PENANG INSTITUTE MONOGRAPHS

#13

07 JAN 2021

Strengthening Food Security in Light of Covid-19

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Strengthening Food Security in Light of Covid-19

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Executive Summary

- The Covid-19 pandemic has been a wake-up call for Malaysia's food security. Logistical complications caused problems such as a temporary lack of produce in certain areas and food waste in the form of post-harvest losses. Although supply disruptions tapered off after a short period of time, the need to ensure that both Penang and Malaysia can maintain a continuous food supply in the event of similar disasters has become obvious.

- Some key strategies that can be carried out immediately post-Movement Control Order (MCO) include analyses of food flows and food systems and the creation of geographic information systems (GIS) to complement and support future responses. These three measures then culminate in the creation of a database that assists in assessing food security conditions and facilitates more centralised planning of food systems.
- An unsustainable and fluctuating nature of industrial agriculture and complex supply chains leave us vulnerable to food insecurity and global shocks if we continue to depend heavily on food imports. In this context, urban agriculture appears a viable strategy for improving food security in a socially just form. Urban agriculture is multifaceted and can contribute to local economic and social development, poverty alleviation, urban environmental management and climate change adaptation.
- The implementation of urban agriculture is not without its challenges. These include risks for health and the environment, lack of coordination and cooperation between stakeholders, difficulty in securing access to land and slow technology development. To overcome these challenges, there must be education initiatives on the proper management of health risks, creation of a conducive policy environment and an institutional home for urban agriculture, creation of an agricultural land bank to connect landowners to land users, and research and education on new technologies that can increase productivity in an environmentally friendly manner.
- To better understand the development, implementation and integration of urban agriculture, we refer to Pingtung, Taiwan, and Havana, Cuba, as case studies. Lessons to learn from these two sites are: Invest and commit to development; foster collaboration and cooperation between all stakeholders, and; promote biotechnology innovation to foster food sovereignty.
- Finally, we must determine potential sites for agriculture locally and develop more household-level farming programmes to introduce people to urban farming. Then a one-stop centre for all things agricultural can be created to provide resources on farming activities. Government and technological support must also be given to agrotechnology hubs such as Perda Ventures Incorporated and Sunway's FutureX project to boost research and development in this sector.

Introduction

The Covid-19 outbreak is neither the first nor will it be the last major global pandemic in human history. The highly interconnected world and its globalised economy have facilitated the rapid transmission of the novel coronavirus to all continents, save for Antarctica (Walsh 2020). In an attempt to curb the spread of the virus, countries and cities all over the world have had to enact measures to limit connectivity at the cost of reducing urban resilience (Drechsel 2020). As a result, the logistics of supplying agricultural products have experienced congestion and disruptions, with "major implications for food security and nutrition" (Blay-Palmer et al. 2020).

Immediate Issues During the Movement Control Order

Referring to Penang Institute's crisis assessment *The Heavy Impact of Covid-19 on the Agriculture Sector and the Food Supply Chain*, the "limited supply of raw materials, labour and market access, along with logistical constraints" (Vaghefi 2020: 4) had negative impacts on Malaysia's food supply system, with perishable and fresh produce bearing the brunt of these constraints in the early phases of the Movement Control Order (MCO) which was initiated in March 2020 (ibid.). Immediate issues that arose in Penang and Malaysia more generally were the lack of access to food in certain areas and post-harvest losses contributing to food waste in others.

During the MCO, many Malaysians lacked economic access to healthy food due to job losses and reduced incomes, among other factors. A study conducted by the Department of Statistics Malaysia (DOSM) showed that about two-thirds of Malaysian businesses had no source of income throughout the MCO (Chung 2020). Additionally, those who relied solely on public transportation and those with mobility issues or disabilities may have had trouble accessing grocery shops, markets and other food retailers due to limited operating hours of both public transport and businesses (Ryan and Marsh 2020; Alifah 2020). Many of those who did have access found it inconvenient to wait in line outside markets and grocery shops as social distancing guidelines restrict the number of people in shops following a one-in-one-out basis. This slowed the process of grocery shopping, increased the time people spent outside and complicated matters for the working class and for busy homemakers with already little time on their hands (Koay S.T., personal communication, 2020).

The MCO also contributed to a second, more pressing, issue of post-harvest losses due to excess fresh produce resulting in food wastage. For example, farmers and traders at one of the country's largest market in Selangor were forced to dump their produce and cited MCO measures for disrupting their normal operations, specifically "roadblocks, shorter operating hours and lack of manpower to offload trucks" (Hazlin and Leong 2020). Increases in excess fresh produce were also partly due to other factors such as a difficulty in judging the fluctuating market demands, as buying patterns of consumers and the hospitality industry changed in addition to logistical disruptions that complicated the supply chain of produce from farm to table (Puri 2020; Vaghefi 2020; ILO 2020).

Covid-19: A Wake-Up Call for Food Security

In line with Vaghefi's prediction, demand for food and supply disruptions were not severe in the short term due to the inelastic nature of demand for basic food commodities. However, as we continue to adapt to Penang's 'next normal'—where social distancing and hygiene measures are commonplace—we must first and foremost analyse and reflect objectively on possible improvements for future responses regarding food security with a focus on the resilience and efficiency, or lack thereof, of our state's system of supply management. An over-reliance on external supplies could be our Achilles heel (Yap 2019: 14–15). As the Covid-19 crisis plays out, it will continue to expose inherent weaknesses in current networks and systemic inequalities while simultaneously providing Penang and Malaysia with opportunities to address and improve these weaknesses.

Planning for Disaster Preparedness

In order to prepare for and mitigate the unwanted effects of another pandemic or disaster, a disaster and emergency management system that takes into consideration all four phases of a disaster cycle—mitigation, planning, response and recovery—must always be in place. The planning phase is vital as "realistic disaster plans involve exercise, practice, and continuous revision" to ensure that available resources can be optimised and funded for in the event of a disaster (Coccolini et al. 2020). These disaster and emergency management plans need to be area specific and adaptable to all manner of natural disasters or disease outbreaks.

Moving forward, there are a few crucial strategies that can be implemented through public–private–non-governmental organisation (NGO) collaboration to increase resilience and security in our food systems. These strategies can be implemented fairly quickly without extensive planning but with immediate results and can be built up to complement and support future responses; however, a sustained effort is required to keep these strategies up to date at all times.

