

SUPPORTING SINGAPORE'S “30-BY-30” FOOD SECURITY TARGET

FINDING THE “SWEET SPOT” IN PROPERTY TAXATION

Policy Report

December 2019

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and Paul S. Teng

RSiS

S. RAJARATNAM
SCHOOL OF
INTERNATIONAL
STUDIES

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TABLE OF CONTENTS

| | |
|--|-----------|
| Executive Summary | 1 |
| Increasing Food Self-Sufficiency as a Path towards Greater Resilience | 3 |
| The Enabling Role of Technologies in Raising Self-Sufficiency in Vegetables | 6 |
| Property Tax as Potential Barrier to Adopting Food Production Technologies | 8 |
| Potential Trade-offs in Revising the Taxation Policy | 11 |
| Policy Recommendations | 13 |
| About the Authors | 16 |
| About the Centre for Non-Traditional Security Studies | 16 |
| About the S. Rajaratnam School of International Studies | 17 |

Executive Summary

Singapore's present status of importing over 90 per cent of its domestic food consumption needs is a result of the city-state's deliberate industrialisation policy to transform from third world to first over the past decades, reducing the farmlands for food production from about 15,000 hectares in the 1960s to about 600 hectares today to make room for higher value-adding industries.

However, during the March 2019 Parliament Debate, Minister Masagos Zuklifli of the Ministry of Environment and Water Resources (MEWR) had aptly observed that "climate change brings new existential threats." The Singapore Food Agency's website notes the risk that Singapore may not have stable food imports from its food sources. Challenges (droughts, storms, pests and diseases, and climate change) faced by food producing countries could quickly spill-over to importing countries when they put their own domestic food security interests first. This makes food security a transboundary issue, which is beyond the state's direct control.

To guard against these threats, Singapore is now aspiring to increase its food self-sufficiency from less than 10 per cent today to 30 per cent by 2030, also known as the "30-by-30" target. Given the high opportunity cost of land, the direction Minister Masagos proposed is to follow the water sector's example whereby self-sufficiency and economic goals are achieved conjointly. Singapore's "Water Story" is about its use of new technologies such as desalination and water recycling to contribute to its 70 per cent water self-sufficiency, while also creating approximately 14,400 jobs and contributing SGD 2.5 billion to GDP.

The newly established Singapore Food Agency (SFA) will thus seek to apply this "Water Story" to food, and develop Singapore's unique technology-enabled "Food Story". A key technology involved, in the case of leafy vegetables, is the use of indoor vertical farms, also known as plant factories with artificial lighting (PFALs). PFALs allow for increasing yields per hectare several times beyond present levels, by farming on multiple levels (up to six levels per storey), increasing the number of cropping cycles per year, increasing the yields of crops through automated nutrition control, and also replicating plant growing environments to produce even the crops that are not indigenous to Singapore.

To scale the adoption of PFAL technologies in Singapore, investors and entrepreneurs will need to be convinced that these are viable investment opportunities. However, a potential barrier to this is the property tax on fixed machineries under the Property Tax Act, which links property tax rates to the cost of acquiring expensive PFAL technologies. This is especially harmful as close to two-thirds of capital expenditures for putting up PFALs goes to vertical farming and environmental control machineries. This tax makes it less economical for companies to adopt these technologies, thereby discouraging their adoption. As the alternative to yield-improving technologies, which is to allocate more land for agriculture, is not a viable option in Singapore, this tax could potentially delay or hinder the achievement of the “30-by-30” target.

One way to address this is to consider that the Property Tax Act exempts manufacturing machinery. This exemption is not presently extended to the upstream agricultural production sector. Removing the tax is not simple, as it implies trade-offs and affects multiple government functions, such as the need to collect sufficient tax revenues to meet expenditure targets. This report thus recommends:

