

NTS Insight, no. IN18-02, February 2018

## Ensuring a Successful Singapore Urban Food Cluster

By

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*This NTS Insight highlights a key issue to consider in pursuing an urban food cluster (UFC) for Singapore, and three strategic considerations in addressing this moving forward. Clusters are geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions in particular fields that compete but also cooperate. Singapore has succeeded previously in developing clusters for industries such as petrochemicals, water, and biomedical services, increasing productivity growth and production capacity in these sectors. Urban food production has recently been identified as a potential new cluster, building on the rapid growth of agricultural technologies (agtech) which are the intersection of food production with advanced technologies. Apart from productivity growth and production capacity expansion, as was achieved by past clusters, the UFC will also seek to contribute to higher levels of food self-sufficiency and food security in the city-state.*

*A key issue the UFC will face moving forward is that the domestic market for certain food commodities could be saturated if firms in the cluster end up producing the same commodities that compete with non-cluster local producers. Prices of commodities would be bid down, bringing down the profitability of this sector, with the potential for domestic firms to close down. This could become a zero-sum game with doubtful net economic benefits and suboptimal food security improvements. To avoid this outcome, the cluster will need to coordinate local production targets, aiming at specific product segments presently being imported, so as to complement local production. Target segments will in turn serve as basis for identifying the other actors needed to support the cluster and farms not in the cluster. Additional considerations in implementing this, moving forward, are then highlighted.*



Urban Farming in Singapore. Credit: [Flickr/Yosomono](#)

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Recommended citation: Jose Ma. Luis Montesclaros and Paul P.S. Teng, 'Ensuring a Successful Singapore Urban Food Cluster', NTS Insight, No. IN18-02 (Singapore: RSIS Centre for Non-Traditional Security (NTS) Studies, 2018).

## The Dual Role of a Singapore Urban Food Cluster

Approximately 10% of Singapore's total food consumption is produced locally (26% of eggs, 10% of fish and 12% of vegetables consumed are self-produced).<sup>3</sup> While the city-state has been scored as the top country for food security in Asia by the Economist Intelligence Unit's Global Food Security Index (GFSI),<sup>4</sup> Singapore's high dependence on food imports creates vulnerabilities to disruptions in the supply chain. For this reason, local production has been identified among the three national food baskets for boosting food security and increasing resilience against disruptions.<sup>5,6</sup> Foremost, increasing domestic production can help achieve goals of greater food self-sufficiency (with targets of 30% for eggs, 15% for fish, and 10% for vegetables).<sup>7,8</sup>

At the November 2017 Food Industry Convention organized by the Agri-Food and Veterinary Authority (AVA) of Singapore, Minister for National Development Lawrence Wong shared Singapore's potential to be a Centre for Urban Food Production, given that urban farming not only boosts food security, but could also serve as a new growth industry. This is premised on increasing food demand and the presence of technologies that have allowed for higher farm yields many times beyond the present levels (e.g. vertical farming) and also for transforming food production processes to more closely resemble the manufacturing sector, as exhibited by companies like Sustenir Agriculture and Panasonic (both practicing indoor hydroponics) and Apollo Aquaculture (vertical fish farming).<sup>9</sup>

Clusters are "geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (...) in particular fields that compete but also cooperate."<sup>10</sup> To fulfil urban farming's potential, the next step proposed was to develop a food cluster in Singapore. This was premised on Singapore's previous successes in creating industrial clusters, such as the Jurong Industrial Estate (manufacturing), Jurong Island and Jurong New Town (chemical industries), Biopolis (biomedical services), and

<sup>3</sup> AVA (2017), AVA Annual Report 2016/17, accessed 15 November 2017, <https://www.ava.gov.sg/docs/default-source/publication/annual-report/ava-ar-2016-17>.

<sup>4</sup> Economist Intelligence Unit (2017), Global Food Security Index 2017: Measuring food security and the impact of resource risks, accessed 2017, <http://www.eiu.com/Handlers/WhitepaperHandler.ashx?fi=EIU-GFSI-2017-Findings-%26-Methodology.pdf&mode=wp&campaignid=GFSI2017>.

<sup>5</sup> Koh Poh Koon, Transforming our Local Agricultural Sector. Speech by MOS Dr Koh Poh Koon for MND at the Committee of Supply Debate, 7 March 2017, accessed 16 October 2017, <https://www.gov.sg/microsites/budget2017/press-room/news/content/speech-by-mos-dr-koh-poh-koon-for-mnd-at-the-committee-of-supply-debate>.

