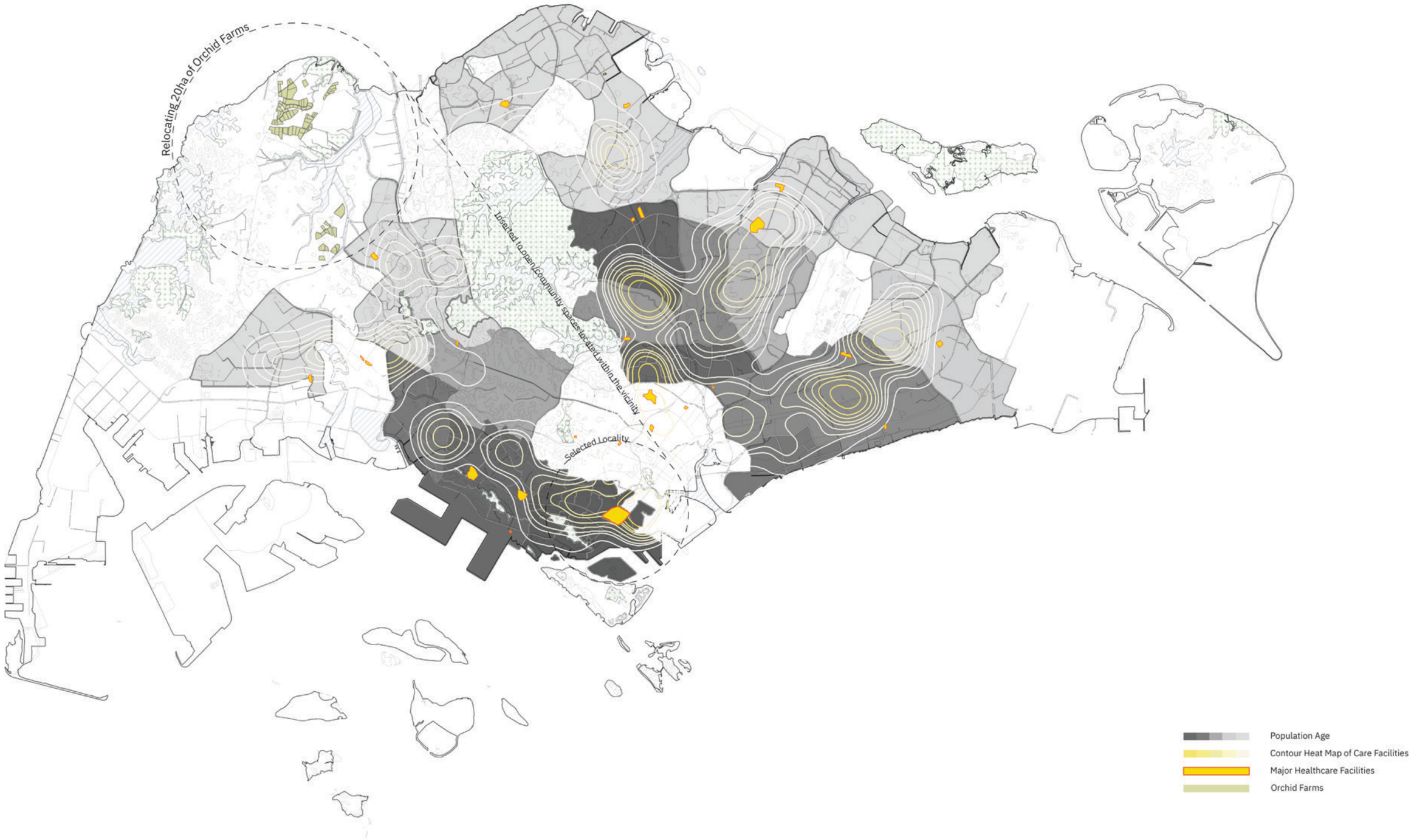


Figure 17. (Left Folded) Micro-Macro Scales of Typological Relationships



Site Selection: Care Facilities & Ageing

Figure 18.

7.3 Site

The region around SGH campus is chosen for the scale of its medical facilities, surrounding aged population and centrality to consumership that will provide the right group of participants and stakeholders (Figure 18, folded left). Key green open spaces and cluster anchoring programs are identified for embedding facilities for orchid cultivation.

The site is characterized by the presence of a green corridor and fragmented green spaces. The locality resides at the juncture of an ageing estate and a highly commericalized heritage district, bringing a confluence of traditions (Figure 19).

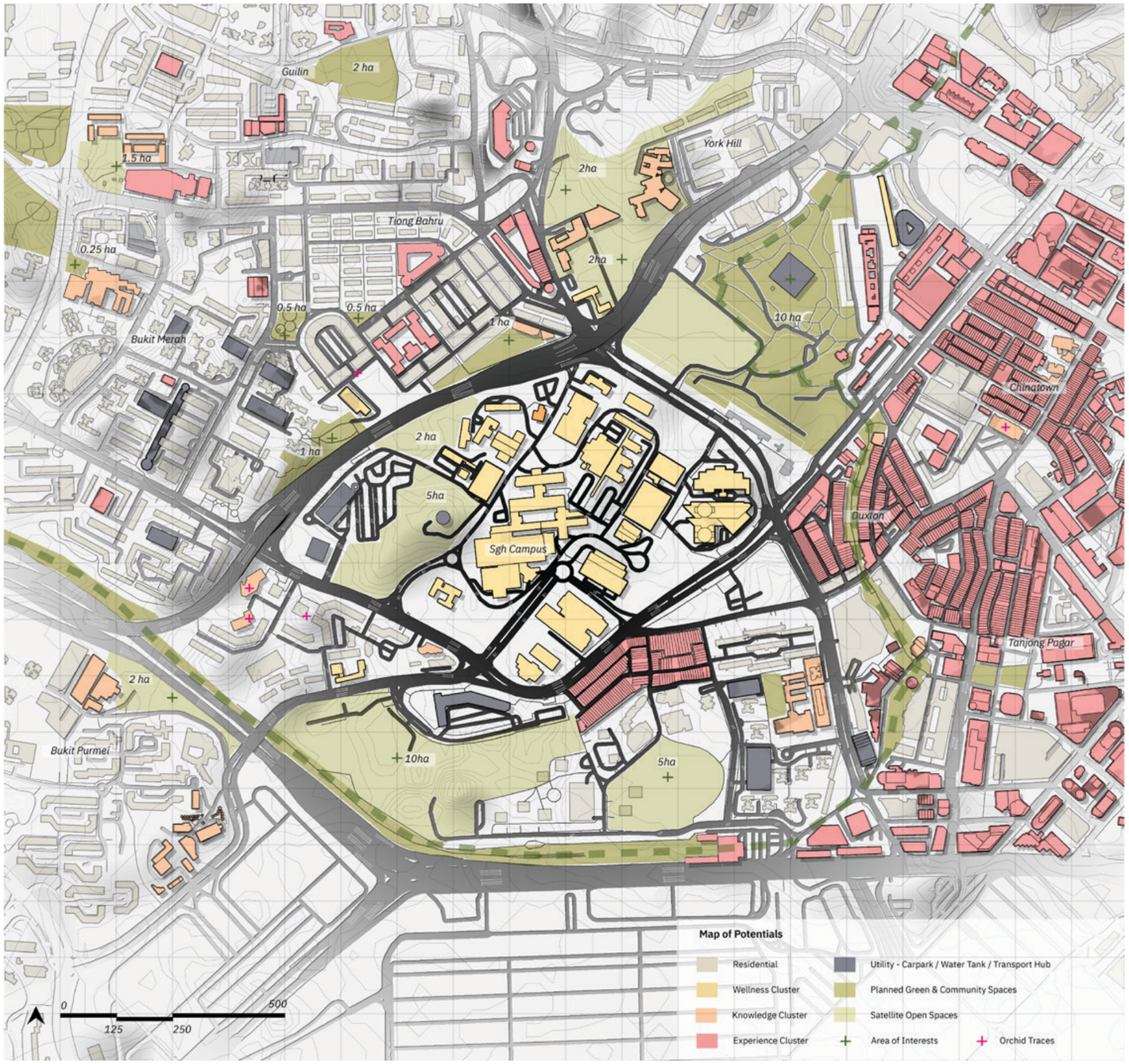
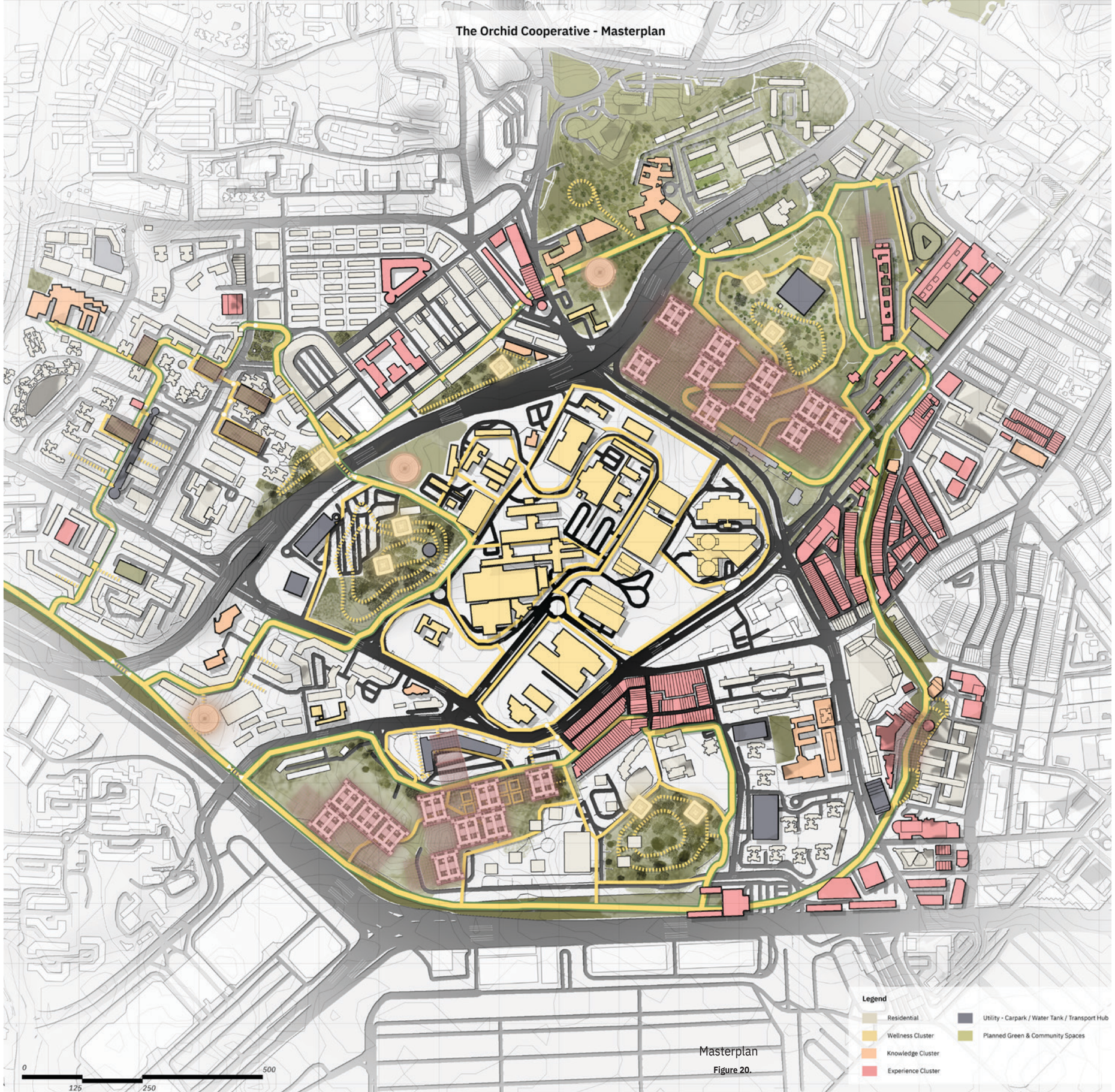
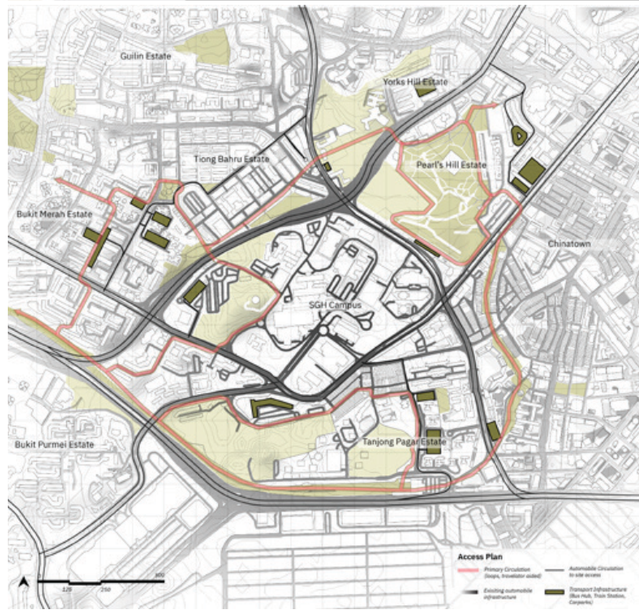


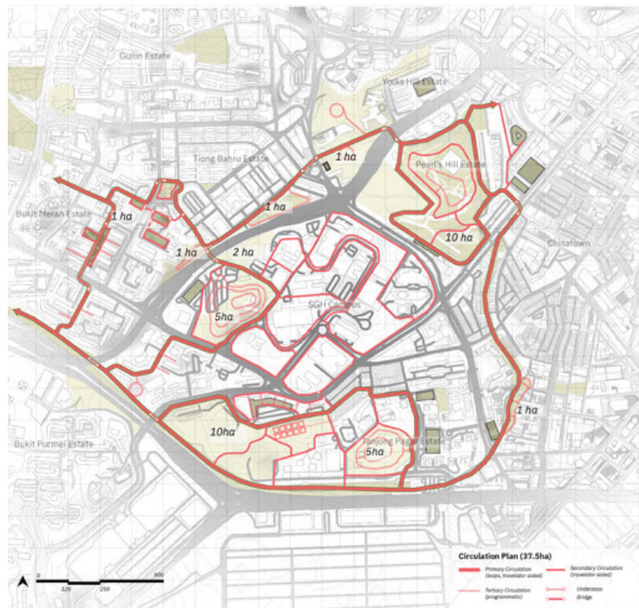
Figure 19. Site Analysis



Masterplan

Figure 20.





7.4 Masterplan

The cooperative imagines a 10km loop that taps into the green corridor, connecting 37.5ha of green open area within the site. The loop is broken down into 3 smaller loops of 2-4km each, reducing the scale of the site while promoting mobility across automobile segregated plots. Key points of automobile and transport accesses are identfied within each loop to ensure strong accessibility.

The wellness cluster emanates outwards from the healthcare cluster, forming the fundamental connectivity throughout the masterplan, extending programmatic facilitation for horticultural therapy as trails. Two key sites; pearl's hill and the open green near tanjong pagar have been identified as high production site with a significantly stronger experiential character. Combined with the influence of adjacent anchoring programs such as schools, places of worship, community, care and medical centres, the green areas serve as sites for typological insertions that will mold according to physical and programmatic conditions.

8

Annex

Figure 21. (Top right) Composition of Farming Grounds

8.1 The agricultural climate amidst food security

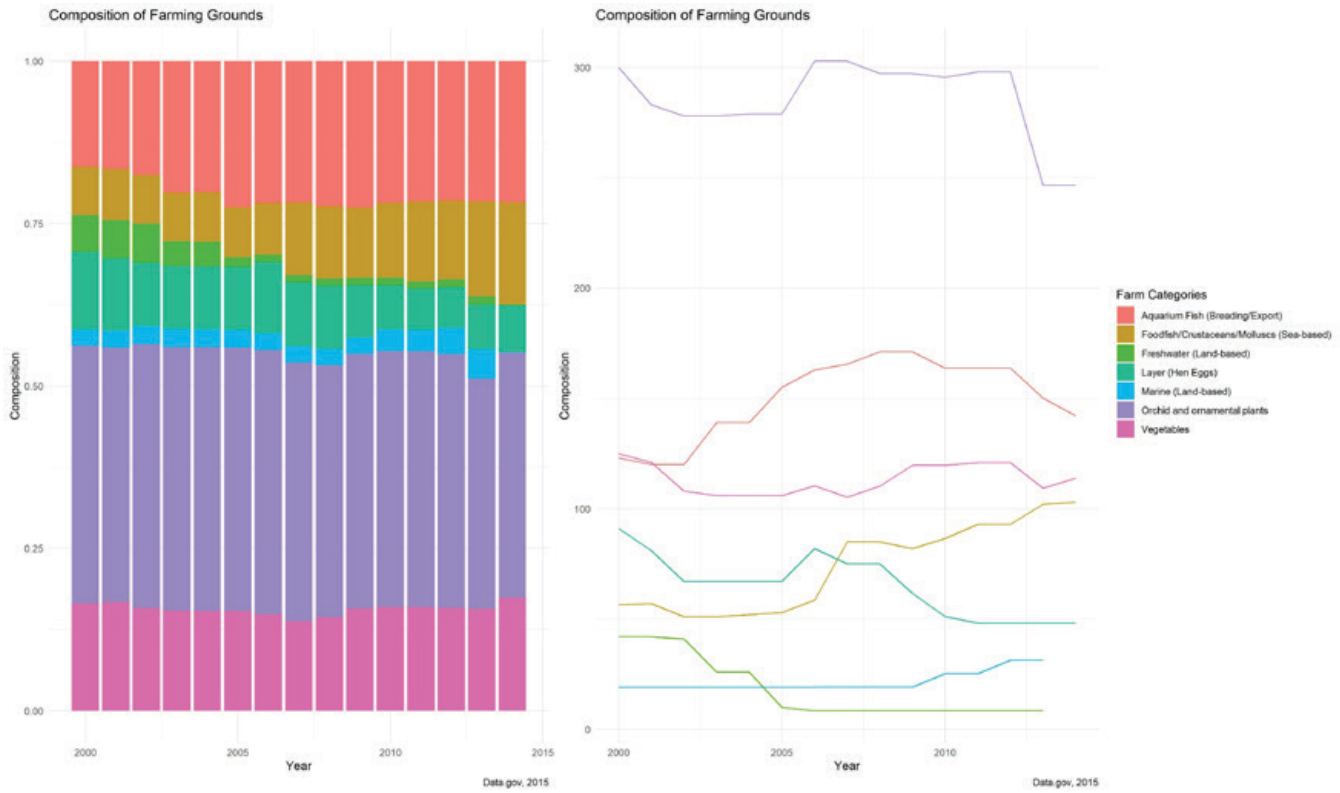
Food security is defined by IFPRI (2020) as "All people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." In response to the projected global demand for food in 2050 by 50% and climate change affecting the supply of food, the potential volatility threatens the nation's sovereignty which is heavily dependent on imports (SFA, 2020). Singapore's three food baskets aim to strengthen the food security by diversifying sources of imports, growing food crops overseas and increasing the local production of the three key food crops to meet 30% of the nutritional demand by 2030.

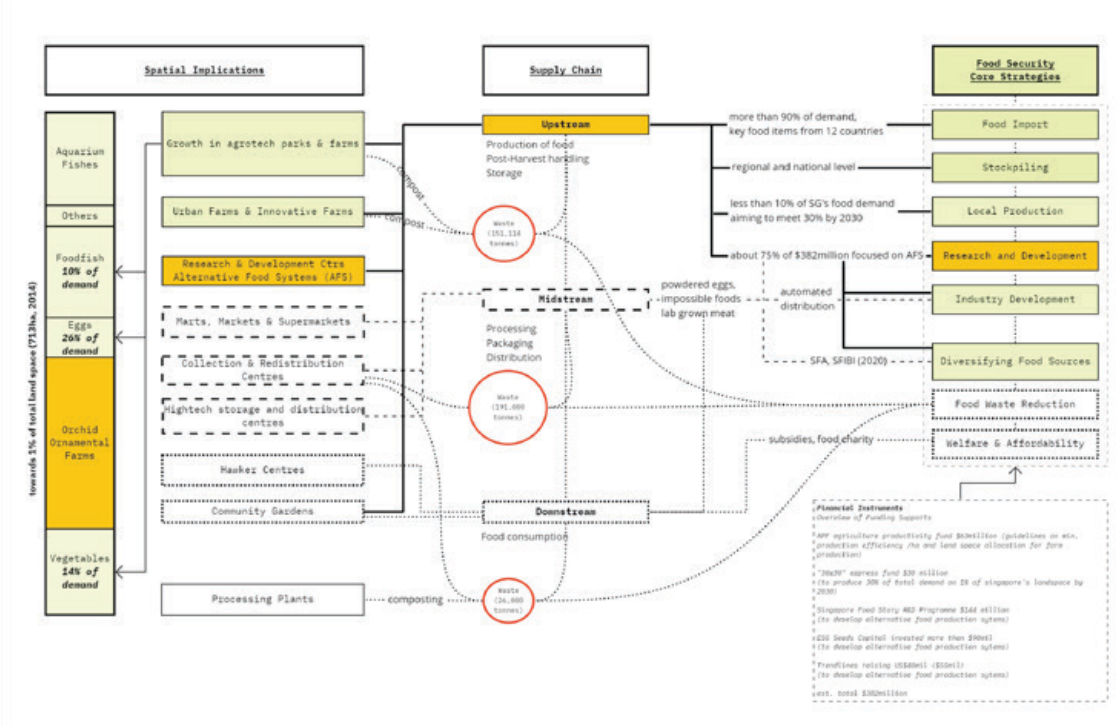
Figure 22. (Bottom right) Singapore Food Supply Chain and Strategy

The strategy involves a key agricultural productivity fund (APF) (AVA, 2014) which aims to incentivize local farms to restructure and intensify agricultural output. Two targets must be met for eligibility and successful tender; the first requires all farms to use at least 90% of farming area for production related activities and the second imposing minimum production levels per hectare. As a result, approximately 143 ha of leafy vegetable farms, 904ha of fish farms and 18.5ha of egg farms will be required for expansion.

Leafy vegetable farms form the strongest competitor for land as egg farms have in place developments of high tech production for intensification, and fish farms have been developing coastal and deep sea farming techniques, as well as satellite farms in Australia and Brunei headed by Barramundi Asia (Chong, 2020) . The recent development of Singapore's 390ha food bowl (Tan & Tan, 2020) will focus on high intensity production of the key food crops within the 390ha of Lim Chu Kang farming grounds, providing more grounds for agricultural food farms to be relocated, consolidated and restructured for high tech farming with outputs far greater than the current standards. The loss of farms are infact beyond just orchid farms, but the other farm types as well given the high level of compartmentalization in the agricultural sectors (). Orchids form the major part of extensive loss that has not been mitigated despite its ailing industry.

The spatial implication of food security is extensive albeit the investments that pale in comparison to the development of food processing industry as illustrated in the diagram(). This presents a fertile opportunity for greater focus on tapping into the growing food industry towards alternative food types in comparison to conventional food options.





30x30 Roadmap
Food Agriculture Expansion

The interests of food security affects the country sovereignty, as 90% of the nation's nutritional demands are met by food imports. Singapore aims to raise local productions to meet 30% of the nation's nutritional demands by 2030; all within 1% of the land space.

Upstream Heavy

Singapore's core strategies are rather invested in the upstream supply chain, driving the growth of agrotech parks and farms.

The expansion of those farms aim to **boost the production of fish, eggs and vegetables**, while **maintaining the total land area of 1% agricultural land space**.

This is only possible through the recomposition of the 12 exclusive farm types within 1% of land space.

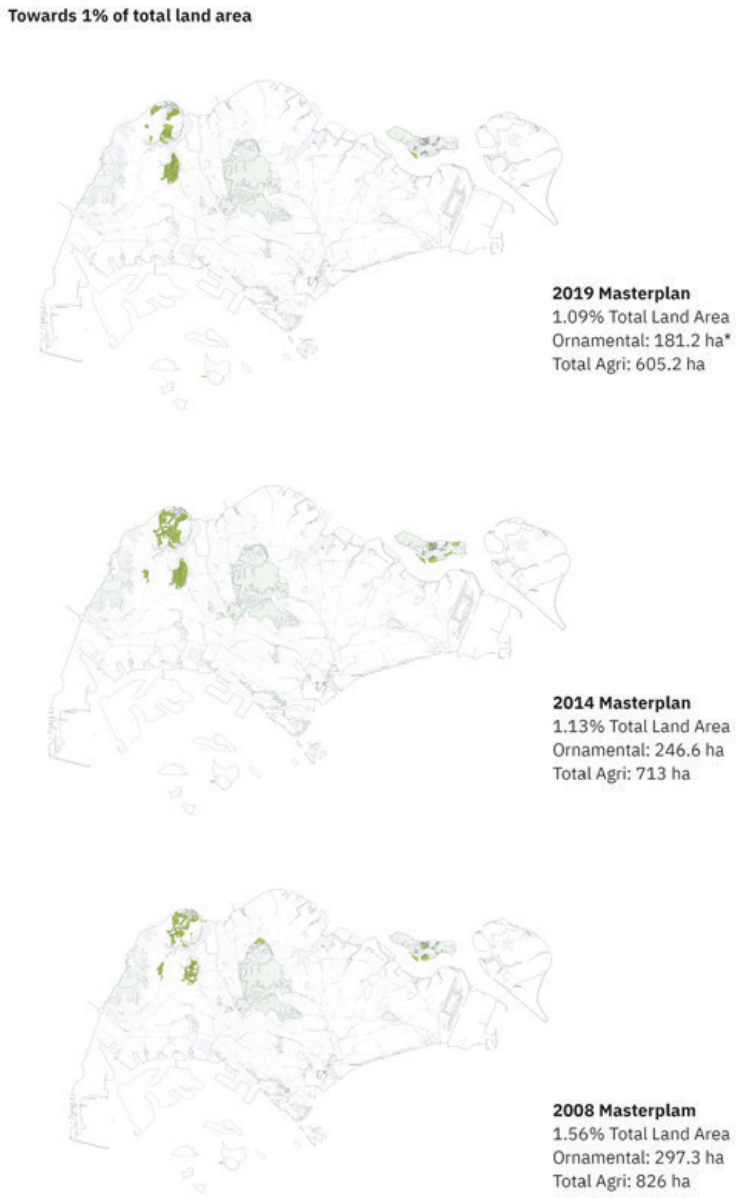


Figure 21. Shrinking agricultural farmland.