Food Flow Analysis

Food flow analysis can be generally defined as "tracing the flows and sources of foods" and starts with the creation of a regional food map that includes all actors of the supply chain (producers, distributors, retailers, consumers) (FAO n.d.). Such a map allows for further analysis on the vulnerabilities, strengths and weaknesses, key foods, commodities and specific issues that need to be prioritised in a region. This could be in terms of providing information on whether the level of regional production is self-sufficient for local consumption, locating sections in the supply chain where food waste is most often generated, where food supply is the most diverse and determining which sections of the supply chain are most vulnerable to climate change and natural disasters (ibid.). In short, food flow analysis will help us better understand regional food systems, activities and markets, and determine future market opportunities and linkages (Cabannes and Marocchino 2018; FAO n.d.).[1]

[1] 'Market linkages' refer to the connection between the producer and the ultimate consumer in terms of transport and communication networks, while taking into consideration various forms, channels and facilities used, spatial distribution, and potential patterns formed by transactions (Tracey-White 2005).

Food System Analysis

Food system analysis is defined as "the analysis of all processes, formal and informal, involved in fully answering nutritional needs of a population: growing, harvesting, processing, packaging, transporting, marketing, consuming and disposing/recycling food, and also includes the inputs needed and outputs generated at each step" (van Veenhuizen and Danso 2007: 22). The analysis encompasses food produced in urban and peri-urban areas, as well as other channels such as rural areas or foreign imports. Vulnerability assessments of food systems can further assist in engaging more food system actors in a broader and community-centred sense. This allows policymakers to identify complementary components of the existing urban food system through a multi-stakeholder process in policy development (ibid.; Blay-Palmer et al. 2020). Examples of such components that are able to reinforce food system resilience are "determining product quantities and tracing the role of each actor involved in the food chain" in order to secure food supply and logistics in times of crisis (Blay-Palmer et al. 2020).

Geographic Information System (GIS)

The creation of a central **geographic information system (GIS)** is a key strategy because it contributes to our understanding of food security using remote sensing techniques. Kane explains that these techniques "examine local food environments, assess changes in land use and land cover, identify areas of importance in specific regions to determine the relationships between biophysical and socioeconomic attributes" and use three-dimensional models to "demonstrate landscape and construct methods to sustain our food sources" (Kane 2014: 1).

This is because food security is intrinsically linked to "increases in population density, limitations on agriculture yields, and the spread of 'food deserts'" (ibid.). Additionally, GIS maps of food systems can assist municipalities and local governments to deliver assistance where it is needed most due to its ability to visualise food supply problems during times of crisis. This can be seen in the case of Quito, the capital of Ecuador, where GIS big data was utilised to tackle the Covid-19 pandemic in tandem with their existing agenda of creating healthy food environments and efforts to strengthen rural–urban linkages (Rodríguez 2020). There is thus empirical evidence that application of GIS is significant in ensuring food security while encouraging sustainable practices.

GIS can be further enhanced through community engagement via crowdsourcing, mobile reporting tools and dashboard applications; this will facilitate collaboration and build strong relationships between governmental, private or NGO agencies and the community (Esri 2015). With increased public participation in GIS, governments and institutions are also able to more rapidly and accurately evaluate areas of concerns that have been flagged by members of the community.

In a local context, Penang has a GeoHub that acts as the "sole gateway for all geospatial products and services" and that coordinates and supplies GIS information services in the state (MyGov 2019). However, the datasets available in GeoHub do not address food security, though there is a map of food suppliers under the "GeoBencana" (GeoDisaster) application that seems to provide a list of food suppliers that are open in the event of a natural disaster, such as floods. It is unclear whether these suppliers are government affiliated, if only open during disasters or if they welcome buyers at any time. From an end-user perspective, the application is confusing due to several issues, such as the lack of information available on the operating hours of the shops and a lack of context as to how these suppliers will be of help during disasters. Through this observation, we can see that there is much room for improvement in terms of keeping the system updated, improving user interface and user experience, and increasing public awareness on the availability of such services.

These three suggestions are important because they culminate in the creation of a database that would assist in assessing the state's food security conditions. This database could also facilitate centralised planning that takes into account all members of the community and actors involved in local food systems. These suggestions also work together in synergy, complementing each other to create a whole that is greater than the sum of its parts.

Looking Ahead

Altieri writes that "humanity is quickly realising that the fossil fuel-based, capital-intensive, industrial-agricultural model is not working to meet global food demands" due to its degradative and volatile properties (Altieri 2008: 2). Industrial agriculture contributes significantly (at least a quarter) to greenhouse gas emissions, the main sources of which are methane and nitrous oxide (ibid.; Bellarby et al. 2008: 5–6). The industry's reliance on fossil fuel in supply chains further contributes to greenhouse gas emissions and food price volatility from cyclical or unpredictable oil prices (Bellarby et al. 2008; Nazlioglu and Soytas 2012). Furthermore, monocultures favoured by industrial agriculture also play a role in the environmental degradation through deforestation, the heavy use of fertilisers and pesticides and biodiversity loss, as well as being more vulnerable to climatic extremes and disease (Altieri 2008, 2009a). As we can see from the Covid-19 pandemic, the large-scale global agricultural industry that relies heavily on international supply chains is neither sustainable nor reliable. Instead, it has left us more vulnerable to food insecurity and global shocks as local food systems lose resilience.

It has been suggested that it is important to strengthen rural-urban linkages to increase the resilience of urban food systems to external shocks and stresses (Drechsel 2020).[2] Among the methods to do so are as mentioned earlier—to carry out food flow analysis in order to better understand the dependence of urban centres on their peri-urban areas and vice versa—though such analyses are not truly standalone solutions. The data collected should then be utilised to determine where investments and improvements must be made to reduce the vulnerability of our production systems and bottlenecks in the supply chain. Drechsel further elaborates that 70% of cities around the world were "already at risk of—or already dealing with—effects of … anomalies challenging urban resilience". Covid-19 simply exposed and accelerated the effects of weaknesses and inequalities that were already present in the current systems.

While the pandemic still rages, suggested initiatives that can work during and beyond Covid-19 are "promoting cultivation within and near the city" to secure urban food supplies, developing and supporting urban food policies that aim to shorten supply chains and "avoiding unnecessary food losses and food waste" to optimise urban food supply (ibid.).