<sup>6</sup> Liyana Othman (2016), How can Singapore strengthen its food supply chain? Channel News Asia, 29 October 2015, accessed 16 November 2017, <http://www.channelnewsasia.com/news/singapore/how-can-singapore-strengthen-its-food-supply-chain-8252060>.

<sup>7</sup> Audrey Tan (2016), Disrupting dependence in water, food, fuel, The Straits Times, 2 July 2016, accessed 16 November 2017, <http://www.straitstimes.com/opinion/disrupting-dependence-in-water-food-fuel?>

<sup>8</sup> AVA (2010), AVA Annual Report 2009/2010, accessed 16 November 2017, <https://www.ava.gov.sg/docs/default-source/publication/annual-report/corp09-10>.

<sup>9</sup> AVA (2017), Speech by Mr Lawrence Wong, Minister for National Development and Second Minister for Finance, at the Food Industry Convention, On 1 November, 9:00 am, at Marina Bay Sands Expo and Convention Centre, accessed 15 November 2017, <https://www.ava.gov.sg/docs/default-source/press-releases/food-industry-convention-2017-speech.pdf>.

<sup>10</sup> Michael E. Porter (2008), Clusters and competition: New agendas for companies, governments, and institutions. Harvard Business School Working Paper, No. 98-080, March 1998.

clusters involved in water desalination and treatment. The goal will be to grow the urban farming sector to achieve both goals of meeting food consumption needs as well as contributing to growth.

However, there are challenges to growing the urban food production cluster, and this takes its root in the unique role that urban farming plays in Singapore's food system.

## Key Risk for a UFC: Market Saturation

Even if an industry cluster can help boost local production, the maximum extent to which the industry can grow is limited by the demand it can capture, i.e. the demand for the commodities produced could be saturated.

Take for instance Singapore's petrochemical industry, where ethylene production more than doubled from 450,000 tonnes in 1992 to 965,000 tonnes in 1997 (twice the global growth rate in this period).<sup>11</sup> This was the result of a number of firms upstream (production inputs) and downstream (distribution) entering the sector in earlier periods when the cluster was still being formed. From just a handful of companies in the 1960s, the Singapore Oxygen Air Liquide Private Limited (SOXAL) expanded its manufacturing plant for industrial gases in 1980, followed by the entry of Sun Ace Kakoh, which provides PVC stabilisers that are used for producing ethylene. Exxon Chemical likewise started a plant for oil additives. Since then, Tetra Chemical, Sumitomo Bakelite, Du Pont, and other companies have joined in, allowing the sector to specialize in particular product segments, and boosting the competitiveness of the sector. However, after the cluster was created, Singapore's petrochemical industry output, which was projected to increase by 82.9% from 1997 to 2000<sup>12</sup> grew by a modest 23.6%.<sup>13</sup> The reason behind this was increased competition from Japan and Korea for a share in the China market, thereby saturating the import market, and limiting the amount that Singapore could produce in a commercially viable manner.

To avoid the pitfall faced by the petrochemical cluster, market saturation is a key issue which should be considered in developing the UFC. If anything, this risk will be even more pronounced, as the UFC's main market is expectedly first and foremost local consumers (rather than export markets). This is because Singapore's GDP per capita is higher than the rest of the region, making it a more lucrative market to sell to. For instance, its total imports of edible vegetables, roots and tubers alone amounted to approximately USD 546 million in 2017.<sup>14</sup>

If newly established firms joining the UFC, or incumbent firms which increase their production levels, were to aim at producing the same agricultural commodities produced by incumbent firms, then prices of commodities would be bid down, reducing the profitability of this sector. Status quo domestic farms, especially those not in the UFC, could close down if they cannot cover their costs given the prices. This can be tantamount to a zero-sum game, as new firms would only benefit at the expense of present suppliers for those same commodities, with hardly (if any) contributions to GDP nor to the amount of food produced domestically, unless they are able to focus on competing for goods presently imported.

This issue also poses uncertainties to firms and investors who are considering entering the cluster. If the cluster cannot be scaled, then returns on investments would be lower, and investors would be better off choosing other clusters or industries to invest in.

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<sup>11</sup> Monetary Authority of Singapore (1999). The petrochemical industry in Singapore. MAS Occasional Paper No. 14, June 1999.

<sup>12</sup> Ibid.