The shrinkage of agricultural farmland has become more pronounced over the years in bid to intensify local production while reallocating land for urban uses. Ironically, forest covers were cleared to make way for agricultural land in the 1950s, and now that the nation has shifted away from its agrarian roots, farms are being cleared for other more economically efficient uses. While ornamental and orchid farms do not contribute to the nation's food security in the food production landscape, they indirectly play an important role in conservation of biodiversity against illegal poaching and loss of habitats,

8.2 Orchids and the Global Biome

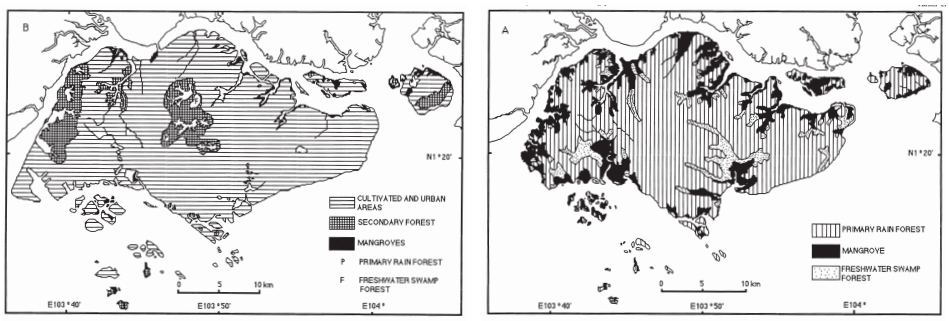
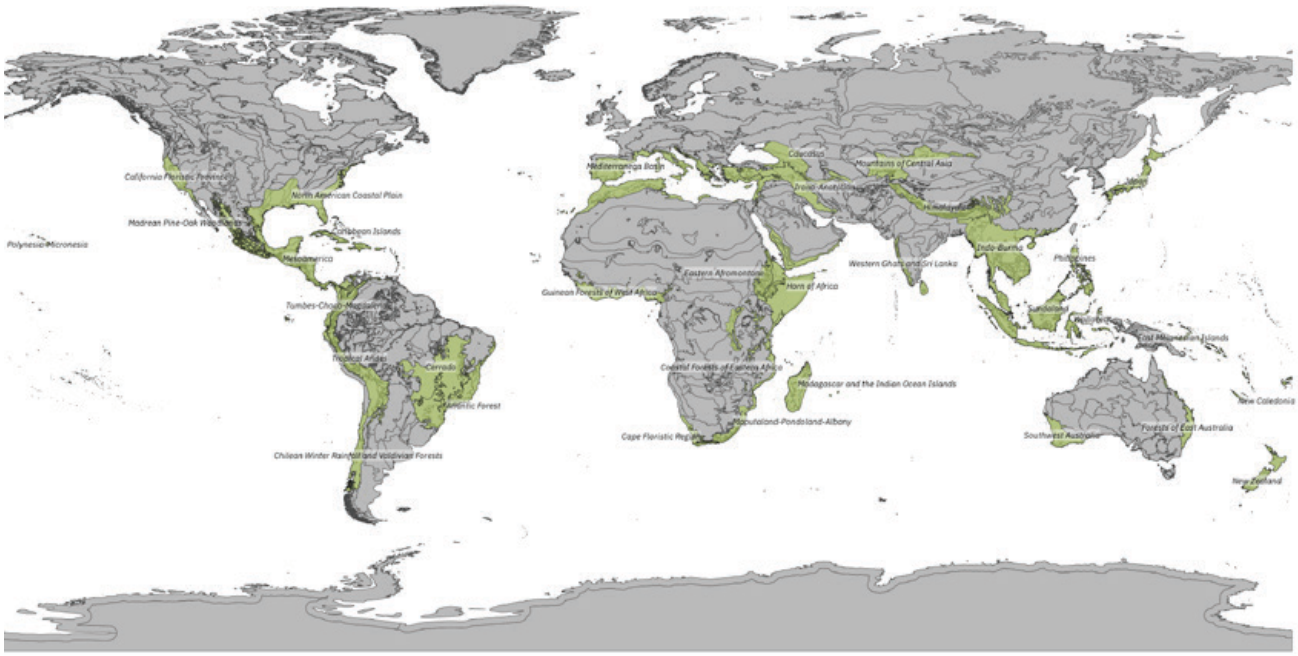


Figure 23. A Study of Plant Species Extinction in Singapore: Lessons for the Conservation of Biodiversity (I.M. Turner Et al., 1994)

Orchid cultivation contributes to a bigger role in the global biome of tropical rainforest diversity. Orchids form the largest family of flora in the world, constituting 22,500 species worldwide, they are highly specific to their ecological biomes. Belonging to one of the 36 biodiversity hot-spots in the world, the nation contributes to 7% of the 3000 species endemic to Sundaland. Being positioned as the second largest exporter of hybrid Orchids in the world contributed indirectly and significantly to conservational efforts of wild orchids endemic to the region. Singapore has lost majority of native Orchid population due to deforestation, but its compactness deters poachers, and the multiple ecological niches makes it suitable for repropagation into the wild. Efforts toward Orchid conservation is a separate effort from the commerical farms, undertaken by Singapore Botanic Gardens.

The praxis of orchid cultivation is by nature a form of ex-situ conservation of species. The lack of in-situ spaces for conservation; natural ecological niches, means that designated green areas and controlled environments are important to conservational efforts in Singapore, especially towards the national interests of a Garden City. This brings an extra importance to the efforts of protecting the praxis of Orchid Cultivation.

Figure 24. (Bottom) 2016 Biodiversity Hotspots Critical Ecosystem Partnership Fund, Conservation International



Estimated Phenolic Content of Orchids - Number of Orchid flowers per serving				
Polyphenolic Content (PPC) of Orchids (Nguyen, et al., 2018) per gram dry weight	POMI-T (Polyphenolic Supplement) Recommended Consumption 2 servings	Estimated dry weight of Orchids required per day	Dry weight of small Orchid flower (estimated by drying overnight at 60deg) Refer to Annex A	**Estimated number of Orchid flowers per serving**
	2 * 640mg Tablets	1280 / PPC	Wet weight 2g	
446.22mgGAE/gdw	~1280mgGAE of polyphenols/day	2.86gdw/ day	>1g	4 / day

Surplus Capacity for Harvest from 20ha of Orchid farms					
Total Capacity (holding capacity 200 000 pots per 3 ha)	Number of plantlets (planned 3 years in advance, 20% of farm stock)	Pots sold per year (replenished by pre-planned stock)	Pots for cut orchids	Pots harvested for cut orchids (10% of stock)	Surplus Capacity Pots for cut Orchids
X = 200 000/3 * 20ha	0.2 * X	Y = (0.2 * x)/3	X – Y	(x-y)*0.1	Z = (x-y)*0.9
1 333 333 pots	266, 666 pots	88, 888 pots	1 244 445 pots	124, 444 pots	1 120 000 pots

Estimated Facility Daily Capacity				
Harvest Surplus per month (flowers last for a month, blooms twice a year)	Flowers per month Assuming (10 sprays on avg)	POMI-T Benchmark (4 flowers per person per month)	Visitors per day (assuming each visitor eats one pill per day)	**20 ha of orchid cultivation supports 15,000 participants per day**
z/6	N = 186 666 * 10	P = N /4	V= p/30	Total Clear Area Per ~ 25sqm / participant (HF Today, 2017)
186 666 pots/ month	1 860 666 sprays/ month	465 166ppl per month	15,505 ppl Per day	25*15 000 = 37.5 ha

Participant : Cultivation Ratio			
Holding density 200,000 pots/3ha	Consumption per person/day (POMI-T Benchmark)	Area Cultivation/ Person (flowers last for a month, blooms twice a year, 6 pots per sqm)	**In a high productivity zone, each participant requires 12sqm of cultivation space per year**.
200 000/30 000sqm	4 flowers /day/person	144 pots/ year/person	
6 pots per sqm	1440 flowers/ year/person	144/12 = 12sqm/ year/ person	

Participant : Cultivation Ratio			
Total clear area required for 15,000 participants	Adjust holding density	Area Cultivation/ Person (flowers last for a month, blooms twice a year, 6 pots per sqm)	**In a low productivity zone, each patient participant requires 20sqm of cultivation space per year**.
~ 25sqm / participant (HF Today, 2017)	1,333,333 pots / 37.5ha	144 pots/ year/person	
15,000*250 = 37.5ha	3.5pots/sqm	144/2/3.5 = 20sqm/ year/ person	

8.3 Orchid Micronutritional Calculation & Cut Flower Trade

Extensive benchmarking of orchid polyphenolic content using gaellic acid equivalent was carried out against other various food types and extracts.

Figure 25. (Left) Orchid Micronutrition Working Calculations

Table 1

Total phenolics, flavonoids, and proanthocyanidins contents of fruit extracts

Fruit extracts	Total phenolics (mg GAE/g)	Total flavonoids (mg QE/g)	Total proanthocyanidins (mg GAE/g)
Blueberry	443.6±17^{a}	151.7±1.1	1589.6±24.3
Jackfruit	411.5±11.2^{ab}	0.24±0.02	39±2.3
Blackberry	269.5±16^{c}	56.7±0.2	763.2±2.8
Black raspberry	965.6±2.9	186.4±2	2677±71.1
Red raspberry	434.3±6.3^{ab}	114.5±2	946.9±32.3
Strawberry	250.1±17.1^{c}	22±1^{f}	488.9±14.2*
California table grape	398.9±22.2^{b}	25±0.2^{f}	378.9±6.8*

Results represent means±SD of three experiments. In each column, mean values with no superscript letters are significantly different from each other at $P \leq 0.01$; mean values with * are significantly different from each other at $P \leq 0.05$; mean values with same superscript letters are not significantly different (Tukey's test). GAE: Gallic acid equivalents; QE: Quercetin equivalents; SD: Standard deviation

Figure 26. Benchmarks retrieved from In vitro Antioxidant Activities and Polyphenol Contents of Seven Commercially Available Fruits (Basu P & Maier C., 2016)

Table 2.

Total polyphenols (TP; mg/100 g)* in foods and beverages (Mean values and standard deviations)

	Mean	SD
Vegetables and potatoes		
Red pepper	448·6	173·0
Dried laver seaweed	204·0	58·9
Parsley	156·8	23·5
Ginger	80·0	12·6
Burdock	49·3	9·3
Green chives	48·4	20·3
Onions	46·5	11·0
Spinach	41·6	13·7
Araceous	35·5	26·1
Broccoli	35·2	8·5
Green onions	32·5	15·6
Egg plant	30·7	2·8
Japanese mustard spinach	18·5	4·4
Sweet potatoes	17·7	6·1
Welsh onions	15·0	12·6
Radishes	13·2	10·6
Maize	13·2	11·5
Bamboo shoots	11·7	9·3
Green pepper	11·7	10·9
Bean sprouts	6·5	4·6
Tomatoes	5·8	6·7
Pumpkin	5·4	5·1
Cabbage	5·1	3·5
Chinese cabbage	4·5	3·1
Celery	3·6	3·1
Potatoes	<0·1	
Cucumber	<0·1	
Cucumber	<0·1	
Carrots	<0·1	
Lettuce	<0·1	
Yams	<0·1	
Konjak	<0·1	
Fruits		
Prunes (dried)	238·7	59·8
Strawberries	100·3	23·1
Sour plums	56·7	13·1
Grapefruit	55·6	4·2
Oranges	54·9	6·3
Bananas	19·2	6·8
Grapes	11·7	13·3
Persimmon	10·3	7·5
Apples	4·8	1·8
Pears	4·3	3·1
Melon	2·4	2·7
Cereals and noodles†		
Buckwheat noodles	110·7	20·3
Pasta (dry weight converted)*	37·8	8·1
Wheat	36·8	7·9
Bread	28·4	17·9
Brown rice	25·9	8·4
Chinese noodles*	15·0	3·2
Udon noodles*	10·7	2·3
White rice	0·8	1·1
Beans and seeds		
Sesame	298·4	151·0
Almonds	266·9	224·1
Natto	114·4	41·1

Figure 27. Benchmarks retrieved from Coffee and beverages are the major contributors to polyphenol consumption from food and beverages in Japanese middle-aged women (Fukushima Y, et al., 2014)

Commerical Applications

REDavid Orchid oil is one of the commercially available products that promotes and reaffirms the project the health benefits that can be reaped from Orchids. The company uses steam extraction to retain a high-grade pure concetration of oil from Cymbidium orchids. Cymbidium Orchids are one of the most commonly found orchid species in the cut flower market, thus easily accessible.

Orchids are relatively more widely used for its scents, as with the encyclopedia of Orchids published by Singapore-Memories. The extraction for scents remain an area of high expertise requiring biochemical practical skills. This reinforces the scope of the project to first remain in the micro-nutritional content of orchids for objective criteria in nutrition compared to scents which remains highly subjective. The existing technology that supports extraction of orchid oil can be further explored in the project to situate the right facilities within the design.

Global Cut Flower Trade

Singapore's fresh cut orchids has a global presence (Figure 28) despite being more expensive. Combined with the minute global share (figure 29), it supports the local fact that the export industry is heavily dependent on the novelty of Orchid flowers over its trade volume. This serves as a crucial insight to how the authorities should revitalize the ailing industry by assessing the untapped values of orchids over its existing ornamental quality that is facing a decline in demand.

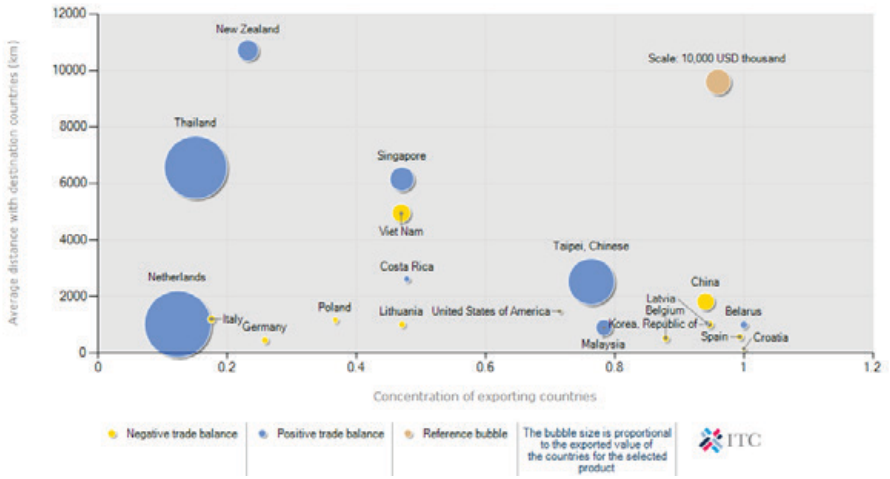


Figure 28. Most Travelled Orchids (ITC, 2020)

Figure 29. Global Trade Partners and Share (ITC,2020)

8.4 Interviews

Interview A (Site Visit)

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Q: How long have you been cultivating orchids and how is the current outlook of the business?

A: I took over with 10years left on the lease, succeeding a family business. The farm leases used to be 20-23 years long, but the new leases are shorter and more expensive. I have 2-3ha land here, and about 6ha In Johor. The recent Covid-19 events has affected our demand by more than 90%.

Q: How is the demand then on average before Covid-19?

A: About 5% of the stocks goes out, and in good season around 10%. Because we cater to a local market, our peak seasons are during Chinese New Year festivities and perhaps stronger demand from changi airport and gardens by the bay.

Q: Is there a lot of unharvested orchids thrown away?

A: Yes, substantial number of orchids are thrown away to prevent pest and fungi attacks.

Q: What are your plans for the cultivation of Orchids since you'll have to move out by the end of 2021?

A: We do not have any plans now as the orchid farms take a high cost of capital to set up and tear down. I have been to some of the new tender biddings, but they cater mainly to food farming, and maybe only a few are for ornamental farming. Honestly, it seems like the government does not want us to farm in Singapore and told us frankly to move to the neighbouring region to set up larger farms at cheaper costs.

Q: What about vertical farming? What future do you see in that?

A: Vertical farming is possible, and the most advanced farming system we have here is indoor farming. But the lack of local demand, and the matured, shrinking global market for orchids does not require us to further intensify production. It is not about how much you can produce but what do you produce for. I make very little profit turnover here due to the extremely competitive prices around us, and the demand is rather low as well.

Q: Where do you get your orchids? Do you hybridize?

A: We purchase our plantlets and do not hybridize as it has a very high overhead cost, not all the farms can afford it. The germination cycle is long, spans from 2-3 years from seedlings to a mature flower, and that is affected by the short 10year leases that we are now offered.

Figure 30. High tech Orchid Farming

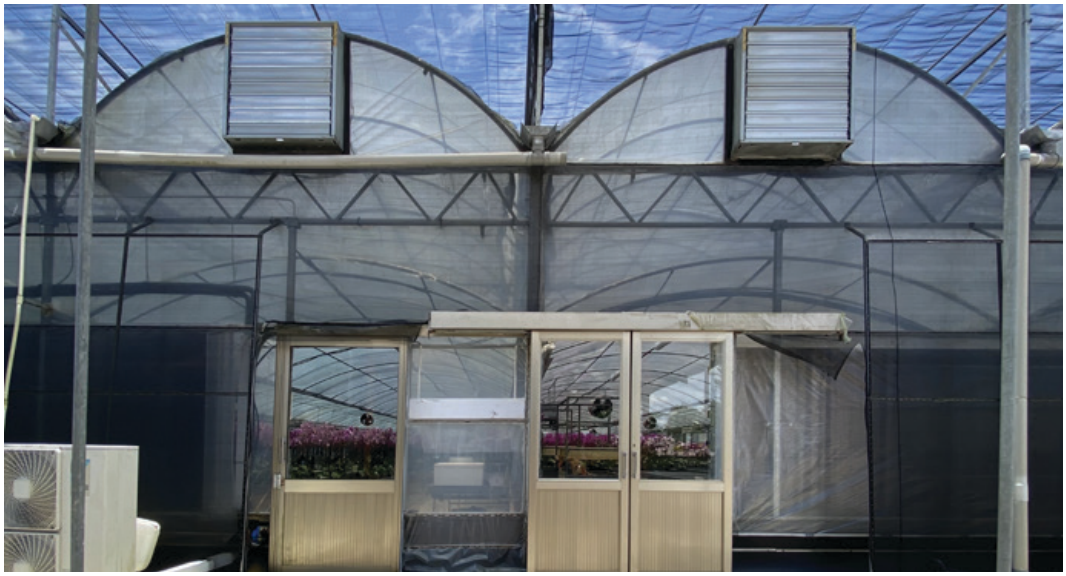

Figure 31. White Sogo Yukidian V3 Phalaenopsis as calculated in Orchid Micronutritional Content (Ngyuen Et. al., 2018)

Figure 32. Air Moisture Control System.

Interview B (Phone Call Interview)

Q: Can the resources from the hybrids bred in nParks be shared for other purposes?

A: The VIP Hybrids are under the jurisdiction of MFA and the strains cannot be sold for other purposes.

Q: How would you view the feasibility of using Orchids as an alternative food source?

A: It depends on the economic returns in the harvest as it takes many years for the orchids to grow, it might not be feasible. Even if it is about the orchid extracts to be used as additives, you have to find out what exactly do you want to extract. For Singapore, the orchid industry focuses in horticulture, no one grow orchids as a source of food. In addition, cultivation of orchids do involve a large amount of pesticide and fungicides which could pose as health threats for human consumption.

Q: What are the role of local farms in the local and regional conservation? Research has shown that orchid farms contribute to the trade of hybrids that indirectly alleviates the pressure on wild orchid trades.

A: Orchid trade in the region is rather big, and the contribution by Singapore's orchid farms is not as significant as before. Orchid farms do propagate species orchids and hence indirectly alleviate the pressure on wild orchid trades.

Q: Do the Orchid farms help out with conservation out of their own interests, or is it part of an agreement?

A: You will have to visit and interview the Orchid farms. They helped us to grow some species in the past but we are no longer doing that.

Q: Do you have the numbers on the agreements between farms and nParks for that matter? How reliant are nParks on the farms, is it an occasional agreement or is it a heavy reliance?

A: I am not aware of such agreements. Some of the plants displayed at the National Orchid Garden are provided by local nurseries.

Q: What is the future of the farms that will be relocated? How does Singapore envision the new Orchid industry?

A: I do not have any information on that. Each orchid farm is unique, every farm has to come up with a viable business plan in order to thrive in the business.

Q: Is the National Orchid Garden considered part of the nursery? I tried to find them at Botanic Gardens but I could seem to do so.

A: The nursery is closed to the public behind the national orchid garden. The NOG is an exhibition space. You should visit the orchid nurseries in Singapore to have a better understanding of what they are like and how Orchids are grown.

Interview C (Email Exchange)

F

S

To: For

Subject: Re: Architectural Thesis on Singapore's Orchid Farms

- External Email -

Hi Shi Yuan,

That's a lot of questions.
I'll need some time to reply to them.
I will need to go through them this weekend.
Thank you for the anonymous representation.
I will try to point you to public data available with regards to information to ensure that data discussed are authentic for your thesis.

With regards to point 2 and 3.
The monthly rate offered by NParks which is a stark difference from the vegetable farm rates is below.
The 28 plots of vegetable farms successfully tendered and taken currently averages at $935.25/hectare/month. (Data from SFA Website, 1 data point omitted as plot was given up)
https://www.sfa.gov.sg/food-farming/farm-land-sales/tender-results

	Land Parcel & Location	Lot No. /Mk No.	Land Area (sqm)	Tenure	Successful Tenderer	Price (excluding GST) ($)	Price/hectare /month	Remarks
1	LCK 218 at Neo Tiew Harvest Lane	Lot 1815W /MK12	20,167.00	20 years	FARM DELIGHT PTE. LTD. AND KG FARM PTE. LTD.	288,000.00	595.03	
2	LCK 220 at Neo Tiew Harvest Link	Lot 1817P /MK12	20,251.50	20 years	VERTIVEGIES PTE. LTD.	279,000.00	574.03	
3	LCK 221 at Neo Tiew Harvest Link	Lot 1818T /MK12	20,250.60	20 years	SUNPOWER GRAND HOLDINGS PTE LTD	291,000.00	598.75	
4	LCK 222 at Neo Tiew Harvest Lane	Lot 1819A /MK12	21,239.90	20 years	SHARON GOH SWEE HOON AND TEO HWA KOK	317,000.00	621.86	
5	LCK 223 at Neo Tiew Harvest Lane	Lot 1820P /MK12	20,208.70	20 years	KESHET AGRITECH PTE. LTD.	277,000.00	571.12	
6	LCK 225 at Neo Tiew Harvest Lane	Lot 1822A /MK12	20,083.00	20 years	A YONG PTE LTD AND TAN TECK TIANG AND VEGEASIA SDN BHD	274,000.00	568.47	
7	LCK 226 at Neo Tiew Harvest Place	Lot 1823K /MK12	20,987.50	20 years	EDEN GARDEN FARM PTE. LTD.	298,000.00	591.62	
8	LCK 230 at Neo Tiew Harvest Lane	Lot 1827C /MK12	20,309.80	20 years	MEOD PTE LTD	280,000.00	574.44	
9	LCK 231 at Neo Tiew Harvest Lane	Lot 1828M /MK12	20,050.40	20 years	MEOD PTE LTD	273,000.00	567.32	
10	LCK 232 at Neo Tiew Harvest Lane	Lot 1829W /MK12	20,428.80	20 years	MEOD PTE LTD	283,000.00	577.21	
11	LCK 70A at Neo Tiew Crescent	Lot 1854K /MK12	15,575.00	20 years	BLUE AQUA INTERNATIONAL PTE. LTD.	378,000.00	1,011.24	
12	LCK 70B at Neo Tiew Crescent	Lot 1853A /MK12	15,574.90	20 years	APOLLO AQUARIUM PTE LTD	378,000.00	1,011.24	
13	LCK 173 at Neo Tiew Crescent	Lot 1890X /MK12	23,961.20	20 years	APOLLO AQUARIUM PTE LTD	587,000.00	1,020.75	
14	ST 35A at Sungei Tengah Road	Lot 3688C /MK11	11,917.10	20 years	OPAL RESOURCES PTE LTD	432,100.00	1,510.78	Data omitted as the plot was given up and reopened for Public Tender recently.
15	ST 76A at Jalan Lekar	Lot 3645W /MK11	11,024.80	20 years	EUTH PTE LTD	509,000.00	1,923.69	
16	ST 76B at Jalan Lekar	Lot 3646V /MK11	11,024.70	20 years	AQUARIUM IWARNA PTE LTD	533,000.00	2,014.42	
17	LCK 176A at Neo Tiew Lane 2	Lot 1940P /MK12	20,117.80	20 years	YILI VEGETATION & TRADING PTE LTD	335,000.00	693.83	
18	LCK 176B at Neo Tiew Lane 2	Lot 1941T /MK12	20,117.70	20 years	YILI VEGETATION & TRADING PTE LTD	335,000.00	693.83	
19	LCK 176C at Neo Tiew Lane 2	Lot 1942A /MK12	20,118.20	20 years	YILI VEGETATION & TRADING PTE LTD	335,000.00	693.82	
20	LCK 219 at Neo Tiew Harvest Lane	Lot 1816V /MK12	20,500.20	20 years	KOK FAH TECHNOLOGY FARM PTE LTD	347,000.00	705.28	
21	LCK 224 at Neo Tiew Harvest Lane	Lot 1821T /MK12	20,250.10	20 years	LIVFRESH PTE LTD AND DELISH VEGGIES LLP	339,000.00	697.53	
22	LCK 114A at Neo Tiew Crescent	Lot 1938T /MK12	16,468.70	20 years	CHI AGRI HOLDING PTE LTD	494,000.00	1,249.85	
23	LCK 114B at Neo Tiew Crescent	Lot 1939A /MK12	16,096.30	20 years	N & N AGRICULTURE PTE LTD	483,000.00	1,250.29	
24	ST 28A at Sungei Tengah Road	Lot 3739K /MK11	6,426.50	20 years	SER POH FARMING & TRADING ENTERPRISE PTE LTD	172,000.00	1,115.17	
25	ST 28B at Sungei Tengah Road	Lot 3740T /MK11	6,208.50	20 years	SER POH FARMING & TRADING ENTERPRISE PTE LTD	162,000.00	1,087.22	
26	ST 28E at Sungei Tengah Road	Lot 3748W /MK11	6,225.30	20 years	BEAN FARM PTE LTD	163,000.00	1,090.98	
27	ST 28F at Sungei Tengah Road	Lot 3749V /MK11	7,811.90	20 years	BEAN FARM PTE LTD	237,000.00	1,264.10	
28	LCK 226 at Neo Tiew Harvest Place	Lot 1823K /MK12	20,987.50	20 years	LITELEAF PTE LTD	373,000.00	740.52	
29	LCK 114D at Neo Tiew Crescent	Lot 1937P /MK12	10,000.00	20 years	HAY DAIRIES PTE LTD	500,000.00	2,083.33	

Based on the 2 plots offered below, the rates that NParks recommended is at $6,037.86/hectare/month and $6,158.26/hectare/month. (Data from GeBiz Website)
From what we know now, there's about a 650% difference in NPark's recommended premiums vs open tender data.