- 1) *to launch a comprehensive analysis on property tax exemption for high-tech fixed machineries in upstream agricultural production in support of the “30-by-30 food security target”;*
- 2) *to consider joint governance of this exemption scheme under both the SFA (under MEWR) and the Economic Development Board (under the Ministry of Trade and Industry), so as to limit tax exemption to companies that truly leverage high-technology fixed machineries for boosting food production; and,*
- 3) *to launch a technical enquiry on calibrating and finding the “sweet spot” in taxation policy, that (i) increases self-sufficiency; (ii) while maintaining affordable food prices; (iii) increasing investments; (iv) having competitive rates of returns; and (v) drawing sufficient tax revenues from business activities. This will need to be complemented by an assessment of other barriers to upgrading technologies in upstream agricultural production.*

Increasing Food Self-Sufficiency as a Path towards Greater Resilience

Singapore's present status of importing over 90 per cent of its domestic food consumption needs is a result of the city-state's deliberate industrialisation policy to transform from third world to first over the past decades. According to the theory of comparative advantage, Singapore, with its small land area (72,250 hectares)¹ relative to other countries, would be better off importing land-dependent commodities, and instead producing goods which are more dependent on capital. In turn, it gradually reduced the land allocated for food production from about 15,000 hectares in the 1960s,² to about 600 hectares today, to give way to industrial sectors that create higher-value jobs.³

However, a shift in its approach could be observed in the past decade. There has been a realisation that food security is a transboundary issue, namely, that challenges within food producing countries can quickly spill-over to food importing countries. Droughts, storms, pests and diseases in the farms of country sources can potentially cause them domestic food insecurity challenges, necessitating them to limit the amount of food which they export to the rest of the world.⁴ A parallel challenge is that the business models for farmers using traditional practices are under stress, requiring transformation to produce more food with less available resources for them to be viable (i.e., more tonnes of food for every litre of water used and for every ha. of land used), as noted by Mr Lee Eng Keat of the Economic Development Board during the 2018 Future Food Asia Conference.⁵ In combination, these can lead to increased uncertainty that Singapore will be able to have stable imports from some of its country sources in future decades, given trends of climate change which make environments less conducive to food production.⁶

¹ Department of Statistics Singapore (2019). Singapore in Figures, 2019.

² Ngiam Tong Tau (2019), "Keep the Food Coming (Interview)," *Urban Solutions* 14, Centre for Livable Cities, January.

³ Singapore Food Agency (2019), "Food Farming: Agrotechnology Parks." Accessed 27 August 2019, <https://www.sfa.gov.sg/food-farming/food-farms>.

⁴ Singapore Food Agency (2019), "Food Farming: The Food We Eat." Accessed 27 August 2019, <https://www.sfa.gov.sg/food-farming/singapore-food-supply/the-food-we-eat>.

⁵ Author's notes.

⁶ Ministry of the Environment and Water Resources & Ministry of National Development (2019). "New Singapore food agency to oversee food safety and security the national parks board to oversee animal and wildlife management, as well as animal and plant health."

During the March 2019 Committee of Supply Debate at the Parliament, Minister Masagos Zulkifli of the Ministry of Environment and Water Resources (MEWR) summarised the present challenge with the quote, “climate change brings new existential threats.”⁷ To become more resilient against these, the minister announced Singapore’s “30-by-30” target of achieving 30 per cent self-production for the food it consumes domestically, by 2030. He also mentioned the establishment of the Singapore Food Agency (SFA) as a new statutory board to focus on “all food related matters from farm to fork” while also “facilitat(ing) better partnership with food businesses to develop new capabilities and solutions...” in support of the target.⁸

Effectively, the “30-by-30” target implies replacing imported food items with locally produced goods. One challenge in meeting this target is that food is relatively affordable in Singapore, which benefits consumers, but makes it more challenging for farmers to cover their rising production costs (energy, water, farm inputs). Addressing this, Minister Masagos provided a vision of how the “30-by-30” target might be achieved in a financially viable manner. He referred to the experience of the water sector, under the MEWR and its Public Utilities Board, as a potential trajectory to follow. In spite of water’s lower cost per unit, the water sector has achieved approximately 70 per cent water self-sufficiency through novel technologies, such as water desalination and water recycling technologies. At the same time, it has created 14,400 high-value jobs and contributed SGD 2.5 billion in revenues to the economy, in over 200 companies. This is similar to other feats Singapore has achieved in the past, using its approach of developing industrial clusters in manufacturing and petrochemical industries, and in biomedical services, as a previous RSIS Publication highlighted.⁹

Towards this direction, the quest now is to identify and apply advanced technologies to contribute to both self-sufficiency in food, as well as economic growth. Essentially, it is to replicate the Singapore’s “Water Story”, in order to develop Singapore’s own “Food Story”.¹⁰

⁷ Ministry of the Environment and Water Resources (2019), “Speech by Mr Masagos Zulkifli, Minister for the Environment and Water Resources, at the Committee of Supply Debate 2019,” 7 March.