La Vía Campesina (The Peasants' Way), an international farmers organisation, provides an alternative view that presents food sovereignty as a "constitutional right" and as the solution to food insecurity because it provides democratic means for transforming our food systems (Kim and Pokharel 2020; Duncan et al. 2020: 1).[3] By prioritising food sovereignty, a region could be supplied with locally grown "healthy, nutritious and climatically appropriate food" while providing defence against international economic shocks (Kim and Pokharel 2020). Food sovereignty can also be viewed as a precondition to achieving food security, which means that it must be actively addressed in the pursuit of self-sufficiency (Maschio 2017). In order to achieve this, the development of an "alternative agricultural development paradigm" is much needed; this new paradigm is one that needs to "[encourage] more ecological, biodiverse,

[2] Rural–urban linkages include functional links in various sectors that include the flow of agricultural and other commodities, goods and services, people, information (regarding market or employment opportunities), and financial aid between rural and urban settlements (IIED 2003).

[3] Food sovereignty is defined as "the right of individuals, peoples, communities and countries to define their own agricultural, labour, fishing, food, land and water management policies, which are ecologically, socially, economically and culturally appropriate to their unique circumstances" (Nyéléni 2007).

sustainable, and socially just forms of agriculture" in order to promote greater local involvement in the distribution, trade and marketing of agricultural products (Altieri 2009b).

Referencing the Milan Urban Food Policy Pact (MUFPP), it would seem that the best approach would be to combine these multiple approaches to tackle our urban food problems. The MUFPP provides comprehensive strategic options to cities that are interested in creating more sustainable food systems by recognising the importance of urban and peri-urban agriculture, food sovereignty, and urban food policies through a framework for action. One of its key principles is recognising that "family farmers and smallholder food producers … play a key role in feeding cities" and "reorienting food systems and value chains … is a means to reconnect consumers with both rural and urban producers" (MUFPP 2015). Among the recommended actions listed by the MUFPP for sustainable food production and distribution are to "promote and strengthen urban and peri-urban food production and processing", "seek coherence between the city and nearby rural food production, processing and distribution" with a focus on smallholders, "apply an ecosystem approach to guide holistic and integrated land use planning and management", "help provide services to food producers in and around cities, including technical training, and financial assistance" and "support short food chains, producer organisations, producer-to-consumer networks and platforms, and other market systems" (ibid.).

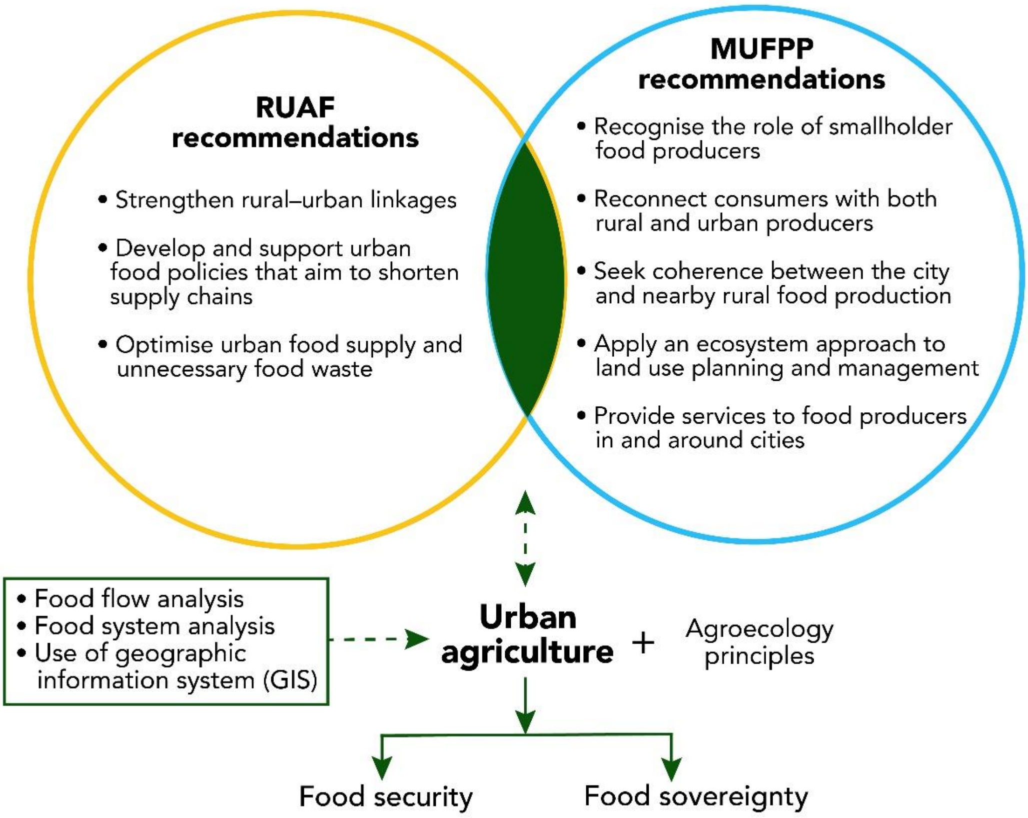

***Fig. 1** Conceptual framework for sustainable food production and distribution*

Fig. 1 presents a summary of the MUFPP recommendations and those of other actors, noting the overlap in suggestions for the promotion of urban and peri-urban agriculture. This tells us that the vital first step of this whole process is to prioritise such activities as it shortens the distance between producers and consumers, increases access and availability of food, and encourages local food production. Furthermore, use of agroecology principles in urban agriculture can "reduce the economic dependency on imports and purchase of expensive tools" as urban farmers reduce the use of industrial methods (Maschio 2017: 11). Agroecology favours the use of human labour, diversification of production and local consumption in lieu of conventional agronomy practices that encourage the use of chemical substances and machinery, monocultures and complex international supply chains (ibid.: 10; Altieri 1999). The cultivation of urban agriculture in conjunction with agroecology principles thus contributes towards achieving food sovereignty as farmers gain more flexibility and autonomy in their production and management. Consequently, urban and peri-urban agriculture is the central focus, while the remaining actions are in place to support its success. When combined with the immediate suggestions above, both short-term and long-term actions will form a two-pronged approach that complements each other to achieve food security and food sovereignty.