Tranche 15. Orchid Nursery Tender on GeBiz.

Key Tender Information

Plot	2.10	5.3
Est. Total Land Size	17,519.3 sqm	14,606.7 sqm
Guide Rent (excl. GST)	S$10,577.91	S$8,995.18
Total Area to be put to Production Use	• 90% of the maximum buildable area* shall be put to production use (i.e. planting / pond / waterbody / soil works / circulation space). ** Buildable area = Total Land Size, minus land required for Green Buffer & Peripheral Planting Verge*	
Maximum area for Ancillary use (10%)	Of this, there are specific GFA caps for: • Worker's quarters (max 30 sqm) • F&B / retail (incl. Outdoor Refreshment Areas) (max 200 sqm) • Visitor Centre (max 200 sqm) • Office (max 80 sqm) • Planting media storage (100sqm)	

NParks - Restricted 5

As agriculture farm rates have always been closely similar for the past decades, the existing orchid farms think that there's something wrong with NParks valuation of agricultural land.
One of the orchid farms in Lim Chu Kang also informed us in the previous year, they tendered for an orchid plot at $2000/hectare/month on public open tender last year.
The tendered rate is about 214% of the average data above.
Being the sole tenderer, they thought that they would have won the bid.
However NParks closed up the tender with any award after the tender exercise.

Being orchid farms, we have little knowledge and would like to find out more about how agriculture land is valued or how lease premiums are priced.
Is there any advice that you can provide us on how to find out more information on this ourselves?
And in this case, where we find a very large deviation, is there anything that we can or should do to ensure a fairer valuation?
The existing orchid farms are very curious and stressed about this and felt something is amiss here.

In recent tenders, NParks also wasn't transparent and hid public tender data away from the public by using a $1.00 bid.

The rates that NParks recommended seems to be more for other uses rather than agriculture production.
From what I know, some of the orchid farms have already approached Ministers with regards to some of these issues.

Thank you.
--
Best Regards,

ong Shi Yuan <e0036860@u.nus.edu> wrote:

> Thank you so much for your extremely detailed and insightful reply, no worries regarding the late reply as I understand that it is a very long list of questions. I am still in the midst of putting together information from different parties; nParks, other orchid farms and a potential food science professor in NUS. All the information that I gather will strictly be confidential and represented anonymously. I will have to apologize if I do/have unintentionally create any form of misunderstanding or confusion as the thesis is still developing as an academic research. I hope our correspondence will bring an added value beyond academia to industrial applications!
>
> Regarding the recent coverage by media and students

I have a few questions in response to your email:

1. The collaboration between with the Japanese craftsman and the polytechnic, did they use the orchids that were discarded or were the orchids harvested specifically for the craft purposes?

2. The 650% lease premium is ridiculously high, I did not know about that. To clarify, am I right to understand that the lease premium is an effective increase in cost due to the difference in lease duration i.e. 3-10 years vs 20years and not that the price of land for Orchid farming is 6.5x that of vegetable farming.

3. What is the current land cost that has been released for tendering? How is it calculated?

4. If the primary production refers to nursery and tertiary refers to landscaping, is it right to infer that the secondary refers to the florists?

5. In terms of B2B, is Toh Gardens heavily reliant on export market or local market?

6. As of now, what is the area of Toh Gardens and the entire holding capacity? How much is harvested to meet the demand?

7. Another farm reflected that less than 5% of the current holding capacity is used to meet the local demand. I understand that large quantities need to accommodate the low and high flowering season, how would you comment on the current demand supply situation in your farm?

8. Given the current capacity of the farm, how much more demand can it sustain?

9. What is the price range of cut Orchids?

10. As you mentioned 2 years ago, nparks did intervene with plans intending to revitalize the orchid industry and the papers did publish their effort in creating hybrids for the local farms. However, there has been no media follow up since then. Has nParks stopped their involvement with the local farms, if yes what made them do so? Is that one of the reasons why there is a lab set up for in-house hybridisation purposes?

11. I have also learnt that nParks used to enlist the farms' help to cultivate hybrids for repropagation of Orchids back into the wild. They are important to the global biodiversity being the most important CITES listed plant species. What is your view in the involvement with the local biodiversity?

12. You mentioned the factor of novelty in orchid attracting tourists, that would mean that Singapore has the most advanced technology and skills for hybridising orchids regionally? Since the hybridised orchids are seen nowhere else in the world and the climatic factor is important for the Orchid to survive.

Once again, thank you so much for your effort and response, it did help me immensely in further developing my thesis. And as I have mentioned, I will keep you posted on the updates regarding the feasibility of orchids in food production. If you wish to, you can reach me at 97275602!

Well wishes,

Shi Yuan

From:
Sent: \
To: Fong Shi Yuan <e0036860@u.nus.edu>
Subject: Re: Architectural Thesis on Singapore's Orchid Farms

- External Email -

Dear Shi Yuan,

Apologies for the slow reply and thank you for visiting us.

I had to check up some information in order to reply so pardon the delay.

I will try to answer all of them with information that I know of and was able to gather.

Do let me know if you need further clarifications on my answers and hope it helps with your thesis.

Also just curious, how did you find out about Singapore's orchid farm? Was it from the papers or from school articles?

It seems that there's students and media working on the information about Singapore's orchid farms projects recently.

Before I start on the questions, I think I should explain a little on orchid production.

A full crop cycle to produce new orchid hybrids take at least 3 years for most of our commercial orchids.

Seedpod Formation - 3 to 6 months

Germination in Lab Culture - 6 to 9 months

Growing them to Mature Stage - 18 to 24 months

Some varieties of orchids like the Tiger Orchid (*Grammatophyllum* speciosum) or *Dendrobium* lasianthera types will take a longer time.

1) formulate an innovative strategy towards space-saving methods of orchid production methods to increase production and shared benefits of Orchids: Decentralizing production & Co-producing
Breaking down the space requirements at different stages of cultivation and assimilating them into the city/ other farming spaces that can reap shared benefits (speculative benefits can be social, environmental etc.)

i) With regards to space-saving methods of orchid production, AVA officers approached our farm a few years ago to study the feasibility of multi-tier tropical orchid production. We did feasibility studies together with their research officers and part of the setup is still in our farm. It was later concluded that the multi-tier setup wasn't effective in producing the commonly grown tropical orchids produced in Singapore. When the orchids are grown in multi-tier, the first layer of plants grew well but the subsequent layers of plants beneath grew crooked and out of shape. The flowering yield for lower tiers also drops a few times compared to orchids grown on a single tier due to the lack of sunlight. The light requirement is high for orchids. As aesthetics is very important for orchid sales, it's not possible to produce the same quality orchids for sales using the multi-tier approach for tropical orchids. There have been suggestions and studies to use agricultural grow lights but the production cost of the final product produced makes it very expensive, and the price is not receptive to the general market as it's not competitive.

ii) I need a further explanation on what Decentralizing and Co-producing mean? Do you mean different stages of the plants at different places in Singapore?

If so, growing different stages of the orchid at different places in Singapore will be a complicated issue (skill, cost, environment and logistics). The quality of the orchid may be compromised from growing under different conditions (light, temperature, maintenance regime). Orchids are very sensitive plants. They need to be provided with their ideal growing conditions to grow properly. The production time from seed to mature flowering plant takes 3 years, and any process that disrupts the growth and damages the orchid would mean that the cycle has to be restarted again from ground zero. If not, most of the orchid plants produced from the damaged batch might not be viable for sales.

iii) With regards to social benefits, do you have an example for reference? What type of social benefits do you mean here? I am a little confused about what this means.

iv) With regards to environmental benefits, orchids cleans the air just like any other green plant. It adds to the aesthetics of an environment and the new orchid hybrids that Singapore produces value-add to her image as a City in a Garden as it is not found anywhere else in the world. It enhances the two major Garden attractions in Singapore, bringing in tourist dollars. Essentially the orchid industry works by the novel factor. One of the reasons that many tourists are attracted to Singapore's Tourist Gardens is because we have new unique orchids hybridized and produced here that are not seen elsewhere in the world. This novelty is a factor that refreshes our tourist gardens annually, attracting the new and returning garden tourists.

2) Land is precious in SG, for orchids to be viable in the long run in nParks vision to revitalize the industry, it needs to be more than just for the ornamental value; other uses of orchids.

i) Yes, land is precious in SG and I believe that's why NParks planned for smaller local orchid farms with higher production. In fact, NParks promised to share with the orchid farms formula on how to achieve this in 2018 (https://www.sgsme.sg/news/nparks-plans-help-nurseries-produce-new-orchid-varieties-revitalise-ailing-industry) which delighted the orchid industry two years ago. Back then, the orchid farms provided information on cultivation methods, chemical use, types of orchids we grow in a few forms requested by NParks.

We do however know at this point of time that NParks has been trying to lump the orchid farms (primary production industry) with the landscape (tertiary service industry) in a bid to increase lease premium for orchid farms. This issue caused a lot of stress for the true blue local orchid farmers who are producing their local orchid hybrids instead of importing them. Most of the orchid growers had previously thought that NParks vision was to help revitalize the local orchid industry and create value 2 year ago, and certainly not discourage local production and having them replaced with foreign imports. Of course, the remaining local orchid farms hope that NParks will look beyond just collecting higher lease premiums and safeguard some of our orchid farms as part of our heritage for the future generation. At this point of time, the orchid farms are confused whether orchid farming is still a trade cherished by the government considering the direction that NParks seems to be pushing the orchid farms in.

Since inception, vegetable and orchid farms have always been classified under the agricultural sector in Singapore with similar rates. As previously mentioned, the lease premium that NParks recommended for orchid farming is about 650% against the current average for 29 vegetable farming plots recently tendered. The costing is markedly different for agricultural land plots dedicated for farming use. It seems highly likely that the current administration will stifle Singapore from producing her own orchid hybrids and more in favouring reliance on foreign imports (like Taiwanese *Phalaenopsis*) instead.

ii) Yes, orchids do actually have more than ornamental value. Orchids are also used as food, spice and medicine as well. For medicine, e.g. *Dendrobium* officinale is used as Chinese medicine. Vanilla orchid produces vanillin which is a very important binding agent in the food and perfume industry. You might be interested to pick up this book from the science library by Dr Teoh - Medicinal Orchids of Asia, https://www.springer.com/gp/book/9783319242729

Here are some of the questions that I have complied, apologies for the really lengthy list!

On sales:

a. What has been the proportion of cut flower sales to potted flower sales? Which is more profitable for the farm?
In the early 80s and 90s, orchid farms' main source of income was mainly from cut flower exports. As Singapore's economy becomes more affluent in the late 90s, potted orchid sales start to increase as hotels, offices and shopping malls pop up all over the cities. Cut flower sales sustained and potted orchid sales grew. I do not have the exact proportion of cut flowers sales to potted flower sales but at this point of time, in terms of value, potted orchid sales are higher than cut flowers as they fetch higher price per pot sold compared to stalks.

b. How is the orchid business run; is there a contract with other businesses to supply orchids every month? Is the Orchid farming model more dependent on B2B or B2C?
Yes, we supply orchids to government and private organizations on a regular basis. The farming models are more dependent on B2B than B2C as they provide a stable income that allows for smoother planning of future crop cycles.

c. How dependent is the orchid farm business reliant on exports?
This is different for each farm. It depends on the business model and type of orchids they produced. If a farm is producing orchids for export, the orchids produced will likely be different from the orchids produced for our local markets. Similarly if a farm is targeting cut flower production, the orchid mix produced will be different from that of a potted orchid production. Each country has their different preference for type and colour of orchids.

d. With respect to the questions above, how has the business fared over the past few months; affecting the B2B and B2C businesses? If there has been a lack of demand, how is the oversupply of orchid waste being dealt with? *There* have *been reports on Thailand throwing out millions of orchids due to 95% drop in demand.*
The business hasn't been faring well as many contracted supplies were stopped or reduced during this period of time. Yes, similarly there's been a close to 100% drop in demand from projects during the lockdown.

On future Orchid Industry:

a. NParks announced plans to reduce and move orchid farms from the current 40ha + to a designated 20ha of farmland in sungei tengah and lim chu kang. Is Toh Garden affected by that move?
We were informed by NParks that we will have to tender again for our farm under their new scheme even if it's for the same use instead of being provided the option to extend our leases. Given an option, we will choose to remain in situ as our farm assets have already been built over the past decades. If we were to take up a new plot, we will have to tear down the existing farming assets, relocate and build new farming assets. This generates hectares of waste out of the orchid farm's capital and could take up to 2 years to complete. It's highly unlikely for orchid farms to continue as production farms but more of a trading company importing foreign products for immediate sales if they are required to move. Singapore is also likely to lose most of her commercial orchid production farms if they are moved as the 3 large sums of capitals are too much for most existing farms to sustain. (1.Capital to restore hectares of incumbent farms to stateland, 2. Capital to pay for the lease premiums, 3. Capital to rebuild farm assets on the new land parcel from scratch).

Orchid production is not a simple task as a farmer has to take laborious time to fully comprehend the microclimate of the plot they are farming on. The orchid farms that Singapore has now took a long time to mature to its current state. The new leases period of 3 and 10 years planned by NParks are really short for orchid production (3 year crop cycle) and with incredibly high lease premiums when compared to similar agricultural use land. When we do a comparison of NPark's recommended lease premiums for agriculture (3 years and 10 years) against the average SFA(AVA) lease premium for agriculture (20 years lease), the rates that NParks proposed are about 650% in differences. It is not possible to recover capital cost sunk into the new infrastructure, much less having to tear down existing farms and restore them to original state land with these short term leases on top of paying high lease premiums. Thus, many local orchid farmers may be forced to retire early, not by choice, despite having keen interest to continue in the trade.

b. Has there been any news on where the future 20ha will be located?
The future 20ha+ is located both in Lim Chu Kang and Sungei Tengah area. The plot allocations are not side by side, it's a total sum of 20ha+ allocated in different areas in Lim Chu Kang and Sungei Tengah areas and some are on the same plots that the orchid farms already are. It is not a single piece of 20ha+ land but separate pieces that adds up together.

c. What are some of the key challenges that you foresee in the future as with the recent disruptive event such as Covid-19?
We foresee that large organizations generally won't keep to contract terms in disruptive events such as Covid-19. Honestly, there's little that can be done in such a situation for most businesses, large or small alike. The cost to maintain the farm is also high despite the low revenue generated during Covid-19 as the orchids cannot be left unattended or the entire crop will be damaged and the crop cycle has to be restarted. We have to uphold our part to produce high quality products.

On Orchid Cultivation:

a. Are the orchids sold from TOH nurseries grown locally or in satellite farms (if any) or imported?
95% or more of the orchids sold at our farms are grown and produced locally. 5% or less imported are mainly temperate orchids that can't be grown here or cost alot to grow here due to climate differences.

b. How much orchids(kg) are thrown out every month? *I understood from a conversation with the workers that the flower sprays* need *to be cut off in the event that it is not sold, so as to prevent insect and fungi attacks.*
We do not measure the amount of orchids thrown out every month so I am not sure of the figure but this varies from month to month depending on several factors (pest, demand, climate etc). Yes, our workers constantly check our orchids for pests and have them removed to isolate any possible spread of pests, this is an everyday process. Pest spreads very quickly in an orchid farm if it's not mitigated as the plants are grown closely to each other. And yes, similar to ripening food, fully mature flowers have to be cut and disposed off or it will attract more pests. However, the farm has to sustain a certain quantity to plants to fulfill contract requirements. Unlike vegetables where all products can be sold after 60 days, orchids have a chance of sales when they are aesthetically pleasing. (e.g. a plant has to be in flowering season with many flowers). Orchids also go through high and low flowering seasons. During the low flowering season, maybe around 1-10% of the entire crop is suitable for sales, during high season, 80-90% of the plants will be suitable for sales. As we have contractual obligations with some clients to sustain their tourist garden attractions, hotels or offices in a constant flowering state, a certain quantity of plants need to be produced in order for us to provide stable supply.

c. Does Toh Garden have the facilities to micro-propagate or hybridize? Where are the new species acquired from?
We have the equipment ready for setup at the present, but Mr Toh is having second thoughts about setting up the lab here due to the high overheads, short and expensive lease. More than 90% of the time, we create our own new hybrids. This is the same for most orchid farms really doing production here. It's unlikely for a production farm to grow a hybrid that's not made by them. Consider spending 3 years of effort growing 300,000 pots of orchids only to realize that there's something wrong with the orchid hybrid. (e.g. it doesn't flower well, or the orchid hybrid is weak and susceptible to diseases or the flower is deformed or just doesn't do well in our climate etc.) All the capital and effort spent in producing the hybrid will be gone to waste and unrecoverable. An incorrect judgement on part of the orchid grower will end up with heavy losses that cannot be recovered so orchid growers are very careful with this. A hybrid that grows elsewhere may not do well here, this is true for many orchid hybrids.

d. Is there any form of licensing that needs to be paid for if you were to cultivate someone else's hybrid?
There's a royalty to be paid if a hybrid has a patent registered. The royalty is usually decided by the registrant of the patent and paid based on the quantity of plants that's going to be produced. The registered hybrid is usually DNA fingerprinted. However, it's likely that Singapore's market is too small for this consideration. Patents are generally registered in large countries where the consumer volume is much higher. (i.e. Even for technological products, it's unlikely for us to observe tech companies fighting over a patent in the Singapore market as compared to the US and European countries)

e. Do you have an estimate of farm space being used by orchids at different stages of cultivation? E.g. in flask, trays, small pots, big pots? *I did a really brief estimate at the farm estimating about 100sqm of sheltered space is used for the little plantlets in trays.*
The sheltered space is not the only area producing little plantlets in the farm. There are other areas too. In general, we prepare about 10% to 20% plantlets to mature plant ratio and these seedlings are preplanned 3 years in advance. The orchids that you see flowering in our farms now are preplanned 3 years ago.

Uses of Orchids

a. Are you aware that Orchids of different colours have varying levels of natural antioxidants that have industrial food applications? *Some are even equivalent to the levels found in commercially available products such as blueberries and raspberries.*
Yes, I am aware that pigments produced in plants are often natural antioxidants. Anthocyanins, betalain, carotenes etc are found in the orchid blooms as well. However, we are not aware of buyers purchasing orchids for extraction of these antioxidants. Would appreciate it if more information can be shared with us if you do know customers who are interested in extracting antioxidants from orchids from the food industry.

Orchids with fragrance are also extracted for perfume production. We had a collaboration with Singapore Polytechnic previously for such a project when they research orchids to create a Singapore fragrance. We have also previously collaborated with a craftsman from Japan who extracted dyes from our orchids to make his fabric.

Once again apologies for taking so long to reply to your questions.

Hope the above helps with your thesis.

Thank you.

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Best Regards,

NUS Institutional Review Board (IRB)

IRB EXEMPTION FORM FOR SOCIAL, BEHAVIOURAL & EDUCATIONAL RESEARCH (SBER)

Section A:

Please refer to the guidelines for IRB Exemption Form (SBER studies) before completing this.
(You can download the relevant guidelines and forms from the NUS-IRB website.)

1a. Protocol Title	A Review on Singapore's Current Orchid Industry & Future Applications of Orchids
1b. Simplified title (if any)	
2. PI and Department	Name of Principal Investigator (PI): Fong Shi Yuan Position/Designation: Student Telephone number: 97275602 Email address: e0036860@u.nus.edu Dept. and Institution: * If there is a Co-Investigator(s) (Co-I), please submit the "List of PI and Co-Investigators" form.
3. Study Site(s)	Site(s) of Research (Dept. and Institution): ☐ Single-centre ☒ Singapore Multicentered ☐ International Multicentered If single-centred, has a similar study been conducted elsewhere? If Yes, state where: Previous Ethics Committee Submission? If Yes, please provide details:
4a. Exemption Category	(please refer to the application guidelines on which types of research can be exempted from IRB review) 3. Survey, interview, focus group discussion and/or observational studies involving public officials and Federal statute(s)
4b. Type of Study	☐ Archived/ Existing Database ☐ Experiments ☒ Survey / Interview / Focus Group ☐ Others, please specify:

5. PI's Declaration
(Please check with the IRB secretariat if unsure)

I hereby declare that my research study:

Yes	No	Risks:
☒	☐	a. Is of minimal risk.
☒	☐	b. Does not place the research participants at risk of criminal or civil liability and is not damaging to the research participants' financial standing, employability, or reputation if their responses are disclosed outside the research study.
☒	☐	c. Has no physical, psychological or economic harm to research participants.
☒	☐	d. Does not involve vulnerable populations (e.g. children, prisoners, pregnant women, non-healthy volunteers, cognitively impaired etc).
☒	☐	e. Does not touch on sensitive topics (including but not limited to illegal conduct, criminal activities, racism, politics, sexual behaviour).
Yes	**No**	**Ethics:**
☒	☐	f. Does not involve deception or withholding study's stated aims and objectives from research participants.
☒	☐	g. Is ethically sound in terms of the protection of research participants.
☒	☐	h. Has no ethical concerns that should be declared for this review.

	☒	☐	i. Only involves investigators with relevant experience and training in the field of the research study.
	Yes	**No**	**Privacy and Confidentiality:**
	☒	☐	j. Research data will be retained in accordance to NUS' Research Data Management Policy.
	☒	☐	k. The PI will protect research participants' privacy and the confidentiality of their personal data, and comply with the NUS Data Protection Policy.
	Yes	**No**	**Consent:**
	☒	☐	l. Uses PIS&CF(s) that complies with NUS-IRB's Guidelines on Participant Information Sheet and Consent Form for "SBER" studies (IRB-GUIDE-S03).
	Yes	**N.A.**	**Additional Declarations, if applicable:**
	☒	☐	m. If there is use of research participants' photographs/ video-recordings/ quotes in publications/ presentations (with or without their personal data), express consent will be sought from research participants.
	☒	☐	n. If posters/ advertisements/recruitment emails will be used, contents of recruitment materials are in accordance with NUS-IRB's guidelines on advertisement for "SBER" studies (IRB-Guide-S04).
	Yes	**No**	**Final Declarations:**
	☒	☐	o. I will not initiate this research until I receive notification of NUS-IRB's approval and any other approval from relevant authorities (local/overseas).
	☒	☐	p. I will promptly report any unexpected or serious adverse events, unanticipated problems and incidents that may occur in the course of this research.
	☒	☐	q. I will maintain all relevant study documents and recognize that the NUS-IRB staff and regulatory authorities may inspect these records.
	☒	☐	r. I understand that failure to comply with all applicable regulations, institutional and NUS-IRB's policies and requirements may result in the suspension or termination of approval for this research, and other actions as stated in the NUS Code & Procedures on Research Integrity.
	☒	☐	s. I declare that there is no existing or potential conflict of interest for any of the investigators participating in this research.
	☒	☐	t. I will promptly report any change in the conduct of the research study that deviates from the IRB application form.