⁸ Ibid.

⁹ Montesclaros, J. M. L., and P. S. Teng (2018). “Ensuring a Successful Singapore Urban Food Cluster.” NTS Insight No. IN18-02. Singapore: NTS Centre, RSIS, NTU Singapore.

¹⁰ Ministry of the Environment and Water Resources (2019). “Speech by Mr Masagos Zulkifli, Minister for the Environment and Water Resources, at the Committee of Supply Debate 2019.” 7 March 2019.

Singapore's "Water Story":
70% Self-Sufficiency Today



70% Water Self-Sufficiency Today
(NEWater, 40%;
Desalinated water, 30%)

(Potential) Singapore's "Food Story": From <10%
Self-Sufficiency Today To 30% by 2030



30% Food Self-Sufficiency by 2030

Figure 1. Singapore's "Water Story" is about how it has achieved up to 70 per cent water self-sufficiency using new technologies. Can technology be leveraged to achieve a Singapore's "Food Story" as well?

Sources: Left Image: Nick via Flickr (Creative commons); Right image: US Coast Guard Academy via Flickr (Public domain).

The Enabling Role of Technologies in Raising Self-Sufficiency in Vegetables

The task of developing Singapore’s “Food Story” requires an eclectic mix of policies which correspond to the multi-faceted nature of food and agriculture. Unlike water, which is a single commodity consumed in large quantities, food is a composite of multiple sub-commodities, each having its own requirements for scaling up.

This report focuses singularly on the leafy vegetable production sector. If it is assumed that 30 per cent of leafy vegetables will be self-produced to contribute to the 2030 target, this means increasing the present production of 11,788 tonnes, to 30,443 tonnes by 2030.¹¹ This translates to an additional 18,666 tonnes of leafy vegetables (or an increase of 158 per cent). In line with the norm in agriculture of estimating total production as a product of area (ha) and productivity (tonnes per ha), two key government approaches relevant to this are (i) land allocation; and (ii) promotion of yield-improving technologies.

In 2017/2018, the then Agri-Food & Veterinary Authority of Singapore (AVA), SFA’s precursor, tendered 24 hectares of land in Neo Tiew Lane/Lim Chu Kang for commercial leafy vegetable production (20 hectares were eventually awarded). Concurrently, the government has also initiated policies for supporting technologies that increase the food production yields (in tonnes) for every hectare planted. For example, the Agriculture Productivity Fund (APF) was created to co-invest with local companies in developing and adopting yield-improving agricultural technologies, accessible to those with credible commitments to obtain a minimum level of productivity improvement. At the intersection of land and technology, JTC Corporation — the lead agency spearheading the planning, promotion and development industrial estates — is developing the Agri-Food Innovation Park, located in Sungai Kadut, which will bring together high-tech farming activities and research and development activities.¹²

Technology development is critical because the city-state’s limited land area provides little leeway for land allocation to have a substantive impact on food self-

¹¹ This is further described in the Technical Appendix, “Simulations for Identifying the Impacts of Property Taxes on Food Security, Investments and Tax Revenues” (Montesclaros, Jose Ma Luis and Paul Teng, 2019).

¹² Ministry of Trade and Industry Singapore (MTI) (2019). Factsheet: Agri-Food Innovation Park (AFIP). https://www.mti.gov.sg/-/media/MTI/COS2019/Factsheet_AFIP.pdf.

sufficiency. A key technology relevant to leafy vegetables, is the use of high-technology indoor farms known as “Plant Factories with Artificial Lighting” (PFALs). These commonly allow for five to six tiers or growing racks of vegetables for each building storey. Given that vegetables need sufficient quantities of light in order for photosynthesis to occur, embedded within these PFALs are multiple, strategically placed LED lighting ports so that vegetables do not end up casting shadows on one another/blocking each other’s access to light.