<sup>13</sup> Author analysis, based on Economic Development Board (2017), Yearbook of Statistics Singapore, 2017, in combination with annual data on the Index of Industrial Production for Chemicals and Chemical Products retrieved from Department of Statistics Singapore (2017), Singstat Table Builder (website), accessed 2017, <http://www.tablebuilder.singstat.gov.sg/publicfacing/createDataTable.action?refId=13496>

<sup>14</sup> International Trade Centre (2017), Trade Map: List of supplying markets for a product imported by Singapore (for Product: 07 Edible vegetables and certain roots and tubers, accessed 16 November 2017, <http://www.trademap.org/>.

## Key Considerations to Ensure Successful Outcomes

To prevent a possible zero-sum game from playing out, UFC members will need to focus on capturing specific food product segments which are presently being imported, rather than the same ones that are presently being produced by local producers. This will lead to a complementary relationship that allows for a net increase in domestic food production, contributing positively to the economy as well as Singapore's food security. A few considerations in achieving this are presented below.

### 1. How can firms identify and coordinate product segments to target among UFC Members?

The first consideration is in how production targets can be coordinated among the cluster members, assuming there is a *laissez faire* situation.. One approach is to aim at capturing specific commodities which are presently imported from abroad, rather than commodities being sourced from local firms. The harmonized system (HS) codes for imported commodities provide information on general categories of vegetables imported, as shown in Table 1 below.

HS Code	Product	Import Price ('000 US Dollar/Tonne)	Imported value ('000 USD)	Imported quantity (Tonnes)
<u>0709</u>	Other vegetables, fresh or chilled (excluding potatoes, tomatoes, alliaceous vegetables, edible brassicas, lettuce "Lactuca sativa" and chicory "Cichorium spp.", carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots, cucumbers and gherkins, and leguminous vegetables)	1,037	174,592	168,300
<u>0703</u>	Onions, shallots, garlic, leeks and other alliaceous vegetables, fresh or chilled	745	70,076	94,080
<u>0704</u>	Cabbages, cauliflowers, kohlrabi, kale and similar edible brassicas, fresh or chilled	810	68,009	83,935
<u>0702</u>	Tomatoes, fresh or chilled	762	30,180	39,596
<u>0712</u>	Dried vegetables, whole, cut, sliced, broken or in powder, but not further prepared	5,830	28,102	4,820
<u>0713</u>	Dried leguminous vegetables, shelled, whether or not skinned or split	1,463	27,830	19,018
<u>0714</u>	Roots and tubers of manioc, arrowroot, salep, Jerusalem artichokes, sweet potatoes and similar roots and tubers with high starch or inulin content, fresh, chilled, frozen or dried, whether or not sliced or in the form of pellets; sago pith	1,244	27,691	22,260
<u>0706</u>	Carrots, turnips, salad beetroot, salsify, celeriac, radishes and similar edible roots, fresh or chilled	644	26,520	41,150
<u>0705</u>	Lettuce "Lactuca sativa" and chicory "Cichorium spp.", fresh or chilled	1,414	24,289	17,177
<u>0701</u>	Potatoes, fresh or chilled	470	24,122	51,276
<u>0708</u>	Leguminous vegetables, shelled or unshelled, fresh or chilled	1,173	18,040	15,378
<u>0710</u>	Vegetables, uncooked or cooked by steaming or boiling in water, frozen	1,406	13,519	9,612

**Table 1: Vegetables Imported by Singapore in 2016**

**Source: International Trade Centre, 2017**

The limitation to this is that product codes alone do not provide sufficient information on what vegetables to produce. For instance, the most specific information only differentiates imported vegetables into the following categories: 'Cabbage lettuce fresh or chilled' (07051100), 'Kohlrabi kale & similar edible brassicas fresh or chilled.', (07049090), 'Witloof chicory fresh or chilled' (07052100), 'Other lettuce fresh or chilled' (07051900), 'Celery excl celeriac fresh or chilled' (07094000), 'Spinach new zealand spinach & orache spinach fresh or chilled' (07097000) and 'Other vegetables fresh or chilled' (07099900). How does one say, for instance, what type of cabbage one should produce, and allocate production targets among firms accordingly?