6. Financial Declaration	Source of funding for study: Amount of Sponsorship / Grant : None Status of grant: Not Applicable The financial benefits or other benefits derived from this study to PI / Co-I(s) / Department / Institution are as follows:
7. HOD's Declaration	I declare that this research is approved by the department and is in keeping with the department's standards.  _____ __08/10/2020___ Signature of Head of Department Date Name of Head of Department:
8. PI's Signature	I hereby declare the information in this application form is correct.  _____ 07 Oct 2020 Signature of Principal Investigator Date

Section B:

1. Specific Aims and Objectives:

1.1 State concisely and realistically what the research described in this application is intended to accomplish and/or what hypothesis is to be tested.

To review the ailing Singapore Orchid industry due to competitive global orchid prices because of land scarcity and lack of demand.

With the data collected the intention is to evaluate the value of Orchids cultivation in cultural heritage, and possibility of using Orchids as a source of nutrient fortification to food products in meeting the changing dietary needs in Singapore.

Reconstructing Orchid farms into an Orchid Cooperative that has both social and economic value in land scarce Singapore.

2. Characteristics of Target Research Participants / Target Research Participants Data:

2.1 What is the target number of research participants? Give a breakdown by site of recruitment for multi-centre studies (if applicable).

Institution(s)/Site(s) of Recruitment	*Total*
Lim Chu Kang/ Sungei Tengah Farms	5
nParks	2
Food Science Department NUS	1
SIFBI	2

2.2 Lower Age Limit: 21 *Upper Age Limit (if any):*

2.3 Inclusion criteria:
Interviewee must be related to the orchid industry, industry with orchid related applications, and food science technology.

2.4 Exclusion criteria:

2.5 Are the research participants vulnerable or in a dependent relationship with the researchers?

☐ *YES* ☒ *NO*

If Yes, please provide details. Please note that research participants who are in a dependent relationship with the researchers should not be approached directly during recruitment, so as to prevent situations where participants consent under duress.

3. Reimbursement:

3.1 Will research participants receive payment/ student course credits for participation? If yes, please elaborate. If no, please state "No reimbursement".

No reimbursement

4. Recruitment Process:

4.1 Explain the process of recruitment in detail, for example, state where and how potential research participants will be recruited/ contacted.

By email, site visits or phone calls.

5. Methodology:

5.1 Discuss in detail the (i) experimental design and research procedures, (ii) subject research visits (frequency and duration of procedures involved) and (iii) period of recruitment to accomplish the aims of this research.

i) A conversational interview in the format of a phone call, in-person visit, or email correspondence guided by a set of questions.

ii) Weekly follow-ups if required, no obligations for immediate correspondence or response from the interviewee is required.

iii) Period from 7 Oct 2020 to 15 Dec 2020.

6. Data Storage:

6.1 Please complete the following questions on measures you will take to protect research data and personal data collected. In addition, if your research involves making use of archived/ existing databases, please furnish the necessary documentation, e.g. permissions to use those databases, if applicable.

6.1.1 Where will the research data be stored?

Offline storage.

6.1.2 Who will have access to the research data, and what are the data protection measures put in place for this study? What will happen to the research data after research completion?

Research data will not be publicly accessible in a local storage device.

6.1.3 Please state the personal data that will be collected (e.g., names and contact information, etc) and how research participants' privacy and the confidentiality of their research data will be protected. What will happen to the personal data collected after completion of the research study?

Personal data will be kept confidential, last name will be published to quote evidence. Upon completion of the research study, data will be archived and disposed at the end of the project (Dec 2021).

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6.1.4 Any other remarks?

7. Application for Waiver of Documentation of Informed Consent (if applicable):

7.1 ***If waiver of documented consent is required (i.e. only verbal consent will be obtained)****, please justify how your research meets the 4 criteria. Please note that stating "Yes" is not a sufficient justification.*

(The NUS-IRB may waive the requirement to obtain documented informed consent if the NUS-IRB finds that the research meets the following 4 criteria.)

7.1.1 The research involves no more than minimal risk to the research participants.

Yes. Research is carried out through a verbal correspondence with no obligations to answer every question asked.

7.1.2 The waiver or alteration will not adversely affect the rights and welfare of the research participants.

Yes. The potential research participants are approached with no obligations to consent to interview.

7.1.3 Whenever appropriate, the research participants will be provided with additional pertinent information after participation.

Yes. Follow-up with relevant materials or in any form an alteration or review of data provided by the participants will be carried out. Permission from the participants will be sought in any change of usage of data outside of this agreement.

7.1.4 The research could not practicably be carried out without the waiver or alteration.

Yes. The methodology of research is informal and spontaneous. It will be logistically daunting for the participants, affecting their consent to participate in the research, therefore hindering the efforts in reaching out to potential participants.

* Please go to the NUS-IRB website to download the relevant guidelines and forms.

9

Annotated Bibliography

Works Cited

ADB. (2020). SINGAPORE'S LONG-TERM CARE SYSTEM ADAPTING TO POPULATION AGING. Retrieved from Aging Asia and the Pacific: https://www.adb.org/sites/default/files/publication/637416/singapore-care-system-population-aging.pdf

The paper provides a comprehensive outline of Singapore's state of ageing population and the need of greater population health. It emphasizes the importance of preventive care as opposed to responsive care, as well as adopting a multi-faceted approach towards providing greater population health that will greatly reduce the cost on healthcare spendings.

Alperstein, J. (2018). Commodity, conservation, and nation building: the orchid and the Singaporean Identity. Vassar College, Senior Capstone Projects.

An anthropological study of Orchids traces the commonplace of flora in Singapore as part of the community and the rootedness in establishing an identity for the nation. It provides a clear and rigorous understanding of Orchids' history in Singapore.

Amport, D., & Schilinger, C. (2014). Growing Out Food Supply in Singapore. In M. Topalovic, M. Knusel, & M. Jaggi, Architecture of Territory (pp. 14-49). Singapore: Tien Wah Press, Singapore.

The studio work carefully documents the hinterland and territories of Singapore. It studies the changes of agricultural land uses and the primacy of SIJORI region in enabling the large scale production of orchids in singapore. The report publishes the hierarchical organization of the orchid farm; number of employees and contract types with the local industry.

ANTEA. (2020). ANTEA – Edible flowers: a new outlet for the horticultural sector in France and Italy. Retrieved from European Commission: https://ec.europa.eu/regional_policy/en/projects/Italy/antea-edible-flowers-a-new-outlet-for-the-horticultural-sector-in-france-and-italy

The venture provides a credible effort in pioneering the investigations in finding new values and uses of flowers in response to the struggles of horticultural sectors. Based on gastronomy and cuisines, it aims to increase the value chain of the horticultural sector by bringing cross-collaboration across different sectors. The report reinforces the scope of project in re-evaluating the value chain of orchids.

Au-Yong, R., & Tee, C. (2018, March 19). NParks plans to help nurseries produce new orchid varieties, revitalise ailing industry. Retrieved from SGSME: https://www.sgsme.sg/news/nparks-plans-help-nurseries-produce-new-orchid-varieties-revitalise-ailing-industry

The report publishes the efforts of nParks in providing support for the local farms, but it does not reflect the responses nor indicate any sort of long term plans for them.

AVA. (2014, August). Agriculture Productivity Fund and Agriculture Policies for Local Farms. Retrieved from nParks: https://www.nparks.gov.sg/~/media/nparks-real-content/news/2014/8/25aug14new-farm-and-nursery-policies_annex-a.pdf?la=en

The media release is important as a guide to farms which are bidding or rebidding new tranches for agriculture as the new farm plans will have to meet two minimum production levels to be awarded the tender and funding for construction. It is evident to Singapore's strategy of intensifying production levels, and it serve as a baseline for us to gauge the scale of land required in food production expansion.

Barnett, J. (2014, October 27). HOW GROWING DEMAND FOR FUNCTIONAL FOODS WILL IMPACT SOUTHEAST ASIA IN 2015. Retrieved from Mintel: https://www.mintel.com/blog/consumer-market-news/how-growing-demand-for-functional-foods-will-impact-southeast-asia-in-2015

The report reflects the growing functionality of food in southeast asia with the evidence of growing SME numbers in the sector of alternative food and beverages.

Basu, R. (2017, October 7). Long-term care: If this is so important, why aren't we putting our money where our mouth is? Retrieved from The Straits Times: Opinion: https://www.straitstimes.com/opinion/new-ways-to-fund-better-long-term-care

The Opinion piece provides an insight to the government spendings on long term care, raising the awareness that much attention is

placed on publicly funded medical care facilities and lesser on the non-profit, non-govermental organizations that depend heavily on donations and community funding.

Begum, S. (2019, May 12). Singapore's high-tech farms: From yesterday's pig farms to today's vertical veggie gardens. Retrieved from SGSME: https://www.sgsme.sg/news/singapores-high-tech-farms-yesterdays-pig-farms-todays-vertical-veggie-gardens

The article documents the journey of a farmer who has remained in the agricultural sector for many years, but has jumped from pig farming to orchid and now to vegetable farming. It chronicles the challenges of different farming models and relays the challenges of being in an agricultural business.

Begum, S. (2020, August 19). Mangroves and wetlands in the north make up Singapore's second nature park network. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/new-lim-chu-kang-nature-park-to-be-part-of-400ha-nature-park-network-along-the-northern

The new nature extension does not explain why the farm leases in lim chu kang will be expiring. Labelled in the newspaper article is a southern extension of which does not have any explicit purpose. This however points to greater accessibility to the farms in the future island wide park connector.

Blooms. (2018, March 30). Importance of Flowers in Indian Culture. Retrieved from Medium: https://medium.com/@bloomsonly123/importance-of-flowers-in-indian-culture-48b642ddf96a

There are many uses of Orchids and one of which is in the ayurvedict treatments derived in the ethnobotanical practices of Indian culture. It plays a symbolic role in spiritual and religious activities in a non-idolatrous manner, which could make orchids a multi-faith proxy.

Bowers, B. (2018, August 6). The path to creating Tanglin Gin, Singapore's first locally distilled gin. Retrieved from Lifestyle Asia: https://www.lifestyleasia.com/sg/food-drink/drinks/tanglin-gin-singapore/

Singapore's local tanglin gin that has its name originating from Tanglin that used to be famous for its spice and herb culture.

Chek, F. (2008). Medical nutrition therapy for chronic diseases. Singapore: SFP. Retrieved from http://cfps.org.sg/publications/the-singapore-family-physician/article/449_pdf

The article raises the importance of medical nutrition as one of the cornerstone strategies in treatment of chronic diseases. It points to the importance of a nutritionally balanced and tailored diet to reduce and prevent further complications of diseases.

Chin, S.-C. (2008). Biodiversity conservation in Singapore. BGJournal, 11-14.

The journal article points out the loss of biodiversity in Singapore over the years, and the strategies of nParks and role of Botanic gardens in conserving the remaning natural habitats.

Chong Jin, G., & Lee, G. (1989). Orchid Industry of Singapore. Economic Botany, 241-254.

This dated reported provides access and insights to the archives of singapore's orchid industry, on how it began and developed over the colonial times. It reveals the importance of Orchids in crafting the identity and presence of Singapore in her formative years, and the trend of orchid cultivation gaining popularity after the recognitition. The narrative of Orchids in the past establishes itself as an important cultural heritage for Singapore.

Chong, C. (2020, Jan 22). Fish farming group Barramundi Asia buying deep tech startup Allegro Aqua. Retrieved from The Business Times: GARAGE: https://www.businesstimes.com.sg/garage/fish-farming-group-barramundi-asia-buying-deep-tech-startup-allegro-aqua

The report points out the move of fish farming from in-land to coastal and sea based. Land shortage will not be a an issue for expanding productions with the deep-sea and costal capabilities that have been developed.

EDB. (2016, January 14). Asia's burgeoning geriatric nutrition market. Retrieved from EDB: https://www.edb.gov.sg/en/news-and-events/insights/headquarters/asia-s-burgeoning-geriatric-nutrition-market.html

The news release is centered on the ageing population of asia; Vietnam, China, Taiwan, Indonesia, Philippines and Singapore, and the changing nutritional demands for geriatric needs that has to be tailored to the dietary requirements of the aged. It estimates about US$40-70 billion market for functional food in the sector, priming a stage for investors to chip in.

En, S. M. (2017). Elderly to make up almost half of S'pore population by 2050: United Nations. Singapore: TODAY.

The news article documents the trend of ageing population in Singapore, expected to reach 6.34 million in 2030. The dependency ratio will also halve to almost 1:1.

Floral Daily. (2016, January 26). Singapore's orchid industry threatened by rising costs, competition. Retrieved from Floral Daily: https://www.floraldaily.com/article/9003663/singapore-s-orchid-industry-threatened-by-rising-costs-competition/

Gasco, A. (2016). THE AIRPORT AND THE TERRITORY Transnational Flows in the SIngapore-Johor-Riau Cross Border Region. In Hutchinson, E. Francis, & T. Chong, The SIJORI Cross-Border Region (pp. 341-362). Singapore: ISEAS–Yusof Ishak Institute.

The book section documents the importance and flow of goods around the SIJORI region, as well as the unique roles that each country plays within the cooperative.

Hinsley, A. (2018). A review of the trade in orchids and its implications for conservation. Botanical Journal of the Linnean Society, 435–455.

The paper highlights the issue of illegal Orchid trade in the southeast asian reigon, and the improtance of hybridisation in providing an alternative for orchid demand. The stock of wild orchids should be conserved as much as possible, and the production of commerical orchids will be one of the key strategies to alleviating the pressures of poaching.

HPB. (2010). National Nutrition Survey. Singapore: National Health Promotion Board. Retrieved from https://www.hpb.gov.sg/docs/default-source/pdf/nns-2010-report.pdf?sfvrsn=18e3f172_2

The report delineates the association between a healthy diet and chronic dieseases that are prevalent in Singapore. It tracks the consumption of nutrition and dietary practices of Singaporeans to structure future plans and strategies to ensure a healthy diet. It provides key finding on data collected from the national nutrition survey 2010.

HPB. (2014, March 15). 1.7 Million Singaporeans Already At Risk of Obesity-related Diseases. Retrieved from Health Promotion Board (HPB): https://www.hpb.gov.sg/article/1.7-million-singaporeans-already-at-risk-of-obesity-related-diseases

The article states the key findings of Singaporeans being at risk of obesity-related diseases, and the one million kg challenge national initiatve to help the obese and overweight. Body mass index is closely related to lifestyle practices including diet, and it highlights the importance of ensuring the right intake of nutrition.

ITC. (2020). Product: 060313 Fresh cut Orchids and Buds, of a kind suitable for bouquets or for ornamental purposes. Retrieved from Trade Map: https://www.trademap.org/Index.aspx?nvpm=1%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c

The data can be visualized in many ways to reflect Singapore's presence in the global orchid trade. It concludes that Singapore's global presence despite its relatively more expensive orchids is infact minimal, and that the global orchid demand has been shrinking.

Jetro. (2011). Guidebook for Export to Japan 2011 . Tokyo: Japan External Trade Organization (JETRO).

Judith. (2013, August 10). He makes failure a blooming success. Retrieved from AsiaOne: https://www.asiaone.com/he-makes-failure-blooming-success

The interview report chronicles the journey of a poor boy to a successful orchid breeder who has won awards in competitions. It highlights the role of Orchids in the past as a way for the poor to unknowingly strike rich given its extremely high value as an exotic flora when global trade was still in its infancy.

K.M, W. (2012). Gardens' Bulletin Singapore 64(1): 279–280 2012. Book Review: Wild Orchids of Peninsular Malaysia. P.T. Ong, P. O'Byrne, W.S.Y. Yong & L.G. Saw. 2011. , 279-280.

Kaplan, S. (1995). The Restorative Benefits of Nature: Toward an Integrative Framework. Journal of Environmental Psychology, 169-182.

The journal proposes the theory of directed and indirect attention through the exposure to nature, given the multitude of natural stimuli, it can help to relax the mind, recover and improve cognitive capacity in restorative experiences.

Khalik, S., & Rashith, R. (2018, August 15). MOH to grow aged care services to meet rising demand. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/moh-to-grow-aged-care-services-to-meet-rising-demand

The newspaper article highlights the key statistics of strategies that the government is undertaking in response to the Lien report of a greater demand for long-term care services and facilities.

Lai, L. (2017, Aug 19). More than 100ha of land to be set aside for landscape nurseries in a first. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/environment/more-than-100ha-of-land-to-be-set-aside-for-landscape-nurseries-in-a-first

Lang, T., & Heasman, M. (2015). Food Wars (Second Edition) The Global Battle for Mouths, Minds and Markets. New York: Routledge.

The book highlights three key food paradigms; productivist, life sciences and ecological, in response to the global 2008 food crisis. It traces the multitude of interests across different stakeholders in food production and the paradigmatic shifts according to the conflicts. The three contrasting paradigms reminds that there will never be a right method of food production that can be accepted, but the primacy of the ecosystem in production is one that has to be considered in its socio-economic and ecological, environmental impacts.

Lee, B. (2011). Asia Pac J Clin Nutr. Dietary Guidelines in Singapore, 20 (3):472-476.

The report highlights the different dietary guidelines in 2011 that have been develoepd to tailor to different dietary needs of people from different age groups. It shows the importance of the guidelines in relationship to health, and its implementation in places of food consumption from workplace canteens to hawker centres, restaurants and schools.

Minh, T., Tuyen, P., Khang, D., Quan, N., Ha, P., Quan, N., . . . Xuan, T. (2017). Potential Use of PlantWaste from the Moth Orchid (Phalaenopsis Sogo Yukidian "V3") as an Antioxidant Source. foods. Retrieved from http://www.mdpi.com/journal/foods

The paper identifies the moth orchid phalaenopsis as one key source of antixodant that can be extracted for applications in food. It highlights its viability given the low cost and price of orchids in the current market, since Phalaenopsis is one of the most commonly found commerical orchids.

MOH. (2016). Executive Summary on National Population Health Survey 2016/17. Singapore: Ministry of Health (MOH).

The report higlights key issues of obesity & overweight, physical activity, smoking habits, binge drinking, cardiovascular screening,

hypertension & hyperlipidaemia and diabettes as the key markers to nationa population health.

MTI. (2019, Mar). Ministry of Trade and Industry. Retrieved from Agri-Food Innovation Park (AFIP): https://www.mti.gov.sg/-/media/MTI/COS-2019/Factsheet_AFIP.pdf

The media release factsheet provides a broad overview of the future agri-tehc hub at Sungei Kadut, on the potential of urban food production and platform for cross collaborationof different agencies to enable innovation and expansion of the value chain.

Ng, M. (2020). Leisure and Community Participation (OTY1008) [Horticultural Therapy]. Singapore Institute of Technology, Singapore.

The training document for Singapore Institute of Technology's module is an extension of the Research and Design Guidelines of Therapeutic gardens, a key evidence of a efforts toward developing the horticulture and therapy in Singapore.

Nguyen, H., Lin, K.-H., Huang, M.-Y., Yang, C.-M., Shih, T.-H., Hsiung, T.-C., . . . Tsao, F.-C. (2018). Antioxidant Activities of the Methanol Extracts of Various Parts of Phalaenopsis Orchids with White, Yellow, and Purple Flowers. Notbulae Botanicae Horti Agrobotanici Cluj-Napoca, 48. Retrieved from http://www.notulaebotanicae.ro/

The study provides an interesting insight in the relationship between color and levels of antioxidants in orchids, yellow being the highest, folloewd by purple and white. The study carried out points to the Orchid flower petals having the highest polyphenolic content, and it is comparable to vegetables that are commonly found in the market.

nParks. (2018, August 29). Research and Design Guidelines of Therapeutic Gardens. Retrieved from nParks: https://www.nparks.gov.sg/gardens-parks-and-nature/therapeutic-gardens/research-and-design-guidelines

This official document serves as a guideline for future facilitators and designers of therapeutic gardens, explaining the three different levels of horticultural therapy across varying degrees of individualization. It also highlights the key spatial principles of designing way finding as well as street furniture to cater to users of varying cognitive abilities and mobility.

OSSEA. (2017). OUR HISTORY. Retrieved from The Orchid Society of Southeast Asia (OSSEA): https://www.ossea.org.sg/about/our-history/

Raguaraman, A. (2020, August 9). Here's to the S'pore Spirit. Retrieved from The Straits Times: https://www.straitstimes.com/lifestyle/food/heres-to-the-spore-spirit

Rajeevan, P., Rao, A., De, L., & Pathak, P. (2019). Global Orchid Industry. In Commercial Orchids (pp. 13-19). De Gruyter Open, Warsaw, Poland. Retrieved from https://www.researchgate.net/publication/336604199_2_Global_Orchid_Industry

The report gives an overview on the major players and exporters of the global orchid industry, and the key orchid types that are traded in the market.

Rashith, R., & Lee, G. (2018, March 15). Orchid nurseries to move to designated land. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/orchid-nurseries-to-move-to-designated-land

The newspaper article publishes the government efforts to protect the local ornamental and orchid industry, however it is shrinking the total land area allocated to orchids from 40ha to 20ha. Some farmers interviewed expressed content over the move as they feel that a cluster will bring more tourists and visitors.

SFA. (2016, July 17). Farming Area. Retrieved from Data.gov.sg: https://data.gov.sg/dataset/farming-area?view_id=d428e485-b768-432d-b702-4cffe078a9fa&resource_id=9a826bf2-34c4-4694-b4af-f338d6205fb3

The data reflects the large percentage of singapore's farmland being occupied by ornamental and orchid production,, and documents the trend of its decreasing share over the years starting from year 2000.

SFA. (2020, July 27). Our Singapore Food Story. Retrieved from Singapore Food Agency: https://www.sfa.gov.sg/food-farming/sgfoodstory/grow-local

SIFBI. (2020, September). FROM LAB TO TABLE: TOWARDS SINGAPORE'S "30 BY 30" FOOD SECURITY GOAL. Retrieved from A*STAR: https://www.a-star.edu.sg/News-and-Events/a-star-news/news/features/from-lab-to-table-towards-singapore-s-30-by-30-food-security-goal

*The media release serves as opening statement for SIFBI. The director of A*Star discusses the importance of alternative food types amidst Singapore's strategy to expanding food production, that the nation needs to consume the right type of nutrition tailored to requirements of health.*

Singapore Memories. (2020). Therapeutic Orchids. Retrieved from Singapore Memories: https://singapore-memories.com/pages/therapeutic-orchids

This is the most prominent company invovled in developing fragrances and uses for Orchids, and the website provides a compendium of uses for different species of orchids from A-Z, as well as those that are found locally.

Singh, D. R., Kishore, R., Kumar, R., & Singh, A. (2016). Orchid Preparations. Sikkim: ICAR - National Research Centre for Orchids, Pakyong, -737106, Sikkim.

India is very well known for orchid cultivation, and the report published by the National Research Centre for Orchids documents the variety of uses that Orchids can provide, from edibility to bioprospects and derivatives of fragrances.

Tan, A., & Boh, S. (2017, May 28). Lim Chu Kang farmers perplexed by 3rd lease extension. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/environment/farmers-perplexed-by-3rd-lease-extension

Tan, A., & Tan, C. (2020, October 5). Lim Chu Kang set for makeover into high-tech agri-food cluster. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/environment/lim-chu-kang-set-for-makeover-into-high-tech-agri-food-cluster

390ha of land surrounding the existing Lim Chu Kang farms will be used to develop high tech food production tranches. While it highlights the opportunity for farms with expiring leases, it does not mention the future use of the existing farmland, neither does it include the opportunity for ornamental orchid farms to be relocated to.

Teng, P., Ma, J., Montesclaros, L., Hulme, R., & Powell, A. (2019). The Evolving Singapore Agrifood Ecosystem. RSIS NTS, 1-14. Retrieved from https://www.rsis.edu.sg/wp-content/uploads/2019/08/NTS-Insight-TengMontesclarosHulmePowell-Aug2019.pdf

The report highlights the greater strategy of agrifood ecosystem over the recent initiatives to expansion of food production, that food industry stillremains the top priorityof Singapore given its land scarcity, to pioneer "Food 4.0" regionally and globally.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. Science, 420-421.

A study conducted by an architect on the view of rooms that patients had while recovering from surgery revealed the positive influences of natural environment on wellbeing. The early study became one of the major findings in establishing the relationship between nature and health.

Wilson, E. O. (2011). Biophilia. Cambridge, Mass, United States: HARVARD UNIVERSITY PRESS.

Edward O Wilson argues the natural affinity of humans for nature, and that its the essence of humanity. It was developed in the context of an american environmental movmenet between 1900-2000 in view of negative impacts of a gradual detachment from our natural surrounings.

Wolverton, B. C., Johnson, A., & Bounds, K. (1989, September 15). Interior Landscape Plants for Indoor Air Pollution Abatement. Retrieved from NASA Technical Reports Server: https://ntrs.nasa.gov/citations/19930073077

It is one of the earliest studies conducted by NASA to design an filter based on the capabilities of plants absorbing volatile organic compounds through its leaves, plant roots and living micro-organisms in soil.

Yam, T., Ang, P., Tay, F., & Wei Jing, S. (2016). Special Ecology Feature: Conservation and Reintroduction of Native Orchids in the City in a Garden. CITYGREEN, 142-147. Retrieved from https://www.nparks.gov.sg/-/media/cuge/ebook/citygreen/cg4/cg4_16.pdf?la=en&hash=C4B0706B6CAB7AA1442C55DCEB4D434DB1222AF5

The report highlights the key findings of the National Conservation Program through seedlings, prepared by the controlled cross pollination of species and growth in laboratory and nurseries. It identifies tree crevices as fertile spots for orchid growth and the flowers should thrive under the right microclimate.