A further yield improvement from PFALs is that plants are grown in controlled environments, so that plants receive optimal amounts of heat, water and nutrients to maximise vegetable growth. A third yield benefit is a doubling or even tripling in the number of plants grown per year that emerges from faster planting cycles. PFAL-grown plants do not need to rely on ambient weather and night-day cycles, so the use of advanced control systems allows for continuous, year-round production. Additionally, given the wide variety of leafy vegetables produced, almost any plant can technically be grown in PFALs, even those which are not indigenous to Singapore, for as long as the ideal environment settings are used. This allows local farmers to take a bigger slice of the vegetable market, even replacing premium imported vegetables from countries like Japan, United States, Australia, and a few in Europe.

Property Tax as Potential Barrier to Adopting Food Production Technologies

If one looks at the indoor farming technologies available internationally, it appears that the “30-by-30” target is feasible. For instance, one Japanese farm company, Spread Co., has a PFAL system which allows for potentially producing 613.2 tonnes of leafy green vegetables on two- to three-storey buildings of 2,868 square metres in size, within land plots of 4,780 square metres large.¹³ If used in Singapore, then only 14.55 hectares of land would be needed for meeting the additional production target. As this space requirement falls within the number of hectares approved by AVA during its recent tender, it can be concluded that from a purely technical perspective, the “30-by-30” target is feasible.

However, the availability of such high-yielding food production technologies offers no guarantee that these will be taken up by farmers and investors in Singapore, unless a minimum return on investments is achieved. In this regard, it is important that there is a conducive business environment that allows this high-technology food industry to be scaled up. A particular challenge faced by this strategic industry raised in this policy report is the property tax on fixed machinery in Singapore.¹⁴ To provide background, the tax on fixed machinery is part of the property taxes levied by the Inland Revenue Authority of Singapore (IRAS). Article 2 of Singapore’s Property Tax Act (copied below) usually exempts fixed machinery for manufacturing purposes from the property tax.¹⁵

Article 2’s intention, according to IRAS’ published interpretation, is “to encourage investments in machinery for manufacturing, processing and other industrial purposes”.¹⁶ This was noted by a High Court Judge in the case, *First DCS Pte Ltd v Chief Assessor and Anor* [2007] SGHC 82.¹⁷ IRAS likewise noted similar policies in the United Kingdom legislation, which the High Court Judge interpreted to mean a desire to encourage investments in manufacturing machinery.

¹³ Kozai T, Niu G and Takagaki M (2015). *Plant factory: An indoor vertical farming system for efficient quality food production*, 1st ed. Cambridge, MA, USA: Academic Press.

¹⁴ Defined as ‘machinery that has been so affixed to the land or building that it has become a fixture. It is usually a large machine that is either held in place by building frames or is resting on its weight’. Inland Revenue Authority of Singapore (2014). “IRAS e-Tax Guide: Treatment of Fixed Machinery under the Property Tax Act,” Singapore: IRAS. Point 2.1.

¹⁵ Government of Singapore (2005). “Property Tax Act (Ordinance 72 of 1960, Revised 2005).”

¹⁶ Inland Revenue Authority of Singapore (2014), *Op Cit.*, Point 3.2.

¹⁷ *Ibid.*

**Box 1: Article 2 of Property Tax Act, Singapore
(Ordinance 72 of 1960, Revised 2005)**

(2) In assessing the annual value of any premises in or upon which there is any machinery used for any of the following purposes:

(a) the making of any article or part thereof;

(b) the altering, repairing, ornamenting or finishing of any article; or

(c) the adapting for sale of any article,

the enhanced value given to the premises by the presence of such machinery shall not be taken into consideration, and for this purpose purpose “machinery” includes the steam engines, boilers and other motive power belonging to that machinery.

Yet, unlike manufacturing industries, which could receive exemptions from Singapore’s fixed machinery tax, machinery for PFALs are presently not tax-exempt. PFAL technologies fall either under the taxable category of fixed machineries, “Service Machinery”, used for “providing basic and essential services for the safety and enjoyment of the occupants of the buildings”^{18, 19} or have not yet been included the list of exemptions.