Urban Agriculture as a New Paradigm

We look to urban agriculture as an alternative strategy that, first and foremost, improves urban food security and nutrition; it also plays a role in "improving urban livelihoods, local governance, urban design, local economic development … and waste management" (van Veenhuizen and Danso 2007: xi). Urban agriculture could be the "alternative agricultural development paradigm" that fits the call for a more sustainable and socially just form of agriculture that promotes localisation (Altieri 2009a, 2009b). As up-and-coming as it may seem, urban agriculture is not a new concept: *bostan*s (vegetable/market gardens) of Istanbul have existed for centuries, while planting victory gardens were heavily encouraged during the First World War and Second World War (Kaldjian 2004: 284–304; Rao 2020).

Mankind has had a long history with urban agriculture, with this idea constantly re-emerging in times of crisis. For example, Sultan Mehmed the Conqueror (re)introduced *bostan*s into Constantinople in the fifteenth century to "assist with the city's economic and social rejuvenation" and to provide the city with food after he conquered the Byzantine Empire (Kaldjian 2004: 290). *Bostan*s, though, have been present in the region since the fifth century. On the other hand, victory gardens emerged in the United Kingdom and the United States (and several other Western countries) in the twentieth century during times of war and economic hardship to ensure that communities were self-sufficient in food production and existing food rations could be bolstered. People were urged to plant crops in "every patch of available soil", which ranged from their own backyards to empty lots and fire escapes with these victory gardens producing "about 40 percent of [the United States's] fresh vegetables" at one point in time (Rao 2020). Now, victory gardens are making a comeback amid the coronavirus pandemic as people try to improve their community's food security, much like they did during the 1918 Spanish flu pandemic when citizens wanted to "cultivate something beautiful and useful in times of great stress and uncertainty" (ibid.).

In more modern times, the (re)introduction of productive landscapes into city design can form a model that represents a microcosm of traditional agriculture based on values that "promote biodiversity, thrive without agrochemicals, and sustain year-round yields", while keeping other preceding examples in mind as we pursue more sustainable forms of development (Altieri 2008: 3). This is because although we can refer to various historical urban agriculture projects globally, the modern urban environment in and around cities provides special opportunities to agricultural production systems that are unique not only to this niche but to each locality. For example, the urban environment provides direct access to urban consumers and markets, proximity to institutions that provide market information, credit and technical advice, and the availability of cheap resources such as urban organic wastes and waste water (van Veenhuizen and Danso 2007). These can then be adapted to suit the various functions of urban agricultural systems that arise due to its multifaceted nature.

Types of Urban Agriculture

Urban agriculture can be defined as "the growing of plants and the raising of animals for food and other uses within and around cities and towns, and related activities such as the production and delivery of inputs, processing and marketing of products" (ibid.: v); it can range from household-level subsistence production to more commercialised agriculture and include both urban and peri-urban areas (ibid.: 1). An alternative definition is "an industry located within (**intra-urban**) or on the fringe (**peri-urban**) of a town, a city or a metropolis, which grows or raises, processes and distributes a diversity of food and non-food products, (re)using largely human and material resources, products, and services found in and around that urban area, and in turn supplying human and material resources, products and services mainly to that urban area" (Mougeot 2020: 11).

Definitions of urban and peri-urban agriculture vary due to a lack of an institutional home, and "diversity in farming conditions within the urban setting and the high dynamism" (van Veenhuizen and Danso 2007: 15). However, these two definitions are general enough to allow for localised characterisation as the sector develops in our region.

Vacant or underutilised plots of land in urban and inner-city areas are the main locations for **intra-urban agriculture**. These areas may be community land in household areas, vacant public or private lands that can be used in the interim or lands that are "not suited for building (such as along streams, in close proximity to airports" (ibid.: 5). **Peri-urban agriculture** takes place in the urban periphery and varies in its size, capital intensity, technology used, crop mix and degree of market orientation. Factors that affect these peripheral areas is their tendency to undergo dramatic changes due to increases in population density, urban sprawl and urban expansion, which can affect agricultural production systems and farming enterprises due to the loss of arable land to development (ibid.; Gumma et al. 2017).

Other subsections in these two categories include the classification of agriculture into community-, institution-, high-technology commercial- or subsistence-based, or multifunctional urban agriculture.[4]. To compare, intra-urban agriculture is done on a smaller scale and is generally more subsistence oriented whereas peri-urban agriculture operates on a larger scale and is more market oriented. Intra-urban agriculture is also usually more "creative" as locations used range from empty lots in schools, prisons, factories, rooftops, cellars and barns, while peri-urban agriculture is more likely to be similar to traditional agriculture, with activities carried out on larger plots of land. However, these are blanket statements as exceptions are always present.

[4] For more information on the models of urban agriculture, strategies, and regulations, see Steele (2017).

Potential Benefits of Urban Agriculture

In terms of **urban food security, nutrition and health,** urban agriculture can contribute by increasing the availability of nutritional food in the city, especially for the urban poor, since a "lack of income translates directly into lower quantity and/or quality of food intake", more so in urban settings than in rural settings (van Veenhuizen and Danso 2007: 41). With urban agriculture, food costs decrease as food is produced in close proximity and local populations are less reliant on rural or international imports; logistical and storage costs are also reduced due to shorter supply chains and fewer intermediaries. Rather than competing with rural agriculture, urban agriculture complements it as it can better provide perishable products (such as dairy or fresh produce) that must be delivered rapidly and which cannot be as easily supplied by rural areas; this is especially important during times of disaster where logistical disruptions may be commonplace. Under "normal" circumstances, urban farming can complement rural production during off-seasons, such as dry or rainy seasons. A reduced reliance on food imports can then "release rural lands for export production of commodities" and allows us to save on foreign exchange (ibid.: 10; de Zeeuw 2003; Dubbeling and de Zeeuw 2011). With Malaysia's food import bill just under US$12 billion in 2018, it is crucial for us to begin the journey to increased food security and food sovereignty (Cheema 2020). It is important to note, though, that once established, urban farms must engage in the diversification of food sources in order to further strengthen community-based adaptive management and reduce the vulnerability of a city (Dubbeling and de Zeeuw 2011).[5]

As noted, urban food production reduces costs via savings in transportation and storage, providing healthier food at a lower cost. This reduced food expenditure in turn allows for local communities to spend more on non-food expenditures such as education, housing, transport and health (Egal et al. 2001: 4). Aside from saving on food expenditure, urban farmers and the urban poor can also generate a sizable income through farming activities, especially if large surpluses are marketed to the wider community. The distinction is that urban farms do so for commercial purposes whereas the urban poor (composed of independent individuals, families or loosely organised groups) do so more for subsistence purposes. Nonetheless, urban agriculture assists in **local economic development**, stimulates the development of microenterprises that would not exist without urban agriculture and provides an economic safety net in times of crisis (Dubbeling and de Zeeuw 2011: 209; de Zeeuw 2003). Examples of such microenterprises include those involved in the production of agricultural inputs, the "processing, packaging and marketing of outputs", and small businesses involved in the "collection and composting of urban wastes, production of organic pesticides, fabrication of tools, delivery of water, buying and delivery of chemical fertilisers" (de Zeeuw 2003: 11). According to Dubbeling and de Zeeuw (2011: 203), although "production levels and turnover of individual urban producers in many cases will be small", increasing numbers of producers in a city will still contribute significantly to the urban economy while generating employment and income for many others.