Yong, J. (2020, February). Two in Five are Flexitarian. Are You? Retrieved from FOOD: https://www.wonderwall.sg/food/two-in-five-singaporeans-are-flexitarian-are-you/

The short report highlights the opportunity for startups and businesses to tap into the trend of growing health awareness and shift towards a plant based diet.

Zaccheus, M. (u.d.). Historic Gardens. Singapore: The Straits Times.

The historic gardens is a publication that documents the history of Singapore Botanic Gardens.

10

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Part II

// Preface

The second part of the thesis further reframes the design research, taking the same content (Part I) from a different perspective to review new opportunities.

It takes the national stance that the ornamental farms should be relocated to free up space for more critical components of nation building and security. On the other hand, we are looking at 20ha of traditional Orchid farms, stocks, businesses, natural heritage, and potential stakeholders that need to be remodeled, and the questions of ‘how’ and ‘what’ the future of these farms are, will be the final culmination of this thesis project - **The Orchid Cooperative**.

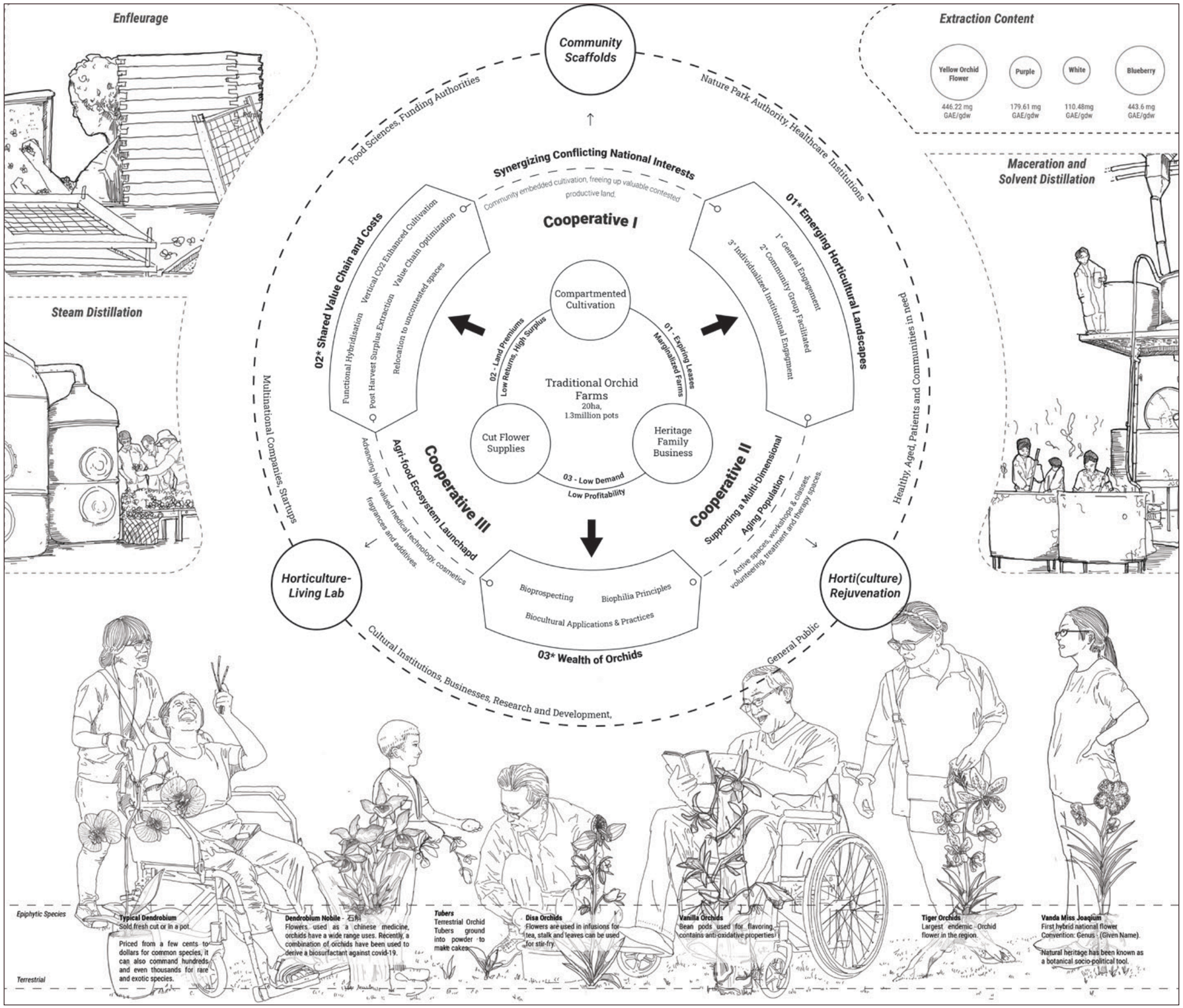
7*

Design Intent ***(Revised from Part I)***

Thesis Statement

The Orchid Cooperative proposes to revitalizes the ailing industry by rembedding the farms into emerging community horticultural landscapes, and through the wealth of orchid uses, optimize and diversify its cultivation into a shared value chain.

Discarding the traditional model of farming, the Orchid Cooperative is anchored by three key thrusts - to synergize multi-stakeholder national interests, support the needs of an ageing population, and advancing high value economic uses.



Orchid Cooperative Interrelational Systems

Fig 1

Fig 2. Site Selection

Situating the Cooperative through Synergy of Interest Conflicts

Following the investigations of part I and the wealth of opportunities that the orchids provide, the cooperative identifies three key national interests and issues; emerging horticultural landscapes, ageing population & population health, and the shift towards post-harvest technology in the development of Singapore's Agrifood Ecosystem.

Singapore has three key institutional healthcare clusters serving different regions central, west and the east, where the region around Singapore General Hospital has the highest concentration of aged demographics. The therefore cooperative situates itself between the terminus of the cross island route - Tanjong Pagar Railway Corridor, and round island network, combining the key principles of round island network and the growth of islandwide therapeutic gardens.

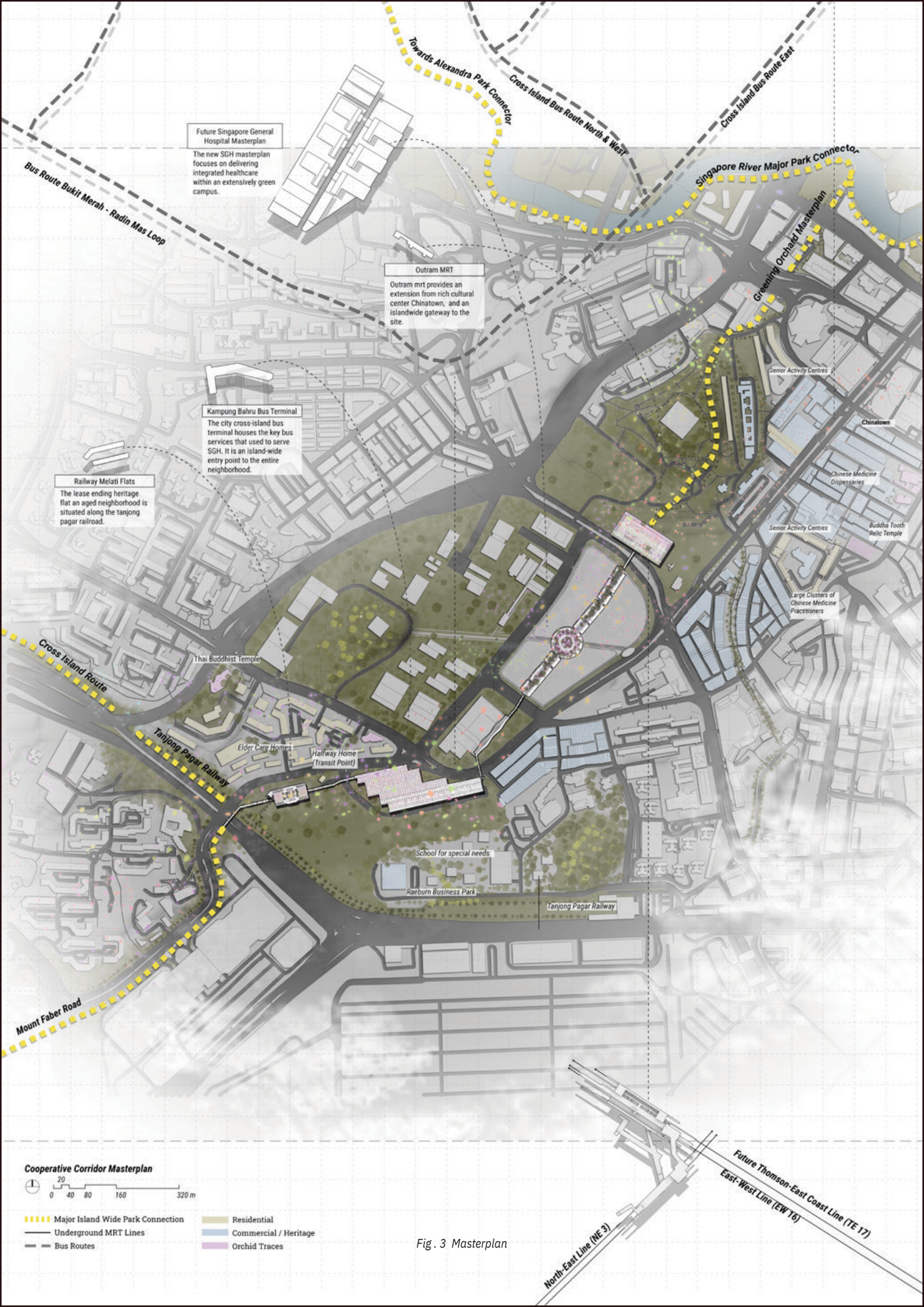


Fig . 3 Masterplan

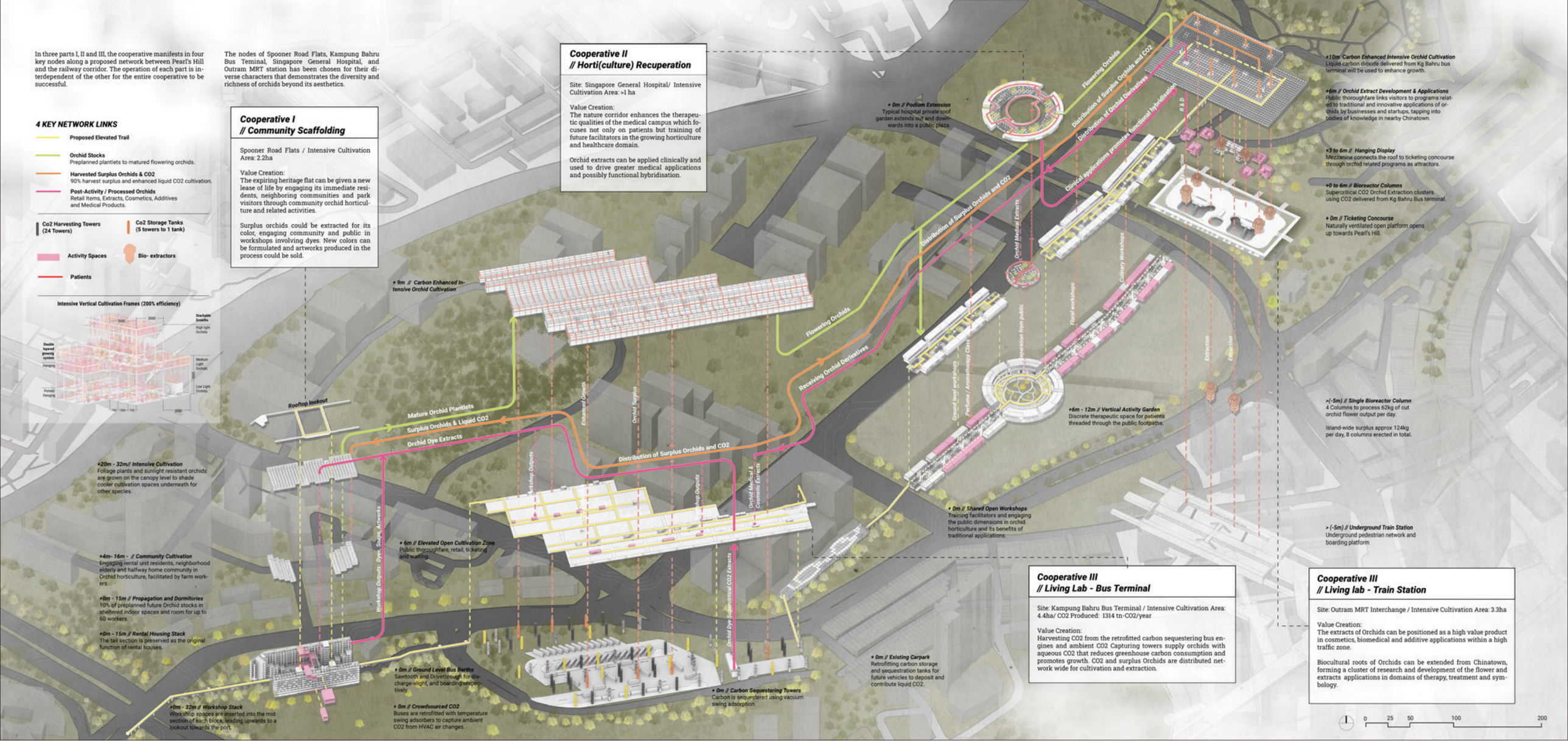


Fig. 4 Internodal Functions and Operations

Three Part Cooperative

In three parts I, II and III, the cooperative manifests in four key nodes along a proposed network between Pearl's Hill and the railway corridor. The nodes of Spooner Road Flats, Kampung Bahru Bus Teminal, Singapore General Hospital, and Outram MRT station has been chosen for their diverse characters that demonstrates the diversity and richness of orchids beyond its aesthetics.

The Orchids are grown in double layers within a 3m x 3m frame to maximize its output to footprint approximately 4 times.

Cooperative I (Spooner Road Flats)

The expiring heritage flat can be given a new lease of life by engaging its immediate residents and neighboring communities through orchid horticulture and related activities. Surplus orchids could be extracted for its color, engaging community and public in workshops involving dyes. New colors can be formulated and artworks produced in the process could be sold.

Cooperative II (Singapore General Hospital)

The nature corridor enhances the therapeutic qualities of the medical campus which focuses not only on patients but training of future facilitators in the growing horticulture and healthcare domain.

Orchid extracts can be applied clinically and used to drive greater medical applications and possibly functional hybridisation.

Cooperative III (Kampung Bahru and Outram Stations)

The extracts of Orchids can be positioned as a high value product in cosmetics, biomedical and additive applications within a high traffic zone.
Biocultural roots of Orchids can be extended from Chinatown, forming a cluster of research and development of the flower and extracts applications in domains of therapy, treatment and symbology.

Harvesting CO2 from the retrofitted carbon sequestering bus engines and ambient CO2 Capturing towers supply orchids with aqueous CO2 that reduces greenhouse carbon consumption and promotes growth. CO2 and surplus Orchids are distributed network wide for cultivation and extraction.

Superimposed Section - Engaging Orchids and Horticulture | 1-150

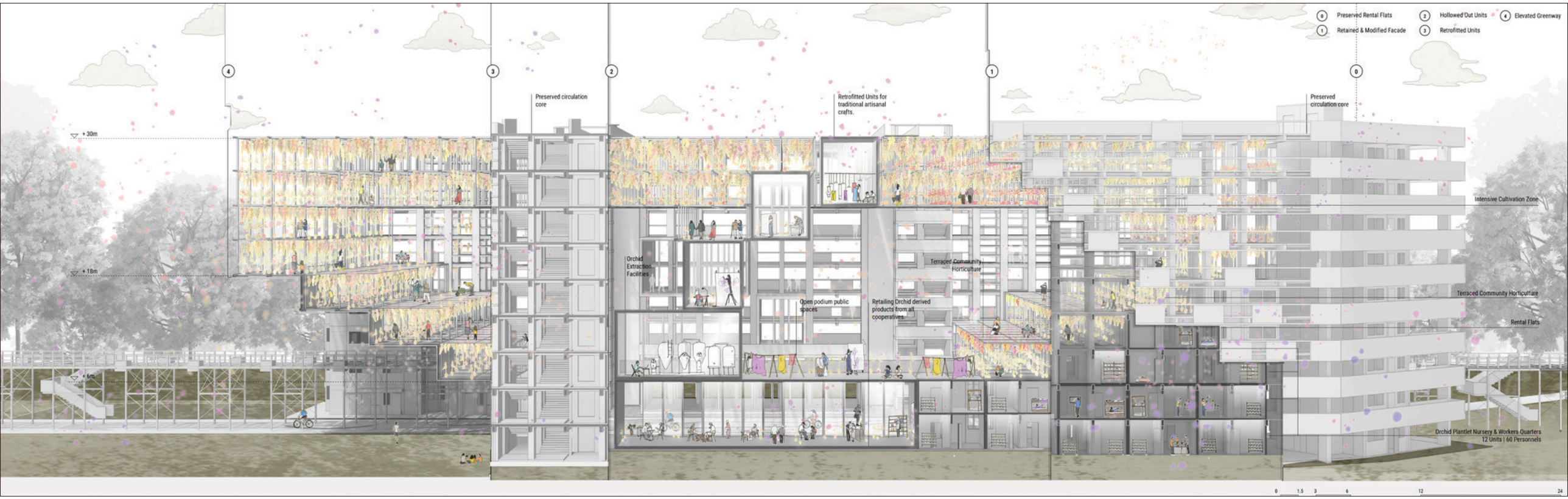


Fig. 5 Superimposed Section - Engaging Orchids and Horticulture

The building facade is partially demolished to increase its porosity for vertical orchid cultivation. The 50% remaining units are kept as rental flats, indoor orchid plantlet nurseries and the worker's lodging. New double height plug in spaces are inserted to accomodate workshops and studios that fosters community activities through orchid related activities such as horticulture, dye making, and traditional forms of extraction methods (Wen Cai, Li Gen, & Qing Wen, 2018) such as enfleurage, maceration, steam distillation and etc.

Extensive terracing from the demolishing of units are further expressed by the frames for communal horticulture by the residents and neighboring communities. The linkway that cuts through the central spine of the building brings visitors in from the Tanjong Pagar Railway corridor, greeting them with the orchid filled atrium with community terraces and plug in studio spaces as a gateway to the entire cooperative.

At the top of the flat resides a public lookout point towards the port to extend vertical circulation to the public for them to explroe the entire facility in its entirety.

I

Community Scaffold | Spooner Road Heritage Flats

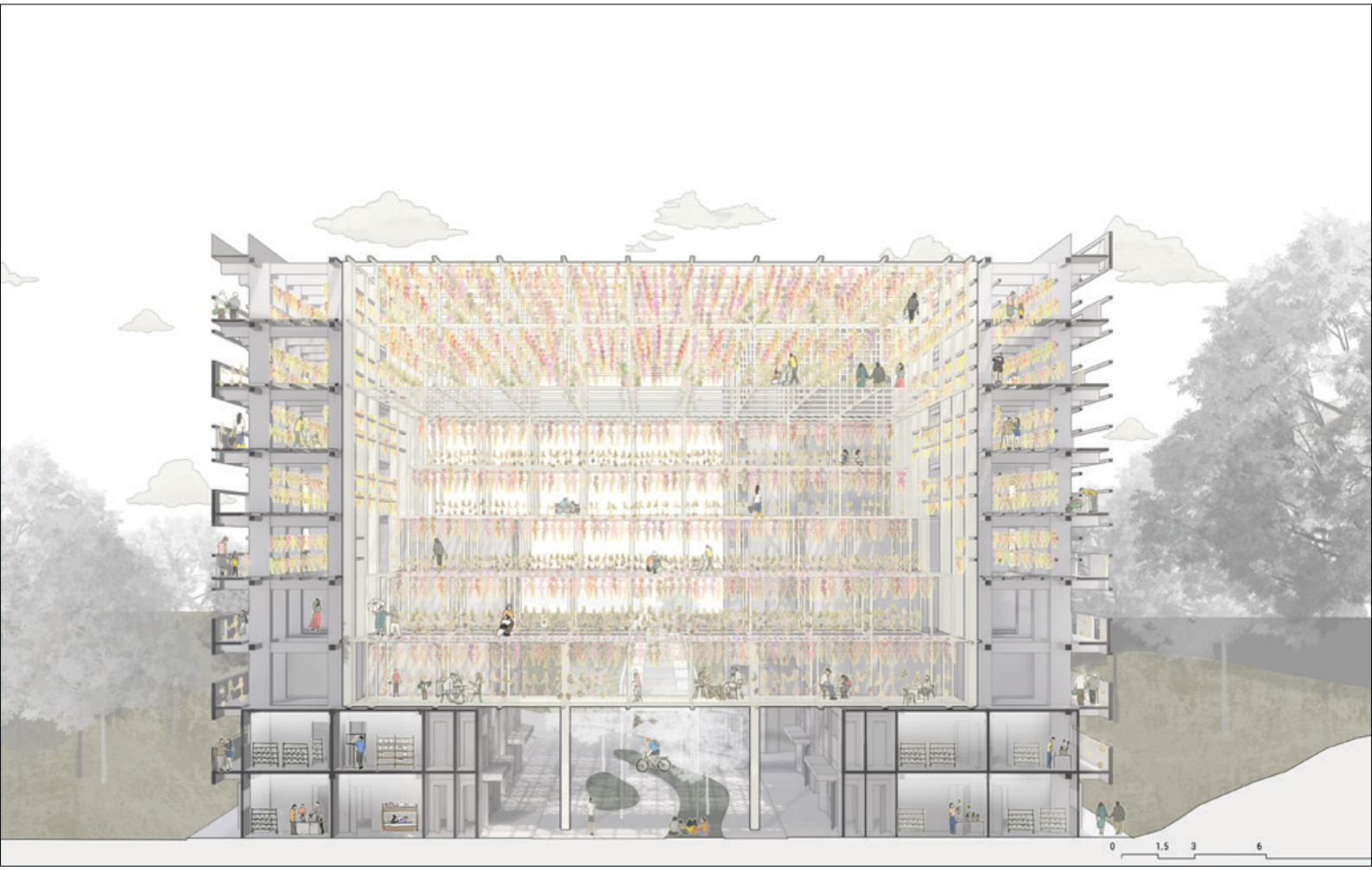


Fig 6. Retrofitted Frames

Cooperative I demonstrates the engagement of community stakeholders in need through the alteration and rejuvenation of the lease expiring (Romesh, 2012) Spooner Road Railway flats by 2021. The community of rental flat resident, aged and halfway home residents in the immediate vicinity brings a rich stakeholder group that has direct benefits to communal activities relating to horticulture. Expanding on the principles of horticultural therapy, this node focuses on non-institutitional, less individualized, group activities.

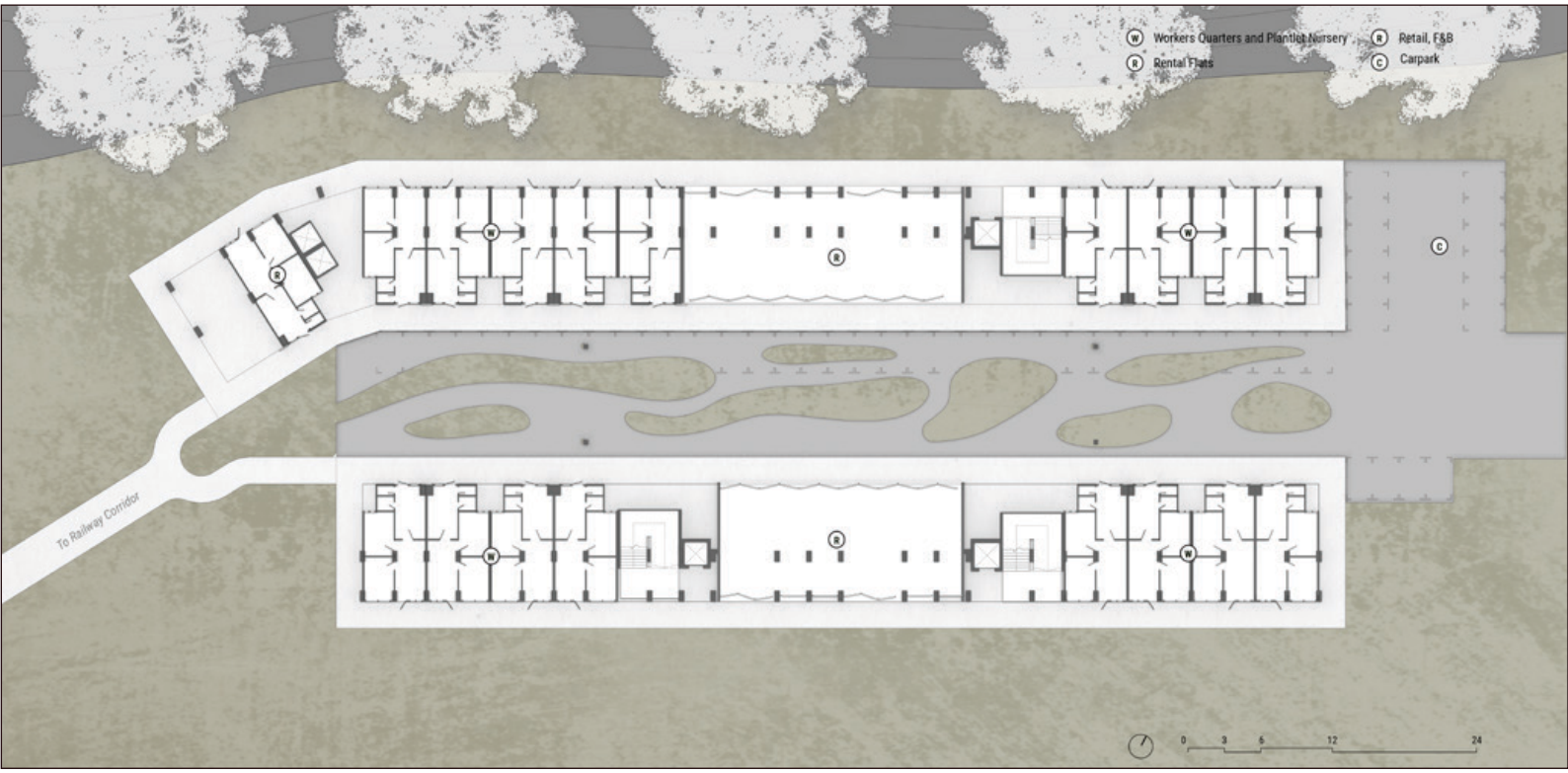


Fig. 7 Ground floor plan

The two flats that were once disconnected are extensively reconnected with the retrofitted frames to form activity and public space as a manner to foster a more tightly knitted community.