The problem is thus that the failure to exempt high-tech PFAL technologies such as growing racks, optimised growing temperatures and LED lighting settings, and water-saving hydroponics technologies could hinder farmers and investors from reaching their desired investment returns, and in turn, dissuade them from adopting these high-tech machineries. (Figure 2). This is especially pertinent given the high upfront infrastructure investment costs for sophisticated technology and machinery. For instance, in Spread Co. company, land and structure take up only 37 per cent of the total capital expenditure,²⁰ with the remaining 63 per cent likely to be used for machinery.

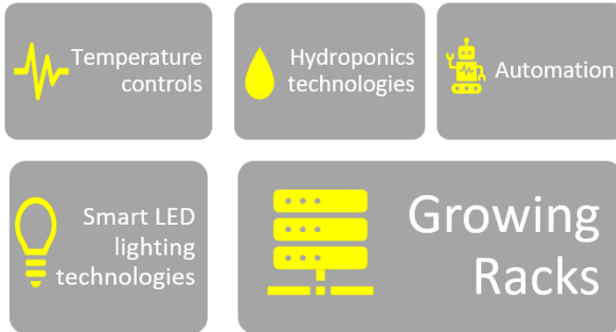
¹⁸ Lumped together with “lighting systems, cooling systems, air purifying systems, pumps, and water supply and distribution systems”.

¹⁹ IRAS (2014). Op Cit., point 5.A.

²⁰ Kozai, Niu and Takagaki (2015), op cit.

Fixed machineries in 'Plant Factories'

make up



close to $\frac{2}{3}$
of total capital
investment cost

Figure 2. Fixed machineries, needed for upgrading productivity within PFALs, make up close to two-thirds of total capital investment costs.

Source: Authors, based on Kozai, Niu and Takagaki, 2015.

The alternative to adopting yield-improving technologies, which is to allocate more land for agriculture while maintaining the same production practices, is not a physically viable option in Singapore. However, this future scenario of “failure to upgrade technologies” is not out of the question, especially if the tax makes the cost of adopting yield-improving food production technologies too high for farmers. This presents a credible risk that could delay or hinder the “30-by-30” food security target.

Potential Trade-offs in Revising the Taxation Policy

While it may seem straightforward that adjusting Singapore's taxation regime can contribute to the "30-by-30" target, doing so does not come without trade-offs across stakeholders involved. Government agency stakeholders, below, equally contribute to sustaining Singapore's continued competitiveness as an investment hub, so it is important to understand how their own functions may be affected.

- Removing the tax would help make SFA's "30-by-30" target possible. Analysis within RSIS also finds that, apart from this objective of scaling production, removing the tax could also potentially contribute to making food even more affordable. For instance, there is potential that the said tax, if not lifted, is passed on by businesses to consumers through higher food prices. Additionally, this tax could go against the productivity incentive presently being offered through the APF, as it limits the extent of adoption of innovative technologies developed through APF partnerships.
- The Economic Development Board (EDB), under the Ministry of Trade and Industry (MTI), is responsible for strategies to sustain Singapore's competitiveness as a business and investment hub. Senior Minister of State Mr Koh Poh Koon has already noted that by developing new food and agri-tech applications, Singapore could take part in this USD 5 trillion industry, by providing innovative applications that meet the needs of farmers in Asia.²¹ As in other economic sectors promoted by Singapore in the past, removing the tax allows for more competitive rates of return to investors, in turn, spurring greater investment in this sector.
- Enterprise Singapore (ESG), also under MTI, is responsible for championing enterprise development to help firms to innovate and internationalise. Removing the tax could reduce the cost of innovation faced by the relatively younger and smaller-sized population of enterprises in the high-tech upstream agricultural production sector, while at the same time facilitating upgrading by older enterprises.
- The JTC Corporation complements the other agencies with the provision of space for promoting strategic economic sectors and industries, in a viable

²¹ Ministry of Trade and Industry Singapore (2019). "Speech by Dr Koh Poh Koon, Senior Minister of State for Trade and Industry, During the Committee of Supply Debate Under Head V," 9 March.

manner. Removing the tax could align with this function, as it helps allay fears that innovative investors and technology entrepreneurs (techpreneurs) are penalised for use of innovative technologies. Such fears, for instance, may discouraged uptake of rooms/offices at the Agri-Food Innovation Park.