With respect to these aspects, urban agriculture plays an equally important role in **social development** and **poverty alleviation.** This is because urban agriculture can aid social integration and inclusion of disadvantaged groups, minorities and those who have been historically marginalised, such as disabled people, orphans, women and the elderly by providing them the opportunity to earn a living while "enhancing self-management and entrepreneurial capacities" (ibid.: 206). It also integrates them into a community through working together constructively. With a greater sense of community and new sources of

[5] Adaptive management' can be defined as "the integration of design, management, and monitoring in order to learn and improve responses to management efforts. It is an ongoing cycle of designing and checking a plan and then modifying management in light of the results. This implies the drawing up and agreement of a management plan, a method of checking/monitoring results, and regular analysis and discussion of whether the plan needs improving". Community-based implies that "the management is carried out by, or with a major role played by the community, local stakeholders, relevant user groups, and also the locally and nationally relevant institutions and private interests" (Govan et al. 2008).

livelihood, social ills may be reduced and prevented (van Veenhuizen and Danso 2007; de Zeeuw 2003; Dubbeling and de Zeeuw 2011: 209). From an alternative perspective, urban agriculture may also provide a sense of "physical and/or psychological relaxation" by converting urban farms into visiting facilities with educational functions and recreational opportunities for visitors (Dubbeling and de Zeeuw 2011: 206). This also allows citizens to directly support producers by purchasing fresh crops during their visit (Madaleno 2001; de Zeeuw 2003; Dubbeling and de Zeeuw 2011).

As urban agriculture cements its role in the urban ecological system, it can begin to play a part in **urban environmental management** by "turning wastes into resources, contributing to a better urban climate and managing the urban landscape" (van Veenhuizen and Danso 2007: 53). For example, urban waste from households, vegetable markets and agro-industries can be turned into a productive resource; this includes reusing greywater for irrigation and using organic refuse to produce composts or animal feed. Solid waste can be converted to be used as fertiliser with vermicomposting to increase soil fertility and productivity, especially in barren and nutrient-poor urban land, and reduce the use of chemical fertilisers. This in turn reduces contamination of groundwater and drainage systems. In terms of irrigation, urban waste water can be wholly or partly treated before recycling for use in irrigation (de Zeeuw 2003). Application of a circular economy concept towards solid waste management can help to alleviate waste disposal problems that most cities struggle with. In addition, urban agriculture further supports urban environmental management through the integration of trees and crops in urban areas. This is because the increase in vegetation increases rainfall capture to reduce surface runoff, thus preventing soil loss, erosion and flooding, much of which Penang has experienced in recent years. Agroforestry on hills and steep slopes can also prevent landslides and extensive development at the same time (Dubbeling and de Zeeuw 2011; Dagar and Tewari 2018).

In terms of **land use**, locally unwanted land that is unsuitable for construction can be made productive through urban agriculture, such as flood plains, earthquake-prone areas and land under or nearby power lines. This infill makes use of vacant land and adds value to areas that would otherwise have little or no economic output (van Veenhuizen and Danso 2007; Dubbeling and de Zeeuw 2011).

On the topic of **climate change adaptation**, urban agriculture and agroforestry have been identified as "important instrument[s] in building resilient cities that are able to respond to, resist, and recover from changing climate conditions" (Dubbeling and de Zeeuw 2011: 209; de Zeeuw 2003). For example, the proximity of food production in urban farms to the end consumers is reduced, thus lessening energy use and greenhouse gas emissions from the transporting, cooling, storing, processing and packaging of food to lower the ecological and carbon footprint of a city (Dubbeling and de Zeeuw 2011). Agroforestry also contributes to the greening of a city and improving the local microclimate by providing shade. This aids in mitigating the urban heat island effect and reduces energy used for heating, ventilation and air conditioning (Dagar and Tewari 2018). Urban agroforestry can even act as a filter to improve a city's air quality by absorbing airborne pollutants including those that make up photochemical smog and haze (such as particulate matter, carbon monoxide, ground-level ozone, sulphur dioxide and nitrogen dioxide) (ibid.). Thus, when properly planned and placed, urban agriculture and agroforestry can act as a buffer between industrial, agricultural and residential areas, allowing urban residents to live in a cleaner and healthier environment with less pollution (ibid.; de Zeeuw 2003; van Veenhuizen and Danso 2007: 52).

To summarise, the advantages of agriculture in an urban setting are manifold. Its multifaceted nature is its greatest strength as it can be adapted to suit the needs of diverse urban situations and stakeholders. Not only can urban agriculture complement rural agriculture and increase the efficiency of the current national food system, it can also facilitate sustainable city development based on local needs and priorities and is capable of contributing substantially to various areas such as local economic development, health and social development (van Veenhuizen and Danso 2007; de Zeeuw 2003). In addition to these benefits, urban agriculture is also increasingly instrumental in "environmental, landscape and biodiversity management and in providing recreational services" (van Veenhuizen and Danso 2007: 1). This is done through waste recycling, urban greening and the creation of green buffer zones that improve a city's microclimate and reduces its ecological footprint (ibid.: 51).

Challenges and Recommendations for Decision Makers

Risks for Health and the Urban Environment

In discussing the merits of urban agriculture, it is also essential to discuss the challenges that hinder its broader implementation in cities and urban municipalities. As with any form of agriculture, urban agriculture too poses risks for health and the urban environment, which require proper oversight to mitigate. Examples of the health risks associated with urban agriculture are the potential contamination of crops from polluted or inadequately treated waste water for irrigation, agrochemical residues and heavy metals as well as occupational health risks (ibid.: 10).