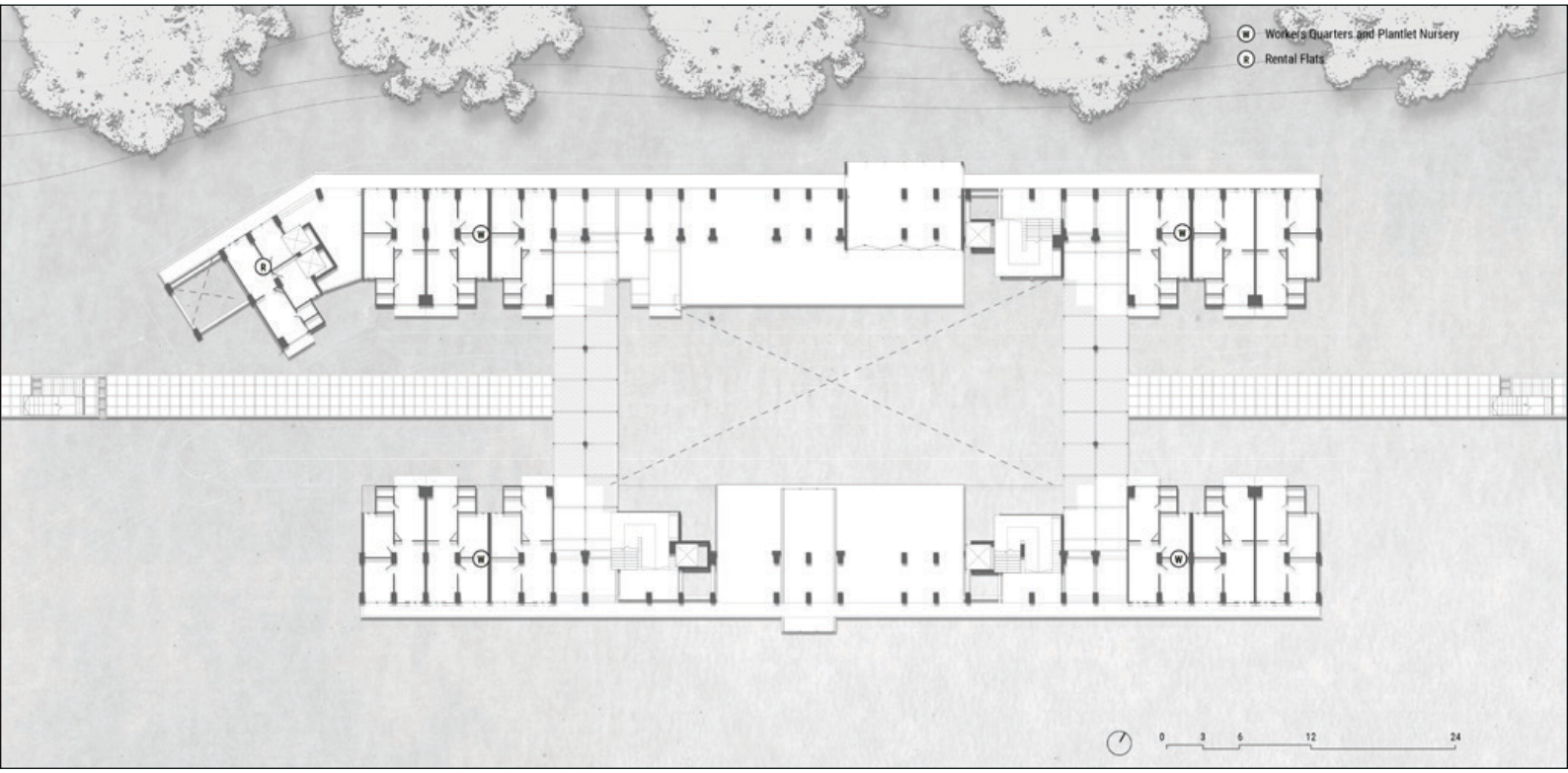


Fig. 8 Second Storey Floor Plan - Linkway and Atrium

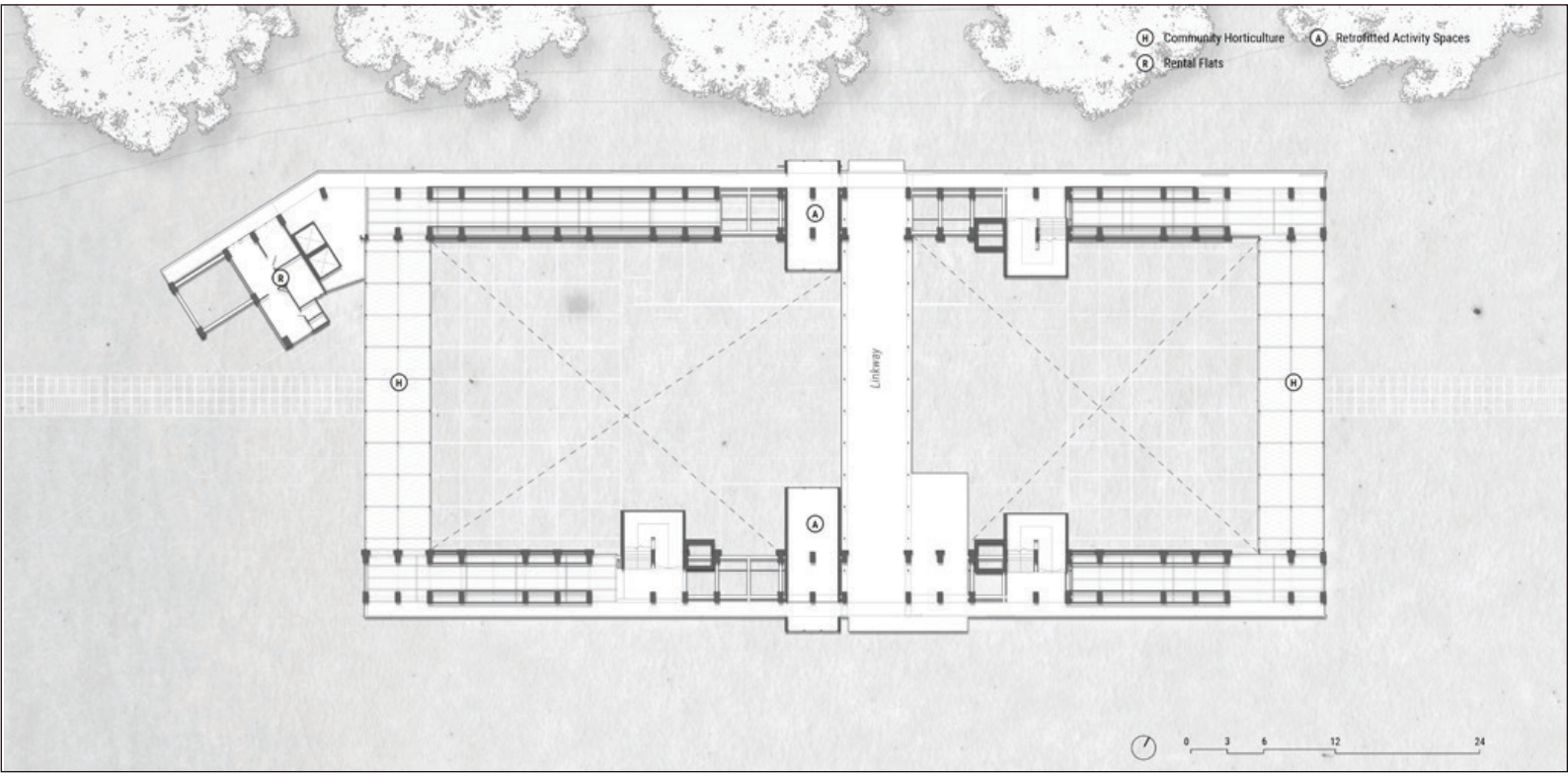


Fig 9. 5th storey floor plan - linkway and community gardening

II

Horti(culture) Recuperation

Vertical Private-Public Intimacy and Separation

This cooperative reinforces the principles of nature and its healing properties (RS Ulrich, 1984) by proposing a park connector that cuts through the future Singapore General Hospital that has a strong focus on a green campus.

Cooperative II demonstrates the expansion of facilitating healthcare through nature as the idea of horticulture and therapy has been growing in recent years as more therapeutic gardens started sprouting up, and educational institutions began offering courses in facilitating such aspects of healthcare.

Situated right under the blocks of elective care, national heart centre and future SGH core, Horti(culture) Recuperation focuses on offering an immediate environment for the end spectrum of rehabilitative therapy, activities as well as opportunitiest for visitors and public to pick up skills in this domain of expertise.

The linkway thus establishes a series of cultivation and activity frames which adjacent units open up towards, extending interior spaces outwards to form open classrooms such as floral workshops, cooking classes, gift shop flower pressing, aromatherapy fragrance making and etc. It provides a shared space that is simultaneously a training ground and recreational purpose.

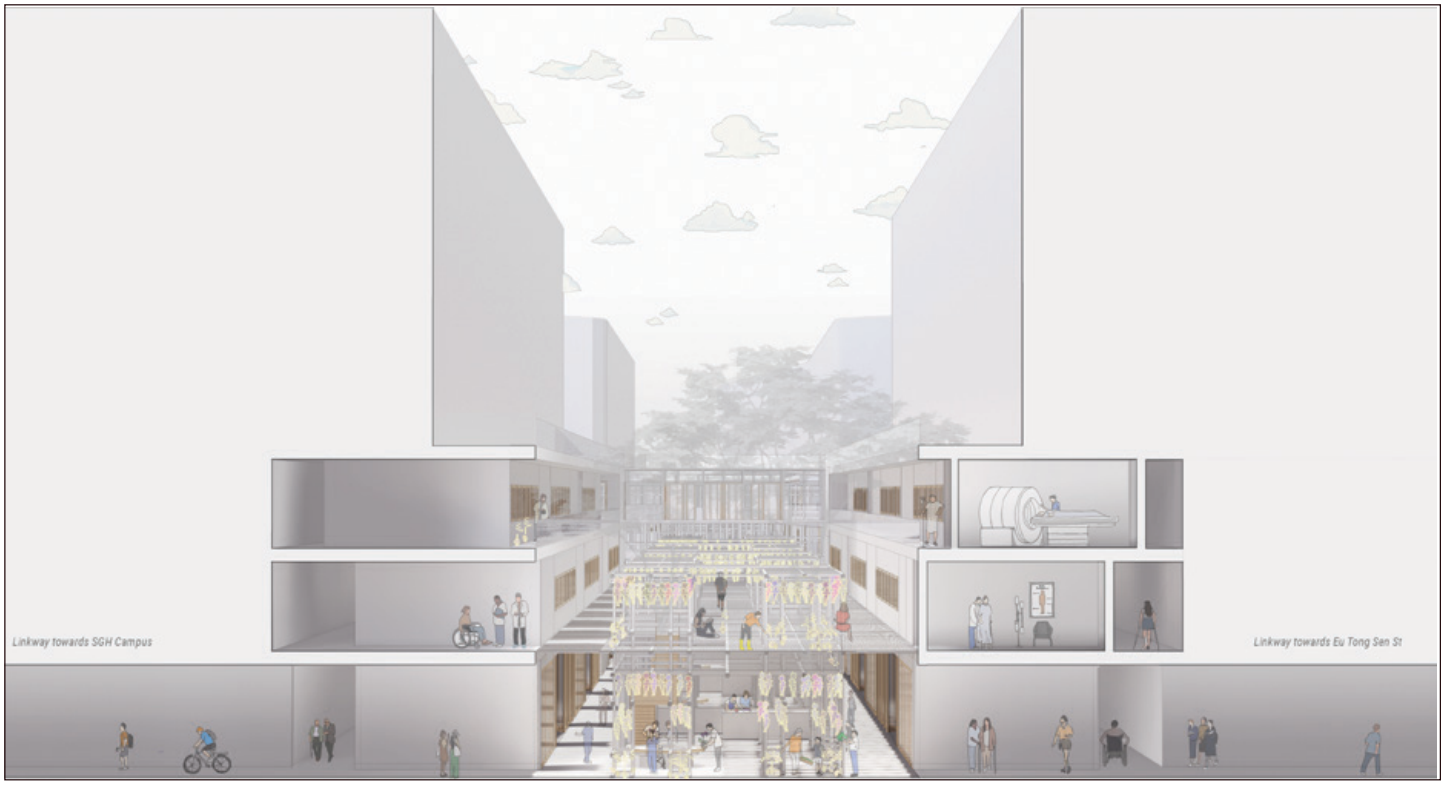


Fig. 10 Thoroughfare Section

Fig, 11 Linkway Section

Double Helical Private-Public Intimacy and Separation

The junction features a two sets of double helical ramp that interweaves public and private circulation without actual interactions. The podium level frames that houses activity spaces for individualized horticultural therapy sessions extend downards to the central courtyard to promote visual connection and simulation following principles of Attention Restorative Theory (Kaplan, 2001). Designed in loops of ramps lifted above the ground level, it provides a low cognition way finding and and mobility dedicated to all types of patients. Shielded by the cultivation of orchids, it provides a vantage point that gives a sense of security that is crucial in therapeutic spaces.

Figure 12. Junction: Double Helical Separation

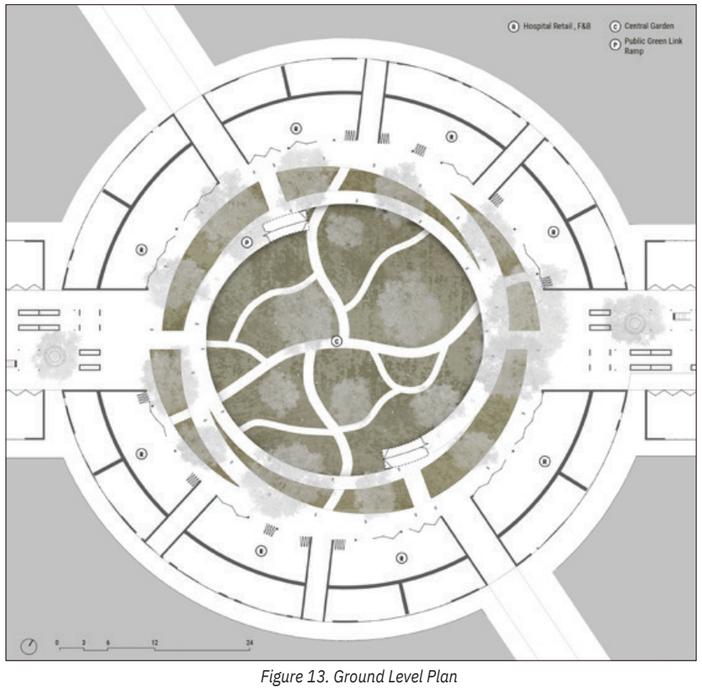


Figure 13. Ground Level Plan

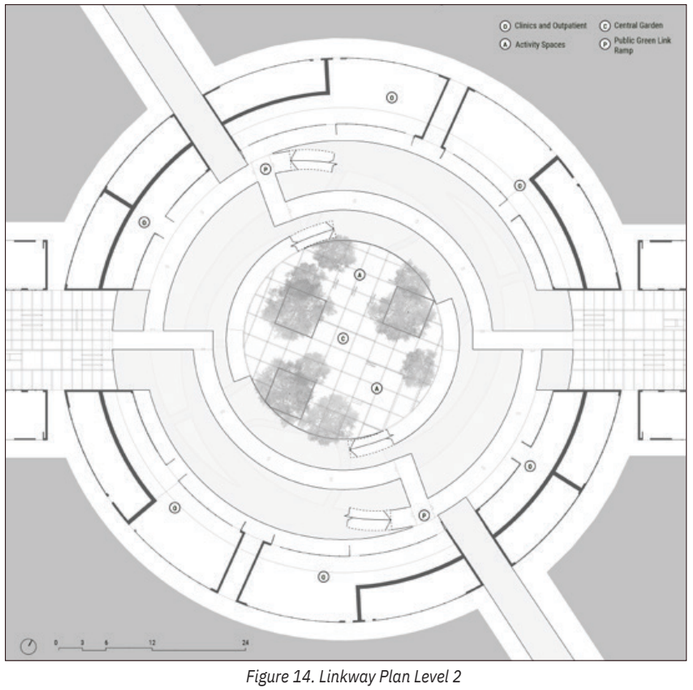


Figure 14. Linkway Plan Level 2

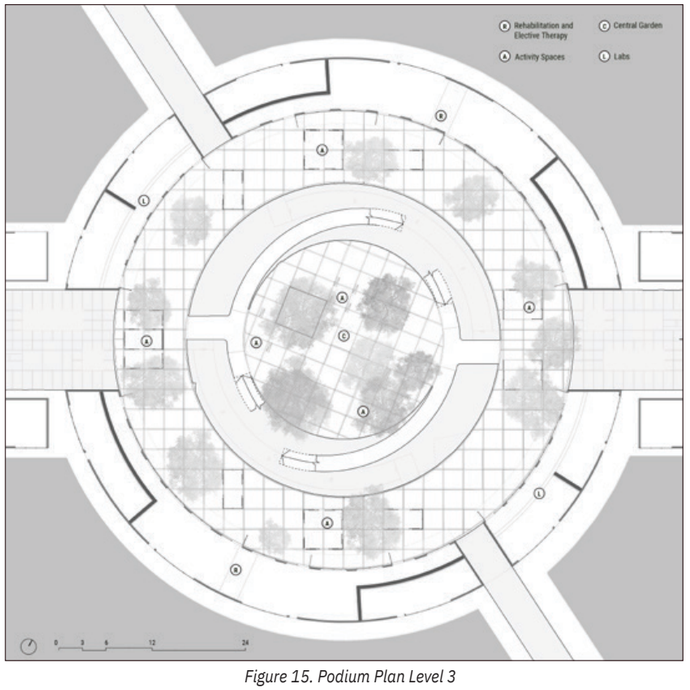


Figure 15. Podium Plan Level 3

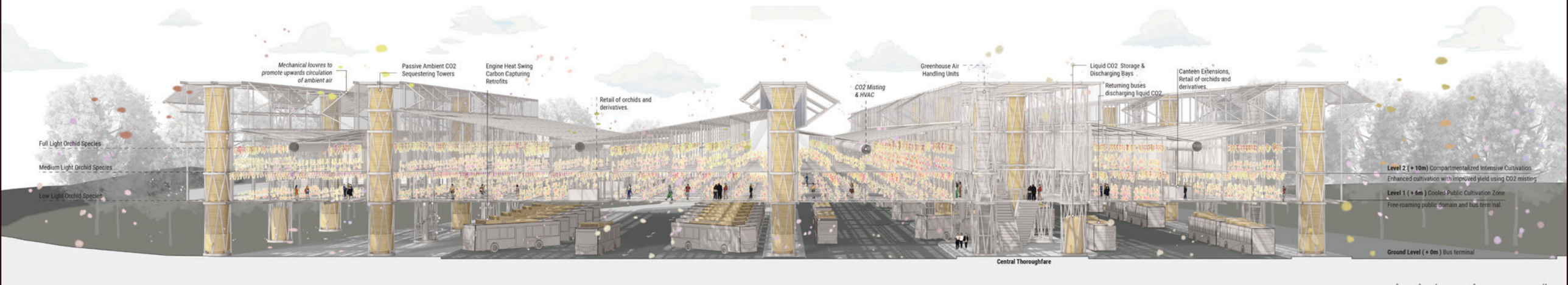


Figure 16. Multi-Tiered Domain and Cultivation

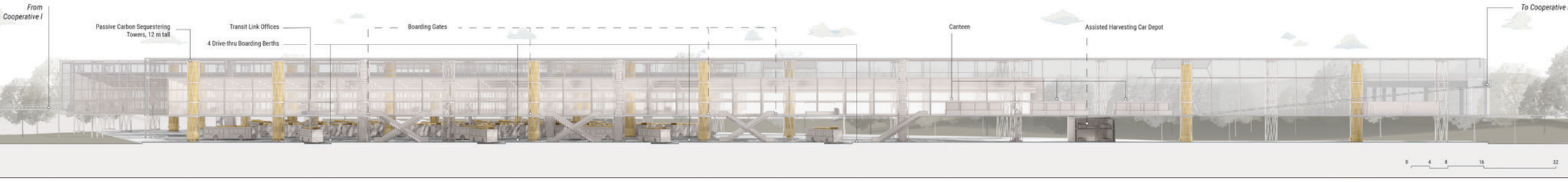


Figure 17. Central Thoroughfare Operations

The administrative operations of the bus terminal are lifted 6m above the ground while the parking facility and passenger berths remain on the ground level. The second level is imagined as an open plan for visitors and passengers to wait and explore.

Carbon Harvesting and Cultivation

Kampung Bahru bus terminal demonstrates a multi-stakeholder synergy of transport, environmental and nature authorities, while enhancing the growth of Orchids to drive down its costs of production.

Orchids are grown either in controlled environments or open air. Typical greenhouses have a much higher yield compared to orchids that are grown in uncontrolled conditions. However, as the costs of operations (McKinsey, 2020) are higher and the need to maintain higher than average carbon dioxide levels (OMAFRA, 12) incurs larger environmental footprint, it is a barrier of entry.

The bus terminal node leverages on the high traffic volume (Sharma & Marechal, 2019) of heavy vehicles to crowd source ((KIT), 2019) the supply of carbon dixoide by retrofitting the bus engines with temperature swing adsorption extensions (Sharma & Marechal, 2019). In addition, to cut down the amount of carbon dioxide levels requirement, the system adopts CO2 misting technology (CO2Gro, 2019) that reduces the consumption of CO2 by 90% while increasing the yield by 40%.

The scale of Kg Bahru bus operations supports only half (10ha) of what the entire cooperative requires. Thereforean extra 21 ambient CO2 direct air capture towers are added to increase the yield., producing a total of 1314 tn/CO2/year to meet the operational needs of the Orchid Cooperative.

The cost of carbon dioxide sequestration and operations is extremely low, since the mechanical towers are targeted to operate at $30/tnCO2 , while the buses have minimal to no cost of sequestration as it utilizes heat byproduct for temperature swing adsorption. This cost is further driven down by carbon tax reaching approximately $15/tn CO2 by 2030.