- The Inland Revenue Authority of Singapore (IRAS), under the Ministry of Finance, is responsible for ensuring that sufficient funding is collected for government operations. The Chief Valuer's Office (CVO) is also responsible for valuing properties in a manner that responds to market conditions and helps achieve state goals. Removal of the tax could have either positive or negative effects on the IRAS' functions. On one hand, tax exemption could be a hindrance, if it entails lower tax revenues collected. On the other hand, the tax could also spur greater business activity, and thereby increase the revenue base which is taxed.

The task at hand, therefore, is to find a "sweet spot" which addresses these multiple concerns, such that (i) self-sufficiency can be increased; (ii) while maintaining affordable food prices; (iii) increasing investments; (iv) having competitive rates of returns; and (v) drawing sufficient tax revenues from business activities; in supporting the country in continuing with efficient operations and improvements in Singapore (Figure 3).

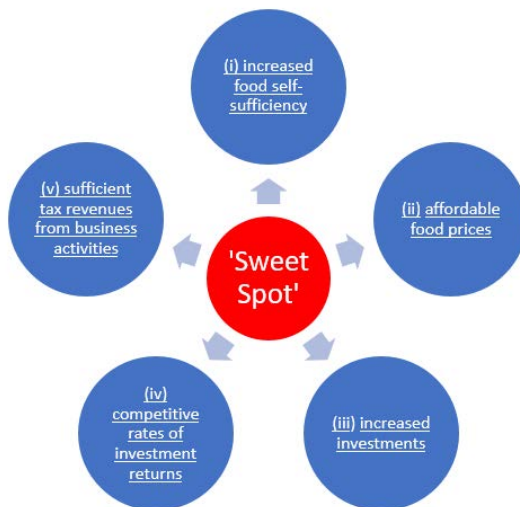


Figure 3. The "sweet spot" in property taxation policy will ideally contribute positively to addressing five key concerns.

Source: Authors

Policy Recommendations

1. Launch a Comprehensive Analysis on Property Tax Exemption for High-Tech Fixed Machineries in Upstream Agricultural Production in Support of the “30-by-30” Food Security Target

Policy dilemmas notwithstanding, Singapore has been able to successfully adjust its taxation policy in order to promote investment in strategic sectors in the past. In 2017, in fact, the Ministry of Trade and Industry launched its Industry Transformation Maps (ITMs) initiative which seeks to develop a long-term roadmap that addresses challenges to scaling in 23 strategic industries. These are supported with incentive schemes to boost their potential contributions to the economy in terms of productivity, jobs, innovation, and trade/internationalisation.²²

In the special case of the upstream agricultural production industry, which primarily contributes to national food security, but which also has similar potential economic contributions, a new incentive category may need to be created. This report thus recommends that the MEWR, and the SFA as a statutory board under it, to launch a comprehensive analysis on the creation of a new tax exemption category that considers the upstream agricultural production sector (which includes leafy vegetable production) as a strategic industry in support of the “30-BY-30” food security target. This scheme would primarily focus on exempting high-technology fixed machineries in upstream agricultural production from the related property tax.

2. Consider Joint Governance Approaches by SFA and EDB of the New Exemption Scheme

The governance of this incentive can be done jointly by the MEWR/SFA (as lead) and the MTI/EDB (supporting). This is given that the “30-by-30” target aims to meet joint objectives of meeting food security targets while value-adding to the economy, following the example of the “Water Story” as Mr Masagos stated. The purpose of joint governance is to identify and limit tax exemption to

²² Note: The ITM industries include only “food manufacturing” (e.g. processing), and not upstream agricultural production. For further information, please refer to: Ministry of Trade and Industry (2017). Media Factsheet – Industry Transformation Maps. Revised as of 31 March 2017, <https://www.mti.gov.sg/-/media/MTI/ITM/General/Fact-sheet-on-Industry-Transformation-Maps---revised-as-of-31-Mar-17.pdf>, accessed 11 September 2019.

companies that truly leverage high-technology fixed machineries for boosting food production.