A mechanism will need to be developed to allow for effectively doing this, and this begins with splitting the market for a particular commodity meaningfully. Even if the most specific category available on trade databases is simply titled as 'Cabbage lettuce fresh or chilled' (07051100), one can look at the import prices for each



source where lettuce is imported from. For instance, Singapore imports the said commodity from 16 different countries, but the prices of commodities differ, including USD 11,000 per tonne from Japan, USD 7,246 per tonne from the United States, USD 2,293 per tonne from Thailand, and USD 909 per tonne from Malaysia.<sup>15</sup> Differences in product prices point to a degree of product heterogeneity, or intrinsic differences in products which mean they are cannot be perfectly substituted for one another.

As such, even within the same product segment (e.g. 'Cabbage lettuce fresh or chilled, 07051100), firms in Singapore can specialize, rather than compete with one another; for instance, one firm can aim to compete with Japan, while another can focus on competing with the United states for the varieties of the said commodity imported from each country, as each would have its own unique characteristics. To complement this, UFC members may then agree on products to aim for, or set up auctions whereby firms bid the amount they wish to produce in particular product segments.

A further step needed is to review the higher level categories for commodities to ensure they accurately capture the subcategories under them. For instance, the general category of lettuce and chicory (0705) includes the product 'cabbage lettuce' (07051100), which should not be the case as cabbage falls under HS Code 0704 ('Cabbages, cauliflowers...').

## 2. What will the role of government be?

The next consideration is about the role of government in the cluster. The foremost challenge in the cluster is in incentivizing firms to pursue the identified product segments. For firms to replicate traits of commodities normally grown in other countries in a manner that is price competitive, allowing them to compete in those segments, they will need to specialize in producing them. This requires significant research and development into the production factors needed, such as how to tailor high tech farms and growing environments, or how to develop varieties of seeds that can produce specific traits which consumers in Singapore desire, whether it be having vegetables that are crispier, smaller/larger, crunchier, sweeter, or combinations of some of these traits.<sup>16</sup>

A potential role for government will be to tailor its present funding and policies towards nudging producers to pursue specific target segments. One example is AVA's Agricultural Productivity Funds (APF). The said funds, capped at SGD 1 million per award, are part of a cost-sharing mechanism between AVA and AVA-licensed firms. This financial incentive allows firms to get up to 70% co-funding from the government when they take part in productivity improving projects that can produce food with yields four times higher than normal production levels, or more.<sup>17</sup>

Presently, the APF is open to a broad base of products (one of five strategic food items: hen eggs, food fish, leafy vegetables, beansprouts, and quail eggs).<sup>18</sup> To tailor the APF so that it not only helps for firms to leverage on updated technologies, but also directs them to specific product segments, the acceptance criteria to qualify for funding can be tweaked accordingly (i.e. awarding only firms that aim to capture specific product segments). In case two firms aim for the same segment, AVA may compare them based on their total yields, and award the one with higher yields, while considering other standards presently applied.

Another role of government in helping firms with needed research & development will be to link Singapore companies with Singapore universities and international research centres that are already looking into this. Leading edge research can be found, for instance, in the Massachusetts Institute of Technology's Media Lab

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<sup>15</sup> International Trade Centre (2017). Singapore imports of 07051100: Cabbage lettuce fresh or chilled. Accessed 2017, <http://www.trademap.org/>.

<sup>16</sup> Apart from research on technical requirements for producing specific segments, **Appendix 1** contains two further important research areas to look into moving forward.

<sup>17</sup> AVA (2017), Agriculture Productivity Fund (Apf) Research & Development (R&D) – Open Call Guidelines for Application, accessed 16 November 2017, [https://www.ava.gov.sg/docs/default-source/tools-and-resources/resources-for-businesses/guidelines-for-application---apf-r-amp-d-\(open-call\)\\_14082017.pdf?sfvrsn=2](https://www.ava.gov.sg/docs/default-source/tools-and-resources/resources-for-businesses/guidelines-for-application---apf-r-amp-d-(open-call)_14082017.pdf?sfvrsn=2).

<sup>18</sup> Ibid.

Open Agriculture Initiative (OpenAg), which shares ‘recipes’ on how to customize growing environments in order to produce tastier vegetables.<sup>19</sup>

### 3. Who should be part of the cluster?

Lastly, it is important to look at the ideal membership of the cluster. An effective cluster is one which allows for a targeted country-product segment to be produced in a commercially viable manner, taking into account the cost and availability of the inputs for the product. While the APF, raised earlier, can offer financial incentives for firms to venture into target product segments, these may not be sufficient if the business models for producing good in that segment are not sound, i.e. if production costs are too high, or if there are uncertainties in the stability of supply of production inputs, as in the case of relying on suppliers based abroad.