Thus, it is vital to educate farmers on the management of hazards associated with urban agriculture to prevent and reduce these risks; for example, education on the proper management of agrochemicals (if used), crop choice and appropriate types of irrigation. The promotion of ecological farming practices such as the use of biological controls or organic fertilisers can further reduce these risks (ibid.). Farmers also need to be trained in proper waste water handling techniques including the use of protective clothing and equipment. Moving forward, safer technologies such as hydroponics or organoponics, drip irrigation and zero tillage systems are potential replacements for traditional irrigation as they substantially reduce water needs as well as the associated health risks while increasing yields (de Zeeuw 2003).

Risks toward the urban environment, on the other hand, include the potential contamination of water sources, harm towards fragile ecosystems of peri-urban areas and slope erosion as competition for urban land drives urban farms to hillsides. To avoid this, zoning can be done to regulate boundaries between agricultural lands in and around the city, allowing for proper separation of any potentially contaminating industries with human contact. It also ensures that urban agricultural lands are properly sited with the least controversy among stakeholders and communities. A ecological way to do so is by planting boundaries, an initiative that doubles as an urban forestry initiative. However, zoning is a double-edged sword and must be wielded with caution; if done incorrectly, zoning becomes more restrictive than regulatory. Thus, zoning policy must be accommodating by extending agricultural permits to urban agriculture or treating it as a set of uses that are conditionally permitted based on the district (Mukherji and Morales 2010).

As a general precautionary measure, cities need to improve urban waste water treatment and recycling facilities in agriculture, especially decentralised treatment facilities that apply low-cost techniques and biotechnologies to ensure the provision of clean and safe water at all times (de Zeeuw 2003). This is because any potential contamination begins and ends with the quality of water used in agricultural activities. Moreover, decentralised (waste) water treatment facilities are more sustainable due to their flexible and localised nature that is more economical and energy efficient than the conventional supply and delivery structure (Fluence News Team 2019).

Lack of Coordination and Cooperation between Stakeholders

In creating cohesiveness between urban agriculture management and its stakeholders, urban agriculture must first be regarded and "understood as a permanent and dynamic part of the urban socio-economic and ecological system", akin to other urban functions (van Veenhuizen and Danso 2007: 59). It is imperative to integrate urban agriculture into the land use system of cities, create an conducive policy environment to aid in sector development and support the establishment and strengthening of urban farmer organisations through the creation of an institutional home for urban agriculture (ibid.: 60, 71). This can be done "by selecting a national lead agency on urban agriculture and the establishment of an inter-departmental committee on urban food production and consumption" (ibid.: 67). Other responsibilities of the agency would include assisting in zoning, connecting farmers to customers, researchers and NGOs, and facilitating public–private collaboration with state assembly members of different constituencies to identify potential sites for agricultural activities. The presence of a central institution would improve cooperation and "ensure the active participation of direct and indirect stakeholders in the formulation and implementation of urban agriculture policies and action programmes" (Veenhuizen 2006: 16). This is vital because urban agriculture is an interdisciplinary industry that requires cooperation between various institutional, public and private entities (van Veenhuizen and Danso 2007: 60).

Combined with the use of GIS technology, such information sharing can aid in more coordinated future efforts and partnerships too. Together, a comprehensive database on urban farming at a municipal, state or even national level could be set up to provide information on successful policies and projects, spatial data and available expertise for business or capability matchmaking. This would be a good complement to food system and flow analyses and mapping carried out in the earlier phases of urban agriculture implementation.

In conjunction with the creation of an institutional home, municipalities and state authorities can have a hand in bridging the gap between the government and urban farmers by drawing attention to the policy and decision-making process of urban agriculture. This can be done through a one-stop department that serves as a platform for consultative multi-actor discussions to coordinate the development of an organisational framework and formulation of policies, carry out joint analyses on urban agriculture perspectives, and plan and implement programmes in this sector. This would allow urban farmers to bypass excessive bureaucratic red tape in carrying out their business through a government-monitored centre while increasing overall efficiency (van Veenhuizen and Danso 2007).

Difficulty in Securing Access to Land

A lack of available urban land—due to intense competition for residential, institutional, commercial or industrial development—is a common problem that urban farmers face (ibid.) and has been a limiting factor for agricultural activities in cities (Andrés 2017: 44). In terms of availability, accessibility and suitability of land, state authorities should facilitate access to vacant lots for farmers to utilise and make productive use of open spaces. It is a misconception that cities lack the land needed for urban agriculture as there are often open spaces that may be used more productively.[6] Examples of open spaces as potential sites for agricultural use include buffer zones between residential and industrial areas, flood-prone or earthquake zones, or land reserved for building (but for which funding is not yet available) (van Veenhuizen and Danso 2007: 52). Providing and prioritising access to suitable and adequate land within a policy-making framework will ensure urban agriculture's long-term survival.

[6] Availability refers to the "land that can be utilized for urban agriculture in the short or medium term, or permanently". Accessibility refers to the "opportunity for actual use of available land by households or groups in need, taking into account administrative procedures and conflict resolution mechanisms in cases where conflicts arise. The suitability of the land for urban agriculture is a function of topography, soil texture and fertility, moisture, and other environmental qualities" (FAO 2007).

Examples of efforts that can be done to facilitate this access include keeping an up-to-date inventory of available vacant urban land (through participatory methods and GIS) and analysing its suitability for agricultural use. To complement this inventory, a localised agricultural land bank can be created to connect landowners with temporary or permanent users with public campaigns to inform those in need of available opportunities of these initiatives. When land is provided, its suitability must be improved through provision of irrigation, fertilisation of topsoil and removal of urban debris. Another initiative to increase engagement in urban agriculture is to earmark space for individual or community gardens in all new public housing projects and upgrading schemes. This form of demarcation would slowly integrate urban agriculture as a form of permanent land use in city plans to protect arable urban land and green spaces while reserving inner city spaces for future use (ibid.; Andrés 2017: 31).