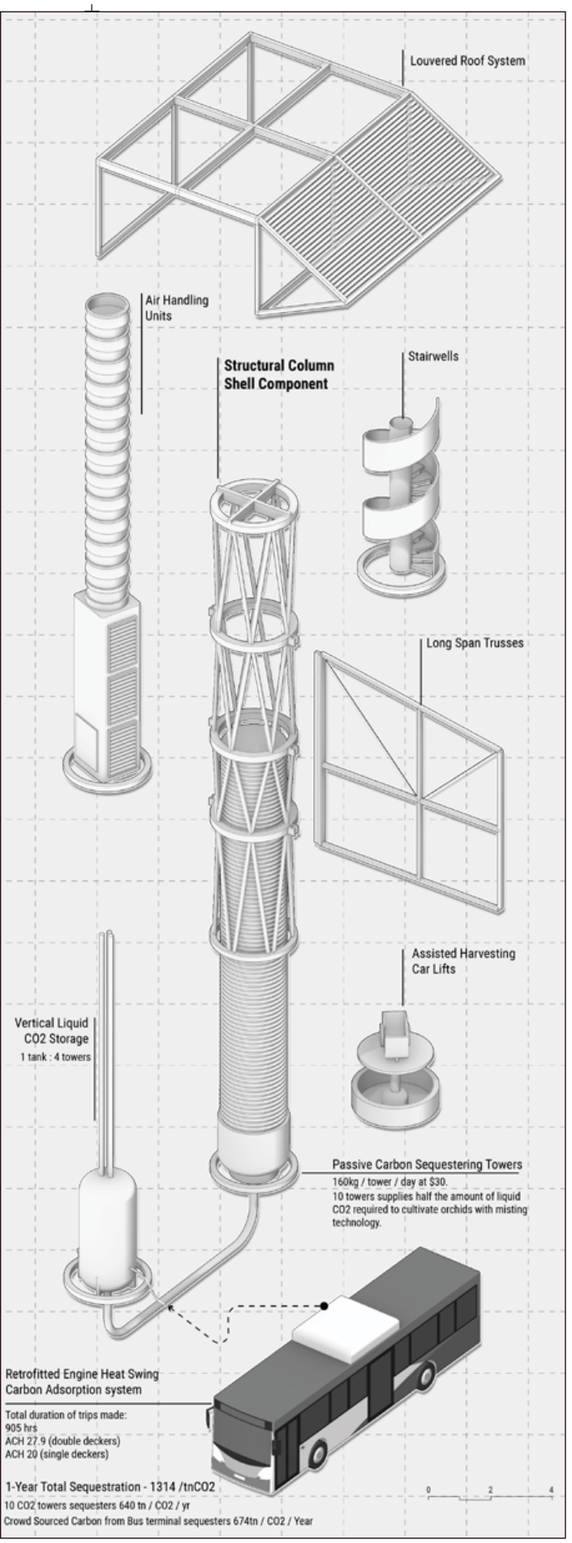


Figure 18. Adaptive Column Component Breakdown

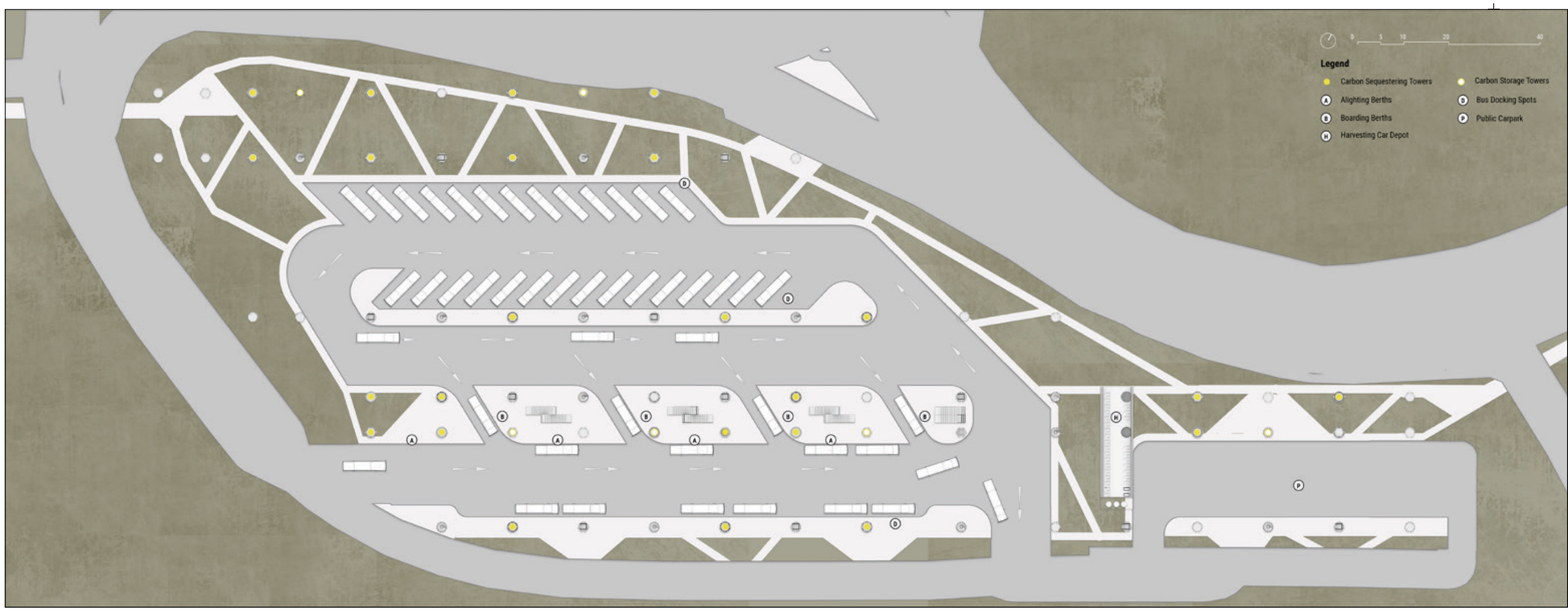


Figure 19. Ground Floor Plan

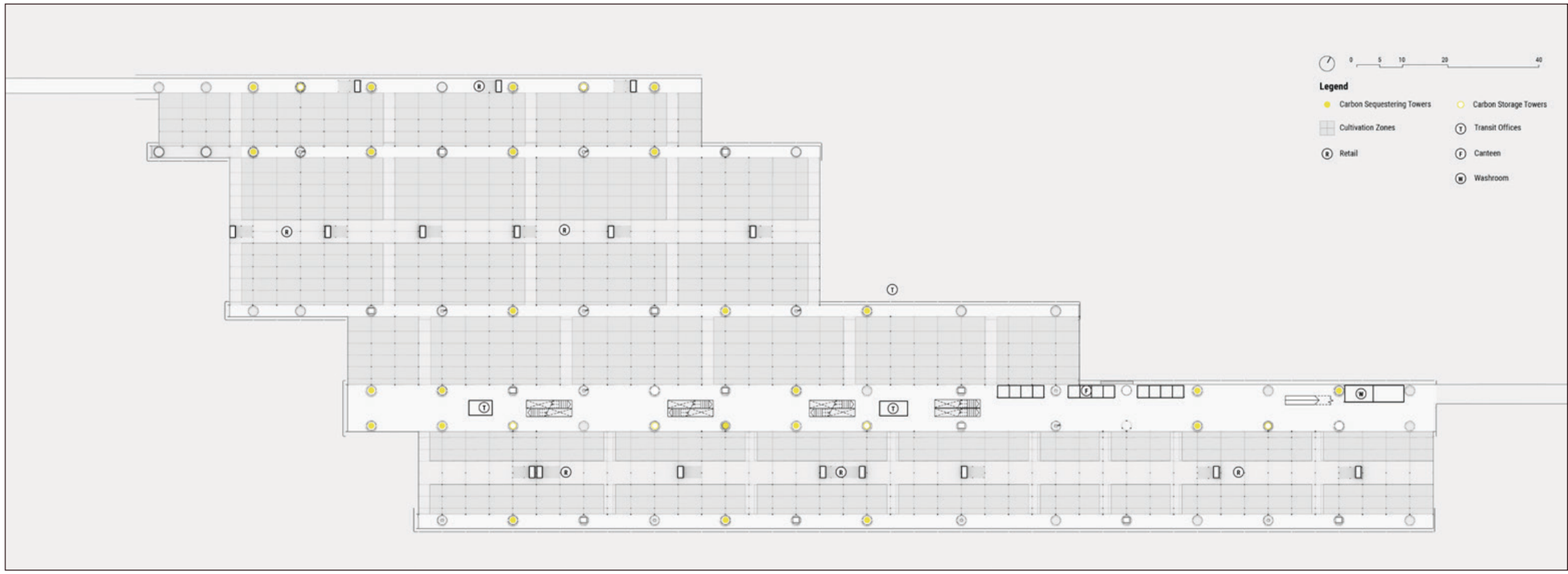


Figure 20. Second Storey Plan

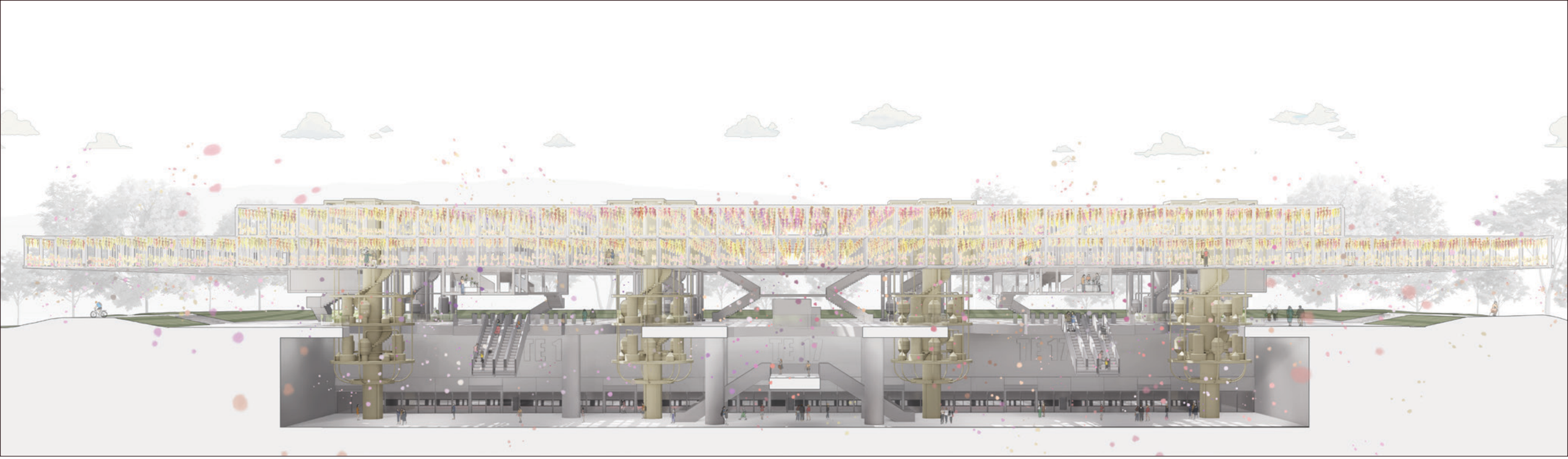


Figure 21. Tropical Roof Orchid Cultivation

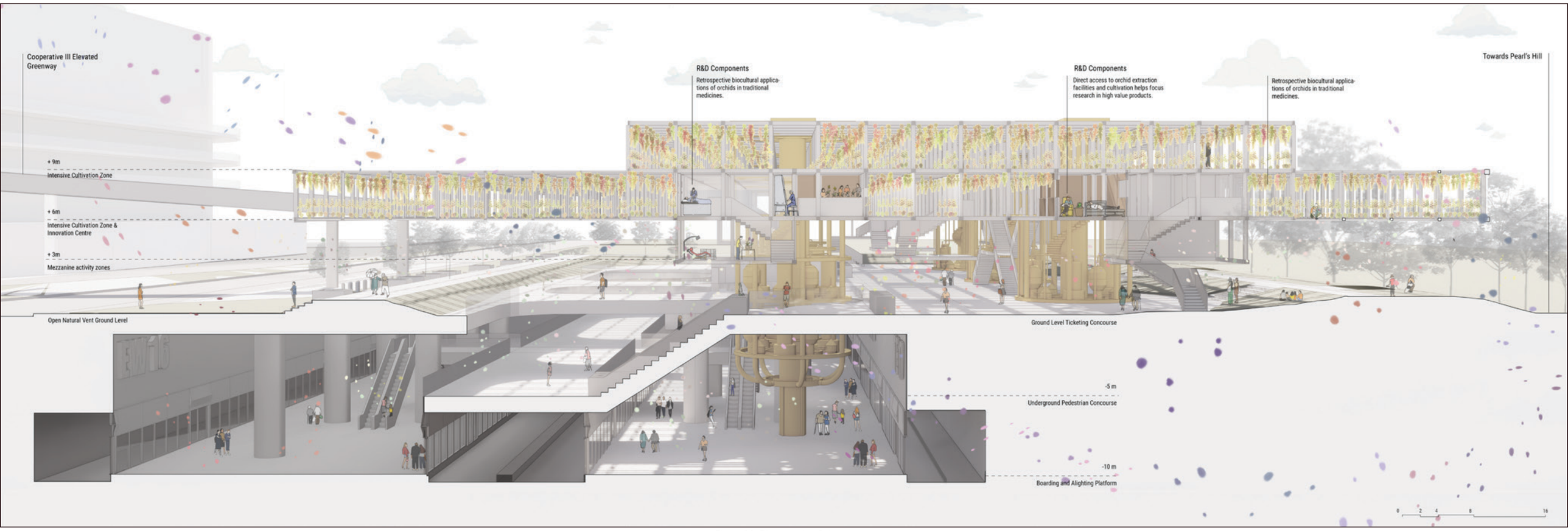


Figure 22. Bioextraction Columns

III

Living Lab | Outram Station

High Tech Bioextraction and Processing

The Outram Orchid Cooperative demonstrates the synergy of biocultural and bioprospecting interactions of Orchids, and the interests of agrifood ecosystem springboard. Known for a long evolutionary history and roles such as anthropological symbolism, traditional applications in medicine, this facility located at a high traffic juncture between Chinatown and SGH deals with the post-processing of the 90% of Orchid surplus from the entire cooperative and beyond.

The facility is composed of 4 large bioextraction columns that brings attention to the cultivation roof which serves as a giant tropical shelter that shades the naturally ventilated space below. Attached to each bioreactor column are innovation and retail spaces that houses potential startups, private research facilities and businesses familiar with the traditional applications of orchids to promote an exchange of knowledge.

The new extracts can be used to advance commerical products and medical applications that can be applied to clincial trials in cooperative II located in SGH, extending stakeholder participation towards the healthcare sector.

Bioextraction Capacity

The 4 sets of bioextrraction columns utilizes supercritical carbon extraction technology to extract the essences of orchids. Carbon dioxide deliver. Each column is capable of extracting up to 18kg of orchid surplus, and in total the facility is capable of processing close to 120k g of dried orchids, above the daily projected surplus of 62kg produced by the 1.3 million pots.

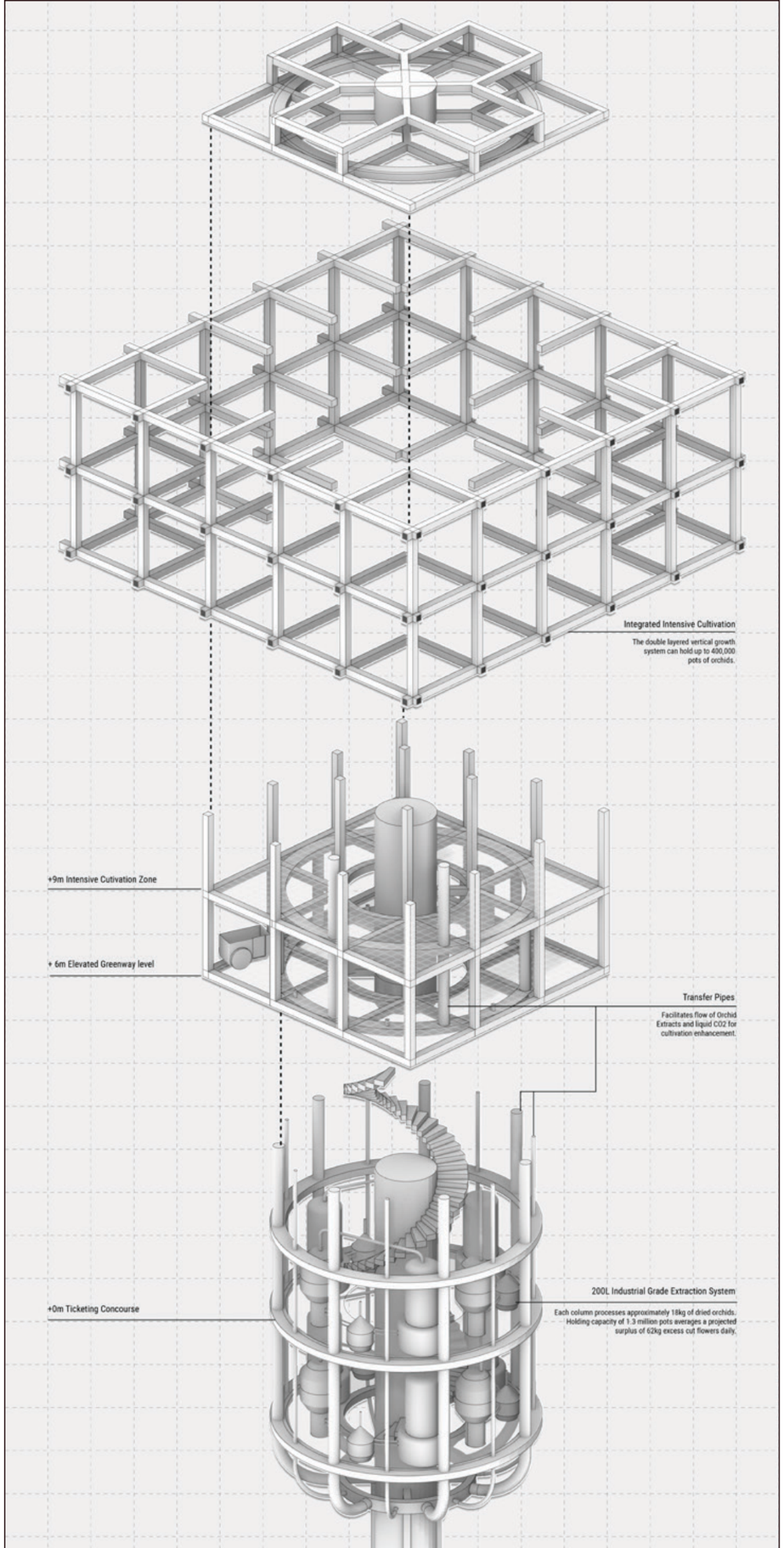


Figure 23. Bioextraction Column Component Breakdown

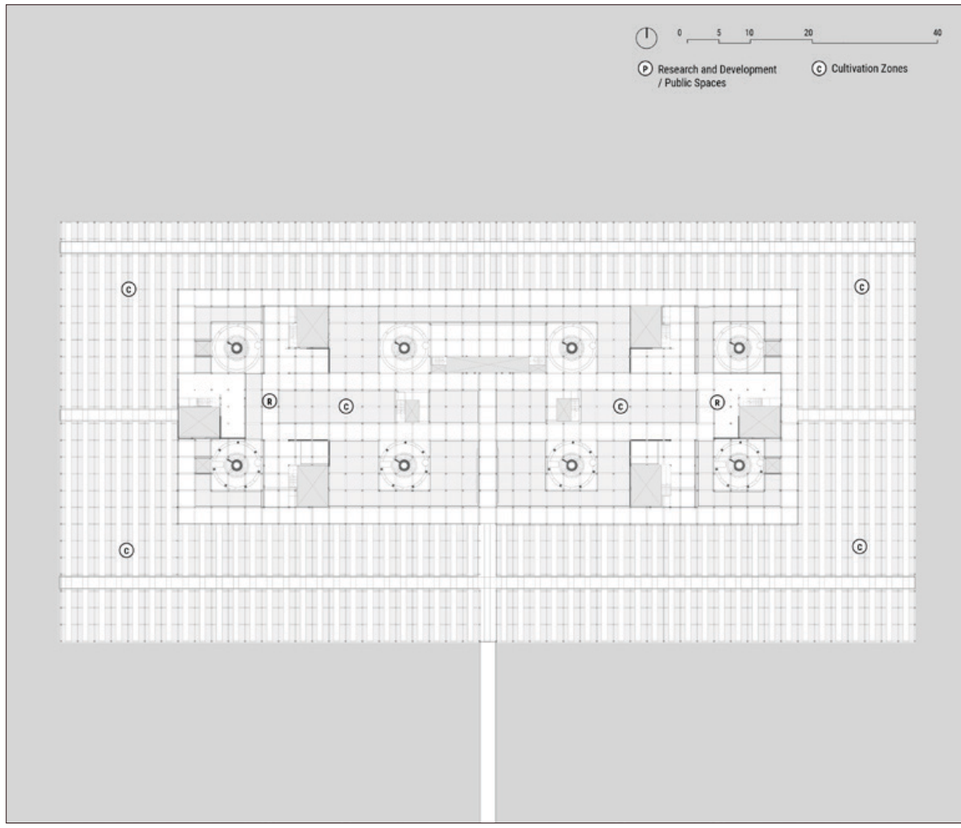


Figure 24. Ground Level Plan

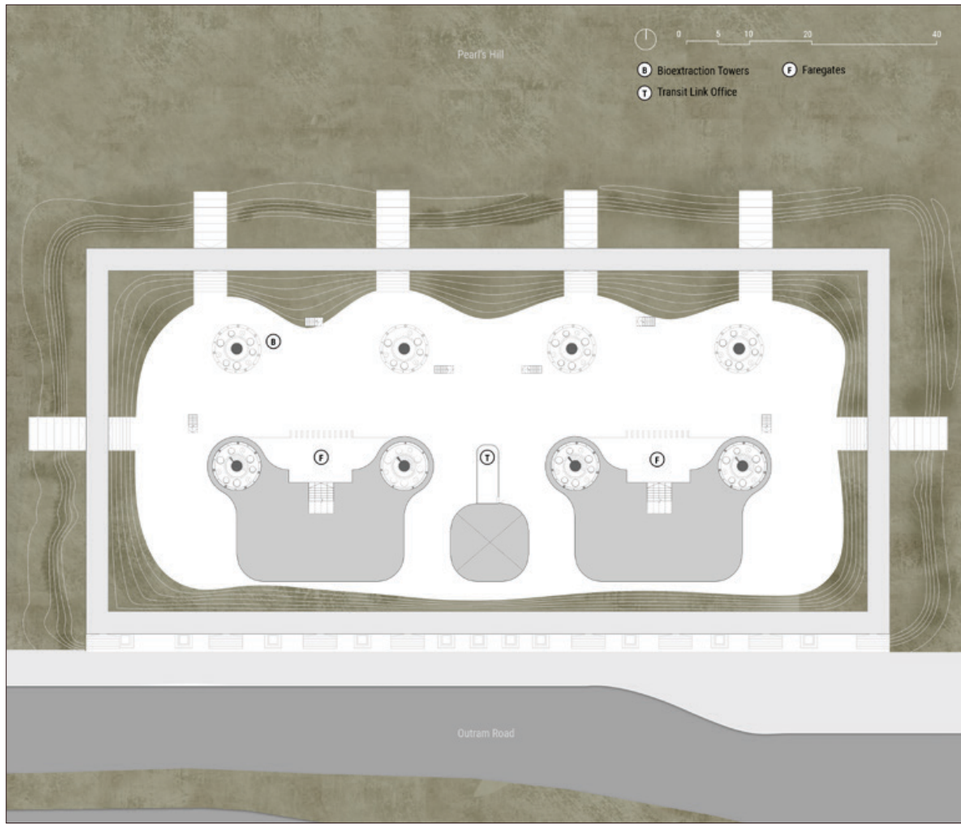


Figure 25. Rooftop Cultivation Plan

8.1.1 Bus Terminal services

Bus Number	Type	Duration	avg Interval	Op. Hour/ day	No. of Trips/ day	Total Travel Duration (mins)
2	1	100	15	18	72	7200
2a	1	60	20	3.5	10.5	630
12	1	105	15	18	72	7560
12e	1	80	30	11	22	1760
54	1	65	15	17	68	4420
120	0.5	75	15	17	68	5100
121	0.5	65	15	17	68	4420
122	0.5	70	20	17	51	3570
174	1	120	15	18	72	8640
174e	0.5	108	14	2	8.571428571	925.7142857
190	1	80	10	18	108	8640
ct8	0.5	50	30	7	14	700
ct18	0.5	55	30	7	14	770
Total	10	1033	18.76923	170.5		54335.71429

8

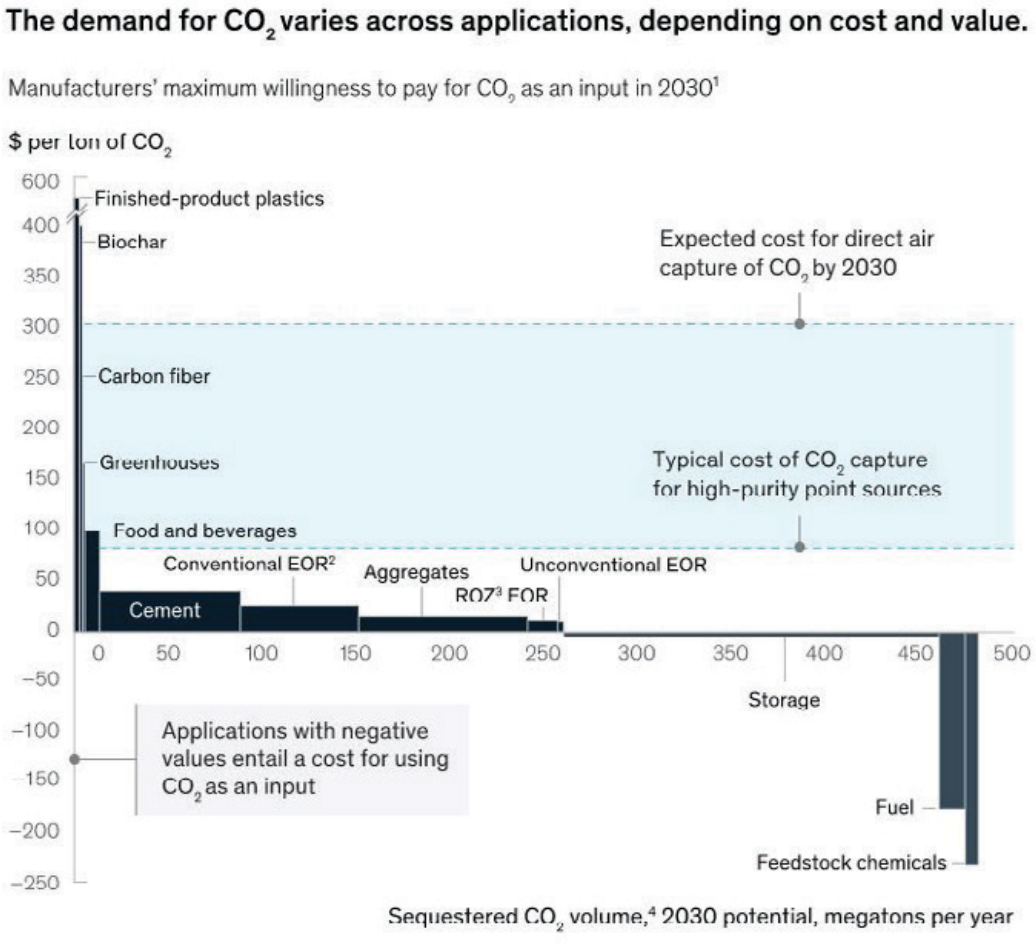
Annex

8.1 Calculation of CO2 Requirements

Typical Greenhouse Consumption	**15kg/ 1000m3/h**
CO2Gro Aqueous Delivery	**1.5kg/1000m3/h**
20ha (t-CO2) traditional greenhouse CO2 consumption	**1314**
1 Year CO2 Consumption of 10ha with CO2Gro (tn)	**657**
Vol. of Double Decker (0.5)	90
Vol. of Double Decker (1)	129
Air Change Rate (ACH)	(60* CFM) / vol
ACH of a double decker bus (1) : number of air changes in one hour	27.9
ACH of a double decker bus (0.5) : number of air changes in one hour	20
Total Travel Duration per Day (H) Single Deck (0.5)	258.0952381
No. of air changes in 1 day (*ACH)	5161.904762
Total volume of air exchanged (*vol. of DD)	464571.4286
weight of Co2 exchanged (90%)	341.1812571
90% efficiency	307.0631314
1 year	**112.078043**
Total Travel Duration per Day (H) Double Deck (1)	647.5
No. of air changes in 1 day (*ACH)	18065.25
Total volume of air exchanged (*vol. of DD)	2330417.25
weight of Co2 exchanged	1711.458428
90% efficiency	1540.312586
1 year	**562.2140937**
Total (1 Year)	**674.2921367**
Deficit	**639.7078633**
No. of Mechanical Trees Required	0.166666667
	3838.24718
	10.5157457

8.2 Benchmarks of CO2 Prices

Figure 26. CO2 global price benchmarks, McKinsey (2020)



9

Annotated Bibliography

Works Cited

ADB. (2020). SINGAPORE'S LONG-TERM CARE SYSTEM ADAPTING TO POPULATION AGING. Retrieved from Aging Asia and the Pacific: https://www.adb.org/sites/default/files/publication/637416/singapore-care-system-population-aging.pdf

The paper provides a comprehensive outline of Singapore's state of ageing population and the need of greater population health. It emphasizes the importance of preventive care as opposed to responsive care, as well as adopting a multi-faceted approach towards providing greater population health that will greatly reduce the cost on healthcare spendings.