Upon identifying the cluster’s research needs (e.g. specific varieties or growing environments), the next step will be to develop domestic industries that will allow firms to provide the seeds with desired traits, or for production inputs for other agricultural commodities, in the targeted product segments, as well as the corresponding inputs and infrastructure, in a financially viable manner. These may include:

- universities and research organizations which are able to convert desired traits into actual vegetable seed varieties which can be grown in Singapore, as well as in identifying the growing environments needed (along with infrastructure requirements) for these;
- companies able to produce and distribute needed specialized seeds at affordable prices, given the relatively small market in Singapore;
- storage providers which can scale up cold storage space in Singapore’s supermarkets;
- transport providers which can maintain the quality of the commodities from farm to market;
- suppliers of plant-growing infrastructure which allow for vegetables to be farmed with less space, such as the figure of yields being 10 times normal production levels which Minister Wong mentioned.<sup>20</sup> These may include light emitting diodes (LEDs) that replace sunlight and allow for continuous growth; inorganic fertilizer solutions such as nitrogen (NO<sub>3</sub>, NO<sub>4</sub><sup>+</sup>), phosphorus (PO<sub>4</sub><sup>-</sup>) and potassium (K<sup>+</sup>); and infrastructure for building and/or customizing farms to meet the needs of growers in a financially viable manner;
- and last, crop analytics software that can upgrade productivity further by uncovering the critical nutrient combinations (and corresponding the ideal quantities of each nutrient), PH levels, and other environmental characteristics such as temperature and air composition. This software can also allow inter-firm collaboration by pooling data from farms using different practices/growing environments, and using this for more multifaceted analysis.

## Conclusion

The government’s thrust to support the development of urban farming as possibly the next successful cluster in Singapore, and that Singapore can be a Centre for Urban Food Production, is bold and ambitious, and not what one would typically expect from a country with limited land resources. On the other hand, this is not an impossible feat, given Singapore’s previous successes in developing commercially viable clusters in the past, from scratch. This NTS Insight has provided some strategic considerations to add to the discourse on what it will take to realize Singapore’s objectives of developing a successful UFC. In order to avoid a Zero-Sum Game, a few policy recommendations have been suggested.

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<sup>19</sup> Zoya Teirstein (2017), AI-Powered Food Computers Designing New Ways of Growing Crops, accessed 30 November 2017, <https://foodtank.com/news/2017/07/ai-powered-food-computers-mit-media-lab/>.

<sup>20</sup> AVA (2017), Speech by Mr Lawrence Wong, Ibid.

# Appendix 1

## Immediate Research Needed

Apart from technical product requirements, further analysis will be needed in the following areas, before any additional steps are taken for the cluster (these are also ongoing projects by the NTS Centre which are relevant to UFCs).

- 1) **Understanding Product Heterogeneity:** Before identifying the target commodities to produce, it will be important to understand the traits which importers look for when purchasing agricultural commodities from specific sources.<sup>21</sup> This will serve as the starting point, to direct research organizations on the traits which they should seek to develop.
- 2) **Assessment of Commercial Viability:** After understanding product heterogeneity, a financial assessment of producing the commodities will be needed, especially given the infrastructure investments required for setting up enterprises such as indoor farms. This test will be crucial, as it will indicate if it will be commercially viable given that limited land availability, as well as differences in land prices within the city-state.<sup>22</sup>

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<sup>21</sup> A study conducted by Stella Liu and Johanna Soo (forthcoming) sought specifically to identify the factors which would lead consumers in Singapore to choose locally produced vegetables over foreign produced ones.

<sup>22</sup> The NTS Centre has recently published its own financial assessment related to this. The reader is directed to: Jose Ma. Luis Montesclaros, Stella Liu and Paul Teng (2018), Scaling Up Commercial Urban Agriculture to Meet Food Demand in Singapore - An Assessment of the Viability of Leafy Vegetable Production Using Plant Factories with Artificial Lighting in a 2017 Land Tender (First Tranche), NTS Report No. 7 (Singapore: RSIS Centre for Non-Traditional Security (NTS) Studies, 2018), accessed 21 February 2018, <https://www.rsis.edu.sg/rsis-publication/nts/scaling-commercial-urban-agriculture-in-singapore-an-assessment-of-the-viability-of-leafy-vegetable-production-using-plant-factories-with-artificial-lighting-in-a-2017-land-tender-first-tranche/#.WpYMYGpuaM8>.

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