Lack of Technology Development

Finally, as farming in urban and rural environments differs in its technological requirements, there must be increased attention to appropriate and adaptive context-based technological development through research, training and educational programmes to meet specific conditions and needs in urban settings. Examples of such conditions include land scarcity, expensive land, urban proximity, the potential conversion of urban waste into agricultural resources and possibilities for direct producer–consumer contacts. The need for intensified use of limited spaces is one that is specific to densely populated urban settings; this can be done using container (or receptacle) farming, vertical farming or biointensive and controlled-environment agriculture for example. Though for urban agriculture to be truly successful in the long term, continuous innovation must occur at the "technical, institutional and policy levels" with the involvement of local authorities, community-based organisations and households (van Veenhuizen and Danso 2007: 65).

Education on available technologies is an often-overlooked aspect of urban farming. Proper education, training and technical advice will be of much service to urban farmers and provide them with the opportunity to learn about ecological farming practices, intensification and diversification of cultivation, enterprise management as well as marketing. Municipalities, state governments and other stakeholders also have a responsibility to "voice the research and technology development needs of … urban farmers to research institutes" and the federal government as they represent a bridge between urban farmers and these separate entities (ibid.). This would further promote congruence between actors and stakeholders involved in urban agriculture. With continuous technological development and innovation, and a healthy policy and planning environment, the productivity and sustainability of urban agriculture will progressively improve.

Case Studies – Application of Biotechnology in Urban Agriculture

To enrich our understanding on the development, implementation and integration of urban agriculture, we refer to two locations with well-established farming practices in city settings—Pingtung in Taiwan, and Havana in Cuba—as case studies.

According to the Secretariat of the Convention on Biological Diversity (2005: 5), biotechnology is defined as "any technology application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use". Biotechnology can also assist in determining new plant architecture, developing increased tolerance to urban pollution, increasing efficiency of nutrient uptake and accelerating crop acclimatisation to new growth substrates through genomics and transgenics (Ortiz 1998; Tyagi et al. 2018). In an agricultural context, biotechnology can be used for endogenous developments by applying it to solve site-specific problems, increase food security for local communities and protect the environment—all of which are of utmost importance in urban agricultural development.

1. Taiwan: Pingtung Agriculture & Biotechnology Park (PABP)

Fig. 2 *Entrance of Pingtung Agricultural Biotechnology Park*
Source: Photograph from Huang Chung-hsin; Taiwan Today, 24 Nov. 2016
taiwantoday.tw/news.php?unit=2,6,10,15,18&post=104466. Accessed 14 Dec. 2020.

Taiwan is a country blessed with both a sub-tropical and tropical climate and year-round abundant rainfall, making it suitable for agricultural production, However, the area is also prone to diseases, pests and natural disasters like earthquakes and typhoons, as well as flooding and landslides from periods of heavy rain. Despite its vulnerabilities, Taiwan is an agricultural powerhouse that boasts exports of US$4.66 billion and an agricultural gross domestic product (GDP) of US$17.58 billion in 2018 alone (Chang 2018: slide 4). At the heart of the country's agricultural industry is the Pingtung Agricultural Biotechnology Park (PABP), which serves as the "incubation base of Taiwan's agri-enterprises and agricultural cluster" (ibid.: slide 3) and proudly touted as "the only one science park dedicated to agriculture" (ibid.: slide 10) (Fig. 2).

Even with its intrinsic advantages, Taiwan's significant success in agriculture can be attributed largely to the overwhelming institutional support in the form of subsidies, investments, incentives and complete infrastructure provided by the government (ibid.; Kam 2020). Proof of this is the investment of US$133 million a year in agriculture to propel agricultural biotechnology research and development in the PABP (Chang 2018: slide 9). The park is equipped with one-stop services to provide for and support agricultural small and medium enterprises (SMEs)—the first in the world to be led by a central government. As a biotechnology park dedicated to agriculture, the PABP aims to "develop agricultural technology and construct the cluster of agro-bio businesses", "foster technology-intensive, high value-added, environment-friendly industry" and "lead the transformation of Taiwan agriculture" (ibid.: slide 10).

In order to do so, the park incorporates incentives (e.g. tax exemptions and loans with low interest rates) and a conducive research environment with less bureaucratic red tape to attract more start-up capital from investors. Benefits from investing in the park include abundant labour, detailed "start-up advice and technological support", a "stable supply of raw materials", comprehensive communal infrastructure and a wide range of distribution chains (PABP 2016). To further incentivise investors, the park practises a "single window" service delivery as a trade facilitation method that provides "government services through a single interface … resulting in increased efficiencies and a reduction in transaction costs" (World Customs Organisation n.d.: 3).

To complement these incentives, biological pest control, quality control and certification of organic products in the park serve to ensure the sustainability and profitability of the agricultural industry (Kam 2020). Thus, Taiwan's possession of the right infrastructure for 'hard' and 'soft' development with support throughout the value chain and an integrated agriculture park has led to immense economic success in the country's agricultural sector.[7]

Overall, the presence of biotechnology parks represents a political and financial commitment to develop and share biotechnology knowledge with key stakeholders, and requires a strong nexus between the government, research institutions and the private sector to benefit the country in the long run.

2. Havana, Cuba: Peri-urban Agriculture

Following the collapse of the Soviet Union, Cuba experienced an extended economic crisis that devastated traditional agriculture. With a severe reduction in food, fuel and fertiliser imports from Russia, it was forced to turn to urban agriculture to sustain its economy and feed its people. The country's success in urban agriculture, especially in Havana, stemmed from "government-community collaboration in technology development and in management" through the founding of a kind of "grassroots government" known as People's Councils that intended to encourage community engagement in problem-solving (Prain 2006: 309). In just over a decade (1989–2000), a period known as *período especial* (special period), urban agriculture in Havana evolved from a negligible part of the urban food system into one with an annual production of 83,000 tonnes of fruit and vegetables alone as of 2012 (FAO 2015). Urban agricultural activities utilise "12 percent of the land area" and involve upwards of "22,000 urban and peri-urban producers, providing between 150 to 300 grams of fresh vegetables and culinary herbs daily" to each of the city's occupants (Prain 2006: 308).

One of the biggest contributors to Havana's spatial- and bio-intensification has been organoponics. Organoponics is a Cuban invention that uses organic substrates such as "crop residues, household wastes and animal manure" to increase fertility of poor soils in urban plots of land, and over time, "the soil quality is gradually improved through the incorporation of organic matter" (FAO 2015: 11). Such gardens can be placed on virtually any surface with various substrates being used depending on the specific crops being grown. Gardens cultivated using organoponics can be productive throughout the year with the use of "drip irrigation, regular addition of compost and good horticultural practices—such as the use of well-adapted varieties, mixed cropping, crop rotation and integrated pest management" (ibid.). Due to its bountifulness, Havana has allocated 30,000 hectares of land in and around the city for urban agriculture purposes and is a recognised land use in the city's strategic plan (ibid.: 6; Sarker et al. 2019: 7) (Fig. 2).