Alperstein, J. (2018). Commodity, conservation, and nation building: the orchid and the Singaporean Identity. Vassar College, Senior Capstone Projects.

An anthropological study of Orchids traces the commonplace of flora in Singapore as part of the community and the rootedness in establishing an identity for the nation. It provides a clear and rigorous understanding of Orchids' history in Singapore.

Amport, D., & Schilinger, C. (2014). Growing Out Food Supply in Singapore. In M. Topalovic, M. Knusel, & M. Jaggi, Architecture of Territory (pp. 14-49). Singapore: Tien Wah Press, Singapore.

The studio work carefully documents the hinterland and territories of Singapore. It studies the changes of agricultural land uses and the primacy of SIJORI region in enabling the large scale production of orchids in singapore. The report publishes the hierarchical organization of the orchid farm; number of employees and contract types with the local industry.

ANTEA. (2020). ANTEA – Edible flowers: a new outlet for the horticultural sector in France and Italy. Retrieved from European Commission: https://ec.europa.eu/regional_policy/en/projects/Italy/antea-edible-flowers-a-new-outlet-for-the-horticultural-sector-in-france-and-italy

The venture provides a credible effort in pioneering the investigations in finding new values and uses of flowers in response to the struggles of horticultural sectors. Based on gastronomy and cuisines, it aims to increase the value chain of the horticultural sector by bringing cross-collaboration across different sectors. The report reinforces the scope of project in re-evaluating the value chain of orchids.

Au-Yong, R., & Tee, C. (2018, March 19). NParks plans to help nurseries produce new orchid varieties, revitalise ailing industry. Retrieved from SGSME: https://www.sgsme.sg/news/nparks-plans-help-nurseries-produce-new-orchid-varieties-revitalise-ailing-industry

The report publishes the efforts of nParks in providing support for the local farms, but it does not reflect the responses nor indicate any sort of long term plans for them.

AVA. (2014, August). Agriculture Productivity Fund and Agriculture Policies for Local Farms. Retrieved from nParks: https://www.nparks.gov.sg/~/media/nparks-real-content/news/2014/8/25aug14new-farm-and-nursery-policies_annex-a.pdf?la=en

The media release is important as a guide to farms which are bidding or rebidding new tranches for agriculture as the new farm plans will have to meet two minimum production levels to be awarded the tender and funding for construction. It is evident to Singapore's strategy of intensifying production levels, and it serve as a baseline for us to gauge the scale of land required in food production expansion.

Barnett, J. (2014, October 27). HOW GROWING DEMAND FOR FUNCTIONAL FOODS WILL IMPACT SOUTHEAST ASIA IN 2015. Retrieved from Mintel: https://www.mintel.com/blog/consumer-market-news/how-growing-demand-for-functional-foods-will-impact-southeast-asia-in-2015

The report reflects the growing functionality of food in southeast asia with the evidence of growing SME numbers in the sector of alternative food and beverages.

Basu, R. (2017, October 7). Long-term care: If this is so important, why aren't we putting our money where our mouth is? Retrieved from The Straits Times: Opinion: https://www.straitstimes.com/opinion/new-ways-to-fund-better-long-term-care

The Opinion piece provides an insight to the government spendings on long term care, raising the awareness that much attention is

placed on publicly funded medical care facilities and lesser on the non-profit, non-govermental organizations that depend heavily on donations and community funding.

Begum, S. (2019, May 12). Singapore's high-tech farms: From yesterday's pig farms to today's vertical veggie gardens. Retrieved from SGSME: https://www.sgsme.sg/news/singapores-high-tech-farms-yesterdays-pig-farms-todays-vertical-veggie-gardens

The article documents the journey of a farmer who has remained in the agricultural sector for many years, but has jumped from pig farming to orchid and now to vegetable farming. It chronicles the challenges of different farming models and relays the challenges of being in an agricultural business.

Begum, S. (2020, August 19). Mangroves and wetlands in the north make up Singapore's second nature park network. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/new-lim-chu-kang-nature-park-to-be-part-of-400ha-nature-park-network-along-the-northern

The new nature extension does not explain why the farm leases in lim chu kang will be expiring. Labelled in the newspaper article is a southern extension of which does not have any explicit purpose. This however points to greater accessibility to the farms in the future island wide park connector.

Blooms. (2018, March 30). Importance of Flowers in Indian Culture. Retrieved from Medium: https://medium.com/@bloomsonly123/importance-of-flowers-in-indian-culture-48b642ddf96a

There are many uses of Orchids and one of which is in the ayurvedict treatments derived in the ethnobotanical practices of Indian culture. It plays a symbolic role in spiritual and religious activities in a non-idolatrous manner, which could make orchids a multi-faith proxy.

Bowers, B. (2018, August 6). The path to creating Tanglin Gin, Singapore's first locally distilled gin. Retrieved from Lifestyle Asia: https://www.lifestyleasia.com/sg/food-drink/drinks/tanglin-gin-singapore/

Singapore's local tanglin gin that has its name originating from Tanglin that used to be famous for its spice and herb culture.

Chek, F. (2008). Medical nutrition therapy for chronic diseases. Singapore: SFP. Retrieved from http://cfps.org.sg/publications/the-singapore-family-physician/article/449_pdf

The article raises the importance of medical nutrition as one of the cornerstone strategies in treatment of chronic diseases. It points to the importance of a nutritionally balanced and tailored diet to reduce and prevent further complications of diseases.

Chin, S.-C. (2008). Biodiversity conservation in Singapore. BGJournal, 11-14.

The journal article points out the loss of biodiversity in Singapore over the years, and the strategies of nParks and role of Botanic gardens in conserving the remaning natural habitats.

Chong Jin, G., & Lee, G. (1989). Orchid Industry of Singapore. Economic Botany, 241-254.

This dated reported provides access and insights to the archives of singapore's orchid industry, on how it began and developed over the colonial times. It reveals the importance of Orchids in crafting the identity and presence of Singapore in her formative years, and the trend of orchid cultivation gaining popularity after the recognitition. The narrative of Orchids in the past establishes itself as an important cultural heritage for Singapore.

Chong, C. (2020, Jan 22). Fish farming group Barramundi Asia buying deep tech startup Allegro Aqua. Retrieved from The Business Times: GARAGE: https://www.businesstimes.com.sg/garage/fish-farming-group-barramundi-asia-buying-deep-tech-startup-allegro-aqua

The report points out the move of fish farming from in-land to coastal and sea based. Land shortage will not be a an issue for expanding productions with the deep-sea and costal capabilities that have been developed.

EDB. (2016, January 14). Asia's burgeoning geriatric nutrition market. Retrieved from EDB: https://www.edb.gov.sg/en/news-and-events/insights/headquarters/asia-s-burgeoning-geriatric-nutrition-market.html

The news release is centered on the ageing population of asia; Vietnam, China, Taiwan, Indonesia, Philippines and Singapore, and the changing nutritional demands for geriatric needs that has to be tailored to the dietary requirements of the aged. It estimates about US$40-70 billion market for functional food in the sector, priming a stage for investors to chip in.

En, S. M. (2017). Elderly to make up almost half of S'pore population by 2050: United Nations. Singapore: TODAY.

The news article documents the trend of ageing population in Singapore, expected to reach 6.34 million in 2030. The dependency ratio will also halve to almost 1:1.

Floral Daily. (2016, January 26). Singapore's orchid industry threatened by rising costs, competition. Retrieved from Floral Daily: https://www.floraldaily.com/article/9003663/singapore-s-orchid-industry-threatened-by-rising-costs-competition/

Gasco, A. (2016). THE AIRPORT AND THE TERRITORY Transnational Flows in the SIngapore-Johor-Riau Cross Border Region. In Hutchinson, E. Francis, & T. Chong, The SIJORI Cross-Border Region (pp. 341-362). Singapore: ISEAS–Yusof Ishak Institute.

The book section documents the importance and flow of goods around the SIJORI region, as well as the unique roles that each country plays within the cooperative.

Hinsley, A. (2018). A review of the trade in orchids and its implications for conservation. Botanical Journal of the Linnean Society, 435–455.

The paper highlights the issue of illegal Orchid trade in the southeast asian reigon, and the improtance of hybridisation in providing an alternative for orchid demand. The stock of wild orchids should be conserved as much as possible, and the production of commerical orchids will be one of the key strategies to alleviating the pressures of poaching.

HPB. (2010). National Nutrition Survey. Singapore: National Health Promotion Board. Retrieved from https://www.hpb.gov.sg/docs/default-source/pdf/nns-2010-report.pdf?sfvrsn=18e3f172_2

The report delineates the association between a healthy diet and chronic dieseases that are prevalent in Singapore. It tracks the consumption of nutrition and dietary practices of Singaporeans to structure future plans and strategies to ensure a healthy diet. It provides key finding on data collected from the national nutrition survey 2010.

HPB. (2014, March 15). 1.7 Million Singaporeans Already At Risk of Obesity-related Diseases. Retrieved from Health Promotion Board (HPB): https://www.hpb.gov.sg/article/1.7-million-singaporeans-already-at-risk-of-obesity-related-diseases

The article states the key findings of Singaporeans being at risk of obesity-related diseases, and the one million kg challenge national initiatve to help the obese and overweight. Body mass index is closely related to lifestyle practices including diet, and it highlights the importance of ensuring the right intake of nutrition.

ITC. (2020). Product: 060313 Fresh cut Orchids and Buds, of a kind suitable for bouquets or for ornamental purposes. Retrieved from Trade Map: https://www.trademap.org/Index.aspx?nvpm=1%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c

The data can be visualized in many ways to reflect Singapore's presence in the global orchid trade. It concludes that Singapore's global presence despite its relatively more expensive orchids is infact minimal, and that the global orchid demand has been shrinking.

Jetro. (2011). Guidebook for Export to Japan 2011 . Tokyo: Japan External Trade Organization (JETRO).

Judith. (2013, August 10). He makes failure a blooming success. Retrieved from AsiaOne: https://www.asiaone.com/he-makes-failure-blooming-success

The interview report chronicles the journey of a poor boy to a successful orchid breeder who has won awards in competitions. It highlights the role of Orchids in the past as a way for the poor to unknowingly strike rich given its extremely high value as an exotic flora when global trade was still in its infancy.

K.M, W. (2012). Gardens' Bulletin Singapore 64(1): 279–280 2012. Book Review: Wild Orchids of Peninsular Malaysia. P.T. Ong, P. O'Byrne, W.S.Y. Yong & L.G. Saw. 2011. , 279-280.

Kaplan, S. (1995). The Restorative Benefits of Nature: Toward an Integrative Framework. Journal of Environmental Psychology, 169-182.

The journal proposes the theory of directed and indirect attention through the exposure to nature, given the multitude of natural stimuli, it can help to relax the mind, recover and improve cognitive capacity in restorative experiences.

Khalik, S., & Rashith, R. (2018, August 15). MOH to grow aged care services to meet rising demand. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/moh-to-grow-aged-care-services-to-meet-rising-demand

The newspaper article highlights the key statistics of strategies that the government is undertaking in response to the Lien report of a greater demand for long-term care services and facilities.

Lai, L. (2017, Aug 19). More than 100ha of land to be set aside for landscape nurseries in a first. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/environment/more-than-100ha-of-land-to-be-set-aside-for-landscape-nurseries-in-a-first

Lang, T., & Heasman, M. (2015). Food Wars (Second Edition) The Global Battle for Mouths, Minds and Markets. New York: Routledge.

The book highlights three key food paradigms; productivist, life sciences and ecological, in response to the global 2008 food crisis. It traces the multitude of interests across different stakeholders in food production and the paradigmatic shifts according to the conflicts. The three contrasting paradigms reminds that there will never be a right method of food production that can be accepted, but the primacy of the ecosystem in production is one that has to be considered in its socio-economic and ecological, environmental impacts.

Lee, B. (2011). Asia Pac J Clin Nutr. Dietary Guidelines in Singapore, 20 (3):472-476.

The report highlights the different dietary guidelines in 2011 that have been develoepd to tailor to different dietary needs of people from different age groups. It shows the importance of the guidelines in relationship to health, and its implementation in places of food consumption from workplace canteens to hawker centres, restaurants and schools.

Minh, T., Tuyen, P., Khang, D., Quan, N., Ha, P., Quan, N., . . . Xuan, T. (2017). Potential Use of PlantWaste from the Moth Orchid (Phalaenopsis Sogo Yukidian "V3") as an Antioxidant Source. foods. Retrieved from http://www.mdpi.com/journal/foods

The paper identifies the moth orchid phalaenopsis as one key source of antixodant that can be extracted for applications in food. It highlights its viability given the low cost and price of orchids in the current market, since Phalaenopsis is one of the most commonly found commerical orchids.

MOH. (2016). Executive Summary on National Population Health Survey 2016/17. Singapore: Ministry of Health (MOH).

The report higlights key issues of obesity & overweight, physical activity, smoking habits, binge drinking, cardiovascular screening,

hypertension & hyperlipidaemia and diabettes as the key markers to nationa population health.

MTI. (2019, Mar). Ministry of Trade and Industry. Retrieved from Agri-Food Innovation Park (AFIP): https://www.mti.gov.sg/-/media/MTI/COS-2019/Factsheet_AFIP.pdf

The media release factsheet provides a broad overview of the future agri-tehc hub at Sungei Kadut, on the potential of urban food production and platform for cross collaborationof different agencies to enable innovation and expansion of the value chain.

Ng, M. (2020). Leisure and Community Participation (OTY1008) [Horticultural Therapy]. Singapore Institute of Technology, Singapore.

The training document for Singapore Institute of Technology's module is an extension of the Research and Design Guidelines of Therapeutic gardens, a key evidence of a efforts toward developing the horticulture and therapy in Singapore.

Nguyen, H., Lin, K.-H., Huang, M.-Y., Yang, C.-M., Shih, T.-H., Hsiung, T.-C., . . . Tsao, F.-C. (2018). Antioxidant Activities of the Methanol Extracts of Various Parts of Phalaenopsis Orchids with White, Yellow, and Purple Flowers. Notbulae Botanicae Horti Agrobotanici Cluj-Napoca, 48. Retrieved from http://www.notulaebotanicae.ro/

The study provides an interesting insight in the relationship between color and levels of antioxidants in orchids, yellow being the highest, folloewd by purple and white. The study carried out points to the Orchid flower petals having the highest polyphenolic content, and it is comparable to vegetables that are commonly found in the market.

nParks. (2018, August 29). Research and Design Guidelines of Therapeutic Gardens. Retrieved from nParks: https://www.nparks.gov.sg/gardens-parks-and-nature/therapeutic-gardens/research-and-design-guidelines

This official document serves as a guideline for future facilitators and designers of therapeutic gardens, explaining the three different levels of horticultural therapy across varying degrees of individualization. It also highlights the key spatial principles of designing way finding as well as street furniture to cater to users of varying cognitive abilities and mobility.

OSSEA. (2017). OUR HISTORY. Retrieved from The Orchid Society of Southeast Asia (OSSEA): https://www.ossea.org.sg/about/our-history/

Raguaraman, A. (2020, August 9). Here's to the S'pore Spirit. Retrieved from The Straits Times: https://www.straitstimes.com/lifestyle/food/heres-to-the-spore-spirit

Rajeevan, P., Rao, A., De, L., & Pathak, P. (2019). Global Orchid Industry. In Commercial Orchids (pp. 13-19). De Gruyter Open, Warsaw, Poland. Retrieved from https://www.researchgate.net/publication/336604199_2_Global_Orchid_Industry

The report gives an overview on the major players and exporters of the global orchid industry, and the key orchid types that are traded in the market.

Rashith, R., & Lee, G. (2018, March 15). Orchid nurseries to move to designated land. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/orchid-nurseries-to-move-to-designated-land

The newspaper article publishes the government efforts to protect the local ornamental and orchid industry, however it is shrinking the total land area allocated to orchids from 40ha to 20ha. Some farmers interviewed expressed content over the move as they feel that a cluster will bring more tourists and visitors.

SFA. (2016, July 17). Farming Area. Retrieved from Data.gov.sg: https://data.gov.sg/dataset/farming-area?view_id=d428e485-b768-432d-b702-4cffe078a9fa&resource_id=9a826bf2-34c4-4694-b4af-f338d6205fb3

The data reflects the large percentage of singapore's farmland being occupied by ornamental and orchid production,, and documents the trend of its decreasing share over the years starting from year 2000.

SFA. (2020, July 27). Our Singapore Food Story. Retrieved from Singapore Food Agency: https://www.sfa.gov.sg/food-farming/sgfoodstory/grow-local

SIFBI. (2020, September). FROM LAB TO TABLE: TOWARDS SINGAPORE'S "30 BY 30" FOOD SECURITY GOAL. Retrieved from A*STAR: https://www.a-star.edu.sg/News-and-Events/a-star-news/news/features/from-lab-to-table-towards-singapore-s-30-by-30-food-security-goal

*The media release serves as opening statement for SIFBI. The director of A*Star discusses the importance of alternative food types amidst Singapore's strategy to expanding food production, that the nation needs to consume the right type of nutrition tailored to requirements of health.*

Singapore Memories. (2020). Therapeutic Orchids. Retrieved from Singapore Memories: https://singapore-memories.com/pages/therapeutic-orchids

This is the most prominent company invovled in developing fragrances and uses for Orchids, and the website provides a compendium of uses for different species of orchids from A-Z, as well as those that are found locally.

Singh, D. R., Kishore, R., Kumar, R., & Singh, A. (2016). Orchid Preparations. Sikkim: ICAR - National Research Centre for Orchids, Pakyong, -737106, Sikkim.

India is very well known for orchid cultivation, and the report published by the National Research Centre for Orchids documents the variety of uses that Orchids can provide, from edibility to bioprospects and derivatives of fragrances.

Tan, A., & Boh, S. (2017, May 28). Lim Chu Kang farmers perplexed by 3rd lease extension. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/environment/farmers-perplexed-by-3rd-lease-extension

Tan, A., & Tan, C. (2020, October 5). Lim Chu Kang set for makeover into high-tech agri-food cluster. Retrieved from The Straits Times: https://www.straitstimes.com/singapore/environment/lim-chu-kang-set-for-makeover-into-high-tech-agri-food-cluster

390ha of land surrounding the existing Lim Chu Kang farms will be used to develop high tech food production tranches. While it highlights the opportunity for farms with expiring leases, it does not mention the future use of the existing farmland, neither does it include the opportunity for ornamental orchid farms to be relocated to.

Teng, P., Ma, J., Montesclaros, L., Hulme, R., & Powell, A. (2019). The Evolving Singapore Agrifood Ecosystem. RSIS NTS, 1-14. Retrieved from https://www.rsis.edu.sg/wp-content/uploads/2019/08/NTS-Insight-TengMontesclarosHulmePowell-Aug2019.pdf

The report highlights the greater strategy of agrifood ecosystem over the recent initiatives to expansion of food production, that food industry stillremains the top priorityof Singapore given its land scarcity, to pioneer "Food 4.0" regionally and globally.

Ulrich, R. S. (1984). View through a window may influence recovery from surgery. Science, 420-421.

A study conducted by an architect on the view of rooms that patients had while recovering from surgery revealed the positive influences of natural environment on wellbeing. The early study became one of the major findings in establishing the relationship between nature and health.

Wilson, E. O. (2011). Biophilia. Cambridge, Mass, United States: HARVARD UNIVERSITY PRESS.

Edward O Wilson argues the natural affinity of humans for nature, and that its the essence of humanity. It was developed in the context of an american environmental movmenet between 1900-2000 in view of negative impacts of a gradual detachment from our natural surrounings.

Wolverton, B. C., Johnson, A., & Bounds, K. (1989, September 15). Interior Landscape Plants for Indoor Air Pollution Abatement. Retrieved from NASA Technical Reports Server: https://ntrs.nasa.gov/citations/19930073077

It is one of the earliest studies conducted by NASA to design an filter based on the capabilities of plants absorbing volatile organic compounds through its leaves, plant roots and living micro-organisms in soil.

Yam, T., Ang, P., Tay, F., & Wei Jing, S. (2016). Special Ecology Feature: Conservation and Reintroduction of Native Orchids in the City in a Garden. CITYGREEN, 142-147. Retrieved from https://www.nparks.gov.sg/-/media/cuge/ebook/citygreen/cg4/cg4_16.pdf?la=en&hash=C4B0706B6CAB7AA1442C55DCEB4D434DB1222AF5

The report highlights the key findings of the National Conservation Program through seedlings, prepared by the controlled cross pollination of species and growth in laboratory and nurseries. It identifies tree crevices as fertile spots for orchid growth and the flowers should thrive under the right microclimate.

Yong, J. (2020, February). Two in Five are Flexitarian. Are You? Retrieved from FOOD: https://www.wonderwall.sg/food/two-in-five-singaporeans-are-flexitarian-are-you/

The short report highlights the opportunity for startups and businesses to tap into the trend of growing health awareness and shift towards a plant based diet.

Zaccheus, M. (u.d.). Historic Gardens. Singapore: The Straits Times.

The historic gardens is a publication that documents the history of Singapore Botanic Gardens.

(KIT), K. I. (2019, May). Crowd oil: Fuels from air-conditioning systems. Retrieved from Science Daily: https://www.sciencedaily.com/releases/2019/05/190503100816.htm

CO2Gro. (2019). CO2 Delivery Solutions. Retrieved from CO2Gro: https://www.co2gro.ca/
Goh, Y. H. (2019, Oct 3). More rooms, facilities at new site of male ex-convicts' shelter. Retrieved from Straits Times: (Wen Cai, Li Gen, & Qing Wen, 2018)

Marisol, O. (2020, 10 15). The world's first mechanical tree prototype is to be built at ASU next year. Retrieved from The State Press: https://www.statepress.com/article/2020/10/spbiztech-the-worlds-first-mechanical-tree-is-to-be-built-at-asu-by-next-year#:~:text=La%20Prensa-,The%20world's%20first%20mechanical%20tree%20prototype%20is,built%20at%20ASU%20next%20year&text=An%20artist%20rend

McKinsey. (2020, June 30). Driving CO2 emissions to zero (and beyond) with carbon capture, use, and storage. Retrieved from Mckinsey and Company: https://www.mckinsey.com/business-functions/sustainability/our-insights/driving-co2-emissions-to-zero-and-beyond-with-carbon-capture-use-and-storage#

OMAFRA. (12, 02). Carbon Dioxide In Greenhouses. Retrieved from MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS: http://www.omafra.gov.on.ca/english/crops/facts/00-077.htm

Romesh, N. (2012, October 10). Tanjong Pagar flats to be rented out to low-income households. Retrieved from Yahoo: https://sg.news.yahoo.

com/tanjong-pagar-flats-rented-low-income-households-041412254--sector.html?guccounter=1

Sharma , S., & Marechal, F. (2019, Dec 16). Carbon Dioxide Capture From Internal Combustion Engine Exhaust Using Temperature Swing Adsorption. Retrieved from Front. Energy Res: https://www.frontiersin.org/articles/10.3389/fenrg.2019.00143/full

Wen Cai, Y., Li Gen, L., & Qing Wen, Z. (2018). Techniques for extraction and isolation of natural products: a comprehensive review. PMC. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5905184/#:~:text=Extraction%20is%20the%20first%20step,the%20most%20widely%20used%20method.

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