- MEWR's/SFA's role would be to set and monitor criteria from the food productivity perspective, such as the extent of food production improvement from these technologies. This is feasible given that they already possess standards under their existing Agricultural Productivity Fund and corresponding "Productivity Enhancement Scheme".²³
- Alongside this, the MTI/EDB could guard against redundancy with existing incentive policies, while also vetting productivity, job-creation, innovation and trade/internationalisation potential.

3. Launch a Technical Enquiry on Revising Taxation Policy, Complemented by an Assessment on Other Barriers to Upgrading Technologies in Upstream Agricultural Production

An in-depth technical enquiry is needed on exempting technologies in the High-Technology Upstream Agricultural Production Industry from the fixed machinery property tax, as a means to promote future investment, complemented by an assessment of other barriers preventing the adoption of these technologies.²⁴ Focusing on addressing the policy dilemmas raised earlier, one way forward is to leverage existing tools, such as the UrbanAgInvest (UAI) simulation tool which the authors adapted to search for "win-win" scenarios in removing the said tax in Singapore.²⁵ Base simulation results, given presently available public information and assumptions on certain market conditions, showed that the fixed property tax could be removed without harm to the five concerns above.

²³ Singapore Food Agency (2019). Agriculture Productivity Fund. Revised as of 31 July 2019, <https://www.sfa.gov.sg/food-farming/funding-schemes/agriculture-productivity-food>, accessed 5 November 2019.

²⁴ Further insights on supporting this new industry are presented in the following NTS Insight Articles:
1) 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); and,
2) Paul Teng, Jose Ma. Luis Montesclaros, Robert Hulme and Andrew Powell, "The Evolving Singapore Agrifood Ecosystem", NTS Insight, No. IN19-03 (Singapore: RSIS Centre for Non-Traditional Security Studies (NTS Centre), Nanyang Technological University Singapore 2019).

²⁵ The tool has been copyrighted as an invention by Jose Ma. Luis Montesclaros (first inventor) and Paul S. Teng (second inventor/co-inventor), Ref. No. 2018-259, © NTU, Singapore, and can be used/further adapted via standard licensing agreements with the university, in collaboration with the inventors.

In particular, tax exemption may allow for fully (100 per cent) meeting the additional production needed for meeting the “30-by-30 target” when tax-exempt, as opposed to a 57 per cent target accomplishment when not exempt. Tax exemption could also allow for a 76 per cent increase in capital investments (earning an 8 per cent internal rate of return); a 28 per cent net increase in total tax revenues collected annually from the goods and services tax, income tax, and property tax, combined; and potentially lower food prices for consumers.²⁶

²⁶ This presents updated findings of an earlier Report, Jose Ma. Luis Montesclaros, Stella Liu, Paul Teng, “Scaling Up Commercial Urban Agriculture to Meet Food Demand in Singapore”, NTS Report No. 7, 2018 (Singapore: RSIS NTS Centre, 2018). As the authors are constantly informing the methodologies, assumptions and quantitative analyses of the tool with the emergence of new knowledge and partners, readers are encouraged to contact the authors of this report at their RSIS/NTU institutional addresses, at ismontesclaros@ntu.edu.sg or ispaulteng@ntu.edu.sg for further details.

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Professor Paul S. Teng serves as Adjunct Senior Fellow (Food Security) in the same centre, while serving also as Dean and Managing Director of the National Institute of Education International Pte Ltd ("NIE International") at NTU. He has over thirty years of experience in developing countries from positions at the World Fish Centre, the International Rice Research Institute and Monsanto Company. Paul has conducted research on new agri-technologies, science-based entrepreneurship, food security and sustainable development, with recent focus on urban food security and agtech. Professor Teng has been recognized with an Honorary Doctor of Science by Murdoch University, Australia; the Eriksson Prize in Plant Pathology and as a Fellow of the American Phytopathological Society; and The World Academy of Sciences. He has published over 250 technical papers.

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