[7] 'Hard' development refers to more "tangible infrastructure such as roads, ports, highways, [and] telecommunications" whereas 'soft' development is less tangible and is geared towards "transparency, customs management, the business environment, and other institutional aspects that are intangible" (Portugal-Perez and Wilson 2010).

Fig. 3 *Organoponico plaza, Havana, Cuba*

Source: Ewing (2008)

The Community Patio project is another programme that encourages communities in Havana to adopt urban agriculture. The project aims to help people transform derelict sites in small home spaces to grow their own food, medicinal plants, spices and ornamental plants using appropriate permaculture techniques, with the resulting produce sold or traded to support lower-income community members. This project further enriches the community by providing environmental education, encouraging recycling and the reuse of solid wastes, promoting healthier eating habits and increasing and improving human relations through community-building activities (van Veenhuizen and Danso 2007).

Ultimately, Havana is closer to achieving and maintaining food security and food sovereignty than many other cities due to its innovation and tenacity in pursuing urban agriculture at every level of the community. Other collateral benefits from Cubans' practice of urban agriculture are the near elimination of local refuse dumps for household waste, continuous technology innovation and the emergence of Cuba as a world leader in pest management through the "production and use of entomopathogens" (Prain 2006: 310).

Lessons to Learn from the Case Studies

After analysing these two case studies, the main point is that urban agriculture requires investment and commitment from all parties in order to succeed. This includes the government (federal, state or municipal), communities, grassroots organisations, private entities and NGOs. Penang, and Malaysia as a whole, is still lacking in this aspect. For example, in terms of financial investment, Taiwan invested approximately 17.3% in agricultural biotechnology of its total investments in agricultural research (US$24.92 million of a total of US$143.59 million) in 2018. In comparison, Malaysia's investment in agricultural biotechnology is only approximately 2.1% of its total agricultural research budget (US$0.81 million out of a total of US$37.38 million) (Tyagi et al. 2018: 20–19). With proper investment in technological development and increased funding, especially for grassroots organisations and community projects, Malaysia and Penang could be set to become a regional leader in innovative urban agriculture and a model for securing food sovereignty.

As can be seen in the case of Pingtung and of Havana, collaboration and cooperation between stakeholders are indispensable for the success of urban agriculture projects. PABP's use of a single window service delivery and Havana's government-community collaboration are examples of successes worth emulating. To complement technological development, we must promote innovation in the agricultural sector to be more globally competitive. Examples of achievements in our case studies are PABP's position as a top global propagator of fish species, while Cuba is a leader in biological control methods. On those grounds, before we can truly achieve food security and food sovereignty locally, we must first, through new and innovative measures, reduce our reliance on outsourcing.

Application in the Context of Penang and Malaysia

Determining potential sites for urban agriculture in Penang and Malaysia should be based on the three main categories of urban farming:

1) community-based urban agriculture;
2) institution-based urban agriculture; and
3) high-technology commercial urban agriculture.

Examples of sites include: 1) parks, peri-urban areas or playgrounds in residential areas; 2) schools, prisons, community centres, hospitals with open spaces or bare rooftops; and 3) warehouses or shipping containers (Haliza 2018). For instance, the use of prison space for urban farming has not only benefited inmates by providing them "with satisfying work, marketable skills and fresh food", it has also been linked to a lower recidivism rate, and excess produce is donated to charities and those in need (Barclay 2014). Given that prison populations also comprise a large portion of Covid-19 clusters, both in Malaysia and globally, an increased self-sufficiency of food supplies would be yet another advantage.

For commercial urban agriculture, the sites must be able to cater to the wide variety of infrastructure needed for different types of high-technology farming such as controlled-environment farming, integrated vertical farming and smart greenhouses. With the integration of high-technology techniques in urban agriculture, access to land will no longer be the deciding factor in establishing an urban farm in the near future. One suggestion for possible sites for high-tech integrated vertical farming could be underutilised commercial or industrial buildings. As property and land development in Penang has rapidly evolved with more and more office blocks, shopping complexes and high-rise apartments being built, many older properties in Penang have suffered from a lack of maintenance, mainly due to low occupancy rates. These underutilised properties could be given a new lease of life with urban farming programmes that follow clear guidelines and regulations formulated to ensure that the issues of health, urban ecological environments and indoor safety are taken into consideration.

The government should encourage and develop more household-level urban farming programmes such as Program Pertanian Bandar (Urban Farming Programme) that was launched by the Ministry of Agriculture and Agro-based Industries in Putrajaya in 2014. Through this programme, the ministry provided basic information sessions on agriculture and technical advice services as well as information about crops, materials and input on how to begin a farming project (Haliza 2018). These programmes can be bolstered by the sale of starter kits and farm modules created by existing "agro-preneurs" and urban farmers to introduce and ease laypeople into starting their own urban farms at the household or community levels. This has already begun with the recently established company CityFarm selling compact hydroponic urban farming kits for apartment balconies and windows (Zuliantie 2016).

Locally, there is a need for the revitalisation of Relau Agriculture Station (now known as Relau Agrotourism Park) into a one-stop centre that can showcase and provide resources on urban farming (Kam 2020). The station can also be upgraded to carry out more agricultural and biotechnology research while allowing visitors to register for recreation and education programmes. Done correctly, the station can emulate the successes of PABP, albeit on a smaller scale.

Government and research support is also necessary for existing agrotechnology hubs such as Perda Ventures Incorporated to develop new techniques for urban farming. Sunway Group's latest project, Sunway FutureX, which aims to create a "skills-building hub for urban farming professionals" is another opportunity for the government to support research and development of urban agriculture (Cheema 2020).

Biotechnology research needs to be done, with "genomics, tissue culture technology, livestock farming, animal health and nutrition, biopesticides and biofertilisers, extraction of metabolites and nutritionally enhanced agriculture products" being identified as key research foci in Malaysia (Tyagi et al. 2018: 19). By advancing and consolidating a technology- and knowledge-intensive model in agriculture and sustainability sectors, the country's global competitiveness will be further increased.

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